Analysis of the Barriers to Wide Spread Adoption of Electric Vehicles in Shenzhen China

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Abstract: China planned to promote the large-scale adoption of Electric Vehicles (EVs) in the thirteenth five-year plan, however, this target faces many obstacles. This paper was trying to analyze the main barriers to widespread adoption of EVs through a survey in Shenzhen, which has the biggest EVs market share in China major cities. Based on previous scholarly findings, this paper conducted a new study which collected 406 approved questionnaires among 500 participants. The study proposed five hypotheses to examine the main barriers to widespread adoption of EVs. The analysis conducted by statistical methods: two-way frequency tables, chi-square test, and factor analysis. The results noted that perception of EVs advantages and recharging access remained the main barriers to EVs large-scale penetration. Besides, financial incentives drop would not cause a significant decline of EVs adoption in future. The study proposed suggestions to carmaker and government policy administrator on the analysis and discussion.

keyword: EVs; PHEVs; Penetration; Adoption; Barriers; Preference; Willingness; Attitude

1. Introduction

There are four types classify on EVs according to their fuel technologies: plug-in hybrid electric vehicles (PHEVs), extended-range battery electric vehicles (E-REVs), battery electric vehicles (BEVs) and hybrid electric vehicles (HEVs)[1]. Relating to EVs, ICEVs represent abbreviation of traditional internal combustion engine vehicles.

It has proposed that EVs is a good solution for the problem of transport GHG (greenhouse gas) and air pollutant emissions[2]. Most of the developed countries have been carrying out variety public policies and financial incentives for EVs large-scale adoption[11]. In the existing literature, many researchers focus on the topics of consumers' choice decision, recharging station placement and economic analysis of EVs promotion[2-10].

Despite there is a broad consensus on EVs large-scale adoption in the world, however, the benefits and realize finally falls on the consumers' willingness to accept the new technology[2]. According to a survey conducted in 2008, 69%of US consumers have little or no familiarity with PHEVs technology[3]. A later research also shows that people could not accept premiums for EVs Adoption[4]. To fully understand the consumer's choice behavior, another survey study conducted in the major United States (U.S.) big cities, which examined consumer's willingness and attitudes toward plug-in electric cars[5]. The result reveals that overall ratio of desired to buy or lease electric vehicles is small. However, the interest in PHEVs technology is greater than EVs[5]. Further, it is considering that range anxiety is a barrier to EVs spread adoption[2-10], several researchers infer that people have little willingness to choose EVs because of range anxiety and inconvenient recharging access[2-10].

Many previous kinds of literature analyzed consumer's opinion, desire and attitude toward EVs[1,6-10], which also examines some other society or psychology influencing on EVs spread adoption[7]. Besides, the previous study also suggests that EVs spread adoption influenced by public policies, financial incentives, and energy price as well[9,11]. Also, many previous studies aimed to investigate consumers' pro-environmental lifestyle, technology oriented lifestyle and openness to change[6,7], Another survey research conducted to explore consumers' environment awareness,

technology views, experiences and interests on EVs[7,8]. As we know, China is the second biggest market for carmakers in the world, however, no much studies on the behavior of Chinese consumers for electric cars. This study will be as an extending of previous research according to a new survey in Shenzhen of China.

China has become as the largest cars producer and the second largest consumption market of passenger vehicles in the world since 2009. The demographic data published by the government shows that EVs market share of China has exceeded the United States, the production and sales data issued from website news on August thirteenth of 2015[10]. Meanwhile, it is well-known that Shenzhen is the most innovative city and EVs demonstration town in China, which has significant contribution in innovation and the openness of the global market. It is valuable to study EVs adoption status and consumers buying behavior on EVs in Shenzhen. Besides, the previous research shows there are significant differences exist in decision-making and values between Western people and Chinese[12]. Some other results of research indicates that Netherlands consumers pay high attention to value and safety[13]. The French favor design, style, and fashion in car advertisement[13]. German and Italian consumers have a similar characteristic with French, they prefer fast, advanced technology and smart and multifunction vehicles[13]. In contrast, American consider cars as a symbol of status and hunt big and powerful vehicles[13]. How about Chinese consumptions behavior toward EVs? This study did a survey among Shenzen residents, the significant contribution of which is that participants have at least three to ten years of driving experiences and they are acutely aware of cars and urban transport conditions. Also, at least one-third of respondent have EVs driving experience. The survey will focus on the participant's preference for EVs, willingness, and attitudes toward EVs.

For the remainder, Section 2 describes material and methods, Section 3 states data quality controls, Section 4 presents the main results of this survey and make some discussion on it, Section 5 is conclusions of this paper.

2. Material and Methods

This paper is aim to examine Chinese EVs consumer consumption behaviors through a questionnaire survey in Shenzhen. As the literature reviewed in the introduction, the previous researches has revealed some barriers to wide-spread adoption of EVs[1-10]. Besides, the earlier findings shows that cross-culture differences influence consumers' purchasing intention toward vehicles[6,7,8]. Another Chinese research also reveals that product-brand affects consumer's buying intention to vehicles significantly other than company-brand[8]. Hence, this paper proposed five hypothesis and tried to confirm it by analysis.

hypotheses # 1: The participants showed more preference for EVs with local brand and elegant style.
hypotheses# 2: The participants' attitude toward EVs depends on the perception to EVs technology advantages comparing with ICEVs.
hypotheses# 3: The participants buying willingness depends on EVs recharging access.
hypotheses# 4: EVs high price is critical barrier to influence the participants' purchasing willingness.
hypotheses# 5: Consumers' purchasing willingness will decrease with financial subsidies drop significantly.

To examine these hypotheses, the survey conducted among residents in Shenzhen which effort to develop new energy products such as EVs, PHEVs, and solar power products. BYD-a well-known EVs producer in China, which have diversity types of EVs selling in global market. BYD EVs products covering electric passenger car, electric bus and electrical engineering vehicles such as BYD K9, electronic Van T5 and electric truck T7. Besides, total miles of EVs running in Shenzhen already achieved 150 million kilometers[15]. There were at least one thousand electric taxis, and three thousand electric buses are operating in Shenzhen during the past three years[15]. Hence, Shenzhen residents have a shorter distance to close EVs. Although Shenzhen owns a population of $1,178,900$, the registered population was only$3,549,900$ from Shenzhen government published data. Most of others residents come from different provinces of China. Thus, the study chooses Shenzhen residents

as a research target which was good representatives of regular status instead of a particular case.

The study collected survey data among Shenzhen residents including EVs experienced drivers, EVs consumers or residents who were familiar with EVs. This research recruited the participants and expressed the study value and contribution to them by social-medium. Each participant can received 100RMB bonus as nominal compensation. A total of 500 questionnaires were distributed in this study. Finally, 406 usable cases with a response rate of 81.2% were collected.

The study used statistics methods including Two-way frequency tables, chi-square, Fisher test and factor analysis to examine the differences between causes and consumers willingness. In the chi-square test and fisher-test, the study used standard 5 percent or 0.05 cut-off for defining the significant difference. An associated p-value less than 0.05 showed there was the significant difference[7]. Further, the study also conducted a factor analysis to explore the relationship between causes and dependent variables by IBM SPSS software. The following sections presented the survey and statistics result based on these methods.

3. Data and Control

We abandoned some questionnaires that participants did not response in the survey. Besides, a preliminary test showed the questionnaire need at least ten minutes with the fastest speed to complete. The mean value of time spent was seventeen minutes, and four questionnaires were removed because time spent less than three minutes. There were fifty-two items composed of the survey which was normal multi-choice style (e.g., not at all, a little, somewhat, a lot). In order to do statistical analysis specifically, the questionnaire answer choice were scored depending on the degree ("not at all": scored 1 , "a little ": scored 2 , "somewhat": scored 3 , "a lot":scored 4).

The survey were categorized into four sections:

I.**Basic Information**: age, gender, income, education, occupation, driving experiences, home ownership and travel pattern.

II. Preference for EVs: EVs characteristics pursued by consumers.

III. Purchasing willingness and attitude toward EVs: present consumer's real willingness and attitude toward EVs

IV. Public policy and financial incentives: present the main public policy and financial incentives established in China currently.

4. results

4.1. Sample Description and Basic information

The research target was aim to examine the consumers' buying willingness, attitudes toward EVs, and to reveal the main barriers to widespread adoption of EVs in China. Besides, the study results could be as a reference for public policy maker in some other cities in China.

The survey collected 406 usable questionnaires. Males respondents accounted for 76.4% of the whole population (n=310), 23.6% of participants were females (n=96). Respondents age mainly concentrated between 22 to 35 years old. The percentage accounted for 53.4% of the whole population. Over 35 years old group accounted for 45.5% and ranked the second position. Only 5 participants less than 22 years old.

With the occupation of the respondents, most of them were office workers which occupied 40.4% of the total participants. Private firms owners ranked in second, the Senior manager's group following. Besides, 9.4% of members were research and design engineers. The rest were students in the university. The overall sample population represents EVs potential consumers. The demographic distribution showed in Table 1

Table 1. Sample Description

Gender	**Male**	76.40%
	Female	23.60%
Age	**18-22 Years old**	1.20%
	22-35 Years old	53.40%
	Over 35 Years old	45.30%
Occupation	**Office worker**	40.40%
	Senior Manager	21.20%
	Private Firm Owner	24.40%
	University Student	4.70%
	Research &Design Engineer	9.40%
Drive Experience	**Less than 3 years**	31.50%
	Between 3-5 years	15.00%
	Between 5-8years	19.70%
	Over 8 years	33.70%
Annual Income	**Less than $8000**	18.00%
	$8000-15000	33.50%
	$15000-50000	35.70%
	Over $50000	12.80%
Home Ownership	**Owned Apartment**	54.20%
	Rent Room	30.80%
	Dormitory	11.30%
	Others	3.70%
Travel Pattern	**Owned Private Car**	55.70%
	Company Scheduled Bus	6.20%
	Public Bus or Metro	26.60%
	Others	11.60%

Besides, the survey summarized the respondents' driving experiences, income level, home ownership and trip pattern. Most survey respondents owned private cars and apartments. By annual revenues, more than 50% survey respondents placed at the middle or even the middle high-level in China. Also, one-third of survey respondents had driving experiences with EVs or PHEVs.

4.2. The Preference for EVs

Overall, according to the basic statistical analysis with Figure 1, 59.3% (n=242) members showed more preferred to Chinese brand, 17.9%(n=73) participants preferred to Germany EVs brand. Also, the following was 15.9%(n=65) respondents aspired to United States EVs brand, and the rest was 6.9%(n=28) participants chose Japan EVs brand. Besides, Fisher's test results (p-value=0.007) revealed there were significant differences between gender and consumers' preference for EVs brand. Males expressed more interest in Chinese EVs brand while females implied preferred to Germany EVs brand. The further Fisher's test (p-value=0.004) revealed that 68.3% office worker and 65.8% Research and Design (R&D) engineers preferred to chose Chinese EVs brand. Private firm owner and senior manager had similarly prefer to EVs brand of China, and the part accounted for 57.6% and 47.6% respectively. For car style, males showed more prefer to sport utility vehicle (SUV) PHEVs than females, and females implied more interest in hatchback car than men.

Table 2. Fisher Test Between Factors and Brand Preference

Factors	Pearson Chi-Square Sig.	Fisher's Exact Test Sig.
Occupation	0.004	0.004
Gender	0.013	0.007
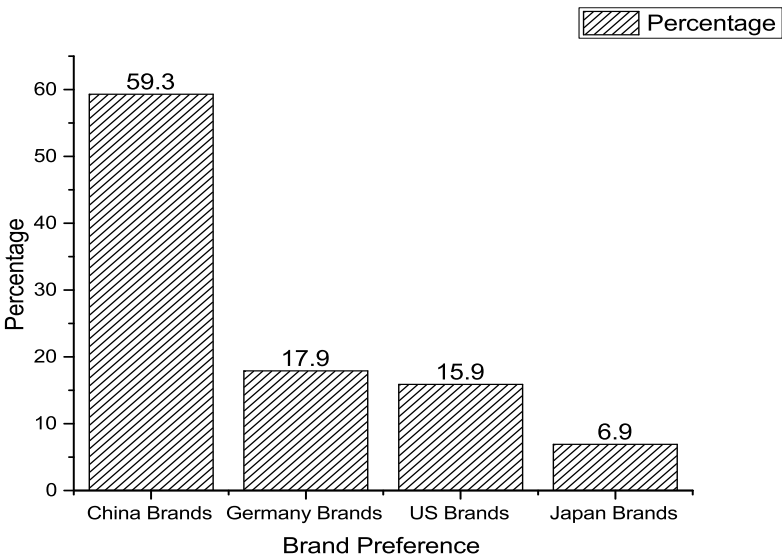
Figure 1. Brand Preference Analysis Demographic

As showed in Figure 2, 55.7% of the participants had private cars, 68.4% (n=279) surveyed respondents had EVs driving experiences. The Fisher tests (p-value=0.029) showed little differences between gender and EVs experience, and males showed more EVs experiences than females. Besides, no significant differences between driving experience and factors such as age (p-value=0.654), income level (p-value=0.318), occupation (p-value=0.135), home ownership (p-value=0.214) and

region (p-value=0.463). However, there are significant differences between driving experience and perception of EVs (p-value=0.006).

Table 3. Fisher Test Between Variables and EVs Driving Experiences

Factors	Pearson Chi-Square Sig.	Fisher's Exact Test Sig.
Gender	0.039	0.029
Perception of EVs	0.008	0.006
Age	0.582	0.643
Income level	0.321	0.317
Occupation	0.132	0.135
Home Ownership	0.224	0.214
Origion	0.07	0.07
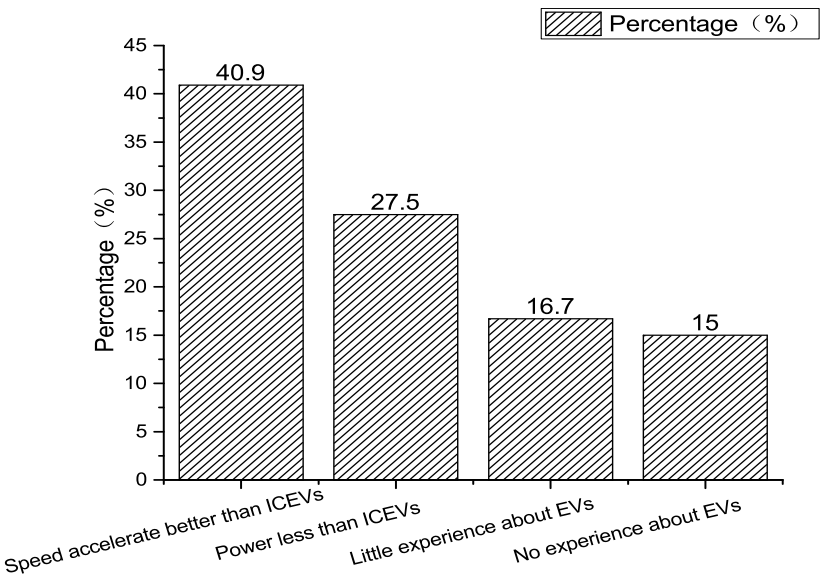
Figure 2. EVs Driving Experiences

Also, the study analyzed the primary factors by SPSS, and the results showed by Table 4, Table 5, Figure 3 and Table 6. The research inferred the common items presented in Table 6. It offered common factors which absolute value greater than 0.5 and sorted as below:

I.**Environment awareness and energy security**: Respondents have high awareness of environment protection.

II.**Private car demand**: Real consumers desire to buy car for transport need

III.**EVs Operation cost**: Consumer's travel cost monthly.

IV.**EVs Characteristics**: Low operation cost, zero tailpipe emissions, symbol of status, etc..

V.**Daily travel mileage**: Consumer's travel mileage every day.

Besides, to examine the associations between consumers' preference and factors specifically, the study conducted a regression by SPSS (Statistical Products and Service Solutions). The regression residual distribution test presented as Figure 3, which showed the regression equation was valid.

Table 4. Factor Analysis Test of EVs Purchasing Preference

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.684
Bartlett's Test of Sphericity	Approx. Chi-Square	578.781
	df	105
	Sig.	.000

Table 5. Total Variance of Principal Components

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.589	17.262	17.262	2.589	17.262	17.262	1.912	12.748	12.748
2	1.580	10.533	27.795	1.580	10.533	27.795	1.677	11.183	23.930
3	1.292	8.611	36.406	1.292	8.611	36.406	1.439	9.593	33.523
4	1.119	7.463	43.869	1.119	7.463	43.869	1.384	9.228	42.751
5	1.020	6.803	50.672	1.020	6.803	50.672	1.188	7.921	50.672
6	.967	6.447	57.119						
7	.881	5.874	62.993						
8	.862	5.747	68.739						
9	.851	5.675	74.414						
10	.823	5.490	79.904						
11	.745	4.967	84.870						
12	.657	4.379	89.250						
13	.601	4.008	93.258						
14	.537	3.581	96.839						
15	.474	3.161	100.000						

Table 6. Rotated Components Matrix

	Component				
	1	2	3	4	5
Q9	.534	.006	.122	.037	.379
Q10	-.127	.398	.047	.467	.100
Q11	.169	.179	.555	-.155	.287
Q12	.053	-.082	-.612	.228	.416
Q13	.022	.020	.083	.017	-.790
Q14	.003	-.058	.720	.210	-.091
Q15	-.154	-.192	-.119	.610	.073
Q16	.703	.119	.030	-.027	-.021
Q17	.751	.106	.063	.041	-.032
Q18	.294	.579	.103	.082	.232
Q19	.536	.240	-.104	-.016	-.038
Q20	.139	.151	.201	.594	-.011
Q21	.137	.661	-.078	-.142	-.167
Q22	.162	.748	.118	.090	-.025
Q23	.244	-.039	-.335	.531	-.237
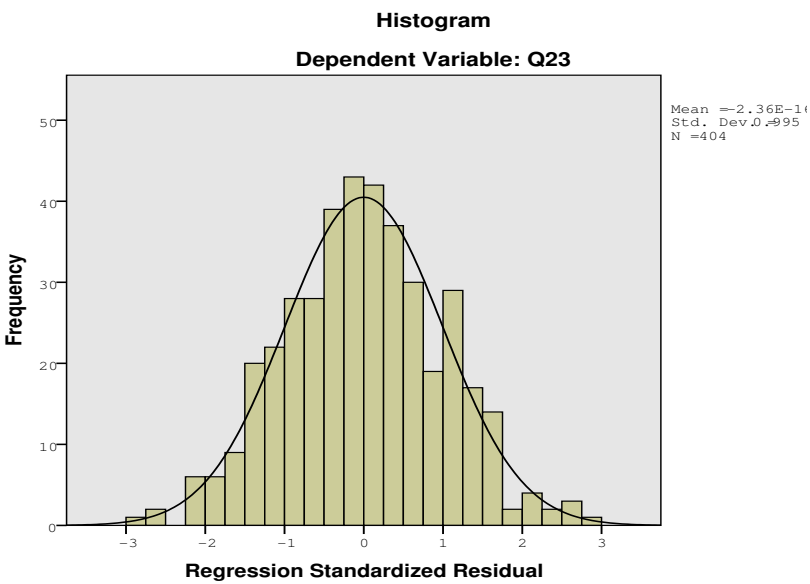
Figure 3. Regression Residual Distribution

Table 7. Regression Coefficients

Model	Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.	Collinearity Statistics Tolerance	VIF
(Constant)	2.364	.030		77.536	.000		
factor 1	.212	.031	.244	6.958	.000	1.000	1.000
factor 3	-.291	.031	-.335	-9.549	.000	1.000	1.000
factor 4	.462	.031	.531	15.147	.000	1.000	1.000
factor 5	-.206	.031	-.237	-6.752	.000	1.000	1.000

The regression performed by SPSS. Thus the results showed by Table 7 and explained by the equation: Preferences for EVs $=2.364+0.212\times$ Awareness of environment$-0.291\times$ EVs operation cost$+0.462\times$ Private car demand$+0.061\times$ travel mileage of consumer.

4.3. Consumers Purchasing Willingness and Attitude

About purchasing willingness to EVs, the study examined the first-time car buyers response. The Figure 4 showed that 41.7% (n=170) respondents wished to buy EVs considering recharging station convenient, 36% (n=147) participants expressed strong interests in EVs because of advantages. Besides, it examined the buyers' willingness to EVs at the second time, which revealed that 54.9% (n=224) members had more willingness than before, 31.6% (n=129) respondents had the desire to buy EVs as the second car. Thus, there was 8.8% (n=129) members' willingness increment comparing to the first-time. However, further analysis showed significant differences between occupation (p-value=0.025), income level (p-value=0.021) and buying desire. It revealed that office worker had more desire to buy EVs than others, middle-income level respondents showed same desire as well. While one respondent had a private car and driving experiences, he or she had greater chance to buy EVs than others.
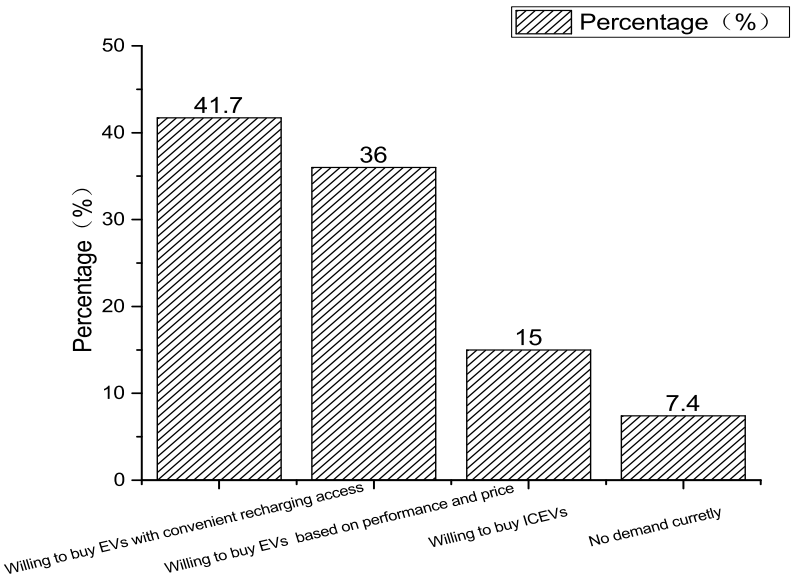
Figure 4. Willingness of The First time Car Buyer
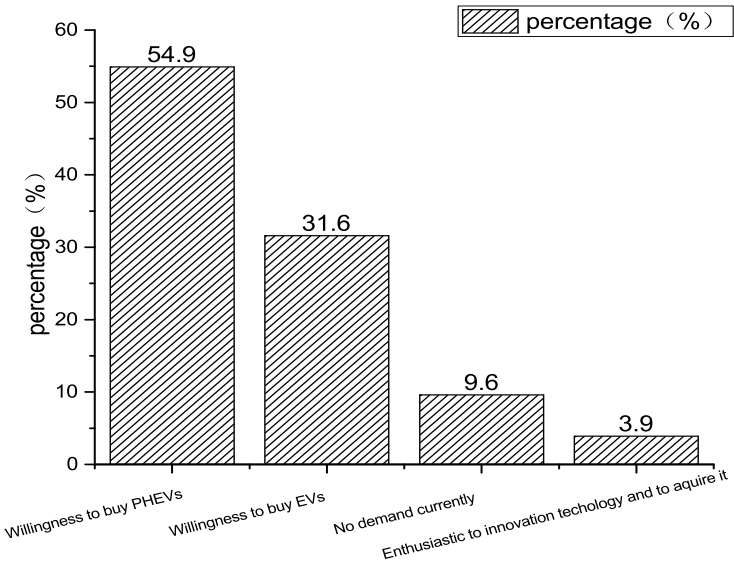
Figure 5. Willingness of The Second time Car Buyer
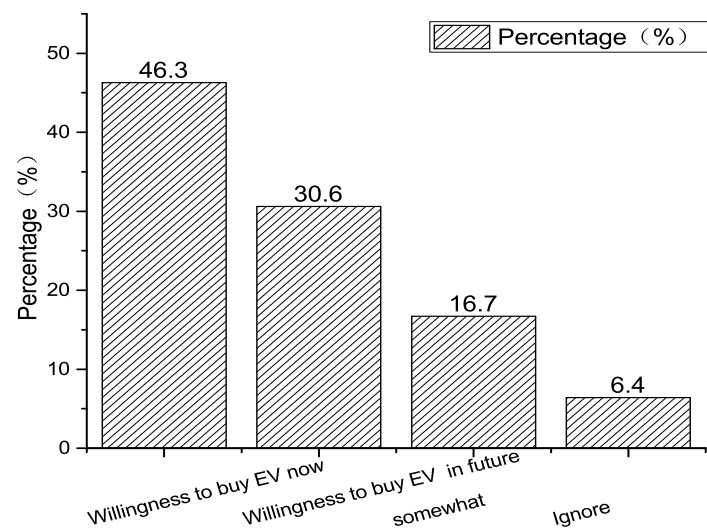
Figure 6. Willingness to buy EVs considering national energy safety

Also, the research inferred that social circle, public policy, and energy security concern influenced the consumers' willingness, and which showed by Figure 6 and Table 8. The analysis revealed that 29.9%(n=122) members' desire changed based on friend's opinion, 27.9% respondents' willingness alternated because of family member's opinion. Further, considering energy security concern, 46.3% (n=189) members expressed the strong desire to buy EVs now, 30.6%(n=125) members had the desire to buy EVs in future, 16.7%(n=68) members expressed somewhat want to buy EVs. Overall, the total percentage of consumers' willingness increased to 93.6%(n=382).

Table 8. Association Test for Willingness to Buy EVs

Factors	Pearson Chi-Square Sig.	Fisher's Exact Test Sig.
Occupation	0.043	0.025
Income level	0.014	0.025
Society network members	0	0.001
ICVs technology improve	0	0
Attitude toward Evs	0.001	0.001

By fuel saving technology grow, or fossil fuel price drop significantly in future, the respondents still had the strong desire to buy EVs. The percentage occupied 75.8% and 80.7% respectively, and presented in Figure 8. When the fuel price rises, the intent to buy EVs will increase more significantly.
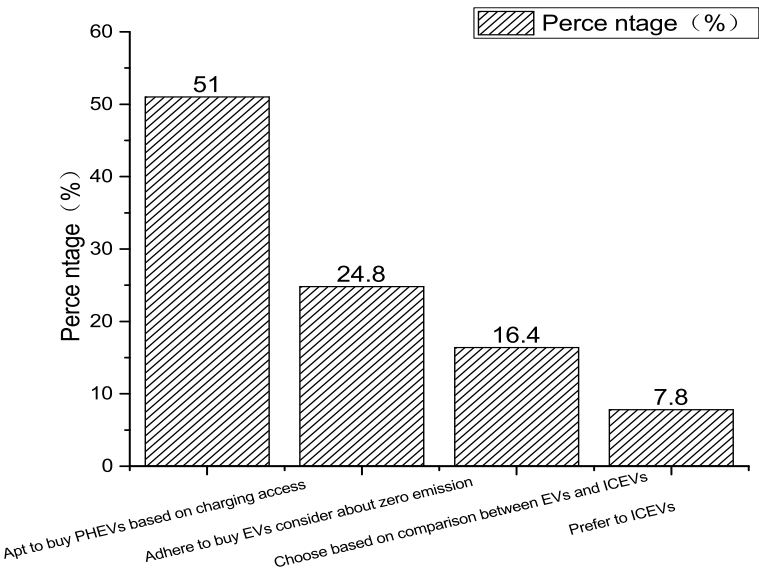
Figure 7. Purchasing Willingness Based on ICEVs Technology Improvement
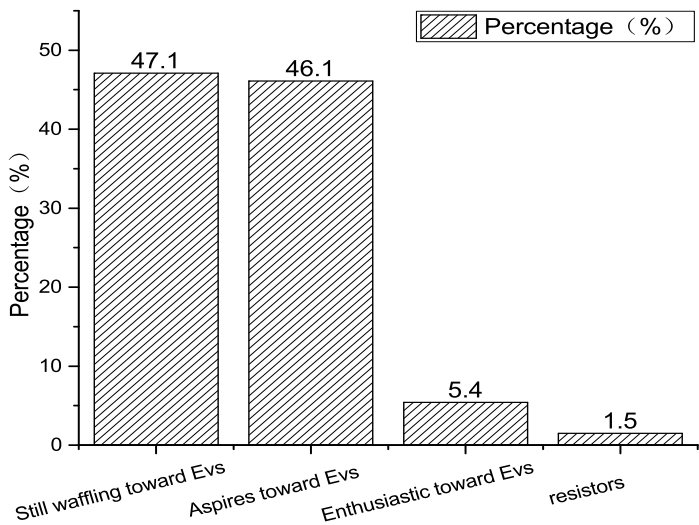
Figure 8. The Participants attitudes toward EVs

Many experts suggested that EVs would be a good choice for environment conservation and energy security. However, consumers' attitudes were critical to EVs large-scale penetration. The study inferred by Figure 9 that 47.1%(n=192) members kept undecided toward EVs, and 46.1%(n=188) members showed aspires toward EVs. Besides, 5.4%(n=22) members were enthusiastic to EVs, and Only 1.5% respondents were against EVs. Besides, Fisher tests showed significant differences between participants attitudes and willingness as showed in Table 8 (p=value=0.001), which means the more positive attitudes toward EVs, the stronger desire to buy EVs.

On the insights of large-scale penetration, the study showed that most of the members (46.8%) held positive opinion toward EVs by Figure 9. Moreover, 38.2% members believed that EVs would be mainstream in future.
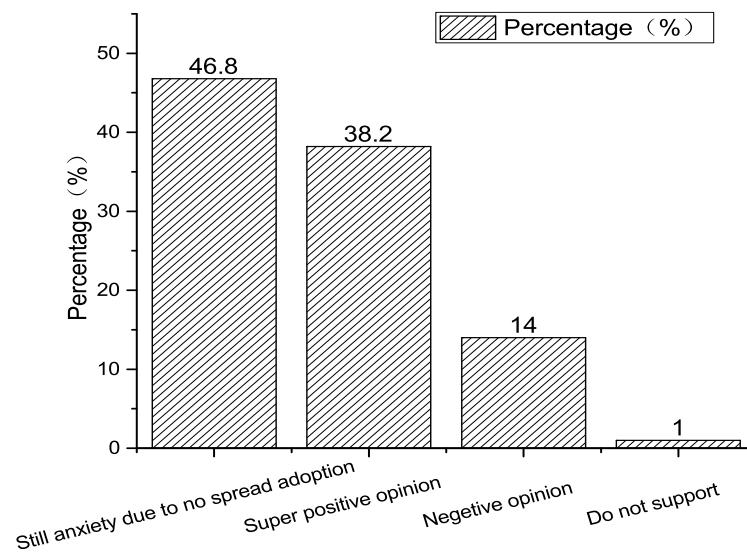
Figure 9. The Participants insights of spread adoption of EVs in future

Besides, the study conducted the factor analyze to explore the main elements in this section by SPSS. The results showed by Table 9, Table 10 and Table 11:

Table 9. KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.771
Bartlett's Test of Sphericity	Approx. Chi-Square	1420.388
	df	153
	Sig.	.000

Table 10. Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.834	21.297	21.297	3.834	21.297	21.297	2.603	14.463	14.463
2	1.863	10.348	31.645	1.863	10.348	31.645	2.054	11.410	25.873
3	1.498	8.323	39.968	1.498	8.323	39.968	1.813	10.071	35.944
4	1.089	6.048	46.016	1.089	6.048	46.016	1.543	8.575	44.519
5	1.035	5.749	51.765	1.035	5.749	51.765	1.304	7.246	51.765
6	.999	5.550	57.315						
7	.948	5.269	62.585						
8	.851	4.728	67.312						
9	.810	4.502	71.814						
10	.742	4.122	75.937						
11	.691	3.839	79.776						
12	.660	3.668	83.444						
13	.647	3.596	87.040						
14	.588	3.268	90.308						
15	.549	3.052	93.360						
16	.530	2.943	96.303						
17	.449	2.492	98.795						
18	.217	1.205	100.000						

Table 11. Rotated Component Matrixa

	Component				
	1	2	3	4	5
Q24	.628				
Q25			.935		
Q26			.926		
Q27					.788
Q28					
Q29					
Q30					
Q31	.554				
Q32	.526				
Q33		.532			
Q34		.678			
Q35		.636			
Q36					
Q37	.603				
Q38				.815	
Q39				.804	
Q40					
Q41	.680				

KMO (Kaiser-Meyer-Olkin) test of factor analysis carried out by SPSS and presented in Table 9, while the KMO value greater than 0.5, which implied the original data was suitable for factor analysis. The total variances of all components explained by the table 10. The study extracted the common elements and divided into five groups by SPSS in Table 11:

I.**Perception of EVs** : Feeling or sense about EVs based on experiences and knowledge

II.**EVs competitiveness**: EVs exceptional performance comparing with ICEVs or other fuel vehicles

III.**EVs prices**: EVs market price.

IV.**EVs full-charge range**: Duration mileage of EVs with fully battery charge.

V.**EVs operation cost**: Operation cost within life cycle period.

Besides, the study carried regression by SPSS based on the common factors. The results showed by Figure 10, Figure 11, Table 12 and Table 13.

Thus, The attitude toward EVs = 2.446+0.390×Perception of EVs+0.127×EVs competitiveness+0.073× EVs full-charge range.

Further, Buying willingness of EVs = 1.944+0.259× Perception of EVs+0.670× EVs competitiveness+0.182× EVs prices−0.182× EVs operation cost.
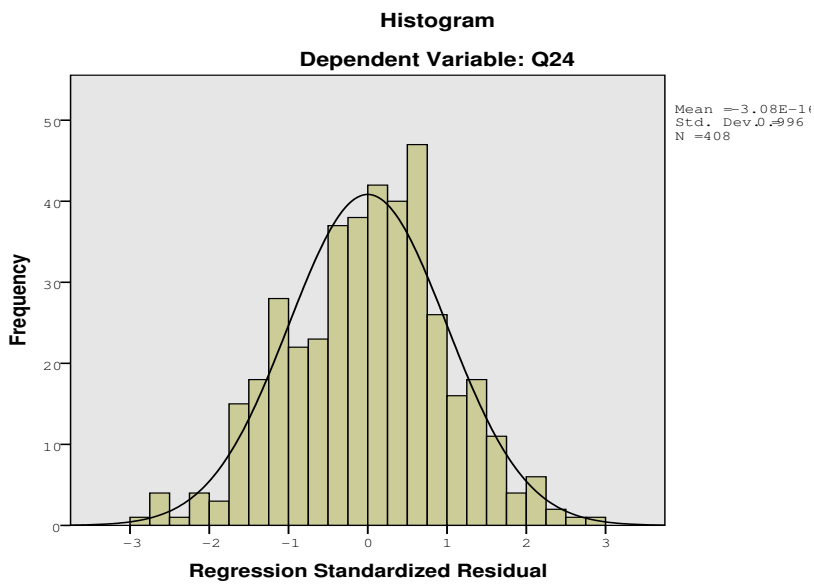
Figure 10. The regression standard residual of attitude toward EVs

Table 12. Regression Coefficients

| Model | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | Collinearity Statistics | |
	B	Std. Error	Beta			Tolerance	VIF
(Constant)	2.446	.023		106.930	.000		
factor score 1	.390	.023	.628	17.011	.000	1.000	1.000
factor score 2	.127	.023	.205	5.558	.000	1.000	1.000
factor score 4	.073	.023	.118	3.197	.001	1.000	1.000

Dependent Variable: Attitudes toward EVs
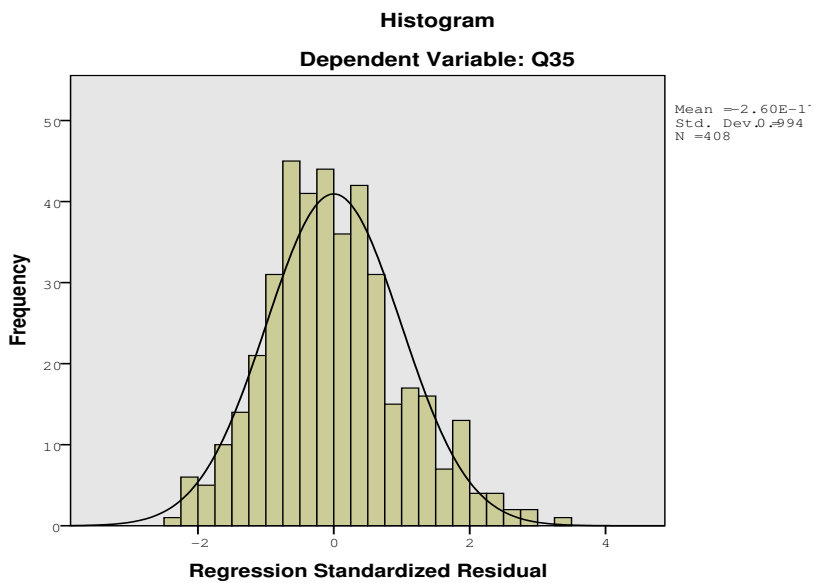
Figure 11. The regression standard residual of purchasing willingness to EVs

Table 13. Regression Coefficients

Model	Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.	Collinearity Statistics Tolerance	VIF
(Constant)	1.944	.036		53.732	.000		
factor 1	.259	.036	.245	7.140	.000	1.000	1.000
factor 2	.670	.036	.636	18.487	.000	1.000	1.000
factor 3	.182	.036	.172	5.016	.000	1.000	1.000
factor 5	-.182	.036	-.173	-5.023	.000	1.000	1.000

a. Dependent Variable: Purchasing willingness

4.4. Public Policy and Price Incentive

Trying to encourage consumers spread adopt EVs, the government settled series of public policy and financial subsidies to stimulate EVs large-scale penetration. China government-supported grant presented in Table 14 and Table 15. This study made a comparison about buying willingness to EVs between financial subsidies support at current and drop in future by Figure 12, Figure 13 and Figure 14. The study showed that 65.7% of members had the desire to buy EVs based on financial subsidies, and 63.9% members had the desire to buy PHEVs based on the grant as well. Besides, if the government cancel or reduce the subsidies by 2020, the buying desire would drop but not significantly. It showed by Figure 14 there were 45.6% respondents still consider buying EVs because of technology trend and market share expectation. Also, 22.3% members insisted on buying EVs based on their attitudes toward EVs. Further, comparing with consumers' willingness status, a Chinese government published data showed that EVs yield (Figure 15) increased robustly in the past three years.

Table 14. EVs price subsides in China

Vehicle Type	Range with Pure Electricity Model			
	80Km$\leqslant$R$\leq$150Km	150Km $\leqslant$R$\leqslant$250Km	R$\geq$250Km	R$\geq$50Km
PEVs(2013) Unit: Ones	$5,319.07	$7,598.67	$9,118.40	N
PEVs(2014) Unit: Ones	$5,319.07	$7,598.67	$9,118.40	N
PHEVs(2013) Unit:Ones				$5,319.07
PHEVs(2014) Unit:Ones				$5,319.07

Table 15. EVs price subsides in Shenzhen

Vehicle Type	Range with Pure Electricity Model			
	80Km$\leqslant$R$\leq$150Km	150Km $\leqslant$R$\leqslant$250Km	R$\geq$250Km	R$\geq$50Km
PEVs(2013) Unit: Ones	$5,319.07	$7,598.67	$9,118.40	N
PEVs(2014) Unit: Ones	$5,319.07	$7,598.67	$9,118.40	N
PHEVs(2013) Unit:Ones				$5,319.07
PHEVs(2014) Unit:Ones				$5,319.07

Figure 12. PHEVs purchasing Willingness Based on Incentives
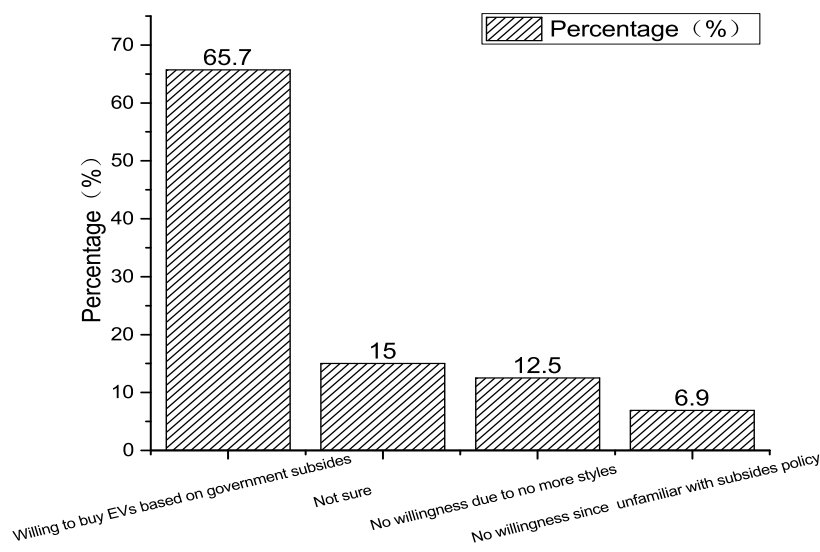
Figure 13. EVs Purchasing Willingness Based on Inventives
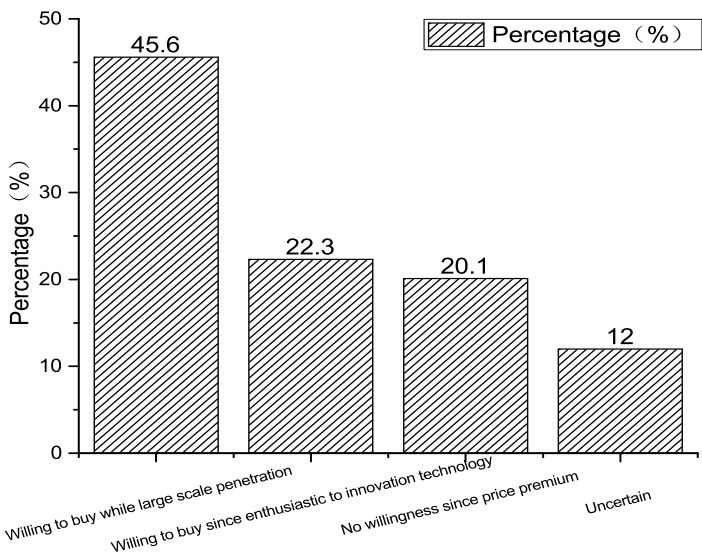
Figure 14. Willingness Changed When Subsides Canceled by 2020
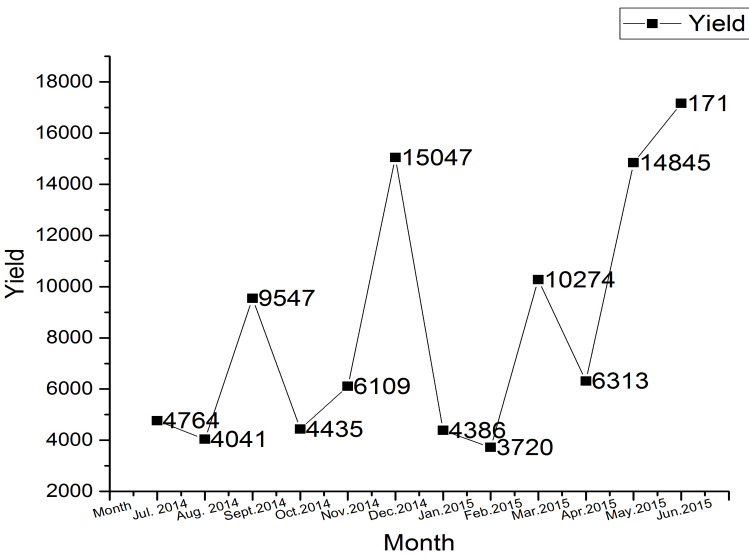
Figure 15. Passengers EVs Yield Past Years

About EVs price premium, this study examined the Shenzhen residents' acceptance degree of EVs price. The results showed that 50% (n=204) of respondents' expectation range concentrated between $13071 and $24509. Also, 37.3% (n=152) of respondents price expectation range concentrated between $24509 to $40849. Besides, 10.3% (n=42) of participants price expectation range concentrated between $40849 to $65359 and only 2.5% percent respondents could accept EVs price range upper $65359. With consumers acceptance of PHEVs prices, which had similarly statistical result with EVs. As it examined the EVs sales price in China market which showed the main products price range concentrated between $24509 and $40849.

Further, the study carried the factors analysis and regression by SPSS. The KMO test inferred the data was suitable for the factor analysis, the results presented in Table 16, Table 17, Table 18 and

Table 19:

Table 16. KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.818
Bartlett's Test of Sphericity	Approx. Chi-Square	839.176
	df	66
	Sig.	.000

Table 17. Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.321	27.672	27.672	3.321	27.672	27.672	2.767	23.059	23.059
2	1.402	11.687	39.359	1.402	11.687	39.359	1.915	15.961	39.020
3	1.094	9.117	48.476	1.094	9.117	48.476	1.135	9.456	48.476
4	.959	7.988	56.464						
5	.921	7.672	64.136						
6	.775	6.459	70.595						
7	.758	6.315	76.910						
8	.673	5.606	82.516						
9	.646	5.385	87.901						
10	.597	4.974	92.875						
11	.468	3.900	96.775						
12	.387	3.225	100.000						

Extraction Method: Principal Component Analysis.

Table 18. Rotated Component Matrix

	Component		
	1	2	3
Q42			.566
Q43		.643	
Q44			.663
Q45	.726		
Q46			.550
Q47	.742		
Q48	.733		
Q49	.660		
Q50	.677		
Q51		.545	
Q52		.620	
Q53		.757	

Table 19. Regression Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
(Constant)	1.429	.029		48.634	.000		
factor score 1	.225	.029	.296	7.634	.000	1.000	1.000
factor score 3	.417	.029	.550	14.174	.000	1.000	1.000

a. Dependent Variable: Purchasing willingness

The study extracted the Rotated components by SPSS and presented the common factors as below:

I.**Price subsidies**

II.**Public Policy Support**:Public policy supporting EVs operation conveniently.

III.**EVs Charge infrastructure placement**: Recharge station placement for EVs spread adoption.

Besides, the paper examined the relationship between common factors and the dependent variable by regression analysis. It inferred the regression equation like this:Buying willingness=1.429+0.025×public policy support+0.417× EVs charge infrastructure deployment.

5. Discussion

5.1. Preference for EVs

This study shows the results limited to support the hypotheses #1 by basic statistical analysis and Fisher test. However, the regression infers that consumer's real demand of private car fixes the preference for EVs[6]. Thus, it needs more research on potential users to evaluate their behaviors for EVs spread adoption[11]. Also, the results show the awareness of environmental and national energy security has a significant influence on consumer's preference[10,11,14,15,17]. It verifies the public policy driven and environmental knowledge education from the central and local government of China. Consistence with previous findings, an inverse proportional to the preference in regression analysis indicates that consumers also aim for lower using cost with EVs[11,21,26].

5.2. Consumers Purchasing Willingness and Attitude

Overall, the basic statistical analysis shows the participants have strong willingness to adopt EVs no matter first-time car buyer or non-fist time. They hold on optimistic about the prospective of EVs spread adoption[11,31]. However, most of them concern about convenient recharging access.   Although Chinese consumers express a strong will to buy EVs, to gain the main items influencing on consumers buying decision, it needs quantitative analysis. The study conducts the regression, which shows the perceptions, advantages and full-charge range of EVs fix consumers' attitudes toward EVs [7,19,20,23]. It support the hypotheses#2 and hypotheses #3. Besides, the perception item has maximum regression coefficient which means it influences the consumers' attitudes significantly[7,10].

Also, the regression reveals the factors determined consumers' buying willingness, which including perceptions, technology advantages[20,21], price and the cost of driving EVs [4,20,21]. Besides, the cost of driving EVs has an reversed relationship to the buying willingness. All other coefficients are positive, and EVs advantages account for a higher percentage. It infers that when customers have enough opportunity to experience EVs, consumer's perceptions of EVs will rise significantly, and buying willingness rise simultaneously[23,24]. Further, considering EVs performance, if EVs advantages better than ICEVs, which also increase the consumers desires significantly. As explained by regression analysis that EVs price is not primary factor influence on buying willingness. The result show differences with previous findings that price premium is critical barrier to EVs adoption[6,8,10].

5.3. Public Policy and Price Incentive

The study implies the public policy on EVs affects the consumers buying willingness, such as central government price subsidies and local government subsidies. Factor analysis indicates that state strategic support and charging point placement are crucial elements to EVs spread adoption[9,25,26,35]. It supports the hypotheses 3 and 4. However, the result rejects the assumption 5 and hold new point that subsidies drop in future will not influence the participants buying willingness significantly.

This paper inherits the general structure of the formal research, which results verify many

conclusions of the previous studies. Also, it replenishes the earlier studies' limit findings that survey respondents have no driving experiences of EVs[1,41]. The study's contribution is that most surveyed participants who have direct experiences in driving EVs, thus the situation of participants can reflect the real status of consumers behaviors accurately. Besides, the study proposes five types of hypotheses based on formal research findings and then verifies the assumptions by statistical analysis. Moreover, it is valuable for carmaker or government to identify the potential market trend and adjust the EVs industrial policies in China.

6. Conclusions

First, the study inferred that participants had high willingness to buy EVs, which limited support the hypothesis. However, considering EVs spread adoption, the uptake of EVs depends on more recharging access placement in community and working place rather than the public recharging station[11,27,28,40]. Second, the research showed that perception of EVs could be a significant barrier to EVs penetration[23,41]. Only consumers can get the EVs knowledge accurately and experience it regularly, the attitudes and willingness toward EVs will rising significantly. Besides, it revealed that EVs maker or government should do more promotion related to EVs technology advantages. Also, about recharging behavior, it suggested that majority of consumers prefer to home night charging and working place charging. Besides, the study revealed that EVs competitiveness, full-charge range, EVs price, operation cost and public policy were crucial factors to widespread of EVs, which supports the hypotheses well. However, it hold new point that financial incentives drop and EVs price premium were not barriers to EVs spread adoption, which verified by the analysis and limited supported the hypotheses.

There were several drawbacks existed in current research. First, the survey population was limit so the results may not be representative the overall status well. Second, future study should improve the survey questionnaire and ensure it is suitable for statistical analysis. Besides, the gender proportion should more balance than currently.

The study is valuable for EVs makers understanding about Chinese consumption behaviors. However, it was only a research focusing on region status at current. The future research is aim to do more comparison study between Shenzhen and some other China cities about EVs adoption. Besides, it is valuable to do more research across the cultural differences in global scope.

Acknowledgments

The authors gratefully acknowledge the work of China BYD company and their colleagues at EVs retailer management division for check the questionnaire used for the survey. We would also like to express our gratitude to the researchers in our lab who provide raw data check and review in the study.

In addition, this work is supported by the National Natural Science Foundation of China (Grant No. 71202022), the National Natural Science Foundation of China (Grant No. 71572090), the Natural Science Foundation of Guang Dong Province(Grant No.2015A030313824),the Natural Science Foundation of Guang Dong Province(Grant No.2014A030310404) and Shenzhen city Special Strategic Emerging Industry Development (Grant No.JCYJ20150331151358130)

Appendix

The questionnaire mentioned in our study is available in the URL of"http://www.lediaocha.com/pc/s/neutew "

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