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### INVESTIGATION AND ANALYSIS OF NEW ENERGY AUTOMOBILE INTRODUCED IN HOUSEHOLDS IN SHANGHAI

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**KEYWORDS:** new energy automobiles, introduction to households, purchase willingness

#### ABSTRACT

This paper selects the new energy automobiles sold in Shanghai market and listed in Catalog of Exemplary Manufactures and Products of New Energy Passenger Car as the object and investigates the issues related to introduction of them to households. This paper makes factor analysis through SPSS17.0 software and with the principal component analysis method and obtains five factors influencing the decision on buying new energy automobiles: after-sale service, purchase cost, energy consumption, perfection of supporting facility and policy influence. The results show that Shanghai residents have a high recognition degree for new energy automobiles as well as a certain degree of willingness for purchase. However, the density of after-sale service network of new energy automobiles is low, the price of repair and maintenance is too high, and there are concerns about the parking lots for new energy automobiles and the convenience of energy supplement. Therefore, the willingness of consumers to purchase new energy automobiles is not generally released.

#### INTRODUCTION

With the continuous development of China's automobile industry, the automobile inventory is increasing large. However, the storage of fossil energy and environmental pollution caused by automobile exhaust become the "stumbling block" for the development of traditional power automobiles [1]. In the economically developed Shanghai, demand of residents for automobiles is strong. In recent years, this demand has been increasing strong. Thus, it brings heavy burdens to oil resources and the environment, and becomes the bottleneck of sustainable development of traditional automobiles.

New energy automobile refers to the automobile in a new structure and with new technology and advanced technical principle produced by taking fuels for nonconventional vehicles as the power source (or fuels for conventional vehicles and new power unit) and combing the advanced technologies about power control and drive [2]. At present, the relatively matured new energy automobiles in the market can be classified into three categories, namely oil-electric automobile, pure electric automobile and fuel cell automobile [3].

Compared with traditional energy automobile, the current new energy automobiles still face certain problems in their use, and the recognition and acceptance of new energy automobiles remain to be studied. In April 2014, Shanghai municipal government issued the *Interim Approach to Encourage Purchase and Use of New Energy Automobiles in Shanghai*, in which the subsidy for pure electric passenger car is set to be RMB 40,000 /vehicle and the subsidy for plug-in hybrid vehicles (including extended range vehicle) is RMB 30,000 /vehicle. This *Interim Approach* is valid until December 31, 2015 [4]. Shanghai, as one of China's economically developed regions, enjoyed the preferential policies provided by the government firstly, but it is necessary to deeply study the actual situation of introduction to households and the existing bottleneck problem. Through questionnaires, this paper investigates the introduction of new energy automobiles to households, thereby intending to improve consumer acceptance for new energy automobiles and promote the widespread use of new energy automobiles.



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### QUESTIONNAIRE SURVEY

#### Features and Applicability of Questionnaire Survey

The questionnaire method, known as questionnaire survey method, is a survey method for an investigator to understand the situation and seek for the opinions of selected objects through a uniformly designed questionnaire. According to the similarities and differences in the forms of questionnaire release and recovery, questionnaire method is divided into direct release method (interview release method) and indirect release method (journal release method, telephone release method, network release method and postal release method). According to different respondents, the questionnaire is divided into personally filled questionnaire and non-personally filled questionnaire. Questionnaire method plays an important role in the social investigation. In modern society, the most common sampling survey takes the questionnaire method as the main survey method.

The questionnaire method has the following features:

- (1) The questionnaire is standardized, namely, the questionnaire is uniformly designed and has a certain structure.
- (2) In most case, the survey is indirect, namely, the investigator does not directly meet the respondents, but the respondents fill the questionnaire; the survey may be direct.
- (3) In general, the survey is written, namely, the investigator asks questions to the respondents in a written form, and the respondents answer questions in a written form.
- (4) The questionnaire method is commonly applied in the sampling survey, namely, the respondents are selected with probability or non-probability sampling method. Meanwhile, there are many respondents.
- (5) The questionnaire method is particularly suitable for quantitative survey, namely, the overall quantity can be inferred through sample statistics. It is often used as one of the means of qualitative survey.

Though the questionnaire method is widely used in social surveys, it is not a universal tool and it has certain applicability:

- (1) Large-scale sample surveys and quantitative analysis.
- (2) Survey population consisting of single components.

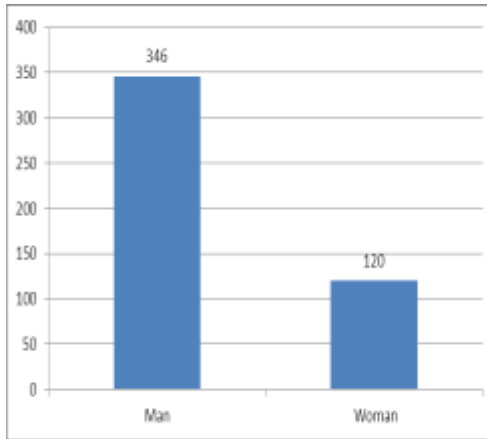
#### Basic Information of Questionnaire Survey

Time: from September 20 to December 31, 2014. Location: all 4S shops of new energy automobiles in Shanghai, Driving School in Songjiang University City and communities. Respondents: salespersons of 4S shops, owners of new energy automobiles, customers of 4S shops, students of driving school, and residents in communities. Questionnaire release and statistics: firstly, 13 new energy automobile sales consultants were invited to fill in the questionnaires; after filling, each person was required to select or propose 5 most important factors that affected the willingness of consumers to purchase new energy automobiles to modify the questionnaire items, in which a total of 65 items were collected and classified separately, relevant research results were discussed for item modification, and 14 items were confirmed at last; secondly, questionnaires were released to owners of new energy automobiles, customers of 4S shops, students of driving school and residents in communities; 500 pieces were released, 489 pieces recovered, in which 23 pieces were invalid through screening and analysis and 466 effective pieces were obtained finally, with the effectiveness rate up to 93.2%. The survey results were satisfactory.

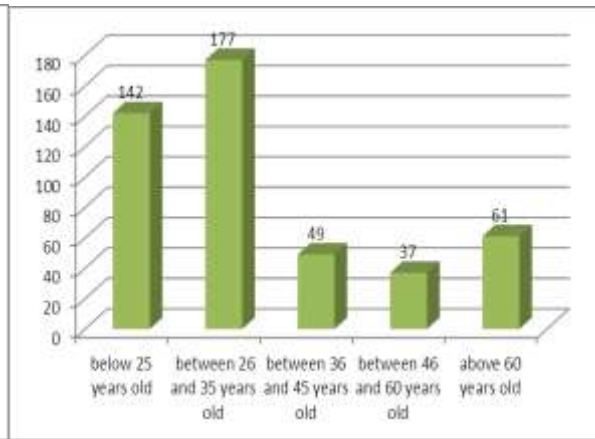
#### Analysis of Questionnaire Data

##### *Basic Information of Respondents*

Through statistical analysis of questionnaires, the basic information of the respondents is shown in Figure 1 and Figure 2.



**Figure 1 Gender distribution of respondents**



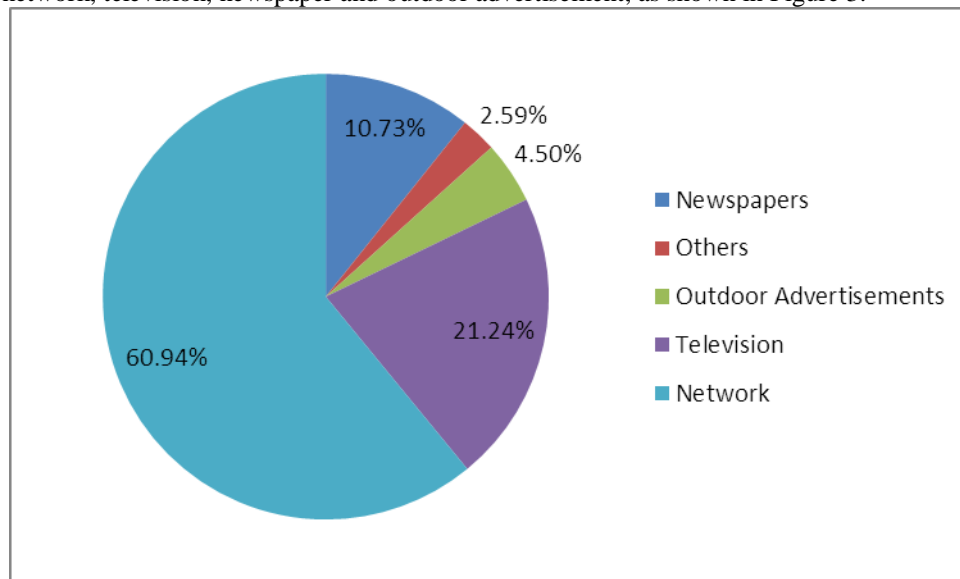
**Figure 2 Age distribution of respondents**

Figure 1 shows that among 466 respondents, 346 are men and 120 are women; figure 2 shows that 142 respondents are below 25 years old, 177 are between 26 and 35 years old, 49 are between 36 and 45 years old, 37 are between 46 and 60 years old, and 61 are above 60 years old. In terms of profession, 75 respondents are engaged in automobile related work and 391 are engaged in other work. In addition, 184 respondents have had one car; 28 respondents have had two cars; 6 respondents have had three cars.

**Investigation of New Energy Automobile**

The questionnaire is designed from three main aspects to investigate consumers’ viewpoints of new energy automobiles: purchase willingness, awareness of development advantages and disadvantages of new energy automobile and judgment for development prospect of new energy automobiles.

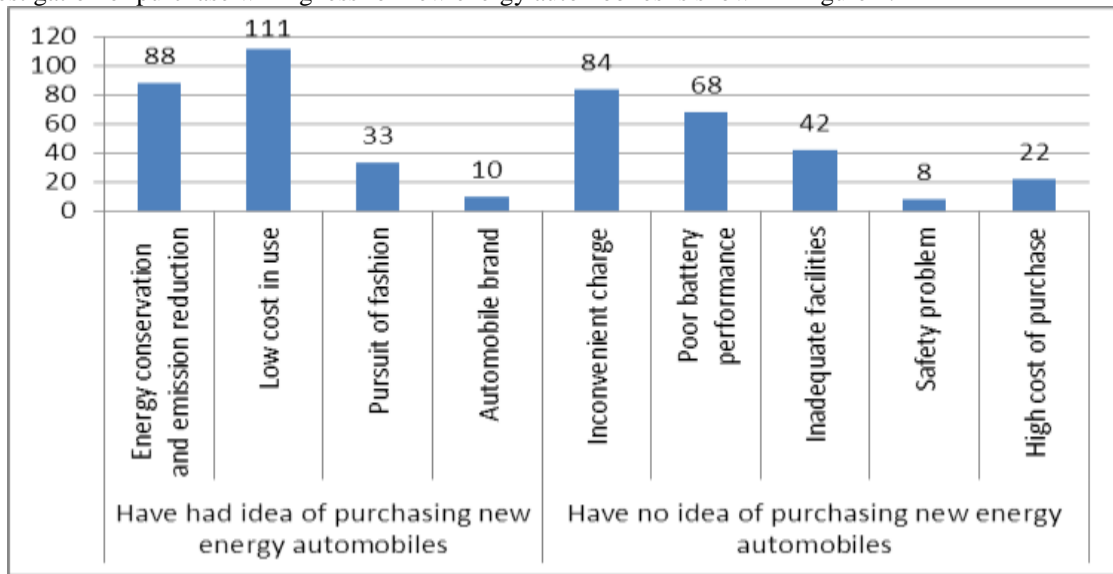
1. In the investigation of purchase willingness, according to “idea of purchasing new energy automobile” and “idea of not purchasing new energy automobile”, the investigation team divides five questions in two groups to study the purchase willingness and reasons. Firstly, the main ways of consumers to understand new energy automobiles were investigated through questionnaires. The results showed that among 466 respondents, the important ways were respectively network, television, newspaper and outdoor advertisement, as shown in Figure 3.



**Figure 3 Important ways to understand new energy automobiles**

Figure 3 shows that in the investigation, the number of consumers using network is the most, accounting for 60.94%; the next two are respectively television and newspaper, accounting for 21.24% and 10.73%. It can be seen that, network has become the most important way in the information dissemination of current automobiles, especially for new energy automobiles.

The investigation of purchase willingness for new energy automobiles is shown in Figure 4.



*Figure 4 Willingness of respondents to purchase new energy automobiles*

Among 466 respondents who answered the question “whether you have the idea of purchasing new energy automobile”, 242 of them “have the idea of purchase”, accounting for 52%; 224 of them “have no idea of purchase”, accounting for 48%. New energy automobile seems to have become one of choices for consumers to purchase automobile. However, through analysis, it is found that, among 242 respondents who “have the idea of purchase”, more than half of them chose the item of “having the idea of purchase, but not purchasing recently” (160, 66%), indicating that consumers’ willingness to buy new energy automobile is not strong and it is difficult to turn the idea of purchase into the behavior of purchase. Among 342 respondents who “have had the idea of purchase”, the investigator implemented a multi-choice investigation of reasons for purchasing new energy automobiles. The results show that, 88 of the 242 respondents chose the item of “energy conservation and emission reduction”, 111 of them chose the item of “low cost in use”, 33 of them chose the item of “pursuit of fashion being the hotpot of future automobile”, and only 10 of them chose the item of “automobile brand”. It can be seen that, different from traditional automobile, in the choice of new energy automobile, for Shanghai consumers, brand is not the most important factor, but the pursuit of low cost of using vehicle and energy saving and environmental protection are the focus. Among 244 respondents who “have no idea of purchase”, the investigator implemented a multi-choice investigation of reasons for no idea of purchasing new energy automobiles. By analyzing the main reasons why 224 respondents did not choose new energy automobile, it could be seen that the main obstacles facing consumers when considering purchasing new energy automobile were “inconvenient charge” (84, 37.68%), “poor battery performance” (68, 30.43%), “inadequate facilities and inconvenient maintenance” (42 people, 18.75%). Other items such as “safety” (8, 2.90%) and “high cost of purchase” (22, 10.15%) were not the main obstacles facing consumers when turning idea of purchase into behavior of purchase. By comparison, the construction of supporting facilities for new energy automobile should become the focus in the development of new energy automobile. On this basis, the investigator further investigated 242 respondents with the willingness to purchase new energy automobile about “which kink of new energy automobile will be your choice”. 199 respondents chose the hybrid power automobile, and 43 respondents chose the electric automobile and hydrogen fuel cell automobile. The analysis shows that in the



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current stage, consumers' acceptance of hybrid power automobile is relatively high, and there is still a long way to go for pure electric automobile.

## EMPIRICAL ANALYSIS

### Reliability Analysis

The reliability testing for 486 pieces of valid questionnaires was implemented by SPSS17.0 software. The reliability coefficient Cronback was 0.911, indicating that the questionnaire has high reliability. Thus, the data obtained by the questionnaire is reliable and the analysis results based on the data are reliable. The sample adequacy test coefficient KMO is 0.531 (Table 1), greater than the empirical value of 0.5. Bartlett sphere test value Sig <0.01, and variables are significantly correlated, so the factor analysis can be performed.

*Table 1 KMO and Barlett Tests*

Kaiser-Meyer-olkin measurement		0.531
Bartlett sphere test	Similar to chi-square	51.307
	Df	36
	Sig.	0.0047

### Factor Analysis

The third part of the questionnaire is the investigation of consumers' viewpoints on performance of new energy automobiles as well as business activities, including 9 questions. The statistical results are shown in Table 2. The average answer value of 9 questions is greater than 4. The respondents considered offset of oil price and low selling price as the first factors, environmental protection, preferential policy and comfort as the second factors. However, the most attention was on whether new energy automobiles can bring actual benefits, as well as the performance guarantee of new energy automobiles and corresponding supporting service facilities, which needs empirical analysis.

*Table 2 Score mean of factors influencing consumption of new energy automobiles*

Environment protection	Experience of new thing	The oil price is too high, and the environmental vehicle can offset oil price	Fashion	Increasingly mature technology and complete supporting facilities	Cheap	Support and preferential policies	Low awareness and loyalty of automobile brand	Good comfort
4.39	4.42	4.46	4.42	4.42	4.46	4.39	4.42	4.39

KMO test and Bartlett test results show that it is suitable for factor analysis. The principal component analysis is used to extract factors and the results are shown in Table 3: among 7 factors with largest variance contribution rate, there are 4 variables with variance larger than 1, namely environmental consideration, experience of new thing, too high oil price and fashion. The contribution rate of these four variables is up to 56.58%.

*Table 3 Variance contribution rate of explanatory variables*



Components	Amount to	Initial eigenvalue variance %	Accumulation %
1. Environmental	1.591	17.682	17.682
2. Experience of new thing	1.312	14.577	32.258
3. The oil price is too high, and the environmental vehicle can offset oil price	1.114	12.377	44.636
4. Fashion	1.075	11.944	56.580
5. Increasingly mature technology and complete supporting facilities	0.948	10.534	67.114
6. Cheap price	0.858	9.536	76.650
7. Support and preferential policies	0.785	8.727	85.377
8. Low awareness and loyalty of automobile brand	0.707	7.859	93.236
9. Good comfort	0.609	6.764	100.000

Use the method of maximizing the variance to make the factor loading matrix analysis. The results obtained are shown in Table 4. As can be seen from Table 3, there are four major components. For the first component, variances 1, 3, 6 (environmental, oil price and cheap) are the largest, which can be considered as “cost saving”. For the second component, variances 2, 4, 9 (experience of new thing, fashion and comfort) are the largest, which can be considered as “personal experience feature”. For the third component, variances 4, 5, 8 (fashion, increasingly mature technology and good comfort) are the largest, which can be considered as “new design feature”. 7 (support and preferential policies) can be considered the fourth component.

**Table 4 Factor loading results after rotation**

	Components			
	1	2	3	4
VAR00001	0.406	0.032	-0.188	0.133
VAR00002	0.235	-0.476	0.321	-0.034
VAR00003	0.349	0.288	-0.297	-0.160
VAR00004	-0.077	0.339	0.449	0.039
VAR00005	0.271	-0.032	-0.403	0.068
VAR00006	0.285	0.175	0.317	0.047
VAR00007	0.124	0.302	0.210	0.673
VAR00008	0.243	0.174	0.332	-0.618
VAR00009	0.227	-0.428	0.228	0.208

From this principal component analysis, the coefficient and functional expression of the first component can be obtained. Functional expression can be used to predict the main components of a sample. Meanwhile, the functional



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expression can list the willingness of samples to purchase new energy automobiles with the first component “cost saving” as the main feature. The original variable after standardization is the functional expression of the first component:

$$Y = 0.362* \text{cost saving} + 0.209* \text{experience of new thing} + 0.312* \text{offset of oil price} + 0.068* \text{fashion} + 0.242* \text{technology maturity} + 0.254* \text{cheap} + 0.111* \text{policy support} + 0.216* \text{loyalty} + 0.202 * \text{comfort}.$$

### Result Analysis

From the above analysis, it can be seen that, for Shanghai consumers, cost saving experience of new thing and new design are the main feature factors when they consider purchasing new energy automobiles. The factor of relevant fees aims at the price of new energy automobile, daily fees, maintenance fees and fees of purchasing parts and other fees of consumer concern. The factor of preferential policies aims at governmental policies on automobile registration, automobile loan, purchase procedure and preferential tax, namely a series of encourage and control policies for new energy automobile. However, it is not the main decision-making factor. The factor of automobile function aims at comfort and fashion, which is an important decision-making factor. Thus, the most attention of consumers is whether the new energy automobile can bring the actual benefits as well as services brought by the performance of new energy automobile to consumers and corresponding supporting service facilities. Environmental protection and preferential policy are not the main features.

### CONCLUSIONS

Through research in this paper, the following conclusions can be made:

1) Through questionnaire survey and statistics of samples, it can be found that the awareness of residents in Shanghai area who understand new energy automobile in two main ways-network and television is relatively high, their willingness to purchase is relatively strong and their market outlook on pure electric automobile is very good. In the current stage, the main reasons why the demand for new energy automobile is not released are the four factors, namely “inconvenient charge”, inadequate supporting service facilities, poor battery performance and high purchase cost. By making the empirical analysis of survey results about consumption of new energy automobile with the factor analysis method, it can be found that the factors that influence the consumption of new energy automobile include factor of relevant fees, factor of automobile function, and factor of supporting service facilities. The results of empirical analysis tend to be in line with the results of descriptive analysis.

2) The findings show that consumer preferences for new energy automobile are still concentrated in the cost price of new energy automobile, construction of supporting service facilities, new design and experience. To promote the large-scale introduction of new energy automobile to household, it is necessary to provide preferential policies on taxation, distribution, retail and other links for manufacturers or distributors of new energy automobile.

3) Supporting facilities for new energy automobiles shall be improved and convenient service guarantee be provided. The manufacturers of new energy automobiles should invest in the construction of related supporting facilities, so that the users of new energy automobiles can easily add energy, thereby expanding the use scale of new energy automobile.

4) When designing and producing new energy automobile, enterprises should start from the interests of consumers. Enterprises should strengthen R&D and technical innovation while bringing new design and experience to consumers, solve problems such as poor battery performance reflected by consumers, and enhance the practicality of new energy automobile to meet consumer needs and obtain the consumer market.

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