Research on the Influencing Factors of Consumer Purchasing Intention of New Energy Vehicles

Tong Pan¹,*, Qiuying Wu², Shuli Tang¹

¹School of Statistics and Applied Mathematics, Anhui University of Finance and Economics, Bengbu, China
²School of Accounting, Anhui University of Finance and Economics, Bengbu, China

*1253269905@qq.com

Abstract

Under the background of "double carbon", the Chinese government attaches great importance to the development of new energy vehicles, and new energy vehicles as an emerging industry, there are still some difficulties and challenges, among which consumers' acceptance and purchase willingness of new energy vehicles greatly affect the promotion and development of the new energy vehicle industry. In this regard, this paper uses factor analysis to obtain the factors affecting consumers' car purchase choice, and uses fuzzy comprehensive evaluation method to further calculate the degree of consumers valuing each factor. The results show that the importance of influencing factors from high to low is product performance, preferential policies, cost and service. Finally, the development strategy of new energy vehicles is put forward.

Keywords

New Energy Vehicles; Consumers; Purchase Intention; Factor Analysis; Fuzzy Comprehensive Evaluation.

1. Introduction

During the National People's Congress and Chinese People's Political Consultative Conference in 2022, "carbon peaking and carbon neutrality" and "new energy" once again became hot topics. General Secretary Xi Jinping has pointed out that the development of new energy vehicles is the only way for China to move from a big automobile country to a powerful automobile power. With the aggravation of environmental pollution and energy tension, new energy vehicles have once again become the focus of people's attention. Its "new" is mainly reflected in the use of unconventional vehicle fuel as a power source, which can be divided into hybrid, pure electric, fuel cell electric and other types. According to data from the China Association of Automobile Manufacturers, China's new energy vehicle sales accounted for 40.70% of the global new energy vehicle sales in 2020, only 3.1 percentage points less than that compared with Europe. In 2021, China's new energy vehicles sales were 3.521 million, up 157.6% year on year. Sales have ranked first in the world for seven consecutive years. Therefore, studying consumers' purchase intention of new energy vehicles and understanding the consumer market of new energy vehicles, such as consumers' purchase intention and product preferences, can promote the development of the new energy vehicle industry.

2. Literature Review

New energy vehicle industry is a newly emerging industry in China in recent years, and the domestic research theory on new energy vehicles is still not particularly perfect. Hong Yongfu[1] (2009) It points out that new energy vehicles, as powerful tools to alleviate resource tension
and environmental pollution, are mainly divided into hybrid electric vehicles, pure electric vehicles, fuel cell vehicles, hydrogen engine vehicles, and other new energy vehicles. For the intention to purchase, Fishbein & Ajzen[2](1975) Research believes that the purchase intention can be interpreted as a subjective psychological probability, which can be used to predict the possibility of consumers taking the actual purchase behavior later; Li Taili [3] (2017) Define the purchase intention as the possibility of a customer to consume a certain product or consumption. In conclusion, this paper defines the purchase intention as the willingness of consumers to buy certain goods or services under the influence of different factors. In terms of purchase willingness influencing factors, Sun Xiaohua and Wang Lin[4](2014) Based on the perspective of technical and economic paradigm transformation, the four major barriers of linking technology and demand, consumer cognitive barriers, infrastructure barriers and institutional barriers are the main barriers in the market. In terms of development prospects, Yang Yi and Li Peng[5] (2022) It pointed out that there is great potential in the new energy vehicle market, the market demand is also considerable. China's "Made in China 2025" plan points out that by 2020, the national output of new energy vehicles will reach 2 million, the production and sales ownership will exceed 5 million, reversing the target, 2017~2020 China's new energy vehicle sales compound growth rate will be about 40%, 2020-2025 is expected to be about 20%. In alleviating environmental pollution, Yan Xiao[6] (2016) It is pointed out that new energy vehicles will play an important role, and it is playing an important historical mission to reduce the automobile industry's dependence on oil and improve the environment. In the research on consumers' willingness to buy new energy vehicles, Zhang Haibin (2015)[7] From the aspect of government subsidy mechanism, it is concluded that government subsidies to consumers can increase consumers' demand for new energy vehicles, thus expanding the scale of the consumer market. YuO (2015)[8] Through the investigation of the national key demonstration and promotion cities of new energy vehicles, the entropy power method is used to study the impact of each index of new energy vehicles on user satisfaction. Sheng Lijun (2019)[9] Factor analysis is used to study the factors that affect consumers to purchase new energy vehicles. Du Jiarui, Gaulle Spring (2019)[10] In the Beijing, Tianjin and Hebei region, the purchase intention of consumers in Hebei, Tianjin and Beijing to buy new energy vehicles was investigated and studied. The 14th Five-Year Plan clearly mentioned the focus on strategic emerging industries such as new energy vehicles. The development of new energy vehicles is also one of the important measures to achieve the peak carbon neutrality. China has always been a country with less oil and more coal. Fuel vehicles will consume a lot of oil energy every year, which aggravates the shortage of domestic oil resources. The energy shortage is becoming more and more prominent. Optimizing the energy structure is also a major problem to be solved in China. The development of new energy vehicles has become an inevitable choice to reduce automobile exhaust emissions, develop low-carbon economy, optimize the energy consumption structure, promote economic development, and narrow the gap between China's automobile industry and the advanced national automobile industry. At present, there are mainly problems of low penetration rate, insufficient promotion, inadequate publicity, and low proportion of production and sales. There is still a broad space for development in the new energy vehicle market. Therefore, from the consumer level, the study of consumers’ willingness to buy and the purchasing factors that affect consumers can provide suggestions for manufacturers and better cater to the consumer market, which is of great significance to the booming development of the new energy industry.
3. Study Design

3.1. Survey Design and Data Collection

The design of this research questionnaire is mainly based on the research of relevant literature and data review, combined with the product characteristics of major domestic brands in the new energy vehicle market, as well as the evaluation and analysis of online consumers on new energy vehicles, the research questionnaire is designed. The questionnaire mainly includes three parts. The first part is divided into basic understanding of information such as personal characteristics of the respondents, including gender, age, education, employment, family population, monthly family income, etc. The second part mainly focuses on the survey of the respondents' understanding and preference of new energy vehicles, including whether they are willing to buy new energy vehicles, the use of buying cars, the understanding channels of new energy vehicles, the acceptance of battery life and other performance and price and other issues. The third part is the Richter scale, which investigates the importance of the factors affecting consumer car purchase from five influence aspects, such as preferential policies and consumption experience. The questionnaire was distributed online, and the online questionnaire website "Questionnaire Network" was selected to collect data. A total of 421 questionnaires were collected and 399 were valid questionnaires, and the recovery rate of valid questionnaires was as high as 94.78%.

3.2. Construction of Indicators Influencing Consumers' Car Purchase Choice Factors

On the selection of consumer factors indicators, based on the preliminary survey understand consumers choice preferences for new energy vehicles and influencing factors, and in the field survey of the car sales staff interview buyers to new energy vehicles consulting questions, concerns, attract point, etc., and combined with the network public evaluation of new energy vehicles and the government on the policy analysis of new energy vehicles. Five levels of "preferential policies", "consumption experience", "product performance", "service" and "cost" are selected, and specific influencing factors are listed at each level, with a total of 18 secondary indicators, so as to build an index system of the influencing factors of consumer car purchase choice, as shown in Table 1. In the questionnaire, these variables were designed as questions through the Richter scale form, which required the respondents to assign values from 1 to 5 according to the importance.

| Influencing Factor       | Metric                  | Influencing Factor       | Metric                  |
|--------------------------|-------------------------|--------------------------|-------------------------|
| Preferential policy      | Purchase subsidy        | Prime cost               | Retail price            |
|                          | Free card               |                          | Operating cost          |
|                          | Free purchase tax       |                          | Maintenance and         |
|                          |                         |                          | maintenance             |
| Experience consumption   | Driving experience      | Serve                    | Car purchase credit     |
|                          | Use convenience         |                          | After-sale service      |
|                          | The brand of the vehicle|                          | Secondary market        |
|                          | Ride comfort            |                          | Pre-sales consultation  |
| Product property         | Appearance and interior |                         |                         |
|                          | Safety performance      |                          |                         |
|                          | Battery performance     |                          |                         |
|                          | Accelerating ability    |                          |                         |

Table 1. Factors affecting consumers' car purchase choices
4. Empirical Analysis

4.1. Descriptive Statistical Analysis of the Individual Characteristics of the Sample

Table 2 shows the statistics of personal characteristics of the collected respondents. Among the 399 valid samples collected, 189 male respondents and 210 female respondents, 47.34% and 52.63%, respectively, and slightly more female respondents are balanced. From the perspective of age structure, the number of people aged 26-45 is the majority, which is the main purchase of new energy vehicles. Most consumers willing to buy have bachelor’s degree or junior college degree, accounting for 81.08%; respondents with monthly household income between 3000-20000 yuan are more willing to buy new energy vehicles, indicating that low-income people have no advantage in buying new energy vehicles. The majority of respondents have 3 or more families, indicating that consumers are mainly married families with children. In terms of work, most of the respondents are employed people, among which private enterprises account for the largest proportion, followed by public institutions and self-employed enterprises, indicating that the consumption of new energy vehicles needs a certain purchasing power.

| Table 2. Sample description statistics |
|----------------------------------------|
| basic document | man | 47.34% |
| | woman | 52.63% |
| age | Age 25 and below | 32.28% |
| | 26-35 Years old | 48.10% |
| | 36-45 Years old | 16.46% |
| | 46-55 Years old | 2.53% |
| | Over 55 years old | 0.63% |
| record of formal schooling | Junior high school and below | 3.16% |
| | High school / Technical secondary school / vocational school | 11.39% |
| | Undergraduate / specialist | 81.01% |
| | Master’s degree or above | 4.43% |
| Family monthly income | RMB 3,000 or less | 12.03% |
| | RMB 3000-5000 | 30.38% |
| | RMB 5,000-RMB 10,000 | 30.38% |
| | RMB 10000-20000 | 20.25% |
| | Over 20,000 yuan | 6.96% |

4.2. Consumer's Cognitive Analysis of New Energy Vehicles

In the understanding channels of new energy vehicles, consumers mainly understand through TV advertisements, auto shows and news. Although most of the respondents have heard of new energy vehicles, but the overall understanding is insufficient. Thus, in the promotion of new energy vehicles, it is necessary to strengthen the publicity of a variety of channels. In terms of car purchase use, consumers can buy new energy vehicles for work and home use. In terms of consumer performance preference for new energy vehicles, the charging time acceptable to respondents is mainly less than 8 hours; the expected range is more than 200km. It can be seen that consumers have higher requirements for the performance of new energy vehicle batteries. The acceptable selling price was generally below 200,000 yuan. Thus, the development of new energy vehicles needs to reduce production costs and lower sales prices.
As shown in Figure 1, in terms of the purchase status quo, 31.58% have purchased new energy vehicles, and most of the respondents have not yet purchased new energy vehicles. Among the respondents who did not buy new energy vehicles, willing to buy and unwilling to buy new energy vehicles accounted for 57.88% and 42.12%, respectively, among which the people willing to buy accounted for a large proportion. Thus, people's willingness to buy is still relatively strong. Strengthening market promotion and publicity will greatly improve the market penetration rate of new energy vehicles.

![Figure 1. Consumer purchase intention](image)

### 4.3. Test of the Reliability and Validity of the Sample

#### 4.3.1. Confidence Test

After data collection, the reliability tests of the various survey items in the questionnaire scales were performed to calculate the Cronbach's values, and the results are shown in Table 3. The Cronbach's values at all levels were greater than 0.7, and the overall Cronbach's value was 0.793, indicating the very high confidence of the questionnaire.

| preferential policy | The Cronbach's value | number of terms | Reliability evaluation |
|---------------------|----------------------|-----------------|------------------------|
| preferential policy | 0.795                | 3               | preferably             |
| experience consumption | 0.780            | 4               | preferably             |
| product property    | 0.711                | 4               | preferably             |
| prime cost          | 0.812                | 3               | beyond compare         |
| serve               | 0.757                | 4               | preferably             |
| ensemble            | 0.793                | 18              | preferably             |

#### 4.3.2. Validity Test

In the validity test section, the data were KMO and Bartlett, and the results are shown in Table 4. The KMO coefficient of the questionnaire is 0.793, indicating that the data of the scale is suitable for factor analysis; while the P-value of the Bartlett spherical test is 0.000, indicating that the structural design of the scale is reasonable.
In order to find the concerns of consumers when choosing a car, factor analysis and fuzzy comprehensive discrimination analysis scale are applied to find out the factors affecting consumers’ car purchase choice, so as to give suggestions to the product design of manufacturers.

4.4. Factor Analysis

Table 5. Descriptive statistics of the car selection factors influencing consumers

| influencing factor          | metric                                | 1(%) | 2(%) | 3(%) | 4(%) | 5(%) | mean |
|----------------------------|---------------------------------------|------|------|------|------|------|------|
| preferential policy        | 1. Purchase subsidies                | 5.1  | 20.4 | 36.7 | 36.7 | 4.03 |
|                           | 2. Free registration                 | 10.2 | 23.5 | 37.8 | 26.5 | 3.77 |
|                           | 3. Purchase tax exemption            | 4.1  | 24.5 | 35.7 | 34.7 | 3.99 |
| experience consumption     | 4. Driving experience                | 4.1  | 16.3 | 41.8 | 35.7 | 4.05 |
|                           | 5. Convenience of use                | 3.1  | 7.1  | 42.9 | 45.9 | 4.3  |
|                           | 6. Brand of the vehicle              | 11.2 | 38.8 | 31.6 | 16.3 | 3.49 |
|                           | 7. Travel comfort                    | 2    | 11.2 | 60.2 | 24.5 | 4.03 |
| product property           | 8. Appearance and interior decoration| 7.1  | 37.8 | 30.6 | 22.4 | 3.64 |
|                           | 9. Safety performance                | 2    | 4    | 27.6 | 65.3 | 4.54 |
|                           | 10. Battery performance              | 2    | 11.2 | 32.7 | 54.1 | 4.39 |
|                           | 11. Accelerate the performance       | 3.1  | 23.5 | 45.9 | 25.5 | 3.9  |
| prime cost                 | 12. Sales price                      | 4.1  | 25.5 | 43.9 | 25.5 | 3.89 |
|                           | 13. Use cost                         | 4.1  | 25.5 | 43.9 | 25.5 | 3.89 |
|                           | 14. Maintenance and repair           | 5.1  | 32.7 | 34.7 | 26.5 | 3.81 |
| serve                     | 15. Car purchase credit              | 16.3 | 43.9 | 21.4 | 16.3 | 3.33 |
|                           | 16. After-sales service              | 7.1  | 16.3 | 38.8 | 36.7 | 4.03 |
|                           | 17. The Second-hand market           | 18.4 | 49   | 22.4 | 8.2  | 3.16 |
|                           | 18. Pre-sale consultation            | 4.1  | 26.5 | 46.9 | 21.4 | 3.83 |

In order to study the importance of consumers’ various car selection factors, the factors that consumers take into consideration when buying cars are divided into four parts: "preferential policy", "consumption experience", "product performance", "cost" and "service", with a total of 18 problems. In the form of the Richter scale, the importance of consumers is divided into five levels, namely "very unimportant", "unimportant", "general", "important" and "very important". When coding, they correspond to "1", "2", "3", "4" and "5". Descriptive analysis of
the questionnaire data is shown in Table 5. It can be seen that the respondents attach great importance to the use convenience, safety performance and battery performance of new energy vehicles, as well as to the purchase of subsidies and after-sales service.

To further investigate the relationship between these 18 factors, the factor analysis was done with SPSS. The results showed a value of KMO of 0.845 and a P-value corresponding to the Bartlett spherical test of less than 0.01, indicating that the data are suitable for factor analysis. Next, four common factors were extracted by PCA, and the cumulative variance contribution rate reached 80.101%. As can be seen from the results of Table 6, the performance factor variance contributed the largest value, which indicates that the performance factor has the highest importance, followed by the policy factor, which shows that consumers also pay more attention to the policy factor.

| factor | Factor naming | Common degree | factor loading | The Variance contribution rate is (%) |
|--------|---------------|---------------|---------------|---------------------------------------|
| F1     | function      | 0.514~0.807   | 0.630~0.871   | 49.231%                               |
| F2     | policy        | 0.621~0.803   | 0.730~0.833   | 16.557%                               |
| F3     | prime cost    | 0.762~0.800   | 0.724~0.794   | 8.746%                                |
| F4     | serve         | 0.488~0.702   | 0.536~0.703   | 5.567%                                |

4.5. Fuzzy Comprehensive Evaluation Method

In order to further study the importance of the respondents to these four factors, the fuzzy comprehensive evaluation method is used to obtain the degree of consumer value to each factor. Fuzzy comprehensive evaluation method is a model that can score on the secondary index evaluation system, so it is applicable to the car purchase selection factor system constructed in this study. Due to the different importance of each index layer, the fuzzy comprehensive evaluation method weights each index layer through the weight vector to form the weight vector matrix A. In this paper, the normalized component load vector obtained in the factor analysis is used as the weight fuzzy subset A, and the scale scale matrix corresponding to each factor is used as the fuzzy evaluation matrix R to obtain the evaluation result B.

To factor F2 For example, the policy factor is a fuzzy evaluation matrix, called R2 For:

$$
R_2 = \begin{bmatrix}
0.01 & 0.051 & 0.204 & 0.367 & 0.367 \\
0.02 & 0.101 & 0.236 & 0.378 & 0.265 \\
0.02 & 0.102 & 0.235 & 0.378 & 0.265 \\
0.01 & 0.041 & 0.245 & 0.357 & 0.347
\end{bmatrix}
$$

$$
A_2 = \begin{bmatrix}
0.2356 & 0.2411 & 0.2689 & 0.2544
\end{bmatrix}
$$

$$
B_2 = A_2 * R_2 = \begin{bmatrix}
0.0178 & 0.0745 & 0.2474 & 0.3551 & 0.3051
\end{bmatrix}
$$

The results showed that the respondents valued the performance as follows: very not important 1.78%, not important 7.45%, generally 24.74%, important 35.51%, very important 30.51%.

Similarly, the judgment results can be obtained based on the fuzzy evaluation matrix and the weight fuzzy subset of the corresponding factors.
Table 7: Fuzzy comprehensive evaluation results

| factor   | Very unimportant for the (%) | unimportance (%) | same as (%) | important (%) | very important (%) |
|----------|------------------------------|------------------|-------------|---------------|-------------------|
| function | 1.49                         | 4.27             | 19.46       | 40.57         | 34.14             |
| policy   | 1.78                         | 7.45             | 24.74       | 35.51         | 30.51             |
| prime cost | 1.00                        | 4.42             | 27.82       | 40.94         | 25.82             |
| serve    | 1.68                         | 14.15            | 37.00       | 27.37         | 19.73             |

As can be seen from table 7, consumers are most important to product performance, including the battery performance, acceleration performance, driving experience, etc., that consumers when buying a car, car performance for consumers to buy choice plays a key role, battery safety and range, good driving experience can improve consumers to buy new energy vehicles, enhance the trust of new energy automobile brand, establish a good reputation. Consumers 'emphasis on policies such as car purchase subsidies follows closely. Preferential and tax exemption policies can promote consumers' willingness to buy, and providing more incentives will create more sales, and play a wider role in publicity and promotion among the public. The cost ranks third, indicating that consumers do not take the price in the first place when buying cars, but the price is also an important factor affecting consumers to buy new energy vehicles. Compared with fuel vehicles, new energy vehicles tend to have higher prices, which has become an obstacle for many consumers to buy. But with the gradual maturity of new energy vehicle technology, the price of new energy vehicles will also fall. In contrast, consumers do not value services, which shows that "convenient credit services" and "pre-sale consultation services" are less attractive to consumers. It is worth noting that the item "after-sales service" in the scale is placed in the factor F1In, explain the consumer to value to after-sales service very much. A series of complex supporting facilities installation procedures and after-sales problems are the purchase of new energy vehicles need to be improved. After consumers order new energy vehicles, they often have a long waiting period, and the lack of charging piles in the process is the most inconvenient to use new energy vehicles, leading to limited use of consumers, worried that the charging problem is difficult to drive a long distance. All these have seriously affected the use experience of consumers, and become a limiting factor for the no widespread popularization of new energy vehicles.

5. Conclusions and Suggestions

5.1. Study Conclusion

Descriptive statistical analysis, men, 26-35, bachelor degree and large family population are more willing to buy. Through data analysis, we found that men were stronger in sex. In terms of age, people aged 26-35 are more willing to buy, with about 50% of respondents willing to buy, more willing to buy, more than 70%, and in terms of income, middle income people have stronger willingness to buy. The results also showed that consumers with three or more households were more willing to buy. Through factor analysis and fuzzy comprehensive evaluation method, when buying new energy vehicles, consumers pay more attention to product performance and government policies, and relatively ignore services. Consumers will mainly focus on the battery performance, safety performance, use convenience, driving experience and other aspects of new energy vehicles. In particular, the battery life time and the charging time are the elements of special concern to consumers. The survey found that the range and safety performance of new energy vehicles...
need to be improved, and the construction of charging piles and other supporting facilities has defects. At present, the new energy vehicles on the market cannot meet the needs of some consumers. Consumers also have concerns about the safety of batteries, such as whether they are prone to explosions, and how quickly their performance decays. At the same time, we know that the vast majority of consumers, around the charging piles “less” or even “very few”, which is also one of the reasons why many consumers do not buy new energy vehicles. In addition to product performance, consumers’ support policies for the state are also very heavy. The preferential subsidies provided by the government and tax exemption policies can promote consumers’ purchase intention to a greater extent. On the contrary, consumers pay relatively little attention to consulting services and credit services when buying cars.

5.2. Suggestions
5.2.1. Recommendations for New Energy Vehicle Manufacturers

First, targeted to 25-36 years old consumers, income of 5,000-10,000 yuan for publicity. The potential market value of this group is very high, and to this group, targeted publicity can increase the product exposure rate. In the era of new media, from new media platform to increase the publicity of new energy vehicles can effectively promote new energy vehicles, because the new energy vehicles relative to traditional fuel cars for the public or a new thing, into the public view can better establish the brand image, the public understanding of new energy vehicles, make consumers to establish trust in new energy vehicles.

Second, strengthen the overall sense of design. Survey results show that consumers pay more attention to the appearance, interior decoration. Therefore, increasing the overall fashion sense of the product, enhancing the design sense of details, and catering to the aesthetic appreciation of consumers, can improve the purchase willingness of people, especially women.

Third, increase the investment in battery research and development to improve the competitiveness of products. According to the model results, consumers attach the most importance to battery performance and acceleration performance. Therefore, enterprises themselves need to increase research and development investment, and actively build a research and development system. For enterprises without battery production system, cooperation with battery manufacturers should be strengthened to improve battery performance.

Fourth, do a good job of consumer segmentation, and develop targeted products. Through the investigation and analysis, there are great differences in consumers' economic ability, purchase intention and demand for cars. Therefore, manufacturers should develop targeted products and develop marketing strategies.

5.2.2. Proposals to the Government

First, optimize the industrial support system, and continue to provide preferential policies. The model results show that the preferential policies have a significant impact on consumers’ purchase intention. Through the understanding of the relevant policies of new energy vehicles, the government gives great subsidies to enterprises and attaches low importance to the preferential policies of consumers. New energy vehicles are still in the promotion period, and preferential policies can promote the promotion of new energy vehicles in the public. But the government should also curb the phenomenon of “subsidy fraud”. In addition, the government can adopt the “old for new” approach to promote new energy vehicles while eliminating traditional vehicles with high energy consumption and high emissions.

Second, speed up the construction of charging facilities, and gradually balance the proportion of car piles. Survey data show that the shortage of charging piles has curbed consumers’ enthusiasm for buying new energy vehicles. Therefore, the government should increase the coverage of charging piles. At the same time, optimize the layout of charging facilities, increase
the coverage density of commercial centers, and improve the construction of intercity high-speed charging facilities. In addition, subsidies will be provided for the private construction of charging piles, and the quality certification of charging infrastructure will be established to solve the incompatibility problem of vehicle piles and reduce safety accidents.

Third, formulate unified technical standards and strengthen market supervision. The technical standards in the production of new energy vehicles include the technical standards for batteries and motors, and the technical standards for vehicle control, forming a scientific and perfect standard system to escort the healthy and rapid development of the new energy vehicle industry.

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