Exploring the Factors of Passengers' Willingness to take the Online Car-Hailing

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Abstract. This study is intended to investigate the influence factors affecting passengers' willingness in taking online car-hailing. It applies basic information, security, convenience, perceived prices, service quality and taking motives as six influence dimensions. This study uses neural network as a tool to deal with the questionnaires data. The most commonly used back-propagation network is applied to train and predict for the passengers' willingness. Next, the frameworks will be pulled out successively to applied comparative analysis which is intended to find out the important order of these factors. The results show that the most importance is convenience, taking motives and perceived prices, respectively. And it is intended to provide businesses of related industries or driver certain information as references for the future operations of online car-hailing.

Keywords: Car-hailing; neural network; take willingness; back-propagation network

1 Introduction

Since the rise of the sharing economy, the disruptive innovation of online car-hailing has rapidly changed the operation of the traditional taxi. Online car-hailing is the same as online taxi booking service. With the rapid development of the mobile technology and economic growth, people's travel behavior has become more diverse, and online car-hailing has gradually become a habit of people's travel; together with the traditional taxi, it is sharing the market of passenger transportation services. In addition to the international brand Didi, a number of domestic online ride-hailing platforms such as UCAR Inc., Ichinait, Yongche, CaoCao, T3 Go, Meituan Taxi, Hello Inc., Huaxiaozhu, etc. are also in the market gradually emerged. Due to the rapid development of the online car-hailing industry, the broad market prospects have attracted many companies to enter the market. According to statistics, as of the end of 2020, the number of online car-hailing users in China has reached 340 million; of which the usage rate among netizens is 36.19% [1].

Secondly, as one of the most common means of mass transportation in cities, taxis have a significant impact on people's daily lives. From the early days of receiving foreign guests and aristocratic transportation to the current ubiquitous public transportation, we can find that taxis play an important role in transportation. Since Didi was officially launched in 2012, the rise of online taxi-hailing has brought huge changes to the style of people's outgoing. People no longer

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face the situation of being unable to hail a taxi on the street when they are in an emergency; the discounts offered by online car-hailing platforms such as Didi and Uber make people more willing to choose. At the same time, this is a major impact on the development of the traditional taxi. Online car-hailing services include taxis, express buses, private cars, car-hailing services, etc. Not only are professional taxi drivers available, but also those who hold a driver's license and have a certain level of driving experience can also work as part-time drivers through Didi and other eHailing platforms to earn money.

To this day, the competition between online car-hailing and traditional taxis has been ongoing. However, the emergence of online car-hailing has also indirectly increased the pressure on urban traffic. Many private cars have appeared more frequently in cities after becoming online car-hailing, which invisibly has a negative impact on urban development (such as road congestion). Coupled with the frequent occurrence of adverse events in online car-hailing in various places (such as dangerous driving, insulting and beating passengers, snatching passengers, etc.), it has caused extremely bad social impact, and these problems will affect passengers' willingness to take online car-hailing [2]. There are many factors that influence passengers' willingness to take online car-hailing services. This study will identify the most important factors that influence passengers' willingness to take rides.

Neural networks have been widely used in various dimensions of daily life, it can solve nonlinear data problems. This study uses passengers' willingness to take online car-hailing as research data, and uses neural networks to predict, compare, and analyze ride willingness.

The main purpose of this study is to use neural networks to process questionnaire data and explore the analysis of passengers' willingness to take online car-hailing [3]. The comparison of influencing factors in this study, to verify its accuracy, in order to establish a decision-making model for the influencing factors of people's ride on car hailing, with the expectation of making significant contributions to marketing decisions in the online car-hailing. In addition, this study expects to identify the influencing factors that influence people to take online car-hailing, the ranking and sequence of their importance were also compared. The results are expected to be provided to relevant businesses or drivers as reference strategies for future online car-hailing operations.

2 Related works

2.1 Neural network

In computer science and related fields, artificial neural networks (ANNs) are computational models inspired by an animal's central nervous systems which is capable of machine learning as well as pattern recognition. ANNs are generally presented as systems of interconnected "neurons" which can compute values from inputs. Each neuron may be connected to numerous of neighboring neurons via this network of dendrites and axons. The network architecture simulates the human brain to handle massive parallel processing quickly [4]. The most frequently used type of a typical ANNs consist three distinct layers of units: a layer of "input" connecting to the hidden layer(s), which is connected to a layer of "output" unit(s) [5].

The back-propagation network (BPN) is one of the best-known multilayered feed-forward ANNs. It utilizes the transmission of input directly to the hidden layer from the input layer and

the computation of the weighted accumulation. This generates an output with transfer functions, and then transmitted to the output layer. Additionally, the BPN learning adopts gradient-descent-type learning algorithm in which the error propagated backward to adjust the connection weights of preceding layers and to minimize output error. It has the abilities of self-learning, massively parallel construction, high memorial capacity, generalization, fault tolerance, robustness and noise insensitive, and among many others. Thus, it is more suitable for dealing with research problems of evaluation and prediction.

2.2 Taking willingness

Taking willingness refers to purchased intention in many studies. The so-called purchased intention refers to the possibility that consumers are willing to purchase the product [6]. However, the higher the consumer's perceived price of the product, the greater the chance of purchasing the product. Purchased intention is a consumer's measure of the possibility of purchasing a product. It is a consumer's subjective tendency towards a certain product and has been proven to be an important indicator for predicting consumer behavior [3]. Therefore, purchased intention is equivalent to in terms of Taking willingness.

This study summarizes literature review as a measurement variable for passengers' willingness to take online car-hailing, and takes basic information, safety, convenience, perceived price, service quality, and ride motivation as the six dimensions of this study. It explanations as follows: (1) Basic information. When designing the questionnaire, basic information about the respondents' answers will be collected based on the theme, such as gender, age, education level, occupational category, monthly income, and frequent travel time. The received data will be divided into several groups for correlation analysis. (2) Security. It refers to enabling consumers to avoid risks and worries during the experience process, including physical, mental and property aspects, such as customer information security, transaction security mechanism, one-click alarm, emergency contact settings, etc. Security, as defined by [7], is to protect consumers from dangers, risks and other concerns, so that they can have a sense of trust in the product. Therefore, safety will affect passengers' willingness to ride. (3) Convenience. Time is considered as a limited and precious resource, and the time spent on consumption can be regarded as a cost. If waiting occurs, it is a loss of time and mental torment for individuals, and may also result in the loss of benefits and passengers that they deserve. Benefits and passengers deserve it. However, car hailing has strong convenience, and through mobile applications, people can book car hailing anytime, whether they are business trips, work, shopping, or even traveling, you can easily book a car. (4) Perceived prices. Price is usually one of the important variables when consumers consider a product, and the price is often the main factor that affects whether consumers will buy it. But most consumers usually don't remember the true value of the product they purchased, and they directly convert it into easy-to-remember methods such as cheap or expensive. The price of leaving a lasting impression is the perceived value [8]. Therefore, price will affect consumers' purchasing intention. (5) Service quality. For passengers, online car-hailing service quality is the gap between passengers' expected service quality and perceived service quality [9]. For business, a high level of service quality can attract new customers and retain old customers; a low level of service quality can lead to the loss of customer resources. In terms of measurement, the SERVQUAL model [10] is generally used, but this model still has many controversies and criticisms [11-12]. In the study of [12], it was shown that SERVPERF has a higher predictive effect and explanatory ability than the

SERVQUAL model for overall service quality measurement. This feature is also in line with the purpose of this study. Therefore, service quality has a certain correlation between service quality and passenger willingness. (6) Taking motivation. The stronger the consumer's purchasing motivation and the better their understanding of the product, the more willing they will be to purchase. When consumers' purchasing motivations are hidden behind their consumption behavior, their purchasing motivations are related to satisfying consumers' intrinsic needs [3].

Summarizing the above-mentioned relevant literature to put forward different perspectives on passenger willingness, it can be seen that scholars have similarities and differences in their views. Therefore, this study uses six dimensions of basic information, security, convenience, perceived price, service quality, and taking motivation as the basis for measuring willingness to take a ride.

3 Research design

3.1 Operational definition

The questionnaire scale adopts a five-point Likert scale, and the respondent's answer must be based on the degree of agreement with each question. This study uses the neural network package of R to process questionnaire data. The input content is based on the questions answered by the respondents. The instructions are as follows. (1) Basic information. Divide consumers into several groups based on basic demographic information, such as gender, age, education level, occupation category, monthly income, and time of frequent ride. (2) Security. Only when consumers are free from physical, mental and property risks during the experience can they have a sense of trust in online ride-hailing, such as customer information, transaction mechanism, one-click alarm and other settings, and their acceptable subjective preferences. (3) Convenience. It refers to consumers' acceptable subjective preferences for online ride-hailing services. (4) Perceived prices. It refers to consumers' acceptable subjective perception of the price given by online car-hailing services. (5) Service quality. A clean and comfortable car environment, service attitude, smooth and familiar driving, good reputation, consistent driver and car information, driver expertise, and vehicle compliance with standards, etc., will all affect consumers' willingness to take online car-hailing services. (6) Taking motivation. There must be motivations and reasons behind the behavior, so we want to understand consumers' inner thoughts about taking online car-hailing services. Passengers choose to take online car-hailing services to their destinations for work, school, travel, etc. to complete their transportation tasks. Or when going out on a rainy day, the willingness to take an online car-hailing service will also increase significantly.

3.2 Model construction

This study adopts back-propagation network (BPN) model to divide the collected questionnaire data into two categories according to the respondent's wishes, one is willing to take, the other is unwilling to take. The structure of three layers neural network shows in **Figure 1.**

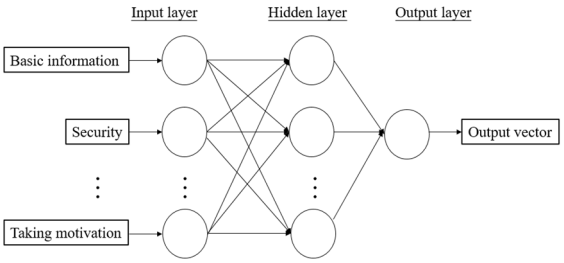

Fig. 1. Architecture of neural network for predicting take willingness.

3.3 Research process

This study uses the neuralnet package of R to design the back-propagation neural (BPN), which has the ability to learn and complete processing functions. It can also train neurons to find the most suitable average correct recognition rate. The research process is as follows:

(1) Literature Review for taking willingness and design questionnaire.

(2) Survey questionnaires. Use online questionnaires to survey respondents who have taken online car-hailing services, hoping to collect more accurate information.

(3) Organizing questionnaires. Among the 389 questionnaires recovered, 25 were incomplete and invalid questionnaires, so there were 364 valid questionnaires. Then coding was carried out, and 18 questions from six dimensions including basic information, security, convenience, perceived values, service quality and taking motivation were translated into English, and the question contents were stored in Excel. The questions use text codes (a, b, c, d, e) to indicate the degree to which the respondent has checked.

(4) Model construction and verification testing. The neuralnet package can perform four steps: design, training, testing, and average correct recognition rate.

(5) Extracting dimensions and verification testing. Reconstruct the model for verification and testing by extracting one dimension at a time, and repeat the operation 10 times. The average correct recognition rate of the output layer of the back propagation neural network will be obtained. Count the results.

(6) Comparison and analysis. Sampling the six major dimensions in sequence, and obtaining the 10-time average of the average correct recognition rate after extracting the facets, and then comparing the values of each dimension, the most important influencing factors can be found.

4 Research results

4.1 Model construction and verification

There are 364 valid questionnaires in this study. The neuralnet package is used to read the Excel questionnaire data and use these data as input factors; the first 70% of the data is the training set data, and the remaining 15% of the data is the test set and validation set respectively . This model is set to be trained for 500 times, and will be tested and verified after training is completed.

As for the setting of other parameters, which is referred to [13]. When the average correct recognition rate (ACCR.) of the verification value is higher, the accuracy of the prediction result is better.

4.2 Dimension extracting and verification

This study uses the back propagation neural network to sort the influencing factors of passengers' willingness to take online car-hailing. Based on the 364 questionnaire data, 7 sets of sample data are used as input data, as shown in **Table 1.**, and the six dimensions are selected in sequence. From the basic information dimension, safety dimension, convenience dimension, perceived price dimension, service quality dimension, and ride motivation dimension, and then repeat the calculation 10 times with the neuralnet package, the results in **Table 2.** below can be obtained. By extracting and ignoring factor of a certain dimensions, we hope to find the important factors that influence passengers to take online car-hailing.

Since the first group processes six dimensions together and cannot distinguish any one dimension, the value of the first group if ignores it. It can be shown from **Table 3.** that the ranking relationship of the factors that influence the passengers' willingness to take online car-hailing is as follows: the first order is convenience, the second order is taking motivation, the third order is perceived prices, and the fourth order is security, fifth is service quality, and sixth is basic information about passengers.

Table 1. The data table for 364 questionnaires.

Group	6-dimesnions					
1	Basic information	Security	Convenience	Perceived prices	Service quality	Taking motivation
2	-	Security	Convenience	Perceived prices	Service quality	Taking motivation
3	Basic information	-	Convenience	Perceived prices	Service quality	Taking motivation
4	Basic information	Security	-	Perceived prices	Service quality	Taking motivation
5	Basic information	Security	Convenience	-	Service quality	Taking motivation
6	Basic information	Security	Convenience	Perceived prices	-	Taking motivation
7	Basic information	Security	Convenience	Perceived prices	Service quality	-

Table 2. Average of 10 times for each dimension.

Group	Average of 10 times for each dimension						
	All	Basic information	Convenience	Security	Perceived prices	Service quality	Taking motivation
1	92.390	89.260	80.157	86.300	80.268	91.266	86.300
2	89.328	91.627	85.603	85.315	86.342	86.007	80.999
3	90.518	87.431	81.000	90.311	83.270	85.391	83.267
4	89.329	88.863	84.333	86.398	85.362	88.379	84.352
5	85.330	86.690	80.007	85.002	85.311	84.038	81.001
6	89.327	88.137	83.230	85.329	81.974	88.054	83.991

7	92.302	87.639	82.068	87.322	87.805	89.773	80.291
8	88.860	92.003	83.257	84.952	85.335	86.312	83.375
9	90.690	88.302	80.201	88.359	84.035	87.008	83.101
10	91.993	90.684	78.268	88.000	80.000	87.604	84.002
Avg.	90.007	89.064	81.812	86.729	83.970	87.383	83.068

Table 3. The table of influencing factors.

Group	ACRR.	Ranking
1	90.007	-
2	89.064	6
3	81.812	1
4	86.729	4
5	83.970	3
6	87.383	5
7	83.068	2

5 Conclusion

This study focuses on the influencing factors of passengers' opinions on online car-hailing. Based on the content of relevant literature, summarize different literature viewpoints. Such as basic information, convenience, security, perceived price, service quality and taking willingness were taken as the six dimensions of the research variables and a survey questionnaire was designed. Next, the neuralent package of R was used as a research tool to conduct a questionnaire survey on passengers who have taken online car-hailing to investigate the factors affecting passengers' willingness to taking it. The number of valid questionnaires after recycling is 364. According to the results of study, the most important factors affecting passengers' willingness to take online car-hailing are first in convenience, second in taking motivation, third in perceived price, fourth in security, fifth in service quality, and sixth in basic information. The results, hopefully, we will help the car-hailing business master the influence factors affecting the taking willingness, and enhancing the competitive advantage.

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