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Paper:

Research on Willingness to Pay of Internet of Vehicles

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This study uses two separate surveys to reveal the mean willingness to pay (WTP) for different attributes of Internet of Vehicles (IoV). It uses conjoint analysis for the first survey with 437 respondents to find the most important attribute among seven attributes of IoV. It uses the contingent value method (CVM) for second survey to reveal the mean WTP of the main attributes from the first survey. The estimated method used is the binomial logit model. The result shows significant concern among people in China about security and willingness to pay an additional CNY 1000 for an IoV product with advanced security features, when other attributes are constant. These results can guide manufacturers in managing technology investments and cost saving targets.

Keywords: IoV, conjoint analysis, willingness to pay, contingent value method

1. Introduction

The Chinese economy has developed rapidly. One example of this progress is in the vehicle industry, which is a huge potential market. Data shows [1] that the number of vehicles in China in 2016 was over 0.17 billion, and will increase to 0.2 billion within 4 years. With such a large market, every vehicle manufacturer is considering winning strategies in the near future. Simultaneously, China has replaced America as having the biggest share of online customers. Many things are possible online in China. Together with the booming Internet of Things (IoT), as the hottest topic in networking, applications of IoT are gaining popularity in many fields, such as smart home devices and smart cities. The future of the vehicle industry lies in the combination of vehicle and network. In addition, these products provide customers in China with the most satisfaction. Indeed, products that combine vehicles and network are not new, for example, navigation systems. However, these products remain less developed due to the lack of both demand and technology. There is increasing popularity of a concept called Internet of Vehicles (IoV), which includes the use of all vehicle applications through the network [2]. In coming years, IoV will undergo rapid development. A research survey conducted by PricewaterhouseCoopers [3] has revealed that before 2020, the market for IoV in China would be in billions of dollars. The future of IoV can be divided into seven attributes such as moving management, vehicle management, entertainment, well-being, autonomous driving, safety, home integration.

As IoV is one of the key directions of the vehicle industry, many studies focus on this field. A social Internet of Vehicles has been put forward and the corresponding vehicle design goals have been discussed [4]. The paper also argues some key issues such as security and the analysis method. After the proposal of the European Telecommunications Standards Institution on Intelligent Transport System (ETSI ITS) scheme, the application has never been tested before [5] Victor tested the architecture performance using the internet. This framework uses different situations, such as neighbor position prediction. In terms of security, a trust system among vehicles over the IoT has been proposed [6]. This study discusses the definition of trust, group clustering, and supervised method. Other studies argue that it may be possible to combine the IoT and vehicles using cloud computing [7]. Other challenges include factors such as government investment. In the real world, an accurate vehicle location system needs three subcomponents: data acquisition, data transmission and reception, data storage and analysis. A location system must satisfy these standards [8]. Different weather and road conditions decide the technology used for location detection, as the Global System for Mobile communication (GSM) is the primary technology for data transfer in IoT. Besides these studies, others propose an algorithm for vehicle data collection using IoT [9]. Using data groping, data collection, and path selection, studies have described a process for vehicle collision avoidance. In contrast, a special IoV called E-health has been discussed [10]. Studies have proposed an algorithm that delivers IoV resources, as some devices (e.g., electromagnetic interference) may result in the malfunction of the medical device. Furthermore, an algorithm to avoid congestion has been proposed [11]. The building blocks of IoT are vehicles and infrastructure. Road information requires real-time updating. On the other hand, the data security code and decode algorithm has been proposed [12]. A dynamic attributed based encryption has been tested. Besides establishing theory establishment, Chang tests the performance of the transmission contract [13].

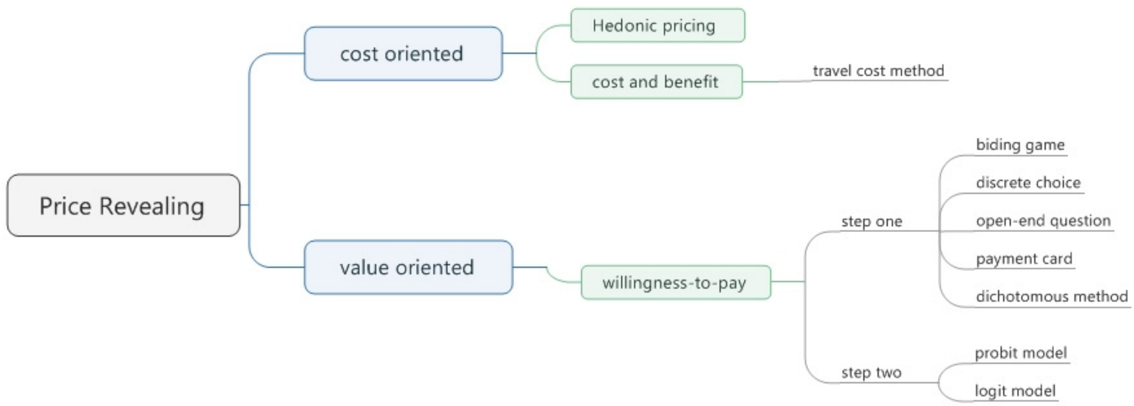

Fig. 1. Structure of research on price revealing and its methods.

As all the above studies focused only on technical issues, considering each attribute of IoV; however, even if the technology is well developed, it may cost too much or meet fewer needs, remaining essentially, an experiment. As the IoV industry has high costs and risks and as it is not possible to develop all the seven attributes simultaneously at the same level, especially with the unbalanced research cost of each attribute, all stakeholders (manufacturers, government, and customers) should consider attributes worth investing in first and their affordability. Answering these questions will finally, open the path to technology development and ensure efficient technology management in IoV.

To study the concerns of the Chinese about IoV and their willingness to pay for this future product, we present a two-step evaluation using two surveys. This study uses both conjoint analysis and WTP.

2. Literature Review

In the first survey, we choose the most popular attribute from the seven branches. The evaluation method is conjoint analysis. There are many elements to evaluation methods. Among them, conjoint analysis is widely used in industries owing to its precise predictions and ease of application. There are many applications of conjoint analysis used in contemporary research. Jaap Fransen utilize a web-based questionnaire with 91 specialists via email [14]. This study uses a binary logit model to analyze the data to find part-worth utilities related to gout. Taylor proposes a literature review of conjoint analysis and its implications in the field of rheumatology [15]. This study not only attempts to find factors but also defines criteria. Other studies use online and interview-based questionnaires with manipulated photographed streets [16]. The photographs list different factors with different levels to offer situations for participants to choose.

According to the results of the first survey, the core attribute respondents would be priced by WTP in the second survey. Willingness to pay (WTP) is a popular, price reveal method in experimental economics, as it is easy to perform and read. As a typical value-oriented method, WTP has been widely used in the last 30 years. Owing to increasing wealth, people prefer satisfaction (personal inter value) to basic function. Referring to previous studies, the two types of motivations that drive consumption behavior are either useful and affordable, or useless with an attractive price [17]. Among many similar products, the one with more add-on value and acceptable price could be the best seller. This is the reason for the increasing popularity of WTP. It is customer oriented. However, there are two ways to reveal WTP using the survey. One is direct and the other indirect; however, both are widely used currently. Added-on value (additional WTP) is calculated using the indirect [18] method with choice experiment. Currently, most researchers who focus on relationships among independent variables use the direct method [19–22]. However, the indirect method is better for real things, which one can feel and touch, as it allows comparison. Currently, IoV is still an experimental product, although one of its attributes – navigation – is in use. However, it is still far from future IoV, meaning that it is difficult to have an exact opinion on IoV today. On the other hand, the first survey compares each attribute. Based on these considerations, this study uses the direct method. The direct method is mostly used in the absolute price revealing process. The direct method is embedded in the contingent value method (CVM) survey, which is widely used in many fields [23–28]. It enables the direct calculation of respondents' willingness to pay for these services.

The basic procedure of a direct WTP measurement has two steps. First, a survey should be conducted among the target customers to reveal the monetary value of the special product. In this step, the survey is conducted using bidding games, discrete choice method, payment card, and open-end questions. Second is measurement. As the WTP from the survey is individual preference and may contain some sample bias, we use the statistical method to find the essential value of the product. In this stage, the logit model and probit model are most popular models. **Fig. 1** shows the structure of research on price revealing and its methods. As the second survey contains the binary

Survey on the Price Distribution of Internet of Vehicle

Base on PWC (https://www.strategyand.pwc.com/cn/home/report/connected-car-2015-study) the attributes of the IoV has been dividend into seven parts. You can treat IoV as an application of internet of things. The definition of the seven attributes are listed as follows:

1. Autonomous driving: Operation of the vehicle without a human driver at the controls, existing only on a partial basis. Examples include self-parking cars, motorway assistance, and the transportation of goods by trucks on well-delineated routes.
2. Safety: The ability to warn the driver of road problems and automatically sense and prevent potential collisions. Exa mples include danger warning signals and emergency call functions.
3. Entertainment: Functions that provide music and video to passengers and the driver. Examples include smartphone i nterfaces, Wi-Fi or Local Area Network hotspots, access to social networks, and the "mobile office."
4. Well-being: Optimization of the driver' s health and competence. Examples include electronic alerts that detect or m itigate fatigue, and other forms of individual assistance.
5. Vehicle management: Support for minimizing operating cost and increasing comfort. Examples include remote contr ol of car features, displays of service and vehicle status, and the transmittal of traffic data.
6. Mobility management: Guidance on faster, safer, more economical, and more fuel-efficient driving, based on data ga thered for the vehicle. Examples include real-time traffic information displays, displays of repair and service-related info rmation, and the transfer of usage data.
7. Home integration: Links to homes, offices, and other buildings. Examples include the integration of the automobile i nto home alarms or energy monitoring systems.

The products mentioned in this survey are integrated with these attributes with different levels. The different levels giv e a different performance of IoV.

Fig. 2. Brief description of the survey.

question, this study chooses the binomial logistic model for evaluating WTP.

3. Research Design

Two surveys and three steps are necessary for revealing the price distribution of the IoV attributes. First, using conjoint analysis, we find the dominant attributes (three in this study) among customers. Second, the study constructs the price-population relationship according to the IoV with combined attributes filtered in the first survey. These relationships could support the management of IoV technology. In this step, this study applies the CVM. Third, the study calculates the average price of each type of IoV with combined attributes using the logit method.

3.1. Dominant Attributes Filter

To obtain a precise result, this study uses an online survey instead of face-to-face interviews, as this technique keeps the geographical bias at a minimum. The survey was delivered on the most popular Chinese survey website [29]. The delivery time is from August 3, 2016 to September 18, 2016. As this survey is oriented for Chinese vehicles, it uses Chinese as the basic language in the survey. All pictures in this study are translations. The survey has three parts.

The first is the description. To remove the technical blind spot, a brief description of IoV and its seven attributes are displayed at the head of the survey with simple examples. **Fig. 2** shows the exact description of the survey. **Table 1** shows the details of each attribute.

The second part is the main body. Owing to the seven attributes and three levels (high, middle, low) with each, there would be 3^7 combinations in the full-profile method. Even the choice-based pair compare method would have over 100 pairs. This is an impossible mission for respondents. This study introduces an orthogonal table to decrease the dimension. Finally, there are 18 existing products with full-profiles, with details in **Table 2**. For a survey, 18 products are quite normal; however, the 18 products are inherently connected in a comparable survey. To reduce pressure on respondents, the rate method has been replaced by the scoring method, which scores the product independently. Statistics show that people submit most online surveys by phone; therefore, to simplify the process, the score blank has been changed to a slide bar with a range from 0 to 100. **Fig. 3** shows the structure of the question.

The third part is demographic questions, which include age, education, and salaries.

3.2. Price Distribution

In this section, we use the three attributes collected from the previous survey as the elements. The IoV products used in this survey all comprise of these three attributes with two quality levels: high quality and middle quality. This survey is also delivered via website [30] and the delivery window is from December 11, 2016 to February 11, 2017. Like the previous survey, this one is also in Chinese.

The survey contains three parts. The first is the description. Similar to the previous survey, some terms should be clarified. The details of the description are shown in

Table 1. Details of each attribute.

Attribute	*Quality categories*
Moving management	High: high precisions of route planning
	Middle: average precisions of route planning
	Low: poor precisions of route planning
Vehicle management	High: high quality of minimizing operating cost
	Middle: average quality of minimizing operating cost
	Low: poor quality of minimizing operating cost
Entertainment	High: broad range of entertainment function
	Middle: average range of entertainment function
	Low: narrow range of entertainment function
Well-being	High: broad range of driver's health and competence
	Middle: middle range of driver's health and competence
	Low: narrow range of driver's health and competence
Autonomous driving	High: more options on automotive
	Middle: average options on automotive
	Low: fewer options on automotive
Safety	High: more sense on potential collisions
	Middle: average sense on potential collisions
	Low: few sense on potential collisions
Home integration	High: more types of compatible devices
	Middle: average types of compatible devices
	Low: fewer types of compatible devices

Table 2. Details of 18 products in the first survey.

The level of each attribute	**Moving management**	**Vehicle management**	**Enter-tainment**	**Well-being**	**Autonomous driving**	**Safety**	**Home integration**
Product one	High	High	High	High	High	High	High
Product two	High	Middle	Middle	Middle	Middle	Middle	Middle
Product three	High	Low	Low	Low	Low	Low	Low
Product four	Middle	High	High	Middle	Middle	Low	Low
Product five	Middle	Middle	Middle	Low	Low	High	High
Product six	Middle	Low	Low	High	High	Middle	Middle
Product seven	Low	High	Middle	High	Low	Middle	Low
Product eight	Low	Middle	Low	Middle	High	Low	High
Product nine	Low	Low	High	Low	Middle	High	Middle
Product ten	High	High	Low	Low	Middle	Middle	Low
Product eleven	High	Middle	High	High	Low	Low	Middle
Product twelve	High	Low	Middle	Middle	High	High	Low
Product thirteen	Middle	High	Middle	Low	High	Low	Middle
Product fourteen	Middle	Middle	Low	High	Middle	High	Low
Product fifteen	Middle	Low	High	Middle	Low	Middle	High
Product sixteen	Low	High	Low	Middle	Low	High	Middle
Product seventeen	Low	Middle	High	Low	High	Middle	Low
Product eighteen	Low	Low	Middle	High	Middle	Low	High

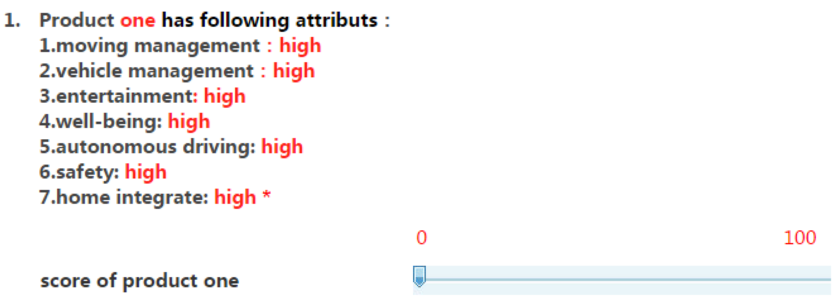

Fig. 3. The structure of the question.

Survey on the Price Distribution of Internet of Vehicle

This survey contains three attributes of internet of vehicle and each attribute has two quality levels such as high quality and middle quality. The description of the three attributes are listed below:

1. Safety: The ability to warn the driver of road problems and automatically sense and prevent potential collisions. Exa mples include danger warning signals and emergency call functions.
2. Well-being: Optimization of the driver' s health and competence. Examples include electronic alerts that detect or m itigate fatigue, and other forms of individual assistance.
3. Mobility management: Guidance on faster, safer, more economical, and more fuel-efficient driving, based on data ga thered for the vehicle. Examples include real-time traffic information displays, displays of repair and service-related info rmation, and the transfer of usage data.

The products mentioned in this survey are integrated with these attributes with two levels. The different levels give a di fferent performance of IoV.

****Assumption: The price of a product integrated with middle level of moving management, middle level of safety, mi ddle level of well-being is RMB 2500

Fig. 4. Description of the price distribution survey.

1. Do you want to buy an IoV product with high level quality of Moving Management and middle level q uality of safety and middle level quality of well-being with RMB 3000? *

○ Yes

○ No

Fig. 5. A dichotomous question.

6. According to the [q5] price,how much extra at most you want to pay for the high quality of moving m anagement, high quality of well-being and middle quality of safety? 0 means you do not want to pay f or this product. *

RMB 0 999

Fig. 6. An open question.

Fig. 4.

The description gives details of each attribute and lists how the quality of the attributes is decided, as service quality standard (represented as high, middle and low). As the respondents may have no idea of the price of the corresponding product, we provide the reference price of a product with middle quality among all three attributes (which is last phase of description part) for comparison.

The following section is a WTP experiment with dichotomous questions. First, a product with exact quality of three attributes and a reference price is given to the respondents to accept or decline, which is shown in **Fig. 5**. If the respondent accepts this price, a higher price would be given to answer and if not, the lower price would be given. After three turns, an open question would be given to the respondent. An example of the dichotomous question and the open question is listed below, which is shown in **Fig. 6**.

The last part is also a demographic question, which includes gender and salary. And the biding process can be described as **Fig. 7**.

3.3. Average Price of Each Combined IoV Product

As the assumption of WTP, the bid price and individual characters (gender and salary in this study) can affect WTP. The decision of individual i, y_i, whether to buy would be defined.

$$y_i = X_i\beta + bid_i b + a \quad (1)$$

β, a, b are estimated parameters, bid_i is the bid price and X_i are characters of individual i.

According to the answers in the second survey, Hanemann [31] represented the single bound probability of affirmative answer and negative answer using the dichotomous method as follows:

$$P^y = 1 - D(bid, \theta) \quad (2)$$

$$P^n = D(bid, \theta) \quad (3)$$

P^y stands for the probability of affirmative answer (answer with yes) and P^n represents the probability of a negative answer. $D(bid, \theta)$ stands for the cumulative distribution function, (CDF) refers to the parameter θ and bid price bid. This also can be interpreted as the CDF of an individual's maximum WTP, as the response would be "yes" only the bid price is less than the maximum WTP.

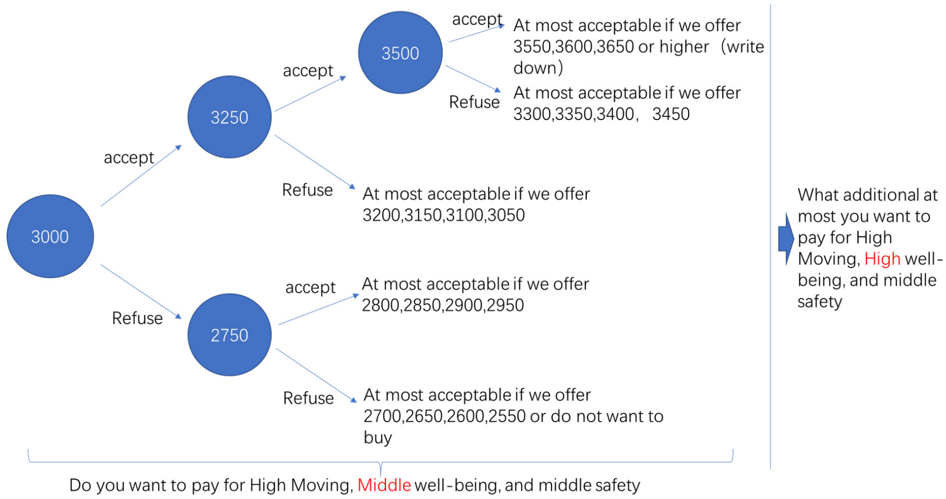

Fig. 7. Bid scheme of the dichotomous method (CNY).

For a normal product, the price distribution always has a long right tail [23]. Accordingly, the most widely used parametric distribution of WTP is the logistic and log-logistic function [32]. As the log-logistic function is better than the logistic one in terms of goodness-of-fit, this study uses the log-logit model. Bishop [33] proposed $D(bid,\theta)$, which satisfied the log-logit CDF as follows:

$$P^n = D(bid,\theta) = \left[1+e^{a-b(\ln(X_i\beta+bid_ib))}\right]^{-1} \quad . \quad (4)$$

where $\theta \equiv (a,b)$, which means that the estimated probability of price by the maximum likelihood method can be described as follows:

$$\mathrm{lnL}(\theta) = \sum_{i=1}^{N}\{d_i^y \mathrm{ln}P^y(bid_i) + d_i^n \mathrm{ln}P^n(bid_i)\} \quad . \quad (5)$$

d_i^y and d_i^n are dummy variables. If the answer is yes, d_i^n equals 0 and d_i^y equals 1.

Based on this theory, this study uses three-turn bids. The level of the following bid price is referred to the answer of the previous bid price. For instance, if the individual accepts the first bid, the second bid price would be higher than the first one. If not, the price of the second bid would be lower. If the individual refuses the second bid with acceptance of the first bid, the third bid price would be between the first and second price. Thus, there would be eight situations in this study. (a) P^{yyy} all the answers are "yes"; (b) P^{nnn} all the answers are "no"; (c) P^{yny} first "yes" second "no," third "yes"; (d) P^{ynn} first "yes," second "no," third "no"; (e) P^{yyn} first "yes," second "yes," third "no"; (f) P^{nny} first "no," second "no," third "yes"; (g) P^{nyy} first "no," second "yes," third "yes"; (h) P^{nyn} first "no," second "yes," third "no." Under the assumption of utility maximizing of the respondent, the likelihood of the answer could be represented as follows. In the case of (a), bid_{i1} is the first bid price of respondent i. $bidh_{i2}$ is the higher price of the second bid. $bidh_{i3}$ is the higher price of the third bid.

$$\begin{aligned} P^{yyy}&(bid_{i1}, bidh_{i2}, bidh_{i3}) \\ &= \Pr\{bid_{i1} \le \max WTP, bidh_{i2} \\ &\quad \le \max WTP, bidh_{i3} \le \max WTP\} \\ &= \Pr\{bid_{i1} \le \max WTP | bidh_{i2} \\ &\quad \le \max WTP, bidh_{i3} \le \max WTP\} \\ &\quad \cdot \Pr\{bidh_{i2} \le \max WTP | bidh_{i3} \le \max WTP\} \\ &\quad \cdot \Pr\{bidh_{i3} \le \max WTP\} \\ &= \Pr\{bidh_{i3} \le \max WTP\} = 1 - D(bidh_{i3},\theta) \end{aligned} \quad (6)$$

As $bidh_{i2} < bidh_{i3}$, $\Pr\{bidh_{i2} \le \max WTP | bidh_{i3} \le \max WTP\} \equiv 1$. Thus, other cases are represented below:

$$P^{yny}(bid_{i1}, bidh_{i2}, bidl_{i3}) = D(bidh_{i2},\theta) - D(bidl_{i3},\theta) \quad (7)$$

$$P^{yyn}(bid_{i1}, bidh_{i2}, bidh_{i3}) = D(bidh_{i3},\theta) - D(bidh_{i2},\theta) \quad (8)$$

$$P^{nyy}(bid_{i1}, bidl_{i2}, bidh_{i3}) = D(bid_{i1},\theta) - D(bidh_{i3},\theta) \quad (9)$$

$$P^{ynn}(bid_{i1}, bidh_{i2}, bidl_{i3}) = D(bidl_{i3},\theta) - D(bid_{i1},\theta) \quad (10)$$

$$P^{nny}(bid_{i1}, bidl_{i2}, bidl_{i3}) = D(bidl_{i2},\theta) - D(bidl_{i3},\theta) \quad (11)$$

$$P^{nyn}(bid_{i1}, bidl_{i2}, bidh_{i3}) = D(bidh_{i3},\theta) - D(bidl_{i2},\theta) \quad (12)$$

$$P^{nnn}(bid_{i1}, bidl_{i2}, bidl_{i3}) = D(bidl_{i3},\theta) \quad (13)$$

After these three-turn bids, the range of true WTP has narrowed rapidly and the log-likelihood function takes the form:

$$\ln L(\theta) = \sum_{i=1}^{N} \{ d_i^{yyy} \ln P^{yyy}(bid_{i1}, bidh_{i2}, bidh_{i3}) + d_i^{yny} \ln P^{yny}(bid_{i1}, bidh_{i2}, bidl_{i3}) + d_i^{yyn} \ln P^{yyn}(bid_{i1}, bidh_{i2}, bidh_{i3}) + d_i^{nyy} \ln P^{nyy}(bid_{i1}, bidl_{i2}, bidh_{i3}) + d_i^{ynn} \ln P^{ynn}(bid_{i1}, bidh_{i2}, bidl_{i3}) + d_i^{nny} \ln P^{nny}(bid_{i1}, bidl_{i2}, bidl_{i3}) + d_i^{nyn} \ln P^{nyn}(bid_{i1}, bidl_{i2}, bidh_{i3}) + d_i^{nnn} \ln P^{nnn}(bid_{i1}, bidl_{i2}, bidl_{i3}) \} \quad (14)$$

d_i^{nnn} is a dummy variable, and if it is equal to 1 it means that the respondent's answer is similar to case (a).

As Hanemann [31] mentions, the maximum likelihood (ML) estimator θ, can be solved by

$$\frac{\partial \ln L(\theta)}{\partial \theta} = 0 \quad (15)$$

Since $\theta \equiv (a, b)$ according to Eqs. (4) and (1), the WTP can be expressed as

$$WTP = \exp\left(-\frac{a + X\beta}{b}\right). \quad (16)$$

4. Results

The program used in this study is R. As there are two surveys and the output of the first survey is the input of the second, the result would be listed separately.

4.1. Result of Conjoint Analysis

Based on the high-efficiency website, over the one-month delivery time, there are 437 respondents. As the automotive discard function is in effect, which means that the survey will be discarded if it remains uncompleted, the 437 respondents are effective and the average time cost is 210 seconds. **Fig. 8** shows the importance of seven attributes and **Table 3** lists the part utilities.

As **Table 3** shows, the F-statistic is 14.09, P-value is less than 2.2e-16. From a statistical aspect, this survey is statistically significantly. As **Fig. 8** shows, the first three significant points of the IoV among these respondents are safety, moving management, and well-being, which would be the input elements of the second survey. The details of the first survey can be seen in another paper [34].

4.2. Result of WTP

After delivering the questionnaire for over two months, we received 464 answers with 440 effective. The payment schemes of the dichotomous method are shown below.

There are eight types of products and only three have been used in the interview, as the other types of products are tested using open questions, owing to the workload.

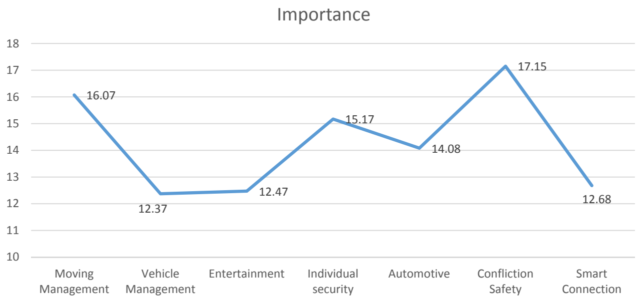

Fig. 8. Importance of the seven attributes.

The other situation is tested by the extra payment method. For instance, according to the payment of high quality of moving management, middle quality of well-being, and middle quality of safety, how much extra do you want to pay for high quality of moving management, high quality of well-being, and high quality of safety. Thus, the expected WTP of high quality of moving management, middle quality of well-being, and middle quality of safety can be described as high quality of moving management, high quality of well-being, and high quality of safety, plus the average value of the extra payment.

Table 4 lists the payment willingness distribution of interviewees under the dichotomous method.

The decision regression function in this study is shown below, and the description of each parameter is shown in **Table 5**.

$$y_i = \beta_1 age + \beta_2 gender + bid_i b + a \quad (17)$$

Table 6 lists the parameter descriptions in Eq. (16) and the socio-demographic details.

According to Eq. (17), the parameters and coefficients are listed in **Table 7** below.

Tables 4 and **7** reveal the price distribution (relationships between price and number of people want to buy) of different types of products. For instance, the price distribution of products with high quality of moving management, middle quality of well-being, and middle quality of safety (HMM), middle quality of moving management, middle quality of well-being, and high quality of safety (MMH) and middle quality of moving management, high quality of well-being, and middle quality of safety (MHM) are shown below.

5. Result Analysis

From **Fig. 8** and **Table 2**, the favorable attribute of IoV for the Chinese is safety, with 17.15% importance. The top three concerning attributes are safety, moving management, and well-being, respectively. This is surprising, as the idea of IoV originates from entertainment (ranked sixth) and autonomous driving (ranked fourth), which seems not so attractive to the Chinese. In contrast, the considerations of a traditional vehicle, such as safety, still dominate consumer decision making. To find if this

Table 3. Part utilities of IoV.

	Moving management	Vehicle management	Enter-tainment	Well-being	Autonomous driving	Safety	Home integration
High	34.50	24.27	13.16	49.74	34.64	55.78	13.54
Mid	−12.03	0.15	11.69	−0.66	−0.37	−0.21	11.42
Low	−22.96	−25.81	−24.86	−43.10	−30.84	−53.66	−2.49
F-statistic: 14.09						P-value: <2.2e-16	

Table 4. Payment willingness distribution of interviewees under the dichotomous method.

The product identification	The answer of the first bid	The answer of the second bid	The answer of the third bid	Number of people	Percentage of all people
HMM	No	No	No	42	9.5
MHM	No	No	No	50	11.4
MMH	No	No	No	30	6.8
HMM	Yes	Yes	Yes	90	20.4
MHM	Yes	Yes	Yes	135	30.6
MMH	Yes	Yes	Yes	150	34.0
HMM	Yes	Yes	No	42	9.5
MHM	Yes	Yes	No	40	9.0
MMH	Yes	Yes	No	35	8.0
HMM	Yes	No	Yes	12	2.7
MHM	Yes	No	Yes	15	3.4
MMH	Yes	No	Yes	15	3.4
HMM	No	Yes	Yes	4	0.9
MHM	No	Yes	Yes	20	4.5
MMH	No	Yes	Yes	15	3.4
HMM	No	No	Yes	10	2.3
MHM	No	No	Yes	15	3.4
MMH	No	No	Yes	5	1.1
HMM	No	Yes	No	18	4.1
MHM	No	Yes	No	15	3.4
MMH	No	Yes	No	25	5.7
HMM	Yes	No	No	82	18.6
MHM	Yes	No	No	70	15.9
MMH	Yes	No	No	120	27.2
HMM	NA[1]	NA	NA	140	31.8
MHM	NA	NA	NA	80	18.1
MMH	NA	NA	NA	45	10.2

NA[1] Sign: "NA" means the respondent does not want to pay for this product.

Table 5. Description of parameters of the decision regression function.

Parameters	Unit	Description
y_i		The decision dummy variable, 1 means yes, 0 means no
age	year	3 age ranges: 1 means 10–20, 2 means 20–30, 3 means 30–40
$gender$		1 means male, 0 means female
bid	RMB	The last bid price
μ_i		The intercept of regression

is due to the respondents' unfamiliarity with IoV, we ask 10 randomly chosen respondents if they had heard of IoV. They all answer yes. Therefore, we assume that the Chinese are not ready for rapid changes in vehicle systems. Even for future technologies, their primary consideration is still safety, which is one of the defining characteristics of a traditional vehicle. **Table 7** proves this point. The Chinese are willing to pay an additional CNY 1000 (30% of the original price) in advanced security systems, e.g., which is the WTP difference between HHH and HMM. This payment is much higher than additional payments for advanced moving management system (average CNY

Table 6. Socio-demographic factors ($N = 440$) and corresponding population data.

Variables	Mean	Std. Dev.	Min	Max
Gender (male = 1)	0.4	0.79	0	1
Age	5.19	28.4	20	40

Table 7. Coefficient of each parameter and statistics information.

The product identi-fication	a	Z-value	b	Z-value	β_1	Z-value	β_2	Z-value	Mc Fadden R2	AIC	Expected WTP
HMM	−24.19	−2.6**	0.006287	2.5*	1.35	1.4	1.24	1.0	0.339	33.46	3190
MHM	−10.33	−2.2*	0.004423	2.6**	−2.17	−1.99*	−0.10	−0.1	0.268	43.5	3288
MMH	−31.52	−2.8**	0.01196	2.8**	−4.59	−2.0*	0.01	0.01	0.554	31.29	3586
HHM	−24.19	−2.6**	0.006287	2.5*	1.35	1.4	1.24	1.0	0.339	33.46	3619
HMH	−24.19	−2.6**	0.006287	2.5*	1.35	1.4	1.24	1.0	0.339	33.46	3647
MHH	−10.33	−2.2*	0.004423	2.6**	−2.17	−1.99*	−0.10	−0.1	0.268	43.5	3790
HHH	−10.33	−2.2*	0.004423	2.6**	−2.17	−1.99*	−0.10	−0.1	0.268	43.5	4126

**p<0.001
*p<0.01

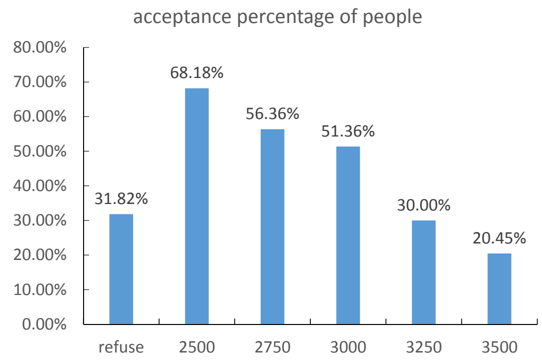

Fig. 9. Price distribution of HMM.

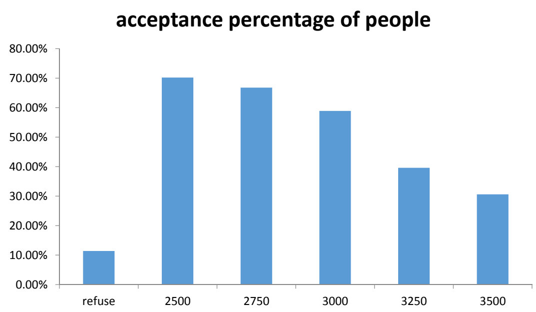

Fig. 11. Price distribution of MHM.

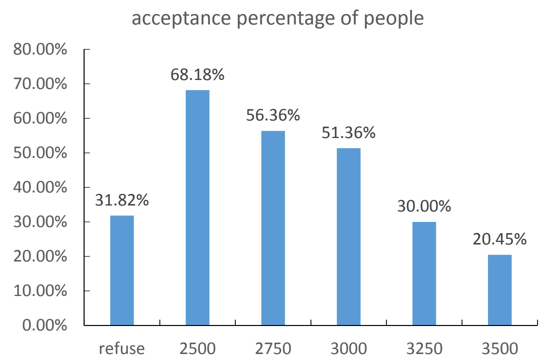

Fig. 10. Price distribution of MMH.

150), e.g., the WTP difference between MMH and HMH, which is shown in **Figs. 9–11**. This is a guideline for technology management, which can enable a scientific arrangement of technology development. The manufacturer should first develop the attributes of security, especially for the Chinese market. Similarly, with other attributes in **Table 2**, at the beginning, if the manufacturers invest too much in other functions such as entertainment, it may be a big culture shock for the market. Specifically, in terms of safety, autonomous driving, well-being, and vehicle management, the differences in each level among its own attributes are quite even, which means that the high levels of this attribute would affect customer evenly. However, the difference between the high level and middle level of the moving management is bigger than in others (percentage). This means that in the field of moving management, people are sensitive about quality. On the other hand, for smart connect and entertainment, the difference between high level and mid-level is small, which is fine for respondents that prefer normal quality.

On the other hand, **Fig. 4** shows that some consumers do not want to pay for this product, e.g., answers with NA. Especially for HMM, over a quarter do not want to pay. **Fig. 6** shows that respondents who take the second survey are mostly male and young (20–30), who consider this product. In technology management, designers should consider the growing share of female and elder population in the vehicle market. For example, designers can enhance the attributes of IoV for females or the elderly, e.g., beauty, and augmented reality.

6. Conclusion

This study gives a brief outline of each attribute of IoV and its presence in the Chinese market. There are two surveys included in this study. The first focuses on all the attributes and attempts to reveal the dominant attribute in the Chinese market. This survey is conducted with the rating scheme and evaluated using conjoint analysis. The results reveal that people in China are more concerned about well-being than entertainment or autonomous driving, which is the basic idea of IoV. In the second survey, the top three attributes picked up from the first survey are included in the questionnaire to make a virtual product. The CVM is used to construct the survey and the different dichotomous method with two bounds is built to collect the data. The WTP is evaluated using a log-logit model. The second survey proves the result of the first survey, showing that the security attribute of IoV is more attractive among people in China. The WTP of each combination is calculated.

The results of this study can be used as a guideline for technology management in IoV. Manufacturers can arrange systems and direct the development of technology. For customers, different IoV products can leave a holistic impression of the concept. The most acceptable attribute of IoV can be the point of insertion for this technology in the market. Furthermore, if the market recognizes and responds to IoV products, it will give a strong signal to the government to enhance infrastructure.

However, this study has some limitations. First, it does not consider the distribution of price and number of people. Second, as there are seven attributes of IoV, conjoint analysis is still a hard workload for respondents, which may result in sample bias. Future research can consider building a decision-making model based on these data to enhance the welfare of society.

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