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Research Article

Analysis of Individuals' Acceptance and Influencing Factors for Young Users of Autonomous Vehicles Using the Hybrid Choice Model

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Autonomous vehicles (AVs) are a vital direction for intelligent transportation; nevertheless, the current research is insufficient, and the aspects and mechanisms that influence individuals' adoption of AVs require additional investigation. This study examines the acceptance of the popularity of AVs from three perspectives: personal-psychological attributes, travel characteristics attributes, and latent variables. The descriptive statistical analysis revealed that the acceptance rate of AVs was 54.6% based on 304 valid questionnaires received through online questionnaires. And the proportion of the 18~50 group in the article reached 92.8%; thus, this study takes the young group as the object to investigate the acceptance of AVs. A quantitative analysis of each factor's impact on the acceptability of AVs was conducted using the hybrid choice model (HCM), which was utilized to observe the link between latent variables. Results from parameter estimates demonstrate that the HCM's fitting impact when latent factors are taken into account is superior to that when latent variables are not taken into account. When latent variables are taken into account, the associated goodness ratio coefficient rises by 0.2337 to 0.2898, which is greater than the model as a whole. The three factors with the highest impact on AV acceptability among the five latent variables were attitude toward use, sense of use gain, and perceived trust, with matching *z*-test values of 2.42, 2.44, and 2.12, respectively. The development and marketing of AVs by pertinent businesses and government agencies would benefit greatly from this research as a source of reference.

1. Introduction

China's Ministry of Public Security reported that, as of June 2020, the number of motor vehicles in China had reached 360 million, including 270 million automobiles; there were 440 million drivers of motor vehicles, including 400 million automobile drivers. 4.17 million new energy cars are currently on the road, up 360,000 from the end of 2019 and growing at a 9.45% annual growth rate. The issues of traffic congestion and safety incidents have gotten progressively worse as a result of the rising number of cars. According to the survey, human factors like inattentive driving, speeding, drinking, drug use, and exhaustion are to blame for more than 90% of all traffic accidents [1]. The development of AVs has the potential to lower travel expenses, car emissions, and traffic accidents [2]. Consideration of people's acceptance of AVs is thought to be becoming more and more significant as AVs advance and become more widely used. The purpose of this essay is to examine the elements that influence people's acceptance of AVs and to comprehend how they see them.

The focus of current study is on the determinants of public acceptability of AVs. Travel feature attributes, sociodemographic attributes, and personal-psychological attributes are the categories into which scholars have divided the influencing factors [3].

Perceived usefulness, perceived ease of use, perceived risk, and trust are the primary personal-psychological characteristics [4]. It has been discovered through study that the public's adoption of AVs is strongly influenced by perceived trust. Numerous researches have demonstrated that perceived trust affects the acceptance of AVs and has a direct or indirect effect on psychological characteristics of the individual, such as behavioral intentions [5, 6]. An immediate and consistent consequence is perceived usefulness. It has a good relationship with the acceptance of AV individual use. Regarding the relationship between perceived ease of use and adoption of AVs, scholars are uncertain. While Xu et al. discovered that perceived ease of use does not significantly affect the acceptability of AVs [7], Wu et al. maintain that there is a favorable association between perceived ease of use and acceptance [8]. Furthermore, Bansal et al. discovered that how well people accept their AVs is significantly influenced by how their neighbors, close friends, and family members see AVs [1]. According to the research of Payre et al., inventive people use AVs more frequently [6].

Gender, age, income, place of residence, country, and other pertinent factors fall under sociodemographic traits [4]. According to studies, older age groups are more receptive to using AVs than younger age groups [9, 10]. Instead, Anderson et al. discovered that individuals who are male and younger find AVs more alluring [11]. Additionally, there are variations in income study. According to Kyriakidis et al., there is a positive correlation between income and acceptance [12]; however, the research of Sivak et al. indicates that there is no statistically significant relationship between income and acceptance [13]. Residents of the district are more anticipating the arrival of AVs than those who live in the suburbs, according to the research of Schoettle and Sivak on residence, which revealed that the difference in place significantly affects people's acceptance [14]. Regarding countries, respondents from low-income countries are more likely to use a robot taxi than respondents from high-income countries [15].

Travel-related qualities, which pertain to travel feature attributes, primarily comprise travel cost, travel time, travel distance, etc. [4]. Studies have revealed that the price of travel is positively connected with the acceptance of AVs [16]. Travel and waiting times influence AV selection during times of travel and have a negative association [17]. Bansal et al. [1] contend that trip distance has little bearing on consumers' willingness to pay for AVs.

Only conventional descriptive statistical analysis, analysis of variance, discrete choice models, and structural equation models are often employed models. Quantitative data can be expressed, and the properties of data distribution can be shown through descriptive statistics analysis. Numerous researchers, like Salonen Haavisto [18], employ this strategy in a quantitative way to explain the survey data's distribution law and examine respondents' attitudes and the degree to which other influencing factors affect their adoption of AVs. The correlation between variables can be objectively analyzed, particularly the correlation between factors, using analysis of variance. Nielsen et al. investigated the impact of factors on acceptability using analysis of variance [19, 20]. The precise impacts of age, perceived trust, and other factors impacting the acceptance and readiness to pay for AVs were specifically examined by Gold et al. using ANOVA [21, 22]. Due to its straightforward implementation, high level of stability, strong adaptability, and other advantages, the discrete choice model has become increasingly popular in studies on the acceptability of AVs in recent years. The mixed logit model [23], probit model [24], and multinomial logit [25] are examples of commonly employed discrete choice models. Numerous researchers employed the discrete choice model to investigate the influences of individual psychological traits and social traits on the adoption of AVs [26]. The structural equation model, which can include both explicit observable variables and latent variables that cannot be directly observed, is the model that has been employed in this field most recently. Recently, many scientists, including Lee, have embraced the structural equation model to study the variables influencing AV acceptability. As a result, it has become a common technique for doing so [27].

The HCM addresses the issue with the conventional choice model by taking into account the innate willingness of psychological preferences. It is frequently employed, and some academics use it to analyze sustainable mobility policy [28]. More particularly, it is represented in the sharing of bicycles [29], vehicle sharing [30, 31], the preference for AVs [32], public transit [33], and other modes of transportation. More are applied to the research domains connected to the choice preference research of transportation. Research has also been conducted on the selection of travel modes, including daily travel modes [34] and campus commuting [35]. What is next? Numerous research have examined the effects of particular latent factors on individual travel, including the effects of travel restrictions due to epidemics [36], psychological inertia [37], and the impact of neighborhood accessibility [38].

Latent variable model and discrete choice model are the two components of the HCM. For each pertinent study, the primary authors, discrete choice models, latent variable models, specific situations of their application, and associated latent variables are presented in Table 1. The latent variable model with the greatest applications is the structural equation model, and the discrete choice model with the most applications is the MNL model. Both of these models are used in this work. Table 1 includes information for each pertinent study.

The current study is mostly from the standpoint of individuals in relation to AVs though few studies have taken into account the effects of AVs on individuals. As a result, the latent variable of sense of use gain is introduced in this paper. As noted above, the emphasis of this study topic is on investigating the factors that influence the acceptability of AVs, yet the research methodologies used are all straightforward single models. This study introduces the HCM on the basis of it.

The creation of AVs has become a widespread trend since the dawn of the artificial intelligence era. This study is to perform extensive research on AVs and examine the young Chinese public's understanding and acceptance of AVs in order to comprehend the young's popular views toward AVs. Before promoting new technologies, it is a good idea to research the aspects that affect the public's acceptance of AVs. This can help us better understand the young's needs

Table 1: Papers using the HCM.

The primary author (reference)	Model 1	Model 2	Application scenarios	Latent variables
Gustavo [28]	MIMIC	MNL, MXL	Sustainable mobility policy analysis	Bus fares; travel and waiting times
Diop [29]	SEM	—	Travelers' acceptance of variable message signs	Perception of information quality attitude and familiarity with rerouting
Adnan [30]	SEM	BL	Preferences for using bike share	Duration to keep the bicycle; availability of escorting facility;
Thapa [31]	SEM	Ordered logit	Willingness to use shared AVs	Rail public transport attitude; wheels public transport attitude
Zhang [32]	SEM	Logistics	Car-sharing choice behavior	Reasonable charges; ease of renting and returning;
Hu [33]	SEM	MNL	Willingness to use shared AVs	Travel cost; waiting time.
Mehdizadeh [34]	SEM	MNL	Multimodal and monomodal green transport use	Public transportation accessibility; Ride time to college;
Ramezani [35]	SEM	MNL	Shopping trip mode choice	The shape and dispersion of activity spaces; being physically active; cultural and social affairs;
Chen [36]	SEM	MNL	Travel decisions	Social responsibility; fear of infection; policies related to COVID-19
Roberts [37]	SEM	MNL	Commuting choice behavior	Attitude toward the environment
Puello [38]	SEM	MLM	Travel rates	Neighborhood accessibility; Residential size; affordability

Note. "—" indicates that the discrete choice model used is not specified; MNL: multinomial logit; MXL: mixed logit; BL: binary logit; MLM: mixed linear model. Model 1 indicates the latent models; model 2 indicates the discrete choice models.

and give us ideas for studying and promoting AVs. In order to investigate the adoption of AVs, this study proposes an HCM. The model is a technique that fuses the conventional discrete choice model with the structural equation model. It may include both latent variables, which cannot be seen with the naked eye, and explicit display variables. The discrete choice model, nevertheless, has excellent adaptability and stability. Its high accuracy is a benefit, and it can effectively increase the characterization accuracy of the aspects that affect whether or not AVs are accepted. The present study presented five latent variables, including the sense of use gain, when employing the HCM to explore the acceptability of AVs, with 2–3 display variables serving as each latent variable. Create a structural equation model first in order to calculate the latent variables' link to one another as well as the impact of the corresponding observable factors on the latent variables. In order to determine how each influencing factor affects the acceptance of AVs, the sociodemographic attributes, travel feature attributes, and latent variables represented by display variables were then added to the multinomial logit model. Understanding the contributing elements can help the government create industrial regulations for autonomous driving and give automakers a foundation for projecting market growth and creating marketing plans.

2. Methodologies

2.1. Measurement Development. This article aims to investigate the factors that influence the public's acceptance of AVs, measure the public's specific opinions on the development and popularization of AVs through a questionnaire survey, and provide a theoretical framework for relevant departments to develop policies relating to the promotion of AVs.

The technology acceptance model (TAM) serves as the foundation for this research's questionnaire design. In studies on the acceptance of new technologies, the TAM theory is frequently employed. It is frequently used to examine the internal influences that shape how quickly people accept new technology. In its early stages, the theory of reasoned action (TRA), which Davis et al. developed in 1989, evolved into TAM, a critical theory that was used to investigate how people accept information systems. It is one of the most often utilized model frameworks for researching AV adoption [39]. Figure 1 depicts the fundamental structure of TAM.

TAM introduces four research variables: attitude, behavioral intention, perceived ease of use, and perceived usefulness. There are two key factors. One is perceived usefulness, which is the extent to which people think using a particular system will improve their performance or how well they use AVs. The other is perceived ease of use, which refers to how easy or difficult it is for users to operate a specific system and how much effort is required for an audience to pick up when they are unfamiliar with AVs. A person's attitude can be defined as their positive or negative remarks about promoting and using new technology or a particular behavior. A person's intention to accept a specific behavior is referred to as behavioral intention. Numerous studies have demonstrated that the perceived usefulness of autonomous driving research is a key determinant of its acceptance.

However, for the purpose of foretelling and employing AVs, the perceived ease of use is irrelevant or meaningless. This article takes into account that the majority of interviewees have not personally engaged in virtual driving because AVs have not been utilized on a broad scale; hence, the perceived usability is not taken into account in the study. Based on this, the research

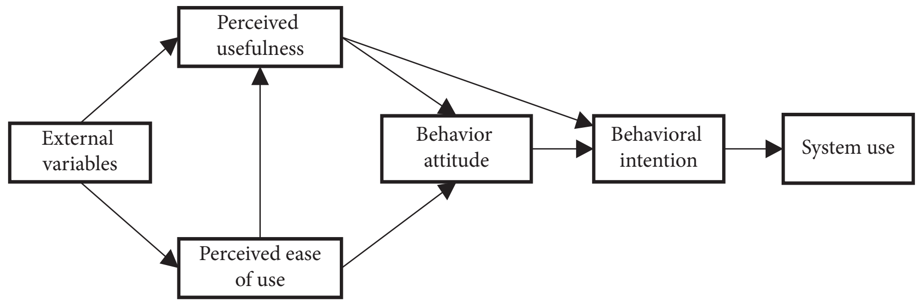

Figure 1: Framework of TAM.

expands the theory of technology acceptance by removing the perceived ease of use and simultaneously adding the two latent variables of sense of use gain and perceived trust.

The questionnaire for this study is broken down into three sections based on the findings of an earlier survey on inhabitants' acceptability of different forms of transportation. Users' characteristics, such as gender, age, education level, occupation, monthly income, possession of a driver's license, number of vehicles owned, and driving experience, make up the first section. The second section consists of attributes related to travel, such as the way and duration of commutes. The latent variables of consumer attitudes toward AVs make up the third section. Attitude toward use (ATU), perceived trust (PT), behavior intention to use (BIU), perceived usefulness (PU), and sense of use gain (SEU) are five latent factors connected to the adoption of AVs that are taken into account by the questionnaire in this study. The psychological gratification and pleasure brought on by utilizing AVs are expressed by the sense of use gain. Table 2 presents the display variables that correlate to the latent variables used to describe ATU, PT, BIU, PU, and SEU. The displayed variables are measured by the Likert scale method, and the selection ranges from "strongly support" and "strongly agree" to "strongly disagree" and "strongly disagree," and the corresponding numerical range is 1~5.

2.2. Hybrid Choice Model. Numerous elements, such as individual traits, behavioral patterns, and subjective preferences, influence how well AVs are received. Therefore, it is important to take into account the impact of variables like traveler perception and attitude when researching the acceptance of AVs. In this context, Ben-Akiva took into account subjective psychological aspects in modeling choice behavior in 2002 and incorporated them into the conventional discrete choice model, known as the HCM [49]. As a first analysis, the HCM was chosen to process and examine the data. The HCM incorporates latent variables into the discrete choice model, based on the early travel modes, to take psychological considerations into account in the factors influencing the acceptability of AVs.

Essentially, an HCM is an extended discrete choice model with latent variables, as shown in Figure 2.

This study carefully took into account five latent variables: attitude toward use, perceived trust, behavior intention, perceived usefulness, and sense of use gain. According to Figure 3, in particular, a structural equation model and a discrete choice model make up the HCM's framework.

Suppose that the utility of residents making a certain choice u_{i} is

$$u_i = \alpha_i s + c_i \eta + \lambda_i z + \varepsilon, \tag{1}$$

where s is the vector of individual attributes of observable residents, including gender, age, income, and other variables that characterize the individual's attributes; η represents unobservable potential variables. This article refers explicitly to residents' attitude toward use, perceived trust, behavioral intention, perceived usefulness, and sense of use gain. z is the individual travel attribute, including commuting time, way of commuting; λ_{i}, α_{i}, c_{i} are the parameters to be estimated; ε is a random item, representing the error in the estimation process of the model.

Assuming that customers always select the option that maximizes utility when making behavioral decisions, the maximizing function d should be

$$d = \begin{cases} 1, & \mathrm{u} = \max(u_i), \\ 0, & \text{others}. \end{cases} \tag{2}$$

The following is the definition of the structural equation of the relationship between the reaction's latent variables:

$$\eta = \Gamma s + \xi, \tag{3}$$

where η represents the endogenous latent variable; s represents the exogenous display variable; Γ represents the parameter matrix to estimate the influence of the exogenous latent variable on the endogenous display variable; ξ represents the residual value of the structural equation model.

Define the measurement equation as

$$y = \Lambda \eta + \nu, \tag{4}$$

where y represents the vector composed of endogenous indicators; Λ represents the parameter matrix to be estimated; ν represents the error term.

Formula (1) and formula (2) constitute a discrete choice model, and formula (3) and formula (4) together constitute a structural equation model with multiple index reasons.

Table 2: Display variables that characterize latent variables.

Latent variable	Display variable	Symbol	Source
Attitude toward using	Are you interested in AVs?	ATU1	Degirmenci [40] and Taylor [41]
	Are you willing to look forward to the popularity of AVs?	ATU2	
	Do you think AVs can replace traditional cars?	ATU3	
Perceived trust	Do you think AVs are trustworthy?	PT1	Choi [42] and Martina [43]
	Do you think AVs are safer than driving by yourselves?	PT2	
	Will you concentrate on events unrelated to driving while on the road?	PT3	
Behavioral intention	Are you willing to ride in an AV?	BIU1	Panagiotopoulos [44] and Rahman [45]
	Are you willing to buy an AV?	BIU2	
	Are you willing to recommend AVs to friends?	BIU3	
Perceived usefulness	Do you think AVs can improve travel efficiency?	PEU1	Yang [46] and Wang [47]
	Do you think using AVs can deliver a higher quality of life?	PEU2	
Sense of use gain	Do you think using AVs to travel will have a sense of use gain?	SEU1	Liao [48]
	Do you think using AVs can bring psychological satisfaction?	SEU2	
	Do you think AVs are a symbol of status?	SEU3	
	Are you willing to pay for customized services of AVs for the sense of use gain?	SEU4	

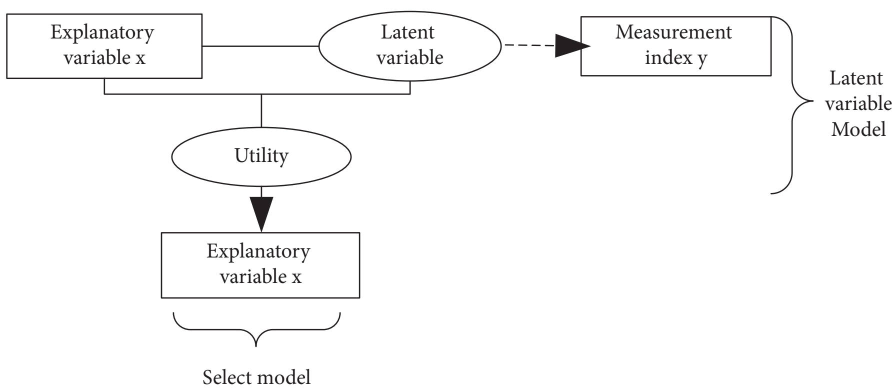

Figure 2: Structure of HCM.

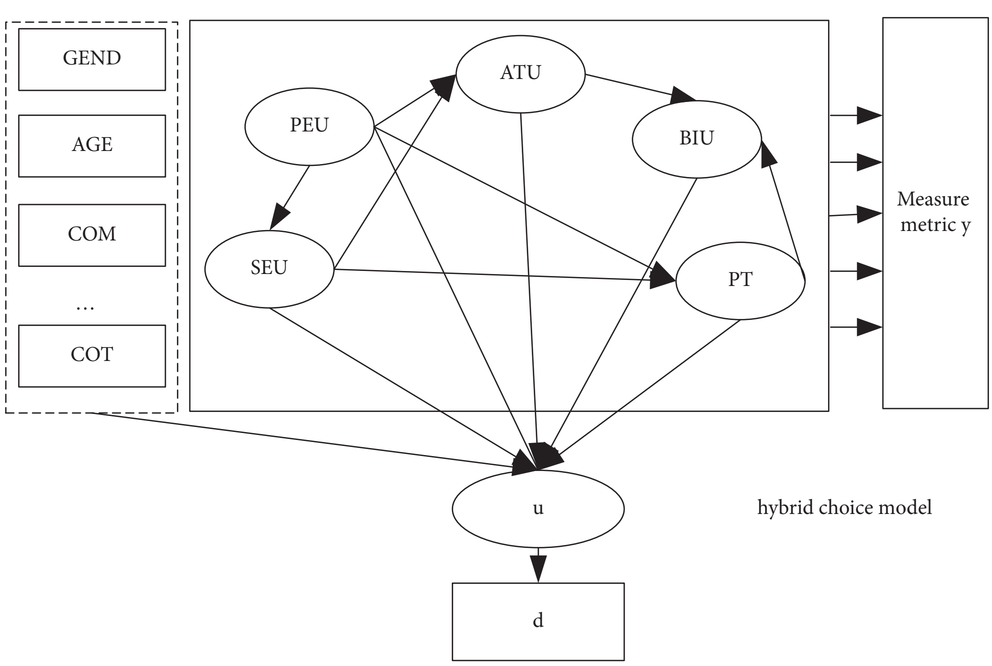

Figure 3: The full path of the HCM.

$$\eta_j = \lambda_{j1}S_{\text{gend}} + \lambda_{j2}S_{\text{age}} + \lambda_{j3}S_{edu} + \lambda_{j4}S_{occ} + \lambda_{j5}S_{in} + \lambda_{j6}S_{\text{linsence}} + \lambda_{j7}S_{\text{car}} + \lambda_{j8}S_{de} + \cdots + \lambda_{jp}S_x, \quad (5)$$

where η_j is the latent variable of the individual's perceived usefulness, perceived ease of use gain, behavior, attitude, etc.; λ_{j1}, λ_{j2}, λ_{j3}, λ_{j4}, λ_{j5}, λ_{j6}, λ_{j7}, λ_{j8}, λ_{jp}, respectively, represent the parameters to be estimated corresponding to the characteristic attributes gender, age, education level, occupation, income, whether you have a driver's license, the number of vehicles owned, driving experience, and commuting mode; S_{gend}, Sa_{ge}, S_{edu}, S_{occ}, S_{in}, S_{linsence}, S_{car}, S_{de}, S_x, respectively, represent the characteristic attributes gender, age, education level, occupation, income, whether you have a driver's license, the number of vehicles you have, driving experience, and commuting mode.

Given that the values of the variables that describe how individuals perceive AVs in this article are multivariate, a discrete choice model and regression are created using the multinomial logit model. When different selection behaviors in the explanatory variables are paired, the multinomial logit model can be thought of as a collection of binary logit models. The particular model is written as follows:

$$\frac{\pi_{r\delta}}{\pi_{r1}} = \frac{P(y_r = \delta|x)}{P(y_r = 1|x)} = \exp(x_r'\beta_\delta)\delta = 2, 3, \quad (6)$$

where this article chooses the first group as the default selection of the benchmark group; δ is the number of types included in the explanatory variable, classified into three categories in this article, which are to maintain a positive attitude, a negative attitude, and a hesitant attitude towards the future of AVs as a revolutionary product; there are three types of attitudes; y_r is a vector representing the endogenous indicators corresponding to the r^{th} explanatory variable; $P(y_r = 1|x)$, π_{r1} indicates the probability corresponding to the r^{th} explanatory variable of the first category group; $P(y_r = \delta|x)$, $\pi_{r\delta}$ indicates the probability corresponding to the r^{th} explanatory variable in the δ^{th} category group; x_r represents the amount of change in the r^{th} explanatory variable; β_δ represents the δ^{th} set of coefficient vectors; $\exp(x_r\beta_\delta)$ represents the change in odds caused by the change of the r^{th} explanatory variable in group δ^{th} relative to the change of the r^{th} explanatory variable in the first group of categories.

The effect of the change in the first explanation on the odds ratio can be expressed as

$$\frac{\exp(x_r'\beta_\delta + \Delta x_{rl}\beta_{\delta l})}{\exp(x_r'\beta_\delta)} = \exp(x_{rl}\beta_{\delta l}), \quad (7)$$

where $\beta_{\delta l}$ is the l^{th} element in the δ^{th} set of coefficient vectors; $\exp(x_{rl}\beta_{\delta l})$ represents the change in the odds ratio of the l^{th} element of the r^{th} explanatory variable relative to the change of the δ^{th} categories group.

3. Data Analysis

The questionnaire star platform was utilized to collect the data for this study, which was distributed over social media in the format of an online survey. There are no restrictions on the scope of choice, and the research has encouraged a variety of organizations to take part in the poll utilizing the Internet as a medium. This time, 330 questionnaires were collected, and some invalid ones that took less than 80 seconds to complete or options that were filled out but had missing values were removed. 304 valid questionnaires were ultimately collected. The questionnaire's total effectiveness was 93%. The young group accounted for 92.8% of the questionnaire survey. Therefore, this study mainly investigates the willingness of young users of AVs.

3.1. Characteristics Analysis. In accordance with their selections, the respondents were likewise separated into three groups (positive attitude, hesitant attitude, and negative attitude towards AVs). Data from a variety of factors, including gender, age, monthly income, possession, or lack thereof of a driver's license, driving experience, were subjected to descriptive statistical analysis. In Table 3, the specific statistical outcomes are displayed.

The findings in Table 3 demonstrate that there was little variation in gender selection across all groups and that gender differences had little bearing on the decision to adopt AVs. 92.8 percent of respondents are between the ages of 18 and 50 in general; however, only 40.3 percent of respondents, or less than half, have a favorable opinion of AVs. The group with a bachelor's degree or more has the greatest percentage among the educational levels, coming in at 77.3%. This demographic, for the most part, views AVs favorably. When looking at the distribution of respondents by occupation, students make up nearly half (47.7%), and the remaining occupations are evenly represented. 52.6% of respondents have one automobile at home, 26.3% have none, and nearly 80% have a car at home. Roughly 80% of respondents had fewer than six years of driving experience, while nearly two-thirds of respondents had a driver's license, showing that driving experience is generally low.

Less than one-fifth (15.5%) of respondents travel everyday by private vehicle, with the majority using buses or subways (43.1%), followed by walking or cycling (37.2%). The average daily commuting time for the majority of the responders is under an hour.

3.2. Display Variables Analysis. When AVs have not yet gained popularity, the intention of people to use AVs is a crucial factor in determining the future of AVs. In this situation, it is essential to use latent variables to examine the adoption of AVs. In order to investigate the adoption of AVs, this study includes five latent variables: attitude toward use, perceived trust, behavioral intention, perceived usefulness, and sense of use gain. Figures 4–8 display the corresponding survey findings for latent variables.

According to Figure 4, more than 54% of respondents said that they were interested in AVs when asked about their attitudes toward them. Additionally, 66.9% of respondents said that they were confident in the continued development of AVs. There is a high level of expectation for the popularity of driving automobiles; 56.1% of respondents think that AVs

Table 3: Sample descriptive statistics.

Variable	Symbol	Name	Definition	Classification 1 (%)	2	3	Sum (%)
Gender	GEND	GEND1	Male	26.3	20.4%	2.6%	49.3
		GEND2	Female	28.3	20.7%	1.6%	50.7
Age	AGE	AGE1	Under 18 years old	2.0	0.7%	0.0%	2.6
		AGE2	18~50 years old	48.4	40.1%	4.3%	92.8
		AGE3	Above 50 years old	4.3	0.3%	0.0%	4.6
Education level	EDU	EDU1	High school and below	8.9	12.8%	1.0%	22.7
		EDU2	College/Undergraduate	29.3	19.1%	1.6%	50.0
		EDU3	Master's degree and above	16.4	9.2%	1.6%	27.3
Occupation	OCC	OCC1	Civil servants /Institutional employees	9.2	4.9%	0.7%	14.8
		OCC2	Company employees/Individual practitioner	14.1	11.5%	1.6%	27.3
		OCC3	Retired	0.7	0.0%	0.0%	0.7
		OCC4	Students	27.0	18.4%	2.3%	47.7
		OCC5	Others	3.6	6.3%	0.0%	9.9
Income (￥/month)	IN	IN1	Under 3000	28.0	22.0%	3.0%	53.0
		IN2	3000~5000	9.5	11.8%	0.7%	22.0
		IN3	5000~8000	11.5	5.3%	0.7%	17.4
		IN4	Above 8000	5.6	2.0%	0.0%	7.6
The number of vehicles	CAR	CAR1	NO	11.8	12.2%	2.3%	26.3
		CAR2	Own one car	29.9	21.1%	1.6%	52.6
		CAR3	Own two cars	10.2	4.6%	0.3%	15.1
		CAR4	Own three cars and above	2.6	3.3%	0.0%	5.9
Driver's license	LICENSE	LICENSE1	With	38.5	26.3%	2.3%	67.1
		LICENSE2	Without	16.1	14.8%	2.0%	32.9
Driving experience	DE	DE1	Less than one year	10.9	4.6%	0.3%	15.8
		DE2	1~6 years	35.2	33.2%	3.9%	72.4
		DE3	Above 6 years	8.6	3.3%	0.0%	11.8
Way of commuting	COM	COM1	Walking/cycling	20.7	15.1%	1.3%	37.2
		COM2	Public transit	20.7	20.1%	2.3%	43.1
		COM3	Private car	10.9	4.3%	0.3%	15.5
		COM4	Others	2.3	1.6%	0.3%	4.3
Time of commuting	CT	CT1	Within 30 minutes	31.6	26.3%	2.6%	60.5
		CT2	30~60 minutes	17.1	13.5%	1.0%	31.6
		CT3	60 minutes or more	5.9	1.3%	0.7%	7.9

Note. "1" represents the attitude of agreeing; "2" represents the attitude of hesitation; "3" represents the attitude of disagreeing.

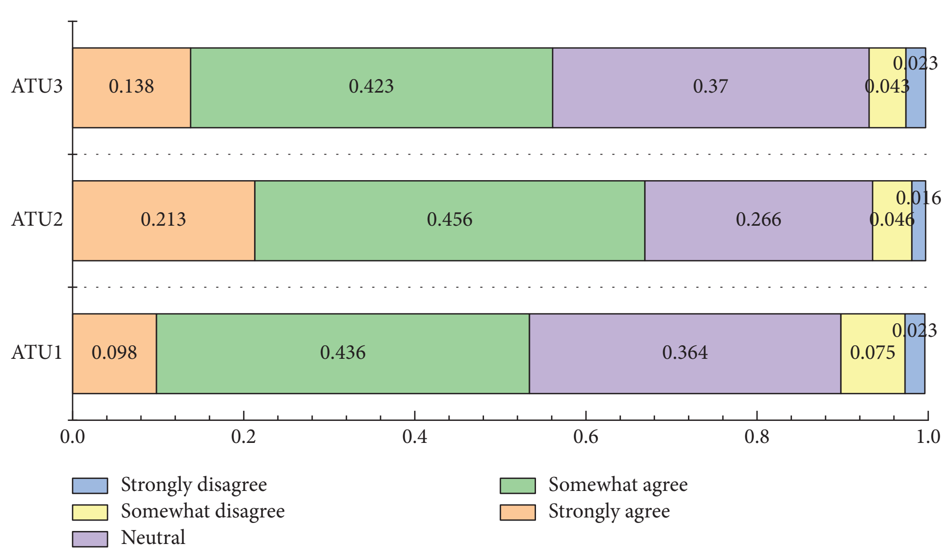

Figure 4: Attitude toward use.

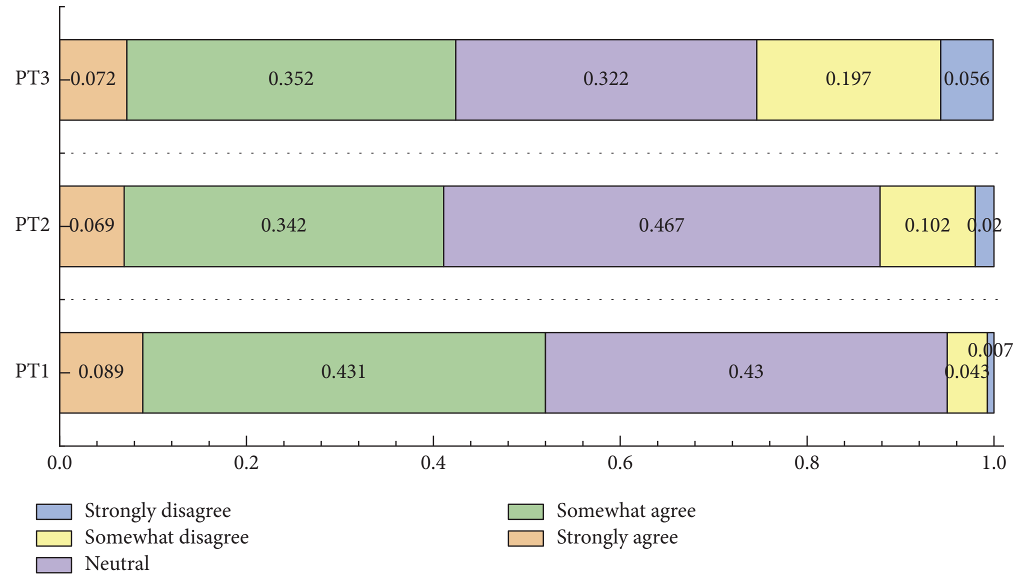

Figure 5: Perceived trust.

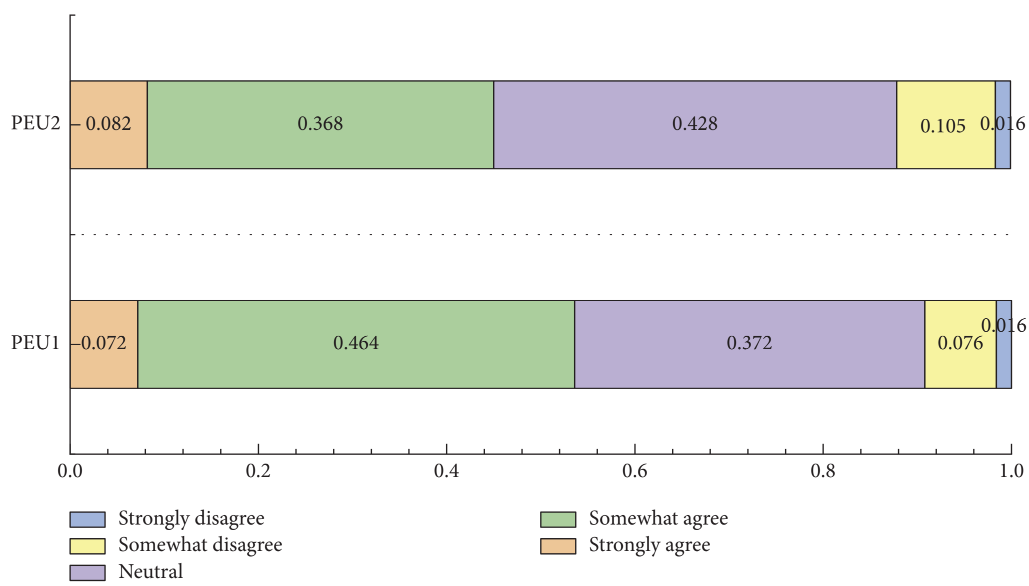

Figure 6: Perceived usefulness.

would eventually partially or completely replace traditional vehicles.

Figure 5 shows the outcome of perceived trust; more than 50% of respondents either entirely or partially trust AVs, and 41.1% of respondents think that autonomous driving is safer than manual driving. One in ten respondents indicated that they highly agree with the idea of being able to study, work, or rest while riding in an AV, and more people continue to express some level of support or disapproval.

Figure 6 shows the outcome of perceived usefulness. The majority of respondents—nearly 50%—said that they agreed completely or partially with the statement that "using AVs will deliver a higher quality of life." Using AVs can increase travel efficiency, according to more than 50% of the respondents, who either strongly or somewhat believe this.

In relation to AVs' sense of use gain, as shown in Figure 7, the assertion that "using AVs can generate psychological fulfillment on their own" was viewed by around half of the respondents as having a neutral attitude, and only a tiny number of respondents expressed complete agreement or disagreement with this statement. Only one-third of respondents (or 33%) strongly agree or somewhat agree with the statement that "the usage of AVs can help individuals feel a sense of use gain." The majority of those polled continue to hold a neutral perspective on this idea.

In terms of behavioral intentions, Figure 8 demonstrates that 49.3% of those polled expressed a desire to travel in an AV, while approximately 54.6% of representatives indicated a willingness to suggest them to friends. Only 45.4% of those

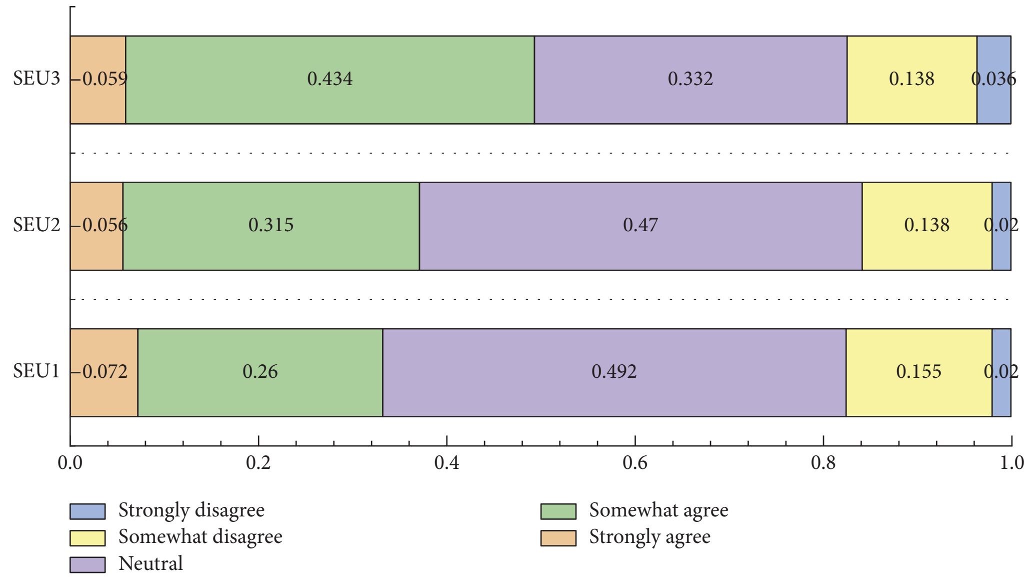

Figure 7: Sense of use gain.

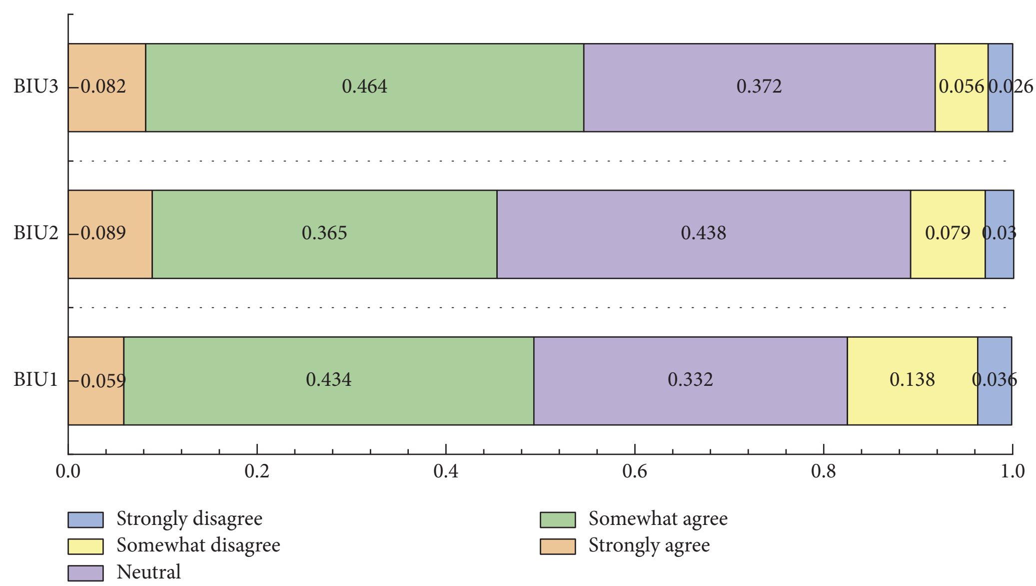

Figure 8: Behavioral intention.

who are eager to purchase their AVs fall into this category, which is a rather tiny portion.

3.3. Reliability and Validity Test. To ensure the stability and reliability of the data gathered by the questionnaire, the Kaiser–Meyer–Olkin (KMO) and Bartlett's sphericity test were employed to assess the data. [50] states that the KMO measure is highly suitable when it is 0.9 or higher; improved fitness is indicated by values of 0.8~0.9; good fitness is indicated by values of 0.7~0.8; bad fitness is indicated by values of 0.5~0.6; and unacceptable is indicated by values of less than 0.5. The questionnaire's total KMO value is 0.919, which denotes a strong connection between the variables. The Bartlett sphericity test results show an approximate chi-square value of 3123.179, and the significance p is equal to 0.000, less than 0.001, indicating that the matrix is not an identity matrix and has greater structural validity.

Following data analysis, the scale's total Cronbach's α value is 0.934, which is greater than 0.7, and Cronbach's α for each subscale is higher than 0.7. Cronbach's alpha values for attitude toward use, perceived trust, behavior intention, perceived usefulness, and sense of use gain are specifically 0.791, 0.763, 0.908, 0.795, and 0.844, respectively. As a result, the results on this scale are quite consistent.

3.4. Correlation Analysis. The investigation of the relationship between the traits of each model participant and their level of acceptance of AVs must come after the analyses of reliability and validity. The precise correlation analysis findings in Table 4 can be used to demonstrate it. According

Table 4: Correlation analysis results.

Variable	Pearson correlation	p
GEND	−0.040	0.491
AGE	−0.084	0.143
EDU	**−0.112***	**0.05**
OCC	0.053	0.361
IN	**−0.128***	**0.025**
CAR	**−0.113***	**0.05**
LICENSE	0.089	0.123
DE	0.000	0.994
COM	−0.035	0.539
CT	−0.076	0.187

Note. *indicates that the correlation is significant at the 0.05 level. The bold values indicates Pearson correlation coefficient and P value corresponding to factors significantly related to the acceptance of autonomous vehicles.

to test results, the family's number of automobiles owned, education level, and monthly family income all have Pearson correlations of −0.112, −0.128, and −0.113, respectively. 0.05, 0.025, and 0.05, respectively, are the corresponding probability p values, which are all less than or equal to 0.05. In light of this, it is reasonable to assume that the three personal characteristic attribute variables of education level, family monthly income, and number of vehicles owned by the family have a greater link with the acceptance of AVs.

4. Results

The structural equation model's and discrete choice model's calibration findings demonstrate the mutual causality between the latent variables under various choices as well as the influence of the latent variables on the acceptance of AVs.

4.1. Structural Equation Model Analysis. The relationship between the latent factors that affect how much an individual can influence whether or not an AV is accepted is built using the structural equation model. The relationship between the five latent variables of attitude toward use, perceived trust, behavioral intention, perceived usefulness, and sense of use gain is combined to clarify the mechanism of action between the latent variables. Figure 9 depicts the generated structural equation model. These include e_8, which represents the residual value of perceived trust, e_{12}, which represents the residual value of behavioral intention, and e_{13}, which represents the residual value of attitude toward use. The rest are the residual values for each variable that was observed. The model eliminates the display variables PT3 and SEU4 to obtain the final structural equation model, as illustrated in Figure 9, after adjusting the structural equation adaption parameters.

The structural model fit index, which can be found in Table 5, shows whether the path coefficients of the structural equation model adhere to the fit specifications. The chi-squared value is 120.502, and the chi-squared value to degrees of freedom ratio is 2.078 (the expected value should be less than 3). Goodness-of-fit index (GFI) is 0.941 (the numerical index standard should be greater than 0.9), and adjusted goodness-of-fit index (AGFI) is 0.908 (the expected value should be greater than 0.9). The root mean square error of approximation (RMSEA) is 0.060 (when the RMSEA value is less than 0.08, which can consider the model fitting effect better). Inferring that the model has a great appropriate effect and satisfies the formal requirements, it can be shown from the aforementioned numerical comparison and analysis that all index values of the model fit agree with the standard proper value.

The purpose of this study was to build a structural equation model to investigate the effects of feelings associated to AVs on attitudes toward use, perceived trust, behavioral intention, perceived usefulness, and sense of use gain, as well as the interplay between various latent variables. Table 6 and Figure 9 show the analysis findings. It demonstrates that ATU2 (individuals' expectations for the future popularization of autonomous driving) and ATU3 (travelers' beliefs that AVs can replace conventional cars in the future) have a substantial influence on their attitudes at the $P < 0.001$ level. Their corresponding path coefficient values are 1.165 and 1.138, respectively, indicating that the more the people's attitudes toward using AVs are stronger, the more people expect autonomous driving to become commonplace, and the more people are committed to replacing traditional vehicles with them. At the $P < 0.001$ level, SEU2 (using AVs will make you feel good psychologically) and SEU3 (having AVs is a status symbol) had a considerable impact on perceived usefulness. And the associated path coefficients are 1.118 and 0.887, respectively. This indicates that the stronger the psychological satisfaction that AVs can produce, the stronger the psychological satisfaction that AVs can receive, and the higher the psychological fulfillment that individuals can experience, the stronger the sense of use gain that people can have. At the $P < 0.001$ level, PI2 (AVs are safer than self-driving) has an effect on perceived usefulness. The path coefficient is 0.945, which indicates that people value AVs more as a result of increased safety.

The two latent variables of attitude toward use and perceived trust are significantly positively influenced by perceived usefulness among the latent variables, with a $P < 0.001$. The path coefficients are 0.773 and 0.819, indicating that a person's faith and attitudes about AVs will be considerably impacted by how valuable they view AVs to be. At the level of $P < 0.001$, the behavioral intention is also substantially influenced by attitudes toward use and perceived trust, showing that residents' acceptance of a certain travel mode is largely influenced by their attitudes and faith in that mode. The sense of use gain, the attitude toward use, and perceived trust, however, do not significantly correlate.

4.2. Hybrid Choice Model Parameter Calibration. Whether or not people think that AVs will eventually lead to breakthrough products is how much acceptance there is for AVs. In the future, AVs will likely produce revolutionary goods, according to more than 50% of people. The percentage of those who think that AVs will never be a revolutionary product is 4.3%. A marginally higher percentage of people (41.1%) are skeptical about this viewpoint. As a result, it was determined whether attitudes toward use, perceived trust, behavioral intention, perceived usefulness, and sense of use gain affected AV adoption. The display variables that

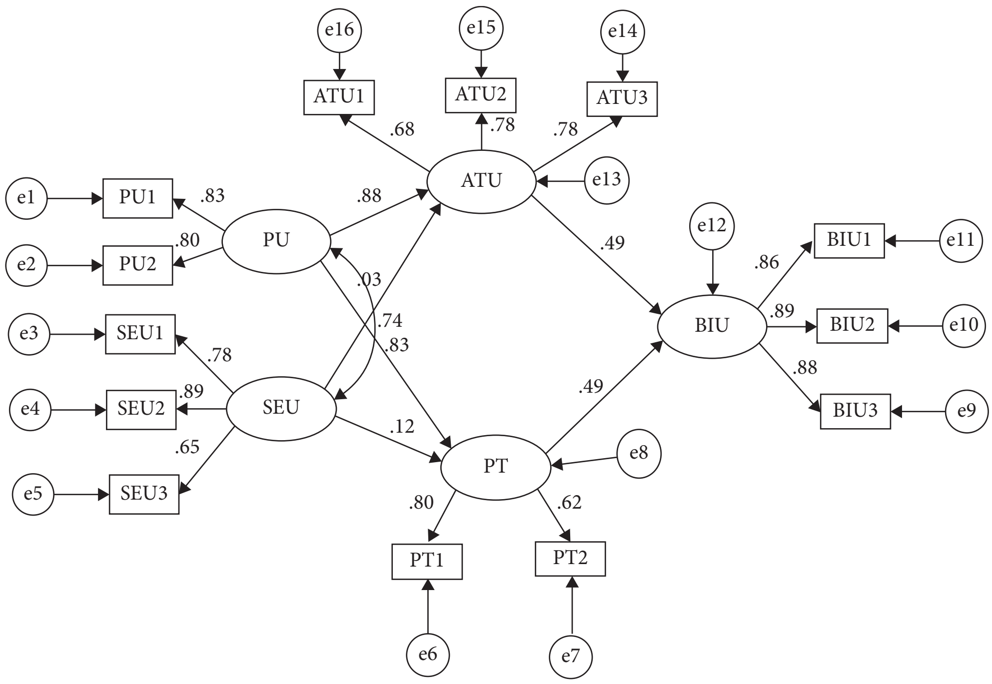

Figure 9: Structural equation model.

Table 5: Index values of fitness for structural equation model.

Adaptation index	Fitted value
χ^2	120.502
χ^2/df	2.078
RMR	0.029
GFI	0.941
AGFI	0.908
RMSEA	0.060
NFI	0.953
IFI	0.975
CFI	0.975

Table 6: Model standardized path relationship values.

Relation	Estimate	Se.	Cr.	*P*
ATU←PU	0.773	0.096	8.059	***
ATU←SEU	0.026	0.078	0.078	0.336
PT←PU	0.819	0.098	8.388	***
PT←SEU	0.123	0.089	1.388	0.165
BIU←PT	0.508	0.123	4.116	***
BIU←ATU	0.573	0.138	4.153	***
PU2←PU	1.015	0.064	15.919	***
SEU2←SEU	1.118	0.076	14.802	***
BIU2←BIU	1.129	0.054	21.070	***
BIU3←BIU	1.055	0.052	20.343	***
SEU3←SEU	0.887	0.080	11.135	***
ATU2←ATU	1.165	0.098	11.953	***
ATU3←ATU	1.138	0.095	11.959	***
PI2←PT	0.945	0.088	10.698	***

Note : ***indicates that the path coefficient is significant at the 0.001 level.

correspond to the latent variable are then used to describe the latent variable's value after the structural equation model has been used to analyze the relationship between the latent variables. Then, it and the personal attributes are substituted into the discrete choice model, with the second-stage estimate dependent variable being whether or not AVs will eventually become a revolutionary product. This study employs the mlogit model to estimate the parameters in two different ways, one that takes latent variables into account and one that does not. It thoroughly examines the effect of several elements on the acceptance of AVs. The high acceptance choice is used as the main utility item for the regression analysis and the relative risk ratio (RRR). Tables 7 and 8 display the findings of the analysis.

The optimal ratio coefficient is typically greater than 0.2, therefore this model can be thought of as having higher accuracy. Tables 7 and 8 show that, for the discrete choice model without taking into account latent variables and the discrete choice model taking into account latent variables, respectively, the goodness ratio coefficients are 0.0561 and 0.2898. It demonstrates the low fitness of the discrete choice model that ignores latent factors. A more suitable discrete choice model is one that takes into account latent variables. The findings in Table 7 are what this study is focused on.

Tables 7 and 8 with the value "1" show that the respondents think that AVs will someday be a revolutionary product. Answer "2" indicates that people are dubious about the potential of AVs to become ground-breaking goods in the future. Answer "3" implies that many think AVs will not ever be revolutionary products. Discrete choice models that account for many latent variables produce significantly different results than models that do not account for latent variables when all other factors are held constant. People most likely feel that AVs will eventually become ground-breaking products, as indicated in Table 8's model, which takes into account the latent variables while maintaining the status quo of other influencing factors. The likelihood of

Table 7: Estimation results of the discrete choice model without considering the latent variables.

		RRR	z	RRR	z
Options	1	2		3	
Cons	Base outcome	9.818	1.66	0.324	−0.33
CT		0.821	−0.86	1.801	1.21
COM		1.014	0.09	1.471	0.95
DE		1.188	0.64	1.141	0.19
LICENSE		1.064	0.22	2.109	1.03
CAR		0.899	−0.63	0.384	−1.85
IN		0.867	−0.81	0.403	−1.75
OCC		1.036	0.31	0.735	−1.1.
EDU		0.603	−2.74	0.967	−0.08
AGE		0.513	−1.33	0.739	−0.23
GEND		0.806	−0.80	0.346	−1.57
Log-likelihood		−238.33078			
LR chi2		28.34			
Prob > chi2		0.1015			
Pseudo R2		0.0561			

Table 8: Estimation results of the discrete choice model considering latent variables.

		RRR	z	RRR	z
Options	1	2		3	
Cons	Base outcome	0.021	−2.15	3.65e-9	−2.68
CT		0.861	−0.56	3.008	1.63
COM		1.009	0.05	0.981	−0.03
DE		1.490	1.22	1.729	0.49
LICENSE		0.948	−0.16	2.657	0.98
CAR		0.841	−0.85	0.231	−2.06
IN		0.851	−0.77	0.607	−0.69
OCC		1.011	0.08	0.790	−0.54
EDU		0.683	−1.77	0.709	−0.58
AGE		0.540	−1.14	0.593	−0.17
GEND		1.286	0.08	0.549	−0.55
PU		1.224	0.96	0.824	−0.36
BIU		1.374	2.25	0.860	−0.39
PT		0.919	−0.42	4.350	2.12
ATU		1.310	1.83	2.616	2.42
SEU		1.227	1.80	2.336	2.44
Log-likelihood		−179.31964			
LR chi2		146.34			
Prob > chi2		0.000			
Pseudo R2		0.2898			

continuing to harbor doubts is 0.021 times greater than the likelihood of continuing to harbor optimism. Few people hold a pessimistic view on the potential for future AVs to be revolutionary products; hence, the likelihood of this view is minimal.

The variables that future AVs will be a revolutionary product are chosen as the benchmark value. According to the findings, the sense of use gain, attitude toward use, and perceived trust all have a significant impact at $P < 0.01$, and the corresponding z-values were 2.44, 2.42, and 2.12, respectively. It demonstrates that the sense of use gain, attitude, and perceived trust in autonomous driving are crucial elements influencing whether or not AVs are accepted: the greater the sense of use gain, the higher the possibility; the more steadfast the use attitude, the higher the possibility; and the greater the degree of perceived trust, the higher the possibility.

5. Conclusions and Discussion

In this study, the acceptance of AVs by young people was investigated using an HCM. It took into account five latent variables, each of which was represented by 2~3 observable display variables: perceived usefulness, sense of use gain, perceived trust, attitude toward use, and behavioral intention. The perception of AVs as a revolutionary product among consumers is used to gauge acceptability. The purpose of this study was to construct a questionnaire on the acceptance of AVs, poll 350 participants, and statistically analyze the travel and personal characteristics of the respondents.

Data indicate that gender has minimal bearing on AV acceptance. People with high education levels, corporate employees, and students in the 18–50 age range are substantially more receptive of AVs. People are quite receptive to AVs. According to the sample poll results, 54.6% of respondents think that AVs will be a revolutionary product in the future. These respondents were followed by those who might be cautious (41.1%) and those who are likely to maintain a negative attitude (4.3%). Moreover, the study evaluated how well AVs were received personally. The acceptability of AVs is highly influenced by the five latent variables sense of use gain (2.44), attitude toward use (2.42), and perceived trust (2.12). Perceived usefulness had an impact on attitudes toward use as well as perceived trust.

According to the data, people are more likely to be favorable about AVs than hesitant (41.1%). Although the acceptance rate is 30% higher than the acceptance rate of this study, it is consistent with the research of Nordhoff et al. [51] because survey results will vary depending on the demographics of the respondents, and because different age groups have varying levels of enthusiasm and realism for novelty. However, the findings of this paper are significantly different from those of the study of Hudson et al. [52], which demonstrates that individuals understand that the emergence and popularization of AVs will favorably affect the improvement of the safety factor in China's road traffic system. Furthermore, there is a significant difference in the acceptance rate of AVs between the participants in this study and those from Europe [53], demonstrating that Chinese users support the usefulness, safety, and psychological pleasure of AVs.

The findings support earlier studies' findings that attitudes and perceived trust had a considerable impact on the adoption of AVs (2.12 and 24.42, respectively). [44] demonstrates that users' attitudes regarding this new technology and their level of safety are crucial preconditions for using or purchasing AVs. Furthermore, this study's key distinction from earlier ones is that it takes into account the sense of use gain component, which has an equally large favorable effect on AV acceptance [44], in line with Panagiotopoulos' research findings. It suggests that consumers may experience psychological pleasure as a result of the sense of use gain. The study also discovered that perceived utility had an indirect impact on adoption of AVs through influencing attitudes and perceived trust rather than having a direct impact. It was quite different from past studies [46]; the main difference may be attributed to the SP survey's restriction. Different outcomes are caused by the items' restrictions, yet this is not counter to common sense. Practicality is a crucial component of daily consumption and has the power to alter consumers' views and level of confidence in AVs.

Therefore, it can be said that the research and development process for AVs should concentrate on enhancing the technology for AV safety and security, raising the bar for quality, and incorporating more identity and status into the design. It is also conceivable to think about including features like automatic parking and phoning. Based on the actual issue of parking difficulty in China, automotive firms can design features that can address the needs directly and work to provide AVs that are safe and useful and have a positive brand image.

The findings show that there is a high level of acceptability of AVs, indicating that most people anticipate AVs becoming more widely used. It also demonstrates that psychological latent variables play a substantial role in AV acceptance and play a catalytic role in AV development. Automotive firms and the government might suggest targeted promotion efforts based on the traits of psychological latent variables to offer a theoretical foundation for the creation and widespread use of AVs.

This research has several restrictions. First of all, none of the poll participants in this paper had ever used AVs. Their opinions of AVs are still based on theoretical understanding and have not been put into practice in real-world applications. Second, this poll ignores changes in the chronology and only uses data surveys from a particular time period. It is unable to comprehend changes in people's attitudes toward AVs or the development of the technology that enables autonomous driving. Thirdly, the respondents to the poll might not accurately represent general audiences. The majority of the poll participants are younger in age, highly educated, and open to trying new things.

Data Availability

The datasets used to support the findings of this study can be obtained from the corresponding author upon request.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

Acknowledgments

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