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Evaluating Acceptance of Novel Vehicle-Mounted Perfume Automatic Dispersal Device for Fatigued Drivers

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Abstract: This paper evaluates the influence of different variables on drivers' willingness to accept and use a vehicle-mounted perfume automatic dispersal device (VP-ADD) connected to the vehicle's electronic map. Based on the technical acceptance model, we clarify and condense the explanation of the model used to evaluate the impact of user behavior attitudes and device characteristics on six factors, perceived usefulness, perceived ease of use, attitude towards use, intention to use, perceived playfulness, and perceived risk, proposing eight hypotheses. Then, we assessed the responses of 562 drivers in China using SPSS for reliability and validity and AMOS for structural equation modeling to test our hypotheses. The findings reveal that the perceived usefulness, ease of use, playfulness, and risk significantly affected the willingness to accept and use the VP-ADD. Furthermore, the perceived risk has a negative influence, while the perceived usefulness, perceived ease of use, perceived playfulness, and attitude towards use have a positive influence. This research is significant for further development and application of the VP-ADD. It is essential to alleviate driver fatigue, ensure traffic safety, and provide theoretical and empirical support for designing more popular driving assistance devices. Furthermore, it offers valuable insights for developing fatigue driving warning policies, in-vehicle device guidelines, and traffic safety regulations.

Keywords: car drivers; perfume; technology acceptance model; structural equation model

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1. Introduction

Road traffic collisions have become a significant cause of human casualties. Among the various causes of road traffic collisions, driver fatigue is one of the most common causes [1]. The number of traffic accidents caused by it accounts for around 10% to 20% of the total accidents [2]. Related studies have shown that driver fatigue can be classified as sleep-related and task-related [3]. Sleep-related fatigue is caused by sleep disorders, restriction, deprivation, and sleep disruption associated with biological rhythms [4]. Task-related fatigue is more often the result of the external environment and the driving task [5]. Recently, effectively avoiding fatigue while driving has been a pressing issue.

Olfactory stimulation is a method that can effectively awaken and refresh drivers without affecting their normal driving behavior [6]. For example, the smell of lavender or vanilla can affect driving performance. Some studies have shown that the fragrance has no impact on speed changes. However, the scent made the driver more emotionally calm [7]. Fruhata et al. [8] conducted a focused study on the effects of using grapefruit scent on fatigued drivers. The results showed that the stimulating scent enhanced arousal, and mint and cinnamon scents increased driver alertness. The vanilla scent helps drivers feel calmer, more comfortable, and more focused. Olfactory stimulation can awaken the drivers' feelings of fatigue. However, releasing the scent when the user needs it is challenging [9].

As a result, there has been proliferation of scent-release devices. Yamada et al. [10] developed a scent release device for outdoor use, worn by users who can move within a defined range. When moving to the appropriate marker, the device will deliver the smell to the nose. For wearable products, the Japanese company VAQSO has also developed a scent playback device that can be loaded onto existing virtual reality (VR) headsets and provide five scents simultaneously [11]. By coincidence, the Feel Real-Time company has also designed a sensory mask that uses heat to generate smell and can provide nine scents simultaneously [12]. Sosuke et al. [13] experimented with the integration of olfactory presentation technology with haptic interaction technology by developing a 3D fruit-picking game in which a force feedback device provides the user with a reaction force when picking fruits. At the same time, the corresponding scent is emitted while picking fruits to give the user a better sense of immersion [13].

Similarly, the Aiko company has fused visual and olfactory presentation technologies. The system generates control commands based on the corresponding image interaction commands to make the olfactory presentation device emit scent [14]. However, the system has a limited variety of scents. Kadowaki et al. [15] investigated the fusion of olfactory presentation and auditory interaction, where the user can control the tone of a voice to identify the corresponding perfume scent. These studies suggest automatic smell-emitting devices in vehicles. McGookin et al. [16] developed an 'off-the-shelf' computer-controlled scent delivery device. Covington et al. [17] reported the development of a simple yet innovative multichannel olfactory display, which can release up to eight different liquid phase aromas (essential oils) using a thermal mechanism. Peng et al. [18] developed a new odor-releasing device, which is low-cost, customizable, semi-automatic, and flexible. The specific requirements of different participants can be used to customize the odorants and their concentrations stored in the scent bottles. Wang et al. [19] designed and developed a simple vortex-based olfactory display for a single user. However, these olfactory emitting devices do not apply to the vehicle's interior environment.

Smell stimulation can induce in-vehicle interaction, alleviating driving fatigue and enhancing driver alertness [20]. Consequently, Dmitrenko et al. [21] compared the potential and suitability of four commercially available devices, Vortex Activ USB, Scentee, oPhone DUO, and Aroma Shooter, for vehicle use. They found that integrating odor delivery systems into cars could provide warnings, enhance mood, or contribute to the overall in-vehicle entertainment system. Vortex Activ USB is a multi-purpose odor dispensing system that can be installed in vehicles. However, the device is relatively large, making it unsuitable for all vehicles, and it cannot flexibly adjust the intensity or duration of the scent. Scentee is a device that can be connected to smartphones but is primarily designed for iOS devices, limiting its compatibility, and the scent may be missed when users move their heads. The high cost of the device may also affect its popularity. Therefore, a new system called OSpace was developed [22]. It allows control over odor type, dilution, and the timing and air pressure of odor delivery. However, in practical applications, issues such as odor mixing and cross-contamination may still exist, the timing of odor release does not consider the driver's fatigue state, and the study does not assess user acceptance.

In summary, olfactory stimulation has been shown to alleviate driving fatigue, and various olfactory or odor-release devices are already available. However, only some of these devices are specifically designed for in-vehicle use, and the timing of odor release needs to be considered. Moreover, there needs to be more consideration for user subjective experience before developing these devices, especially regarding how different variables influence drivers' willingness to use in-vehicle perfume automatic diffusion devices (VP-ADDs). These factors may significantly impact the acceptance and willingness to use a VP-ADD, but empirical research is minimal. Further research into these potential influencing factors will help us design fatigue warning devices that better meet the needs and preferences of drivers and improve their effectiveness in practical applications. Additionally, it will contribute to further refining traffic control policies and measures. Therefore, this study introduces a theoretical framework of a VP-ADD and conducts a case study based on the

Technology Acceptance Model (TAM) to investigate drivers' acceptance and willingness to use the VP-ADD. Since Davis proposed the Technology Acceptance Model (TAM) in 1989, numerous studies have used it to predict and explain the degree of user acceptance of emerging technologies or devices [23–27]. This study will provide a theoretical basis for subsequent research related to the VP-ADD and the application of the VP-ADD, which is significant for research on alleviating driving fatigue and driving assistance systems.

2. Materials and Methods

2.1. Device Description

A VP-ADD can effectively monitor road conditions and release perfume at the appropriate time according to pre-set environments to relieve the driver's fatigue and promote traffic safety. Specifically, the device can acquire information about road geometry and traffic conditions according to the predetermined driving parameters and calculate the timing and concentration of the perfume release. In addition, the user can adjust the concentration of perfume release and whether to turn on the automatic release function at any time according to personal habits. Further, the device can release the perfume at specific locations. The VP-ADD includes a host, transmission interface, Bluetooth, sensors, and real-time connection with the vehicle's electronic map.

The device consists of five units, as follows (Figure 1):

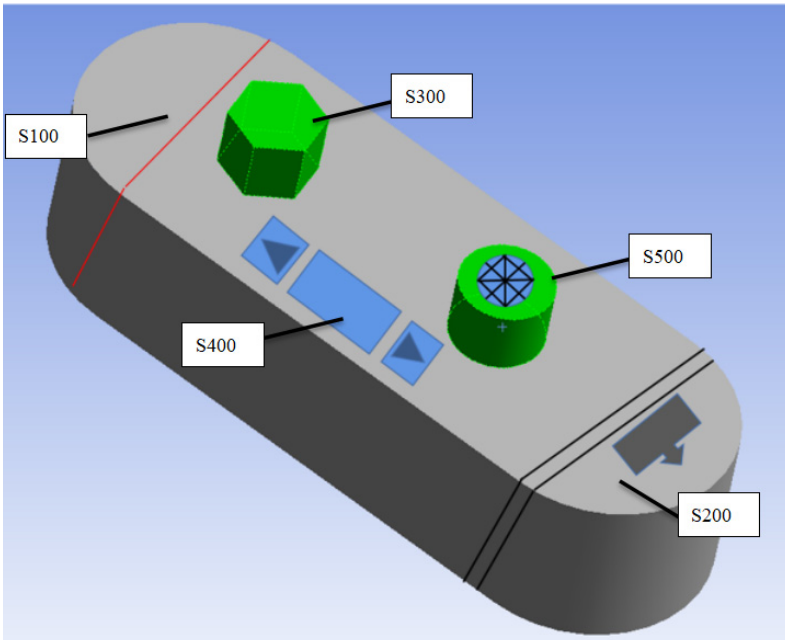

Figure 1. Overview of VP-ADD.

Electronic Map Acquisition Unit (S100). This unit interfaces with the map app currently on the market.

Perfume Box Loading and Unloading Unit (S200). This unit disperses different flavors of perfume into the automatic release device.

Manual Adjustment Unit (S300). This unit manually adjusts the release concentration and release switch.

Display Unit (S400). This unit displays the current position and the perfume concentration in real time.

Automatic Release Unit (S500). This unit includes an automatically adjustable release hole or net.

2.2. Methodology

2.2.1. Technology Acceptance Model

The TAM is one of the most influential consumer-acceptance information system models, effectively predicting whether the users can accept information technology. The model helps analyze the factors influencing individual users' acceptance of new technology applications [28,29]. The model was proposed by Davis [30], based on rational behavior theory. It extends the relationship between attitude, behavior, and intention. It holds that: (a) the system's use is determined by behavior intention, (b) behavior intention is determined by behavior attitude and perceived usefulness, and (c) behavior attitude is determined by the perceived usefulness and ease of use.

The TAM mainly includes variables such as perceived ease of use, perceived usefulness, behavioral intention, system use, attitude to use, and external factors. With the continuous progress of science and technology, in the past few decades, researchers have developed various models to explain users' attitudes to accepting new technologies. These models have been validated many times and are considered very effective [31]. Therefore, based on the TAM and the device's characteristics, this study expands the TAM and selects six factors to determine the driver's attitude towards the VP-ADD and its market prospect. The factors are perceived usefulness, perceived ease of use, attitude to use, intention to use, perceived playfulness, and perceived risk.

2.2.2. Theoretical Model and Hypotheses

The conceptual TAM consists of six constructs (Figure 2): (1) perceived usefulness, (2) perceived ease of use, (3) perceived playfulness, (4) attitude to use, (5) intention to use, and (6) perceived risk. In addition, these constructs are related to eight hypotheses. Details of these constructs and hypotheses are presented next.

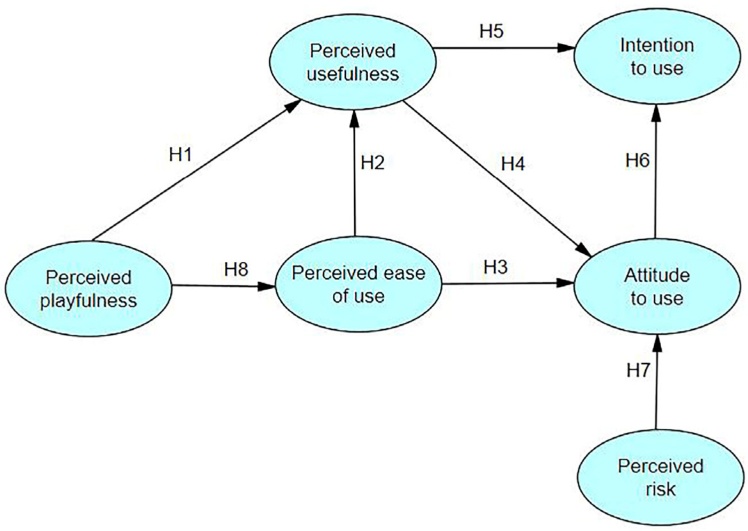

Figure 2. Conceptual model.

1. Perceived Usefulness and Perceived Ease of Use

Perceived usefulness means that when users use this new technology or new device, they can feel that it provides obvious help for their life, work, or learning and can improve their efficiency. In the preliminary study of the TAM, perceived usefulness and perceived ease of use are the most common and essential determinants of technology acceptance [32]. Perceived usefulness is usually defined as a person's belief that using a system will help improve their performance. Perceived ease of use is whether the user has operational difficulties and convenience when using this technology [33]. In this study, the perceived usefulness is redefined as whether the driver can effectively help alleviate driver fatigue and ensure the driver's safety when using the VP-ADD. The perceived ease of use is defined as whether the driver can quickly operate this new technology, which will not increase the precious time of driving and will not bring more driving burden to the driver during driving.

2. Perceived Playfulness

The VP-ADD is a new device that overturns the perception that traditional car perfume can only last for a short amount of time. People may have a greater interest in it. Furthermore, it is very playable because it has many functions and can interact with the cell phone app in real time. Its presence will entertain the driver during the driving process and, therefore, they will be more willing to use it.

3. Attitude to Use and Intention to Use

Accepting something new depends heavily on one's attitude, directly affecting one's willingness to use it. Davis [30] defines the attitude toward a new system as "an individual's overall emotional response to using the system." Venkatesh et al. defined the behavioral intention to use the system as "the degree to which an individual believes he or she will continue to use the system" [34]. Furthermore, the more favorable a person's attitude toward using a new system, the greater their intention to use it [35]. In this study, attitude to use and intention to use was defined as the driver's friendliness toward the VP-ADD. That is, whether they would be willing to try using the device and continue to use it in the future and recommend it to others around them.

4. Perceived Risk

The importance of risk as a critical predictor of human behavior is undeniable. Perceived risk is a person's perception of whether he/she decides to perform an action or activity [36]. When users use any new technology or newly developed product, they consider the possible risks associated with its use. Perceived risk was negatively correlated with intention to use [37]. The higher the perceived risk, the lower the user's willingness to continue using it. During driving, drivers need to consider whether the device we have developed will pose a hidden risk to everyday driving, threaten the driver's life to some extent, or affect the typical driving environment.

5. Research Hypotheses

Various factors usually influence a behavior or the acceptance of technology. Based on the above analysis, it is clear that perceived usefulness and ease of use, perceived playfulness, attitude to use, and perceived risk affect the willingness to use the devices we invent. To better explain this behavior, we developed a hypothetical model using an extended TAM. Based on the analysis of several variables, the following seven hypotheses were formulated (Figure 2).

H1: *The perceived playfulness has a positive effect on perceived usefulness.*
H2: *The perceived ease of use positively affects perceived usefulness.*
H3: *The perceived ease of use positively affects the attitude to use.*
H4: *The perceived usefulness positively affects the attitude to use.*
H5: *The perceived usefulness positively affects the intention to use.*
H6: *The attitude to use positively affects the intention to use.*
H7: *The perceived risk of use negatively affects the attitude to use.*
H8: *The perceived playfulness positively affects the perceived ease of use.*

Among them, perceived playfulness, perceived ease of use, and perceived risk are exogenous variables that are not influenced by other variables; perceived usefulness, intention to use, and attitude to use are endogenous variables, which are both influenced by and affect other variables.

3. Case Study

3.1. Participants

To study drivers' attitudes and willingness to use the VP-ADD, we conducted a questionnaire survey using the Questionnaire Star app. A total of 562 questionnaires were collected, and 59 questionnaires were removed due to missing and incomplete data, so 503 valid questionnaires were obtained after removing invalid ones. Among the subjects, 306 (60.8%) were male and 197 (39.2%) were female. Most of the subjects were 18–45 years old (85.6%), and 72 (14.6%) were over 45. The primary educational attainment is a bachelor's degree (62.0%). The distribution of driving experience is as follows: Participants with 1 to 5 years of driving experience constitute the largest proportion, accounting for 40.8% of the total sample; those with 6 to 10 years of driving experience account for 41.7%; while experienced drivers with over ten years of experience make up 11.1% of the sample. Novice drivers with less than one year of experience represent 6.4%. Specific information is shown in Table 1. This study was conducted under the guidance of the ethics committee of the College of Civil Engineering, Fuzhou University. All participants voluntarily participated in the experiment and signed a written consent form.

Table 1. Sample characteristics (N = 503).

Variable	Number (%)
(a) Gender	
Male	306 (60.8)
Female	197 (39.2)
(b) Age Categories	
18–35 years	226 (44.9)
36–45 years	205 (40.7)
45–60 years	72 (14.4)
(c) Educational Attainment	
Secondary school	69 (13.7)
Bachelor's degree	312 (62.0)
Graduate degree	122 (24.3)
(d) Driving experience	
Less than 1 year	32 (6.4)
1–5 years	205 (40.8)
6–10 years	210 (41.7)
More than 10 years	56 (11.1)

3.2. Measurement

Based on the TAM framework, we designed a questionnaire and conducted a pre-survey combined with the VP-ADD characteristics. The questionnaire included six variables: perceived playfulness, perceived ease of use, perceived risk, perceived usefulness, intention to use, and attitude to use. The questionnaire included definitions and descriptions of variables totaling 18 items derived from previous research [38–41], as shown in Table 2. The scale uses a five-point system (1 indicates complete disapproval, and 5 indicates complete consent).

We processed the questionnaire data using SPSS25.0 and AMOS22.0 software. First, we verified the questionnaire's reliability and validity. Then, we analyzed the each variable to determine the correlation between variables. Finally, we conducted a confirmatory factor analysis of variables, established a structural equation model, and conducted a correction and fitting test.

Table 2. Definition and description of questionnaire variables.

Dimension	Response Symbol	Definition [1]
Perceived playfulness (PP)	PP1	It can be used to decorate the interior space, which is very interesting.
	PP2	This is a device I never thought about. It makes me feel crazy.
	PP3	It can automatically emit scent and interesting settings.
Perceived usefulness (PU)	PU1	Using it to refresh yourself when driving.
	PU2	Using it makes me more focused on driving tasks.
	PU3	Using it improves in-car odors and creates good driving conditions.
Perceived ease of use (PEOU)	PEOU1	Getting road information through it is simple.
	PEOU2	It is easy to operate and handle.
	PEOU3	It is easy to use it to interact with people and the road environment.
Attitude to use (AU)	AU1	It is a significant invention.
	AU2	It is worth using money to buy it.
	AU3	It satisfies all my imagination of car perfume.
Intention to use (IU)	IU1	I would like to try to use it.
	IU2	I will always use it later.
	IU3	I will recommend it to my friends.
Perceived Risk (PR)	PR1	It may have security risks.
	PR2	It will waste money and resources.
	PR3	It distracts my attention while driving.

[1] The word "it" refers to the VP-ADD.

4. Result

4.1. Validity of Questionnaire

Cronbach's alpha was used to assess the internal consistency of the questionnaire and to test its reliability. The reliability is usually considered acceptable when Cronbach's alpha coefficient is greater than 0.6. The suitability of the questionnaire for factor analysis is mainly tested by KMO and Bartlett's sphericity tests [42,43]. Both KMO and Bartlett's sphericity test results validated the sampling adequacy of the data set, and exploratory factor analysis using principal component extraction was performed to test the structural validity of the scales. In addition, each measure had a standard value factor loading of greater than 0.4 [44]. It shows that the structure has sufficient convergence validity.

The results of the statistics and questionnaire test of the variables are shown in Table 3. The reliability analysis results show that the internal consistency of the questionnaire is high because α of Cronbach's alpha is between 0.649 and 0.859 [45]. In addition, the extraction amount of the factor load is greater than 0.4, and the KMO value is 0.769, which means that the questionnaire demonstrates good validity.

Table 3. Statistics and questionnaire test of the variables (KMO = 0.769).

Factor	Cronbach's Alpha	Mean	Response	Mean	Factor Loading
Perceived playfulness (PP)	0.649	4.08	PP1	3.68	0.718
			PP2	4.05	0.850
			PP3	4.50	0.676
Perceived usefulness (PU)	0.780	4.01	PU1	4.00	0.802
			PU2	4.31	0.854
			PU3	3.71	0.686
Perceived ease of use (PEOU)	0.859	2.53	PEOU1	2.41	0.893
			PEOU2	2.35	0.866
			PEOU3	2.84	0.834
Attitude to use (AU)	0.762	3.88	AU1	3.76	0.834
			AU2	3.69	0.742
			AU3	4.19	0.653

Table 3. *Cont.*

Factor	Cronbach's Alpha	Mean	Response	Mean	Factor Loading
Intention to use (IU)	0.755	3.36	IU1 IU2 IU3	3.42 3.35 3.31	0.842 0.650 0.841
Perceived Risk (PR)	0.838	1.54	PR1 PR2 PR3	1.56 1.56 1.50	0.857 0.867 0.848

4.2. Descriptive Statistics

According to the results of the questionnaire survey (Table 3), the drivers' overall intention and attitude to use the VP-ADD are still at a high level (mean of intention to use = 3.36 and mean of attitude to use = 3.88), indicating that most drivers recognize the device's value and will be supported by the market after its popularization and application. In addition, the drivers' perceived ease of use of the device is low (mean = 2.53), which is lower than the intermediate value, indicating that the drivers are still suspicious of the device's operability because the device is still in the theoretical stage. Some specific physical objects are needed to verify its operability. However, drivers generally show an intention to use it and there is a large market. Finally, drivers believe any device or invention has risks but believe that this device is an interesting invention. The perceived playfulness (mean = 4.08) and perceived usefulness (mean = 4.01) are at a high level, which fully shows that once the device enters the market, it will attract the attention of many drivers, and the drivers generally believe that it will not bring any risk and has sufficient trust. Therefore, overall, the VP-ADD is easy for drivers to accept and will be widely used in the future, entering the field of automobile interior decoration. The VP-ADD is expected to substantially contribute to mitigating driver fatigue.

4.3. Model Verification

To evaluate the fit of the proposed model, in addition to χ^2/df, this study also selected indicators such as the CFI, GFI, AGFI, RMSEA, and TLI. The CFI (Comparative Fit Index) reflects the degree of improvement of the model fit relative to the baseline model, with values closer to one indicating a better model fit. The GFI (Goodness of Fit Index) measures the consistency between the model data and observed data, with values closer to one indicating a higher model–data fit. The AGFI (Adjusted Goodness of Fit Index) considers the influence of model degrees of freedom on the GFI and is a better indicator of the accuracy of the model fit. The RMSEA (Root Mean-Square Error of Approximation) measures the size of errors between the model and the data, with smaller values indicating more minor model errors, typically considered good if less than 0.08. The TLI (Tucker-Lewis Index), the non-normed fit index, is like the CFI but more strictly penalizes model complexity, with values close to one indicating a good model fit. The fit indices calculation results (Table 4) showed that $\chi^2/\text{df} = 2.797$, GFI = 0.932, AGFI = 0.907, CFI = 0.933, RMSEA = 0.060, and TLI = 0.942, which indicates that the final structural model has a good model fit. After the model was modified, the visual structural diagram of the acceptance intention model was created, as shown in Figure 3. In the figure, observed variables are represented by square symbols, latent variables by elliptical symbols, and error terms by circles. Single arrows represent causal relationships between variables (from cause to effect), and the numbers next to the arrows represent regression coefficients (latent variable $\rightarrow$ latent variable) and loadings (latent variable $\rightarrow$ manifest variable). Larger loadings indicate a closer relationship between latent and manifest variables. The path coefficients between all variables are significant at the level of 0.05. According to Figure 3, PP positively affects PU ($\beta = 0.21$, $p < 0.001$), supporting hypothesis H1, indicating that devices with a higher entertainment value are more likely to be perceived as applicable by users. PEOU has a significant positive effect on PU ($\beta = 0.23$, $p < 0.001$), supporting hypothesis H2, indicating that when users find the VP-ADD easier to operate, they are more likely to perceive it as applicable. Hypotheses 3 and 4 regarding the positive effects of PEOU and PU on attitudes toward use are accepted, indicating that improving these perceived attributes of the VP-ADD will positively influence user attitudes. The positive effects of PU and attitude toward use on intention to use indicate that H5 and H6 are accepted, emphasizing the importance of usefulness and positive attitudes in promoting the adoption of new technology. In addition, perceived risk (PR) negatively affects the attitude toward use (AU) (β = −0.11, $p < 0.05$), indicating that if the users perceive greater risks, their attitude toward using new devices may be more negative, confirming hypothesis H7. PP positively affects PEOU (β = 0.22, $p < 0.001$), implying that more entertaining device features can enhance user perceptions of ease of use, supporting hypothesis H8.

Table 4. Assessment of model fit.

Index Name	χ^2/DF	CFI	GFI	AGFI	RMSEA	TLI
Final model	2.797	0.933	0.932	0.907	0.060	0.942
Standard requirement	<3.0	>0.9	>0.9	>0.9	<0.08	>0.9

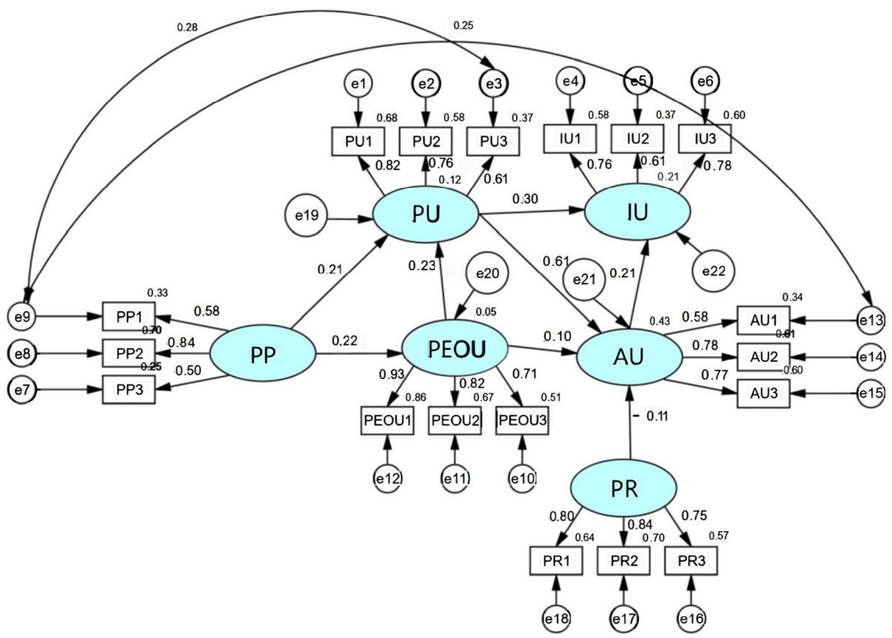

Figure 3. Structural equation model for the intention to use the VP-ADD.

4.4. Results of Hypothesis Testing

Based on the above analysis, we verify the degree of fitting based on the TAM and then verify the assumptions in the model. The hypothetical relationship is determined by the path coefficients of the model and the explicitness between them. From the perspective of the hypothesis results and the path coefficients of the model, the model constructed in this study contains multiple influencing variables, and the relationship between variables is realized through multiple paths. On the one hand, PU and AU directly affect the driver's intention to use the new vehicle perfume device. On the other hand, PP, PR, and PEOU indirectly affect the driver's intention to use the new vehicle perfume device, and there is an intermediary variable between them. Therefore, these factors' direct, indirect, and total impacts on the target use behavior were calculated to analyze the interaction between variables in depth. Therefore, the model is further explained by the interaction between the variables, as shown in Table 5.

Table 5. Standardized direct, indirect, and total effects of the influencing factors on the target behavior intention to use (IU).

Influencing Factor	Direct Effect	Indirect Effect	Total Effect
PU	0.298	0.125	0.423
AU	0.206	0.000	0.206
PP	0.000	0.116	0.116
PR	0.000	−0.023	−0.023
PEOU	0.000	0.118	0.118

The preliminary results based on Figure 3 and Table 5 are as follows. The PU as an intermediate variable affects the intention to use but also directly impacts the target behavior variables, and the total impact is the largest, 0.423. PEOU and PR indirectly affect the driver's willingness to use the device through the intermediate variable, AU, and the total impact is 0.118 and −0.023. PP needs to indirectly affect the willingness to use the device by affecting PU and PEOU, so the impact is the smallest, and the total impact is 0.116. In short, PU has the greatest indirect or direct impact. In a certain sense, PU is the most critical factor affecting drivers' intention to use new devices.

5. Discussion

With more and more road fatigue collisions, a new alerting device needs to be applied to the in-vehicle system. This study proposes a vehicle-mounted perfume automatic dispersal device and evaluates driver's attitude and willingness to use it based on the TAM. This study quantifies users' perceptions of the entertainment value, perceived ease of use, perceived risk, perceived usefulness, intention to use, and attitudes towards the VP-ADD through questionnaires. The collected data are analyzed using Structural Equation Modeling (SEM) to validate the effectiveness of the TAM. The results show that the perceived usefulness, ease of use, playfulness, and attitude constitute the driving factors affecting the use of the device. The perceived risk is a significant obstacle to using the device. Attitude and perceived usefulness significantly impacted drivers' willingness to use the VP-ADD (β = 0.30 and 0.21). This is consistent with the conclusion obtained by Kim et al. [46] when studying the user acceptance of the on-board infotainment system, which proved the critical role of factors such as the perceived usefulness, ease of use, and playfulness for the driver in choosing the on-board equipment. The total effect of the perceived usefulness was the strongest among all explanatory variables. Perceived usefulness significantly impacts user motivation, consistent with previous studies [47]. At the same time, a relationship exists between perceived usefulness and perceived ease of use, which is not independent. Individuals' perception of the usefulness can positively impact the device's acceptance. Like the perceived usefulness, when a person perceives that a specific consumption pattern is easy to operate and master, the attitude towards this consumption pattern will become more active and people will be more inclined to use this consumption pattern [48]. That is, the perceived usefulness of new technology or device increases when a driver realizes that the easier it is to operate, the easier it is to learn [30]. This conclusion thoroughly explains the mechanism of the usefulness and ease of use on the driver's willingness to accept, clarifies the positive promotion of the willingness under the interaction, and maintains consistency with the conclusions of previous studies [49].

The perceived usefulness and behavior attitude directly affect the behavior intention, while perceived ease of use has an indirect effect. This can effectively predict and explain the users' behavior intentions and actual behavior. The behavioral attitude refers to the individual's assessment of all aspects of new technology, reflecting the individual's sense of good or bad behavior [50]. An essential variable in the TAM model is the attitude to use, which can reflect people's positive or negative attitude towards using a product. Many studies also show that consumers' use of specific consumption patterns or purchase products is usually determined by attitude. Perceived usefulness and perceived ease of use can affect consumers ' attitudes toward products, further influencing their willingness to use them [51]. In this study, the attitude to use directly affects the willingness to use and is positively correlated, consistent with previous studies [52]. In addition, the perceived risk negatively impacts the driver's intention to use. That is, the risk of the device affects the driver's attitude when using it. From the perspective of the driving environment, when there is a new device in the interior environment that emits a comfortable smell at the appropriate time, this may lead to distraction for the driver. The distraction negatively impacts driving performance and safety, which may lead to traffic collisions [53–55].

The above contents prove that the driver's willingness to use the fatigue warning device will significantly affect driving safety. In order to strengthen the control of traffic safety, it is necessary to carry out certain mandatory provisions from the policy aspect. At present, although China has clear regulations and punishment measures for the problem of fatigue driving, the provisions on fatigue warnings are still weak. Most of the current policies and technical means are limited to the management and punishment of the driver's behavior after the event, and there are still some deficiencies in the early warning measures and active fatigue protection. In particular, there is a lack of clear and specific management means and technical support for how to effectively prevent drivers from driving in a state of fatigue for a long time. By investigating drivers' willingness to use a new type of vehicle perfume automatic diffusion device, this study analyzed the main influencing factors and functions of this device and found that it can be used as an effective means of advanced management of tired driving, has a positive impact on the existing prevention and control policy of tired driving, and help establish a normal supervision and management system. At the same time, it can help policymakers to fully realize the important role of such equipment in the prevention and control of tired driving, provide theoretical support for future policy formulation, and further improve relevant regulations.

6. Conclusions

This paper has proposed a vehicle-mounted perfume automatic dissemination device based on an electronic map and evaluated the drivers' acceptable attitudes toward its implementation. A theoretical model based on the TAM was established to explore the driving and hindering factors affecting drivers' use of the perfume automatic emission device. Based on this study, the following comments are offered:

The results show that perceived usefulness, perceived ease of use, perceived playfulness, and attitude positively affect the intention to use, and perceived usefulness is the most significant factor. However, the perceived risk negatively affects the intention to use. This may be because the driver cares most about the device's practicality during driving. The connection with the electronic map enables the device to provide timely fatigue warnings for the driver in a unique driving environment and improve driving safety. At the same time, the simple operation mode of the VP-ADD and the variety of fatigue warning forms also make it easier for drivers to accept the equipment. On the contrary, if the use of the device makes the driver feel that the risk of driving is increasing, it will make the driver resist the device and reduce the willingness to accept the device.

A vital feature of the new device is that it is connected to the vehicle's electronic map. This feature allows the driver to select specific road locations at which the perfume is released. Such locations may include complex interchanges, congested areas, or a location after a specific long drive. In addition, the device defaults to distribute refreshing perfume to drivers prone to fatigue, at locations such as long tunnels or monotonous highway sections. Of course, the users can adjust these parameters according to their habits. The device can be continuously developed in the future to include other functions. The VP-ADD will develop more port docking external technologies, such as face recognition technology.

However, there are still some areas for improvement in this study. First, this study adopts the questionnaire method to collect empirical data. Still, when designing the questionnaire, some measures were taken to avoid the influence of subjective tendencies in participants' response sets, such as avoiding tendentious items. However, the disadvantage of the subjective test method is that it is susceptible to individual characteristics, which can only be avoided partially [38]. Second, the variables we consider need to be revised, and more variables can be added for investigation in the future. Third, our results indeed reflect to some extent the attitudes and willingness of respondents towards the VP-ADD, but these results are primarily based on one-time survey data and a specific sample group. Therefore, although the results are persuasive and representative to some extent, we recommend further studies to verify these findings across different groups and contexts for their universality and stability. Finally, the risk associated with the current device still needs to be clarified. Future research and development of the VP-ADD should explore the possible risks and operability of the device in practical applications.

In short, the VP-ADD has been recognized by drivers to some extent. For vehicle design, insight into user needs and reflection in vehicle design are core topics for any car manufacturer. VP-ADDs consider the driving environment and driver fatigue, helping to guide future vehicle designs toward more user-friendly and comfortable development. In addition, by using VP-ADD equipment, the driver's fatigue can be reduced to a certain extent, and alertness can be improved, directly impacting driving safety. With the development of driver assistance systems and new types of equipment, traditional safety standards need to be updated and adjusted as necessary. The design and application of VP-ADD equipment may inspire relevant institutions to conduct in-depth investigations and provide regulations on the safety impact of onboard equipment and promote the establishment and improvement of relevant systems. The VP-ADD is expected to substantially contribute to mitigating driver fatigue. As such, we hope the device will be part of vehicles' interior system functions.

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