

Research Article

Factors Influencing Users' Willingness to Adopt Connected and Autonomous Vehicles: Net and Configurational Effects Analysis Using PLS-SEM and FsQCA

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To accelerate the widespread adoption of connected and autonomous vehicles (CAVs) and take full advantage of CAVs' transportation safety, efficiency, and pro-environment, a deep understanding of CAVs acceptance is needed. However, little is known about the combined effects of factors influencing CAVs acceptance using traditional statistical methods. We developed an integrated model to explore how various antecedent factors work together on CAVs' acceptance. The symmetric (Structure Equation Modeling) and asymmetric (Qualitative Comparative Analysis) techniques were utilized for analyzing data from 362 Chinese. PLS-SEM assesses the net effect of each antecedent on CAVs' adoption, while fsQCA provides supplementary analysis by revealing the configurations of causal conditions associated with CAVs' adoption. PLS-SEM results show that perceived usefulness, perceived ease of use, and initial trust directly influence users' willingness to adopt CAVs, while perceived risk, social influence, and facilitating conditions do not. Meanwhile, automation, ubiquitous connectivity, structural assurance, and corporation reputation indirectly influence CAVs adoption, while environmental performance and technological uncertainty have no statistically significant indirect effect. Interestingly, fsQCA reveals five configurations resulting in a high level of CAVs' acceptance, and seven configurations leading to the negation of CAVs' acceptance. The complementary analysis results provide insights into both theory and practice.

1. Introduction

The rapid adoption of shared mobility services and electric vehicles, coupled with the prospect of driverless vehicles, has the potential to radically transform transportation around the world. Three revolutions in transportation (3 Revolutions), including electrification, automation, and shared mobility, stand as a promising alternative to improve transport efficiency and reduce costs, times, and carbon emissions [1]. Connected and autonomous vehicles (CAVs), as advanced technology of automation, have become the forefront of the vehicle market and attracted widespread attention. Various connected and autonomous technologies and systems, e.g., intelligent technology products, body

electronic control products, and vehicle-mounted electronic devices, could make transportation safer (fewer accidents), cleaner (lower fuel consumption, emissions, and environmental pollutants), more efficient (reduced congestion and driving time), and more comfortable [2–7]. CAVs may bring not only substantial benefits but also tough challenges, e.g., users' safety and data safety [7]. Therefore, there is still much uncertainty in the transitions toward CAVs for transport. Thus, CAVs are slowly gaining market share, but less than expected, particularly under the Covid-19 pandemic. Recent surveys have shown that the level of consumers' actual purchases of CAVs is generally low. For example, a survey in China reported that 45% of the respondents were familiar with CAVs. However, 24% and 12% of respondents are

willing to purchase high and fully automated vehicles, respectively. Another survey including more than 8,500 consumers by Kantar, one of the world's leading data and consulting companies, shows that 40% of consumers in Europe and 32% of consumers in North America accept connected car technologies. Ordinarily, innovations sometimes meet resistance or refusal in the marketplace [4]. Any innovative technology is hard to become a reality without the adoption of its targeted customers [8]. Market penetration rates depend largely on public opinions regarding benefits, concerns, and the adoption of CAVs. Hence, it is important to understand consumers' willingness to adopt CAVs [9].

Besides the concept, benefits, and concerns of CAVs [10], plenty of researchers have identified determinant factors influencing users' willingness to adopt or purchase CAVs from different perspectives of primary technology adoption theories. On the one hand, most empirical researches identify the critical factors of CAVs adoption, drawing on a single theory, e.g., theory of planned behavior (TPB) [11, 12], behavioral reasoning theory [13], technology acceptance model (TAM) [2], unified theory of acceptance and use of technology (UTAUT) [4, 14], diffusion of innovation (DOI), behavioral reasoning theory [13], cognitive appraisal theory [15], and innovation resistance model [16]. As a single theoretical perspective is insufficient for comprehensive analysis and a better understanding of the adoption decision-making process [17], it is necessary to integrate various theories or additional factors according to the specific background to improve the model's explanatory power [8, 17–20]. On the other hand, the dominant methodology employed in empirical studies for analyzing the relationships between independent and dependent variables is the conventional symmetric-based approaches, e.g., multiple regression analysis [12, 14, 21–23], covariance-based structural equation modeling (CB-SEM) [11, 17, 24–28], and partial least square (PLS-SEM) [6, 16, 17, 29–32]. The traditional methodologies, which are only centered on the net effects of individual variables, are criticized for multicollinearity and symmetry [33–35]. At the same time, the relationship between antecedents and consequences, in reality, is highly asymmetric [36, 37]. Therefore, as a holistic approach, qualitative comparative analysis (QCA) has been recommended for dealing with the disadvantages based on causal complexity theory [38–42].

To fill these gaps, this study responds to answer the calls for applying integrated theoretical models and a holistic approach to understanding consumers' intention to accept CAVs. First, based on the detailed literature review related to studies on CAVs adoption, the primary models and constructs that have been extensively used in a majority of studies are selected as a theoretical foundation to develop a systematic and integrated model, including the factors that influence CAVs adoption, e.g., perceived usefulness, perceived ease of use, perceived risk, initial trust, social influence, facilitating conditions, and technological (automation, ubiquitous connectivity, environmental performance, and technological uncertainty) and environmental characteristics (structural assurance, corporation reputation). Subsequently,

using a sample of 362 respondents in China, we apply not only symmetric (PLS-SEM) but also asymmetric (fsQCA) to analyze the net effect and combined effect of the above factors on CAVs adoption. As our theoretical models involve several factors from different models, it starts with assessing the net effects of each factor on CAVs' adoption by PLS-SEM. What is more, fsQCA is used to offer a deeper insight into the complex reality of CAVs' adoption that PLS-SEM cannot find. FsQCA can explain how the factors combine together to produce numerous causal equifinality pathways that could result in CAVs' adoption or the negation of CAVs' adoption (causal asymmetry). The results of PLS-SEM and fsQCA provide complementary insights, which are of double significance both in theory and practice.

2. Literature Review

2.1. The Definition and Acceptance of CAVs. From the view of the technology development pathway, intelligent vehicles can be chopped up into three solutions: connected vehicles (CV), autonomous vehicles (AV) (also called self-driving cars, driverless cars, or automated vehicles) [2, 3, 25, 43], and the fusion of the first two, namely, connected and autonomous vehicles [9], or intelligent and connected vehicles. As a node of the IoV system, CAV refers to a new generation vehicle equipped with advanced technologies and intelligent cooperative driving capabilities, aiming to make sure the safety, comfort, and efficiency of drivers.

The levels of automation (SAE International Standard) include no automation, driver assistance, partial, conditional, high, and full automation [44]. While the reality of fully autonomous cars on the road is still some way off, many CAVs have already existed. CAVs are believed to produce substantial benefits and shift people's lives in the short run by improving traffic safer, more efficient, and pro-environmental. Nevertheless, a broad range of CAVs issues still exist, e.g., the slightly higher price [10], and vehicle safety concerns in complex conditions, which could hinder CAVs' acceptance [11]. Therefore, to facilitate the widespread adoption of CAVs, many scholars with different disciplines and perspectives have studied the user's adoption aspects of CAVs and investigated what factors drive the user to accept and purchase a CAV. Table 1 provides a summary of previous empirical studies on CAVs acceptance.

Studies on consumer preferences toward CAVs can be divided into economic and psychological studies [59]. For economic studies, discrete choice modeling has been the prevailing approach for understanding various aspects of the demand for CAVs. Choice models try to capture decision-makers' preferences amongst a set of available alternatives [9]. The estimated model can be used for calculating CAVs' market share or adoption rate [60], calculating willingness-to-pay for CAVs [7, 61–66], or developing agent-based models or market penetration models to simulate market penetration when the overall demand is known [67].

For psychological studies, based on psychological or behavioral theories, many conceptual models have been proposed to study the adoption of different CAVs, e.g.,

TABLE 1: Empirical studies on CAVs acceptance.

Author	Theory	Types of CAVs	Methodology (collection & analysis)	Antecedent conditions (IV) and outcome (DV)
[22]	TAM	Autonomous vehicles	Online survey (318 participants in Korea) & multiple regression	PU*, PEOU*, SI, and FC* on intention to use AVs
[26]	UTAUT and DOI	Automated shuttles	Questionnaire (340 individuals in Germany) & SEM	PE, EE, SI, FC, compatibility (COM)*, trialability, trust*, and sharing* on behavioral intention (BI)
[45]	TAM and DOI	Autonomous vehicles	Survey (274 respondents in China) & SEM	PU*, PEOU*, relative advantage (RA)+, image+, COM+, result demonstrability+, visibility+, and trialability+ on BI
[13]	Behavioral reasoning theory	Autonomous vehicles	Online survey (849 individuals in China) & SEM	Attitude (ATU)*, reasons for (against) adopting AVs*, face consciousness+, need for uniqueness*, and risk aversion* on adoption intention
[15]	Cognitive appraisal theory	Autonomous vehicles	Online survey (362 responses in the United States) & CB-SEM	SI+, hedonic motivation (HM)+, trust+, PE*, perceived risk (PR)*, and emotions* on intentions
[46]	UTAUT2	Autonomous delivery vehicles	Online survey (501 German) & SEM	Trust in technology*, price sensitivity (PS)*, innovativeness*, PE*, HM*, SI*, and PR* on BI
[27]	TAM	Autonomous vehicles	Survey (340 participants in China) & SEM	ATU*, PU*, PEOU, knowledge of AVs*, PR*, public engagement, and face consciousness* on parents' intentions.
[32]	TAM	Automated vehicle	Web-based survey (647 drivers in China) & PLS-SEM	PU*, PEOU*, initial trust (IR)*, SI*, personality traits*, and sensation seeking* on BI.
[47]	Identity threat theory and identity control theory	Autonomous vehicles	Survey (353 consumers in Singapore) & SEM	Technology anxiety*, self-identity on perceived observability*, willingness to try, and intention to accept AV technology
[12]	TPB	Automated vehicle	Survey (505 Australian drivers) & linear regressions	ATU*, subjective norms (SN)*, and perceived behavioral control (PBC) on intentions to use
[48]	UTAUT2 and TPB	Shared autonomous vehicles	Survey (268 participants in Vietnam) & SEM	PE+, EE+, habit+, price value+, HM+, FC+, ATU*, subject norm*, and PBC* on BI
[28]	No specific theory	Autonomous vehicle	Survey (992 respondents in Hungary) & SEM	HM*, utilitarian motivation*, technological anxiety*, and data privacy concern on BI
[7]	No specific theory	Autonomous vehicles	Survey (1194 respondents in Florida) & SEM	Pro-technology service quality*, self-driving features*, driving assistance features*, pro-driving, trip privacy*, data privacy*, and technology concerns on AV adoption and WTP
[31]	TAM	Connected vehicles	Online survey (116 participants t) & PLS-SEM	PU, PEOU, ATU*, privacy concerns, privacy risk, trust in provider, information control, and social norm* on BI

TABLE 1: Continued.

Author	Theory	Types of CAVs	Methodology (collection & analysis)	Antecedent conditions (IV) and outcome (DV)
[49]	TAM	Autonomous vehicles	Online survey (316 participants)	PU, PEOU, ATU*, SI*, system characteristics*, and individual factors* on usage intention
[50]	TAM	Autonomous vehicles (AVs)	Survey (391 participants in Turkey) & SEM	PU*, PEOU*, trust*, and sustainability concerns* on BI
[6]	Social cognitive theory, TPB, prospect theory, and value perception theory	Fully autonomous vehicles	Survey (355 samples in Beijing, China) & PLS-SEM	Mass media+, social media+, self-efficacy*, SN*, PU*, and PR* on adoption intention
[51]	DOI and perceived value theory	Autonomous vehicles	Survey (526 residents in Seoul, Korea) & SEM	RA+, COM+, complexity+, trialability+, observability+, perceived value*, and trust* on public acceptance
[11]	TPB	Autonomous vehicles	Survey (526 residents in Seoul, Korea) & SEM	ATU*, SN*, behavioral control*, cognitive and emotive factors (RA+, COM+, complexity+, and HM+) on acceptance
[52]	UTAUT2	Autonomous delivery vehicles	Online survey (501 German) & SEM	PE*, EE, SI*, FC*, HM*, PS*, and PR* on BI
[8]	TAM	Autonomous shuttle services	Survey (700 respondents in Taiwan) & SEM	PU*, PEOU+, ATU*, trust*, and perceived enjoyment+ on use intention
[25]	TAM and initial trust theory	Automated vehicles	Face-to-face survey (216 drivers in Shenzhen, China) & SEM	PU*, PEOU+, perceived safety risk+, perceived privacy risk, IR+, and ATU* on BI
[5]	No specific theory	Autonomous vehicles	Survey (742 Korean respondents) & PLS-SEM	Trust in technology*, perceived benefit (PB)*, PR*, BI, and willingness to pay
[53]	TAM	Autonomous vehicles	Online survey (313 Korean respondents) & PLS-SEM	RA+, psychological ownership*, self-efficacy*, PR*, PU*, and PEOU on intention to use
[54]	TAM	Autonomous electric bus	Online survey (268 passengers in Germany) & SEM	PU, PEOU, ATU*, individual differences (trust*, desire to exert control, privacy concerns, ecological awareness, and personal innovativeness), social impacts (image and SN*), and systems characteristics (perceived enjoyment, RA, and price evaluation* on intention to use
[17]	TAM and the life-oriented approach	Self-driving public bus	Online survey (268 passengers in Germany) & PLS-SEM	PU*, PEOU, ATU*, life choices, subjective well-being, factors of travel quality, and life domains on intention to use.
[55]	TAM	Automated vehicles	Online survey (1177 participants in Europe, China, and North America) & PLS-SEM	Environmental protection, innovativeness+, perceived enjoyment+, objective usability+, PU+, PEOU+, and ATU* on BI.
[2]	TAM	Autonomous electric vehicles	Online survey (470 respondents in China) & SEM	Environmental concern*, green PU*, and PEOU* on BI
[24]	Trust and TAM	Autonomous vehicles	Online survey (369 German participants) & SEM	Trust*, concern of giving up control*, PU*, PEOU, driving enjoyment*, and personal innovativeness* on the adoption intention of AVs

TABLE 1: Continued.

Author	Theory	Types of CAVs	Methodology (collection & analysis)	Antecedent conditions (IV) and outcome (DV)
[30]	No specific theory	Self-driving vehicles	Survey (1355 participants in Tianjin and Xi'an, China) & PLS-SEM	Demographic (familiarity, age*, gender, education*, and income*) and psychological factors (PB*, PR*, perceived dread*, and trust*) on WTP
[9]	DOI theory and agent-based simulation modeling	Connected autonomous vehicles	Survey (327 employees of the University of Memphis) & simulation modeling	Price reduction*, mass communication (marketing), and peer-to-peer communication (word-of-mouth)* on CAV market share
[4]	UTAUT	Autonomous car	Online survey (241 respondents in France) & SEM and multi-group analysis	PE*, EE*, SI*, and consumer innovativeness* on purchase intention
[21]	TAM	Autonomous driving	Web-based survey (483 respondents in Greece) & multiple regression analyses	PU*, PEOU*, perceived trust*, and SI* on BI to have AVs
[14]	UTAUT	Automated road transport systems	Survey (315 participants in Greece) & Hierarchical multiple regression	PE*, EE, SI*, FC*, and HM* on BI
[56]	No specific theory	Fully autonomous vehicles	Online survey (482 participants from the United States) & principal component analysis and SEM	ATU, social norm, trust, COM*, and system effectiveness* on BI
[57]	UTAUT	Automated road transport systems	Survey (349 respondents from France and Switzerland) & Hierarchical multiple regression	PE*, EE*, SI*, and BI
[16]	Innovation resistance model	In-vehicle infotainment (IVI) systems	Online survey (1070 samples in Korea) & PLS-SEM	Technographics, SN, prior similar experience, PU*, perceived complexity*, PR*, and resistance on intention
[58]	UTAUT	Self-driving vehicles	Online survey (556 residents of Austin, Texas) & Ordinal regression model	PE*, EE*, SI, perceived safety*, anxiety*, ATU about technology, desire for control*, technology use*, and technology acceptance on intent to use
[29]	TAM and trust theory	Autonomous vehicle	Online survey (552 drivers) & PLS-SEM	System transparency+, technical competence+, situation management+, trust*, PU*, PEOU*, PR, external locus of control*, and sensation seeking on BI

Note. Perceived usefulness, PU; perceived ease of use, PEOU, perceived benefit, PB; perceived risks, PR; performance expectancy, PE; effort expectancy, EE; social influence, SI; facilitating conditions, FC; hedonic motivation, HM; price sensitivity, PS; relative advantage, RA; compatibility, COM; attitude, ATU; subjective norms, SN; perceived behavioral control, PBC; behavioral intention, BI; "+" shows a significant impact on other variables that are not the dependent variables, and "*" indicates a significant impact on BI.

autonomous delivery vehicles [46], automated shuttles [26], autonomous electric buses [54], shared autonomous vehicles [48, 68, 69], connected vehicles [9, 31], and Robo-taxi services [23]. Various factors have been empirically found to have a significant influence on accepting CAVs among multiple regions, e.g., Korea [5, 11, 16, 22, 53], Germany [17, 24, 26, 31, 46, 49, 54], China [2, 6, 13, 25, 27, 30, 32, 45], United States [7, 9, 15], Singapore [47], Australia [12], Vietnam [48], Hungary [28], Turkey [50], Taiwan [8], France [4], and Greece [14, 21].

In terms of theoretical models, previous studies have mainly attempted to identify the antecedents of CAVs' acceptance using a single theory, e.g., TAM [2, 8, 21–23, 27, 31, 32, 49, 50, 53, 54], TPB [11, 12], UTAUT [4, 14, 46], DOI, behavioral reasoning theory [13], cognitive appraisal theory [15], and innovation resistance model [16]. In order to offer a comprehensive comprehension of CAVs acceptance [17], some scholars have suggested that the combination of various theories or additional factors according to certain contexts [8, 17] can increase the model's explanatory power.

Increasingly scholars have used the integrated model to study CAVs' acceptance, e.g., the combination of TAM and initial trust theory [8, 24, 25, 29], or DOI [45], as well as the combination of UTAUT and DOI [26], or TPB [48]. Hence, in this study, we answer this call and integrate several primary theories and constructs to identify the comprehensive factors and improve the model's explanatory power.

In terms of methodology, most empirical studies have employed the conventional symmetric-based methods, e.g., the regression model [14, 21–23], structural equation modeling (SEM) [2, 4, 8, 11, 13, 15, 24–28, 45–48, 50, 54], and partial least square (PLS) [6, 16, 17, 29–32, 49, 53], to investigate the effects between variables. However, these methods emphasize the net effect, while ignoring possible asymmetric relations between variables in complex contexts, resulting in the correlation coefficients and significance that may differ in various models. The outcome is often produced from various combinations of antecedents in a real-life context, rather than individual ones [70].

2.2. Technology Adoption Model. In the information system (IS) domain, technology adoption has been one of the extensively enduring topics [71]. Various theories and models, e.g., theory of reasoned action (TRA) [72], technology acceptance model (TAM) [73], theory of planned behavior (TPB) [74], unified theory of acceptance and usage of technology (UTAUT) [75], initial trust model (ITM) [76], diffusion of innovation theory (DOI) [77], have aimed to identify, predict, and explain variables influencing adoption behavior at the individual level to accept and use technological innovations [78].

Among these theoretical models, TAM, initially proposed by Davis, may be possibly one of the most extensively applied models in understanding IT adoption and usage processes. Two specific constructs in TAM, i.e., perceived ease of use and usefulness, are significant for behavior intention to accept innovation. Most of the studies have found TAM as the valid, robust, and most dominant model to explain technology adoption at the individual level. Therefore, TAM is broadly applicable for exploring the users' acceptance across a wide variety of contexts, e.g., parking Apps [79], telemedicine services [80], mobile library Apps [81], and virtual reality [82, 83]. As seen in Table 1, TAM serves as an adequate theoretical foundation, which is the most used in CAVs adoption studies [8, 22, 27, 31, 32, 45, 50].

2.3. Conceptual Model and Hypotheses. Although TAM is a robust and concise model for effectively explaining the adoption of various technologies [31, 84], it may be too general to be applied to every technology in its original form (i.e., it cannot adequately reflect the specific effects of technical and contextual factors that may change user adoption) [21, 80–82]. Therefore, consideration should be given to integrating other adoption models or additional factors [8, 80]. To fully explain consumer's acceptance of CAVs, we propose an integrated framework of CAVs acceptance that combines TAM with other constructs from perceived risk theory, initial trust theory, and UTAUT, and with constructs specific to

technological and environmental characteristics, as a single perspective is not sufficient for a comprehensive study [17]. Specifically, based on TAM selected as the basic theoretical framework for adaptability in the CAVs' context [16, 25], we merged initial trust and perceived risk in the initial TAM, on account of the new technology's uncertainties. Furthermore, both the two-sidedness of the innovative technologies, that is, the technological advantages (unique characteristics such as automation and ubiquitous connectivity) and the possible negative consequences (technology uncertainty) of CAVs should be investigated in parallel. In addition, environmental characteristics such as social influence, structural assurance, and corporation reputation are also considered. Moreover, CAV requires drivers to possess certain capabilities and resources. Therefore, facilitating conditions need to be considered. Considering the specific attributes of CAVs, the integrated model is shown in Figure 1.

2.4. Perceived Usefulness and Ease of Use of TAM.

Perceived usefulness believes that employing a particular innovation could improve one's work performance [73]. Perceived usefulness resembles the notion of performance expectancy in UTAUT [85], and relative advantage in DOI. It has been extensively examined in previous studies on IT adoption, e.g., virtual reality [82, 83], parking App [79], telemedicine services [80], mobile library App [81], autonomous vehicles [2, 6, 21, 22, 24, 25, 27, 32, 45, 50, 53], Robo-taxi [23], and autonomous shuttle [8]. Consumers are inclined to be willing to purchase innovative technologies if they possess uniqueness over existing technologies. Compared with traditional cars, CAVs can replace the driver for some or all of the driving tasks, and have several potentially helpful functions and benefits. For example, in 2016, motor vehicle-related crashes on U.S. highways claimed 37,461 lives. US Dept of Transportation research shows that 94% of serious crashes are due to human errors. CAVs can monitor the environment continuously and let drivers stay fully informed of the current driving situation, making up for lapses in driver attention, which can improve vehicle safety and eliminate crashes by the combination of passive safety, active safety, and automated driver assistance. What is more, CAVs can plan the best route, forecast traffic jams, and predict the best time to schedule a trip, which allows drivers to get an energy-optimized driving experience, and reduce fuel consumption. In addition, the drivers of CAVs will be able to solve their personal and business tasks right on the go, without the need to be distracted from driving. CAVs with a self-parking feature will also allow the drivers to save a lot of time since, after the arrival, the car will part itself independently, and the owner will be able to proceed with tasks [6, 54]. Many researchers have suggested technological usefulness could improve consumers' satisfaction and willingness to pay [53].

H1: Perceived usefulness positively influences users' willingness to adopt CAVs.

Perceived ease of use means one believes that employing a particular innovation would be effortless [73]. It is analogous to effort expectancy from UTAUT [85], and complexity from

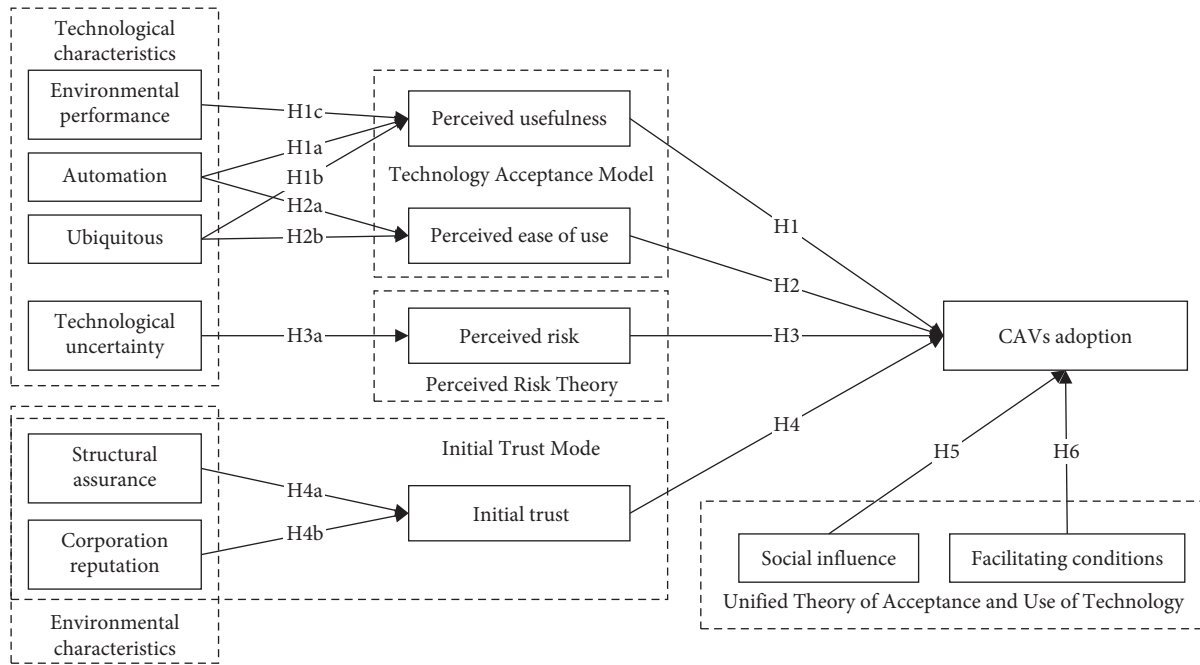


FIGURE 1: The research model.

DOI, which has been considered as a key precursor to the adoption of various technologies, e.g., virtual reality [82, 83], parking Apps [79], telemedicine services [80], mobile library App [81], Robo-taxi [23], and autonomous vehicles [2, 8, 21, 29, 32, 45, 50, 86]. CAVs benefit from the human-machine interface and artificial intelligence (AI), which may reduce the complexity of CAVs, and make it easier for people to operate CAVs. For example, several carmakers offer automated driving systems that allow for hands-free driving, including Tesla, GM, Ford, and Mercedes-Benz. CAVs are expected to become an option for people, particularly for impairment and disabilities. Managed with voice commands (e.g., Apps and settings, car controls, climate controls, navigation, phone, and media), they achieve better mobility with the car making all the necessary decisions. The easier it is to handle the key features and services of CAVs, the more possibility of adopting and purchasing CAVs [11]. Thus, the following hypotheses are formulated.

H2: Perceived ease of use positively affects users' willingness to adopt CAVs.

Automation refers to the performance by machine agents of functions previously performed by humans [87]. The widespread popularity of automation technology in intelligent vehicles has been accepted as wider connectivity improves the economy and simplicity of the vehicle. For CAVs, the automation defined by NHTSA is a vehicle capable of operating at least some mission-critical control without the need for human intervention [3]. Compared with traditional, fully manually controlled vehicles, automation characteristics possess several benefits for overcoming the inconvenience of controlling, managing, and monitoring vehicles [25, 68]. For example, CAV has enormous potential in decreasing accidents caused by human error and improving vehicle safety

with the help of collision avoidance applications [3, 11, 43, 54]. In addition, highly automated driving and adaptive cruise control reduce driving workload and improve comfort on longer trips. Riding in CAVs with full automation takes drivers off driving tasks and allows them to choose their preferred leisure or pick-up activities unrelated to driving [88]. Moreover, CAVs offer new travel options for special groups, e.g., the older people and the disabled [68, 89], providing them with a greater extent of mobility [9]. Numerous studies have found a significant relationship related to automation with consumers' attitudes to CAVs, e.g., smart homes [87] and CAVs [9].

H1a: Automation positively affects the perceived usefulness of CAVs.

H2a: Automation positively affects the perceived ease of use of CAVs.

Ubiquitous connectivity means continuous Internet connection, which is increasingly needed by users [90]. As sensors, computing, AI, and bidirectional communication technologies are embedded in CAVs, IoT-based services in CAVs become ubiquitous. Ubiquitous connectivity plays a significant role in the safety of vehicles and passengers. CAVs could synchronize information with intelligent transportation infrastructures through wireless communication technology by capturing traffic and environmental conditions to avoid traffic jams [9]. Moreover, ubiquitous connectivity makes users to be "always connected" or "always-on," offering free access to information services, e.g., in-vehicle infotainment [16]. It is validated as a predictor of willingness to use technology applications, e.g., smartphone-based SNS [90].

H1b: Ubiquitous connectivity positively affects the perceived usefulness of CAVs.

H2b: Ubiquitous connectivity positively affects the perceived ease of use of CAVs.

Environmental performance, a nonfunctional characteristic of the product, means that the product will contribute to environmental sustainability and help reduce environmental pollution [91]. With the idea of “green and low-carbon life” embedded deeply in human nature, consumers with environmental concern [92, 93] and ecological awareness [94], are more likely to deviate from their present behavior to a more environment-friendly behavior [92] such as the purchase behavior of environmentally sound products (e.g., plugin hybrid electric vehicles, and electric vehicles [93]). CAVs could utilize real-time traffic data to efficiently navigate to a prearranged destination by better routing planning and more efficient vehicle operation (optimized braking and acceleration) [54], and thus avoid traffic congestion, reduce additional fuel consumption, and generate fewer pollutants [9, 25, 43]. This characteristic may be considered a significant factor in the willingness to buy for consumers with environmental awareness.

H1c: Environmental performance positively affects the perceived usefulness of CAVs.

2.5. Perceived Risk. Perceived risk is the extent to which users are uncertain and problematic about the possible negative consequences of using innovation, according to the perceived risk theory [95]. It is negatively related to IT adoption across multiple contexts, e.g., mobile payment, and autonomous vehicles [5, 6, 13, 15, 25, 27, 46, 53]. Despite their potential, CAVs are surrounded by risks and concerns, e.g., users’ safety and data safety. For users’ safety, with the progress of CAVs technology, consumers have become more familiar with the potential safety because CAVs would not get distracted or drive when tired; however, they still have expressed more concerns related to safety when systems fail or drive in complex road conditions. No carmaker offers fully autonomous vehicles, though, but only capable of navigating marked highways in ideal, safe situations. For example, more than 35% of all Autopilot crashes occur when the Tesla vehicle is rear-ended by another vehicle. For data safety, by adding network connectivity, there can be risks with security, privacy, and data analytics and aggregation due to the large volume of data being accessed and shared when systems connect to the Internet. For example, Tesla has collected vast amounts of data from a fleet of more than 1 million cars around the world for data analytics, crash simulations, and further tests, which may lead to privacy disclosure, e.g., drivers’ in-vehicle experiences, activities, location, or history. Therefore, consumers are naturally going to be risk-averse, and these risks would be regarded as a significant obstacle to CAVs adoption [6, 9]. Stemming from the above arguments, the following hypothesis was suggested.

H3: Perceived risk negatively impacts users’ willingness to adopt CAVs.

Technology uncertainty involves the unpredictability of technological development, the technical environment, and the technology’s consequences [96]. When users perceive

uncertainty concerning the technology, they tend to overestimate the likelihood of potential losses [97]. Uncertainty perception would make them perceive more risks and technology anxiety, then dampen their intentions to utilize innovation [47]. Therefore, the inherent uncertainty of CAVs when operating in complex conditions and unclear legal liability of traffic accidents can increase consumers’ perceived risk of CAVs [68].

H3a: Technology uncertainty positively affects the perceived risk of CAVs.

2.6. Initial Trust. Initial trust means trustor trusts in an unfamiliar trustee without credible, meaningful information about each other [31]. Numerous studies have investigated initial trust plays a major role in affecting the acceptance of different technologies, e.g., parking App [79], telemedicine services [80], autonomous vehicles [5, 24, 25, 29, 30, 32, 46, 50], and autonomous shuttle [8, 17, 26, 32, 54, 86]. In the early days of the market of CAVs, enough trust of potential consumers could increase the perceived benefits of successfully using CAVs, and conquer the perceived risks and uncertainties of employing CAVs [25, 87].

H4: Initial trust positively has a positive influence related to users’ willingness to adopt CAVs.

Structural assurance means the infrastructure supporting technology use [98]. It refers to individuals ensuring that adequate structures and supports, e.g., guarantees, regulations, commitments, or other procedures, are in place to ensure an innovative technology’s successful use. In the context of mobile services, an individual with a high degree of network-related structural assurance will assume that legal and technical Internet protection, such as data encryption, can protect personal privacy, identity, or money [99]. Since the CAVs market is still in its early stages, many surveys report consumer concerns about the unclear legal liability of traffic accidents, and the safety of CAVs might be compromised because of online intrusion and hacking thefts [68]. For example, no carmaker is willing to accept liability for accidents that happen during self-driving sessions, with the notable exception of Mercedes-Benz, which will take full legal responsibility for its cars when its Level 3 autonomous driving system is active. Especially in the absence of direct experience, such structural assurance can help individuals develop confidence in innovative technologies, thereby promoting trust in a specific technology [5], especially safety, privacy, and security issues of CAVs [21].

H4a: Structural assurance positively affects users’ trust in CAVs.

A corporation’s reputation reflects consumers’ perceptions of its ability to deliver products and services effectively, the organization’s credibility, and business engagement’s reliability [98]. It plays a critical part in forming confidence and willingness to use offered information services [99]. Using big data analysis of Chinese consumers’ behavior, nationality, reputation, and brand ranking are the determinants of consumers’ consideration and preferences for electric

vehicles [100]. Motor corporation reputation can increase consumers' recognition of a newly introduced product and service and help maintain confidence in future purchases, especially for novice consumers. For example, Tesla has built its reputation for quality and customer support, and has the most loyal customers. When Tesla was hit with negative publicity involving the fatal accidents, CEO Musk was quick to address the issue and salvage its reputation via social media channels. Many studies find that firm reputation is a significant antecedent in users' trust [99]. It strongly influences the willingness to use innovative technology.

H4b: Corporation reputation of motor positively affects the user's trust in CAVs.

2.7. Social Influence and Facilitating Conditions of UTAUT. Social influence is defined as an individual feels the importance that the others believe he or she should use the new technology [85]. Previous scholars have revealed the impact of social influence on IT adoption in different contexts, e.g., AI [101], mobile banking, autonomous vehicle [3, 4, 21, 22, 32, 46], Robo-taxi [23], and automated public transport. Humans are essentially social [11], so they are susceptible influenced by social networks [17], and social norms [12,31,48], even if making decisions alone. For CAVs, that is a disruptive innovation in an emerging market, and while it will be a while before we have fully AVs on our road, many of them already exist. Therefore, increasingly consumers will follow the mainstream. Moreover, the popularity of CAVs among friends and family would result in a higher intention to accept and purchase CAVs [4].

H5: Social influence positively influences users' willingness to adopt CAVs.

Facilitating conditions means users' awareness of the resources and supports available to carry out a certain behavior [85]. Willingness to utilize innovative technologies could be influenced by facilitating conditions in varying contexts, e.g., AI [101], mobile banking [99], telemedicine services [80], autonomous vehicles [22], and automated public transport [14]. Autonomous vehicle technology as a developing technology requires R&D expenses, which means that CAVs are sold at a premium. The unaffordable price of purchasing CAVs might be one major obstacle to users' decision to utilize CAVs [23,46,54,91]. Moreover, some functions of CAVs may require users to have certain knowledge. If users have the necessary money and operational knowledge, they will accept or purchase a CAV.

H6: Facilitating conditions are positively related to users' willingness to adopt CAVs.

3. Methodology

3.1. Research Design. We employ a survey to gather empirical data from potential consumers in China. Based on the theoretical models, our quantitative questionnaire was designed and validated. The measurement model of PLS-SEM is used to examine the instruments. The structural

model of PLS-SEM is used to test our model and hypotheses, and provide symmetrical "net effect" explanations [102]. Besides, considering the limitations of symmetric statistical approaches and the occurrence of multiple realities (i.e., complex causality), the same data were calibrated and analyzed by fsQCA to explore the cause-effect relations between antecedent conditions and outcome, and to provide a holistic perspective of the interrelationships that jointly influence CAVs acceptance. The sections below describe the instruments development, data collection, and the reasons why to choose PLS-SEM and fsQCA.

3.2. Instruments Development. To improve content validity [73,103], the scales are adapted from prior literature and modified to match CAVs' context. The translation and back-translation method is employed to make sure that the meaning of the original language statements was retained to realize the semantic equivalence [22]. We measured the constructs using a five-point Likert scale (see Table 2).

The instrument was refined by revising ambiguous items during a pre-test to improve the understandability, with the involvement of several postgraduate students. Afterward, a pilot sample including 30 undergraduate students was conducted to confirm the scales' reliability, validity, and translational equivalence.

3.3. Data Collection. A self-administered online survey was conducted to collect data using Wenjuanxing (<http://www.wenjuan.com>), which is a professional online questionnaire survey and voting platform, in China from 22 to 26 June 2020. The questionnaire includes short explanations of the definition and functions of CAVs to help respondents understand this concept. The questionnaire was distributed randomly to actual respondents by Wenjuanxing. In total, 420 participants participated in our survey. Excluding invalid questionnaires with uncompleted data or identical answers, 362 questionnaires were deemed valid for the study. The detailed demographic profile is shown in Table 3.

As shown in Table 3, the gender distribution for the sample was comparable with the population distribution for China (i.e., 51.24% of the population are male). Age is biased towards young people, and education was slightly skewed toward higher educational attainment. It is mainly because of the online survey method which is mostly used by young people and highly educated people. For CAVs services most frequently used, unconscious pay is the most frequently used (54.70%). One probable reason is that electronic toll collection (ETC) systems are operating today for the turnpike covering 29 provinces in China, which reduces congestion and improves the efficiency of revenue collection while passing the highway toll station. Another is that increasingly parking lots have been connected to third-party payment (e.g., Ali pays and WeChat pay) to allow unconscious pay, so that users can pay the parking fee through unconscious pay and enjoy a convenient and efficient smart parking experience. The next is the connectivity-based intelligent services, i.e., human-machine interaction (46.41%), intelligent navigation (30.11%), and in-vehicle infotainment (22.38%). In

TABLE 2: Measurement scale.

Constructs	Items	Description	References
Automation	AU1	CAVs could help the drivers voluntarily without human intervention.	[87, 104]
	AU2	CAVs offer auto-adjusted control.	
	AU3	I could control CAVs through a simple operation.	
Ubiquitous connectivity	UC1	CAVs can assist me in being well informed about my vehicle.	[90, 105, 106]
	UC2	CAVs can allow me to obtain useful information anytime.	
	UC3	CAVs can help me to get information and monitor my vehicle regardless of where I am.	
Environmental performance	EP1	CAVs will contribute to environmental sustainability.	[2, 91]
	EP2	CAVs will help to reduce environmental pollution.	
	EP3	CAVs are important to save natural resources.	
Perceived usefulness	PU1	CAVs could improve my driving productivity.	[6, 29]
	PU2	CAVs could increase my driving performance.	
	PU3	CAVs could enhance my driving effectiveness.	
	PU4	Overall, I find CAVs very useful.	
Perceived ease of use	PEOU1	I realize that learning to operate CAVs would be easy.	[25, 29]
	PEOU2	I could easily understand how to make CAVs do what I wanted to do.	
	PEOU3	I do not have difficulty in interacting with CAVs.	
Technological uncertainty	TU1	The wireless network of CAVs is unstable.	[97, 107]
	TU2	The security of CAVs is questionable.	
	TU3	The technologies related to CAVs are undeveloped.	
Perceived risk	PR1	I fear for the general safety of CAVs.	[5, 6, 25, 84]
	PR2	I am more concerned that malfunctions of CAVs will lead to an accident.	
	PR3	I'm afraid CAVs may steal too much personal data from me privately.	
	PR4	I'm worried CAVs may misuse my personal data for commercial purposes without my authorization.	
	PR5	I'm worried CAVs will share my personal data with other entities without my authorization.	
Structural assurance	SA1	I believe that advances in intelligence, communication, encryption, and other technologies make it safe for me to use CAVs.	[99, 108]
	SA2	I am confident that legal and technological structures are sufficient to protect me from the problems associated with using CAVs.	
	SA3	Mobile communication is a robust and safe environment where to use CAVs.	
Corporation reputation	CR1	Motor corporation of CAVs is reliable.	[87, 99, 108]
	CR2	The motor corporation keeps promises and commitments.	
	CR3	The motor corporation keeps consumers' best interests in mind.	
	CR4	I feel confident in the brand of the motor corporation.	
Initial trust	IT1	CAVs are very dependable.	[25, 108]
	IT2	CAVs are very reliable.	
	IT3	In general, I could trust in CAVs.	
Social influence	SI1	People who matter to me think that I should use CAVs.	[14, 85, 109]
	SI2	People who influence my behavior think that I should use CAVs.	
	SI3	People whose opinions that I appreciate suggest that I use CAVs.	
Facilitating conditions	FC1	I have the resources (budget) necessary to use CAVs.	[14, 85, 109]
	FC2	I have the knowledge necessary to use CAVs.	
	FC3	When there are difficulties with CAVs, the assistance of specific people can be provided.	
Users' willingness to adopt CAVs	AD1	I am willing to accept and buy CAVs.	[6,14,85]
	AD2	I predict that I will accept and buy CAVs in the future.	
	AD3	I plan to accept and buy CAVs.	

making CAVs, manufacturers have introduced human-machine interaction and in-vehicle infotainment (IVI) systems into their major product lines, which provide a variety of information and entertainment services, including vehicle-specific information, navigation, and much more [16]. The proportions of the respondents that use CAVs services of the lower automation level are adaptive cruise

control (20.17%), automatic parking assist (15.47%), and collision avoidance system (14.09%), respectively. These advanced driver-assistance systems are designed to increase the safety of driving a vehicle, which is great for applications like blind-spot monitoring, lane-keep assistance, and forward-collision warning. For the high automation level, only 2.49% of the respondents have used self-driving, the smallest

TABLE 3: Demographic profile.

Characteristics	<i>n</i>	%	
Gender	Male	186	51.38
	Female	176	48.62
Age	18–25	121	33.43
	26–30	66	18.23
	31–40	131	36.19
	41–50	32	8.84
	More than 51	12	3.31
Education	High school and below	8	2.21
	Junior College	16	4.42
	Undergraduate	133	36.74
	Graduate (Master)	117	32.87
	Graduate (Ph.D.)	86	23.76
Occupation	Senior manager	55	15.19
	Professionals	93	25.69
	Civil servant	3	0.83
	Company employee	50	13.81
	Service worker	3	0.83
	Labor	2	0.55
	Private entrepreneurs	8	2.21
	Self-employed	10	2.76
	Student	118	32.60
	Unemployed	7	1.93
	Other	13	3.59
Monthly household income (CNY)	Less than 3001	22	6.08
	3001–5000	45	12.43
	5001–10000	110	30.66
	10001–15000	80	22.10
	15001–20000	47	12.98
	20001–30000	34	9.39
License holder	More than 30000	23	6.35
	Yes	318	87.85
Purchase experience	No	44	12.15
	Yes	193	53.31
Number of cars owned by the household	No	169	46.69
	0	54	14.92
	1	206	56.91
	2	91	25.14
	3	8	2.21
CAVs service most frequently used	>3	3	0.83
	Automatic parking assist	56	15.47
	Adaptive cruise control	73	20.17
	Collision avoidance system	51	14.09
	In-vehicle infotainment	81	22.38
	Human-machine interaction	168	46.41
	Intelligent navigation	109	30.11
	Unconscious pay	198	54.70
Self-driving	9	2.49	
Other	79	21.82	

proportion in our study. This suggests that the wide used of self-driving is not as easy as expected.

Common method bias (CMB), in the context of PLS-SEM, is a phenomenon that is caused by the measurement method used in an SEM study, and not by the network of causes and effects in the model being studied. CMB is evaluated through a full collinearity assessment approach recommended by Kock [110]. Kock notes that if all variance inflation factors (VIF) resulting from a full collinearity test

are equal to or lower than 5 (3.3), the model with measurement error can be considered free of CMB. Since all VIFs are below 5, the probability of CMB could be excluded.

3.4. Data Analysis Approach. Data were analyzed by PLS-SEM for estimating the measurement and structural model [103], as well as fsQCA for revealing the configurations of the antecedent conditions on outcome [38].

3.4.1. PLS-SEM Approach. Compared to other approaches, PLS-SEM provides great flexibility in modeling (e.g., complex models and formative constructs) and data requirements (e.g., small samples and nonnormally distributed data) [103]. Therefore, PLS-SEM has been widely used in various study domains, e.g., organization management, information management [111], and transportation management [53].

Following the recommendations [103], our research aims to identify key “driver” constructs, and our proposed structural model is complex. Therefore, we select the PLS-SEM approach through the specific software SmartPLS 3.2.9.

3.4.2. QCA Approach. QCA, originally developed by Ragin [112], is a methodology of in-depth analysis of the causal contribution of different conditions to an outcome of interest, based on set theory [113]. QCA can distinguish various complex forms of causation, e.g., configurations of causal conditions (not just single causes), equifinality (multiple causal pathways are leading to the same outcome’s occurrence) [114], multifinality (identical conditions could generate different outcomes), and causal asymmetry (the causes of failure may not simply be the absence of the cause of success) [38, 115].

In everyday life, the outcome often results from different combinations of antecedent conditions, rather than any one individual condition, in the context of great causal complexity [116]. FsQCA is particularly suited to analyzing causal processes, providing a configurational understanding of how causes combine to produce outcomes, and dealing with significant causal complexity [115]. Therefore, fsQCA is very appealing to many researchers and is widely used in different contexts to assess cause-effect relations, e.g., strategy and organization management [115] and information management [117].

PLS-SEM and fsQCA rely on distinct principles. PLS-SEM is a variable-oriented approach that verifies each independent variable’s net effect and significance on the dependent variable by a series of regression analyses [37, 118]. It does not answer what variable is sufficient or necessary for a certain outcome. Conversely, fsQCA is a case-oriented approach that analyzes the causal contribution of different conditions. FsQCA is a complementary analysis suitable for PLS-SEM when effects due to unobserved heterogeneity are detected, as it explains how factors work together in producing an outcome [117]. Thus, many studies empirically test the proposed models, both employing a symmetrical approach with PLS-SEM and an asymmetrical approach with fsQCA to analyze the casual and outcome conditions in complex situations, e.g., technology adoption [44, 119], organizational learning [102], and mobile shopping [37].

4. Results

4.1. Results of PLS-SEM Analysis. Based on the two-step process of PLS-SEM assessment recommendation [103], the measurement model is adopted to examine the reliability and validity of our instrument, and the structural model is employed to estimate the model and hypotheses.

4.1.1. Measurement Model. A reflective measurement model assessment includes indicator and internal consistency reliability, and convergent and discriminant validity [103].

Indicator reliability, obtained from squaring outer loadings of reflective constructs, clearly describes the relationship between the latent variable and its measures [111]. Table 4 shows that the constructs’ outer loadings are greater than 0.708 [103], thus suggesting acceptable indicator reliability.

Internal consistency reliability is assessed by Cronbach’s alpha (CA), ρ_A , and composite reliability (CR) [103,120]. Table 5 suggests that all criteria are above 0.7, thus indicating good measurement reliability.

Convergent validity is examined according to the average variance extracted (AVE) [120]. Table 5 shows that AVE is greater than 0.5, thus indicating that the measurement shows good convergent validity [103].

Discriminant validity is evaluated by Fornelle–Larcker criterion [120]. Table 6 indicates that AVE’s square root is greater than the correlations between variables, confirming adequate discriminant validity.

4.1.2. Structural Model. Standard assessment criteria of the structural model contain R^2 , and the significance and relevance of the path coefficients [103,111].

Before assessing the structural model, multicollinearity must be tested through the variance inflation factor (VIF). Table 5 shows that all VIF values are between 1 and 4.11, less than 5 [103], indicating no concern about multicollinearity issues.

Through PLS bootstrapping with 5000 iterations of resampling, the result of the structural model is presented in Figure 2.

As depicted in Figure 2, the effect of automation ($\beta = 0.339$, $p < 0.001$), ubiquitous connectivity ($\beta = 0.223$, $p < 0.05$), and environmental performance ($\beta = 0.260$, $p < 0.001$) on perceived usefulness are statistically significant. Thus, the hypothesis of automation (H1a), ubiquitous connectivity (H1b), and environmental performance (H1c) as a predictor of perceived usefulness are supported, and the model explains 58.0% of the variation in perceived usefulness, showing a moderate explanatory power. The effects of automation ($\beta = 0.531$, $p < 0.001$) and ubiquitous connectivity ($\beta = 0.225$, $p < 0.05$) as predictors of perceived ease of use are statistically significant. Thus, the hypothesis of automation (H2a) and ubiquitous connectivity (H2b) are confirmed, and the model explains 53.1% of the variation in perceived ease of use, suggesting a moderate explanatory power. The effect of technological uncertainty ($\beta = 0.614$, $p < 0.001$) as an antecedent of perceived risk is statistically significant. Thus, hypothesis H3a is confirmed, and the model explains 37.70% of the variation in perceived risk, indicating a weak explanatory power. The effects of structural assurance ($\beta = 0.637$, $p < 0.001$), and corporation reputation ($\beta = 0.300$, $p \leq 0.001$) on initial trust, are statistically significant. Hence, H4a and H4b are supported. The model explains 81.7% of the variation in initial trust, indicating a substantial explanatory power. For the direct effect of each variable on CAVs adoption, the

TABLE 4: Loadings and cross-loadings.

	PU	PEOU	PR	IT	SI	FC	AU	UB	EP	TU	SA	CR	AD
PU1	0.92	0.72	-0.26	0.68	0.73	0.67	0.67	0.63	0.64	-0.20	0.66	0.63	0.69
PU2	0.85	0.61	-0.28	0.59	0.70	0.59	0.60	0.55	0.53	-0.18	0.59	0.61	0.57
PU3	0.92	0.76	-0.28	0.72	0.78	0.70	0.69	0.66	0.67	-0.19	0.70	0.70	0.73
PU4	0.86	0.73	-0.32	0.64	0.67	0.64	0.62	0.61	0.59	-0.18	0.63	0.54	0.63
PEOU1	0.75	0.96	-0.31	0.62	0.70	0.72	0.66	0.61	0.62	-0.26	0.60	0.58	0.67
PEOU2	0.77	0.97	-0.29	0.65	0.73	0.77	0.69	0.64	0.64	-0.26	0.63	0.62	0.69
PEOU3	0.78	0.96	-0.33	0.69	0.77	0.79	0.72	0.66	0.67	-0.26	0.67	0.64	0.70
PR1	-0.27	-0.26	0.88	-0.21	-0.31	-0.23	-0.33	-0.42	-0.24	0.50	-0.26	-0.20	-0.25
PR2	-0.29	-0.31	0.89	-0.26	-0.33	-0.28	-0.36	-0.45	-0.29	0.50	-0.31	-0.22	-0.27
PR3	-0.27	-0.29	0.89	-0.24	-0.34	-0.23	-0.32	-0.42	-0.24	0.49	-0.29	-0.23	-0.26
PR4	-0.29	-0.28	0.86	-0.23	-0.30	-0.26	-0.36	-0.37	-0.32	0.53	-0.25	-0.21	-0.29
PR5	-0.25	-0.24	0.75	-0.27	-0.31	-0.26	-0.37	-0.34	-0.35	0.58	-0.28	-0.28	-0.28
IT1	0.73	0.66	-0.29	0.97	0.72	0.71	0.79	0.74	0.69	-0.16	0.84	0.78	0.75
IT2	0.70	0.62	-0.24	0.96	0.68	0.69	0.74	0.69	0.65	-0.13	0.83	0.80	0.71
IT3	0.73	0.68	-0.30	0.95	0.73	0.70	0.79	0.73	0.69	-0.16	0.89	0.82	0.77
SI1	0.79	0.75	-0.33	0.73	0.94	0.73	0.70	0.68	0.65	-0.23	0.72	0.70	0.68
SI2	0.75	0.72	-0.36	0.70	0.95	0.73	0.70	0.66	0.65	-0.26	0.71	0.71	0.68
SI3	0.75	0.69	-0.36	0.66	0.93	0.74	0.69	0.67	0.65	-0.25	0.68	0.70	0.68
FC1	0.58	0.61	-0.25	0.63	0.67	0.87	0.64	0.56	0.60	-0.21	0.58	0.60	0.57
FC2	0.68	0.74	-0.25	0.61	0.67	0.89	0.61	0.56	0.59	-0.23	0.57	0.56	0.62
FC4	0.67	0.72	-0.27	0.68	0.71	0.86	0.74	0.63	0.64	-0.26	0.63	0.65	0.65
AU1	0.58	0.57	-0.35	0.68	0.61	0.63	0.86	0.69	0.64	-0.22	0.65	0.71	0.65
AU2	0.67	0.65	-0.39	0.74	0.67	0.67	0.93	0.78	0.74	-0.22	0.73	0.75	0.74
AU3	0.70	0.71	-0.37	0.75	0.72	0.73	0.90	0.75	0.74	-0.26	0.74	0.69	0.80
UB1	0.65	0.63	-0.46	0.71	0.66	0.62	0.76	0.94	0.68	-0.29	0.70	0.70	0.70
UB2	0.61	0.59	-0.45	0.65	0.63	0.61	0.74	0.94	0.66	-0.26	0.66	0.65	0.63
UB3	0.69	0.66	-0.41	0.74	0.72	0.66	0.82	0.93	0.72	-0.23	0.75	0.75	0.76
EP1	0.63	0.62	-0.31	0.66	0.66	0.67	0.73	0.67	0.94	-0.34	0.65	0.67	0.75
EP2	0.63	0.61	-0.35	0.64	0.64	0.66	0.74	0.68	0.94	-0.29	0.65	0.67	0.74
EP3	0.69	0.66	-0.31	0.68	0.65	0.64	0.76	0.71	0.95	-0.26	0.70	0.67	0.81
TU1	-0.22	-0.26	0.54	-0.16	-0.27	-0.28	-0.26	-0.27	-0.30	0.91	-0.17	-0.19	-0.25
TU2	-0.15	-0.21	0.57	-0.13	-0.22	-0.22	-0.22	-0.22	-0.28	0.93	-0.13	-0.14	-0.17
TU3	-0.21	-0.28	0.58	-0.14	-0.24	-0.25	-0.24	-0.27	-0.30	0.92	-0.15	-0.13	-0.24
SA1	0.71	0.65	-0.31	0.84	0.73	0.64	0.74	0.74	0.69	-0.15	0.95	0.78	0.76
SA2	0.66	0.59	-0.28	0.82	0.70	0.64	0.73	0.69	0.63	-0.15	0.93	0.80	0.68
SA3	0.70	0.63	-0.33	0.85	0.69	0.65	0.76	0.71	0.69	-0.17	0.95	0.79	0.75
CR1	0.64	0.60	-0.28	0.81	0.68	0.64	0.74	0.70	0.64	-0.15	0.80	0.93	0.69
CR2	0.65	0.56	-0.26	0.77	0.68	0.62	0.72	0.70	0.65	-0.15	0.80	0.94	0.68
CR3	0.67	0.60	-0.22	0.75	0.71	0.66	0.73	0.68	0.67	-0.17	0.75	0.94	0.66
CR4	0.68	0.62	-0.25	0.80	0.73	0.67	0.79	0.72	0.70	-0.15	0.80	0.94	0.71
AD1	0.69	0.64	-0.30	0.74	0.69	0.66	0.79	0.71	0.79	-0.25	0.73	0.71	0.93
AD2	0.71	0.68	-0.30	0.72	0.67	0.66	0.75	0.69	0.75	-0.21	0.73	0.66	0.95
AD3	0.71	0.70	-0.30	0.74	0.69	0.67	0.78	0.71	0.78	-0.22	0.74	0.70	0.96

Bold values are the factor loadings of the constructs.

arrows in Figure 2 indicate that perceived usefulness ($\beta = 0.184, p < 0.05$), perceived ease of use ($\beta = 0.163, p < 0.05$), and initial trust ($\beta = 0.410, p < 0.001$) are statistically significant to explain CAVs' adoption. Therefore, H1, H2, and H4 are confirmed. In contrast, perceived risk ($\beta = -0.042, p > 0.05$), social influence ($\beta = 0.073, p > 0.05$), and facilitating conditions ($\beta = 0.070, p > 0.05$) have insignificant direct relationships with CAVs adoption. Accordingly, H3, H5, and H6 are not confirmed.

For the indirect effect of each factor on CAVs' adoption, the results suggest that the total indirect effects of automation ($\beta = 0.149, p < 0.001$), ubiquitous connectivity ($\beta = 0.078, p < 0.05$), structural assurance ($\beta = 0.261, p < 0.001$), and corporation reputation ($\beta = 0.123,$

$p < 0.001$) are statistically significant on the intention to adopt CAVs. In contrast, environmental performance ($\beta = 0.048, p > 0.05$) and technological uncertainty ($\beta = -0.026, p > 0.05$) have no significant indirect influence on CAVs adoption. To sum up, the model explains the variance of 68.7% (R^2) in CAVs acceptance, indicating a moderate explanatory power [103]. Table 7 summarizes the results for the fourteen hypotheses.

4.2. Results of Qualitative Comparative Analysis. The key procedures of fsQCA empirical research include model development, sampling, data calibration, analysis of necessary conditions, analysis of sufficient conditions, and findings' interpretation.

TABLE 5: CA, ρ_A , CR, AVE, and VIF.

	CA	ρ_A	CR	AVE	VIF (AD)	VIF (PU)	VIF (PEOU)	VIF (PR)	VIF (IT)
PU	0.91	0.91	0.94	0.78	4.10				
PEOU	0.96	0.96	0.97	0.92	3.71				
PR	0.91	0.91	0.93	0.73	1.17				
IT	0.96	0.96	0.97	0.93	2.80				
SI	0.93	0.93	0.96	0.88	4.11				
FC	0.85	0.85	0.91	0.77	3.58				
AU	0.88	0.89	0.93	0.81		4.10	3.13		
UB	0.93	0.94	0.96	0.88		3.31	3.13		
EP	0.94	0.94	0.96	0.89		2.81			
TU	0.91	0.91	0.94	0.84				1.00	
SA	0.94	0.94	0.96	0.89					3.35
CR	0.95	0.96	0.97	0.88					3.35
AD	0.94	0.94	0.96	0.89					

Note. perceived usefulness, PU; perceived ease of use, PEOU; perceived risk, PR; initial trust, IT; social influence, SI; facilitating conditions, FC; automation, AU; ubiquitous connectivity, UC; environmental performance, EP; technological uncertainty, TU; structural assurance, SA; corporation reputation, CR; users' willingness to adopt CAVs, AD.

TABLE 6: Discriminant validity of the constructs.

	PU	PEOU	PR	IT	SI	FC	AU	UB	EP	TU	SA	CR	AD
PU	0.89												
PEOU	0.80	0.96											
PR	-0.32	-0.32	0.86										
IT	0.75	0.68	-0.29	0.96									
SI	0.81	0.77	-0.37	0.74	0.94								
FC	0.74	0.79	-0.29	0.73	0.78	0.88							
AU	0.73	0.72	-0.41	0.81	0.74	0.76	0.90						
UB	0.69	0.66	-0.47	0.75	0.72	0.67	0.83	0.94					
EP	0.69	0.67	-0.34	0.70	0.69	0.70	0.79	0.73	0.94				
TU	-0.21	-0.27	0.61	-0.16	-0.26	-0.27	-0.26	-0.28	-0.32	0.92			
SA	0.73	0.66	-0.33	0.89	0.75	0.68	0.79	0.75	0.71	-0.17	0.94		
CR	0.70	0.63	-0.27	0.83	0.75	0.69	0.80	0.75	0.71	-0.16	0.84	0.94	
AD	0.74	0.71	-0.32	0.78	0.72	0.70	0.82	0.74	0.82	-0.24	0.78	0.73	0.95

Note. The bold diagonal is AVE's square root.

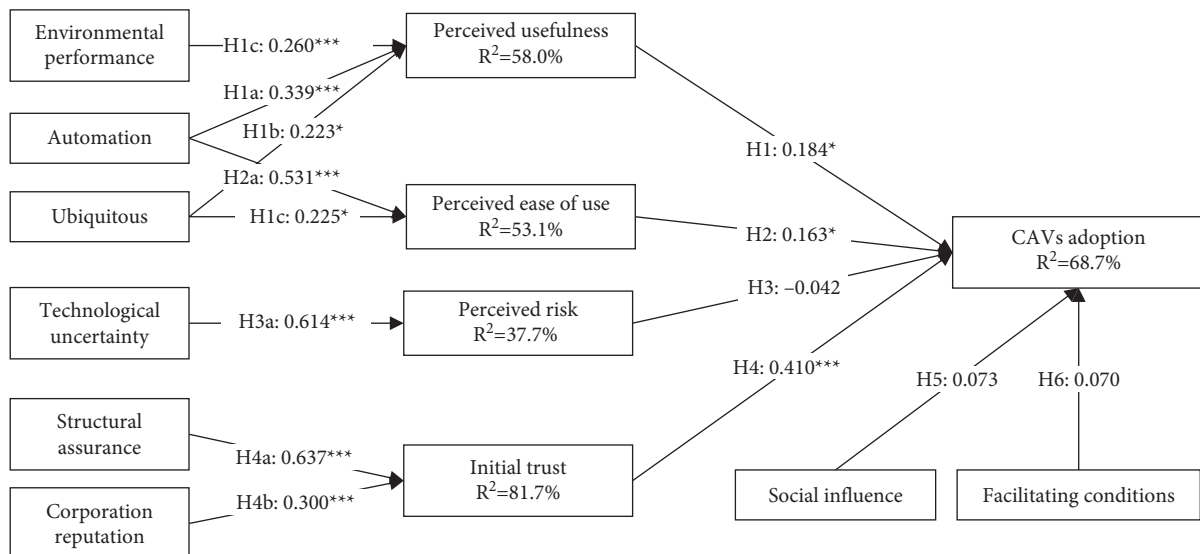


FIGURE 2: The results of the structural model of CAVs adoption. Note. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

TABLE 7: Summary of the hypothesis test.

Hypothesis	Structural path	β	SE	T value	p value	Supported
H1a	Automation \rightarrow Perceived usefulness	0.339***	0.084	4.052	0.001	Yes
H1b	Ubiquitous \rightarrow Perceived usefulness	0.223*	0.091	2.436	0.015	Yes
H1c	Environmental performance \rightarrow Perceived usefulness	0.260***	0.069	3.765	0.001	Yes
H1	Perceived usefulness \rightarrow Adoption	0.184*	0.075	2.464	0.014	Yes
H2a	Automation \rightarrow Perceived ease of use	0.531***	0.092	5.775	0.001	Yes
H2b	Ubiquitous \rightarrow Perceived ease of use	0.225*	0.107	2.109	0.035	Yes
H2	Perceived ease of use \rightarrow Adoption	0.163*	0.071	2.286	0.022	Yes
H3a	Technological uncertainty \rightarrow Perceived risk	0.614***	0.049	12.417	0.001	Yes
H3	Perceived risk \rightarrow Adoption	-0.042	0.033	1.285	0.199	No
H4a	Structural assurance \rightarrow Initial trust	0.637***	0.053	11.987	0.001	Yes
H4b	Corporation reputation \rightarrow Initial trust	0.300***	0.055	5.470	0.001	Yes
H4	Initial trust \rightarrow Adoption	0.410***	0.068	5.988	0.001	Yes
H5	Social influence \rightarrow Adoption	0.073	0.080	0.917	0.359	No
H6	Facilitating conditions \rightarrow Adoption	0.070	0.075	0.926	0.354	No

Note. * $p \leq 0.05$; ** $p \leq 0.01$; *** $p \leq 0.001$.

TABLE 8: Data calibration.

	Full nonmembership	Crossover point	Full membership
PU	1	3.9	5
PEOU	1	3.9	5
PR	1	2.3	5
IT	1	3.9	5
SI	1	3.9	5
FC	1	3.9	5
AD	1	4.1	5

4.2.1. *Calibration.* The data used in PLS-SEM should be calibrated into fuzzy sets for fsQCA analysis. The fuzzy set ranges from 0 to 1 on a continuous scale, where 0 represents the full nonset membership, and 1 shows the full set membership. As our actual data are not a normal distribution, consequently, the mean value of each condition is selected as a crossover point [37, 115]. By the procedure of fsQCA 3.0, data calibration is automatically calculated (see Table 8).

4.2.2. *Analysis of Necessary Conditions.* An analysis of necessary conditions tests whether there are any causal conditions that can be considered necessary to produce an outcome, which is CAVs’ adoption in our study. According to the recommendations by previous studies [38], a condition is necessary when its consistency must be more than 0.9 [37]. As seen in Table 9, except for the perceived usefulness and ease of use, any condition alone is not necessary for CAVs adoption (“AD”). In addition, no condition alone is necessary for the negation of CAVs’ adoption (“~AD”). The results suggest that no single condition on its own can result in output “~AD.”

4.2.3. *Analysis of Sufficient Conditions for CAVs’ Acceptance.* An analysis of sufficient conditions determines all conditions that are sufficient for an outcome. This study sets the frequency threshold (five) and the raw consistency threshold (0.8) to avoid distractions of less important configurations. According to the threshold setting, the remainder configurations capture 82% of the cases, meeting the recommendation for at least 75–80%.

TABLE 9: Analysis of necessary conditions.

Conditions	Outcome			
	AD (CAVs adoption)		~AD (negation of CAVs adoption)	
	Consistency	Coverage	Consistency	Coverage
PU	0.932	0.841	0.734	0.494
~PU	0.439	0.689	0.764	0.893
PEOU	0.931	0.827	0.745	0.493
~PEOU	0.430	0.693	0.739	0.888
PR	0.552	0.752	0.747	0.759
~PR	0.823	0.813	0.756	0.557
IT	0.893	0.893	0.693	0.516
~IT	0.516	0.693	0.856	0.857
SI	0.881	0.887	0.677	0.508
~SI	0.512	0.680	0.849	0.842
FC	0.854	0.891	0.670	0.521
~FC	0.541	0.688	0.860	0.814

Bold values show that the consistency value of each condition is greater than 0.9.

Based on the “Standard Analyses” procedure of fsQCA 3.0, the complex, intermediate, and parsimonious solutions are automatically given [38]. As the intermediate solution is most suitable for theoretical interpretation [115], it was used for our analyses. Table 10 reports the combinations of conditions that result in the high-level CAVs adoption. Any isolated condition is not sufficient for “AD,” and five equifinal configurations (divided into four types by the core conditions) with a consistency of more than 0.8, indicating that all these configurations are sufficient. Moreover, every configuration’s coverage (a similar approach of R^2 of regression model) is more than 0, suggesting they are empirically relevant [38]. Solution consistency (0.908) and solution coverage (0.869) should be more than 0.75 and 0.25, respectively [38]. In addition, solution coverage presents that total solutions account for 86.9% of samples related to high CAVs adoption.

As shown in Table 10, the presence of PU and PEOU and the absence of PR as core conditions are, respectively, listed in the different configurations. This result means that consumers’ perception of technological characteristics

TABLE 10: Sufficient configurations for high CAVs adoption.

Causal condition	Configurations				
	1a	1b	2	3	4
PU	●	●		●	○
PEOU	●	●	●	●	○
PR		●		○	○
IT	●		●		
SI		○	○	●	○
FC		○	○		○
Raw coverage	0.840	0.377	0.423	0.734	0.381
Unique coverage	0.104	0.004	0.001	0.025	0.023
Consistency	0.923	0.953	0.946	0.941	0.861
Solution consistency			0.908		
Solution coverage			0.869		

Note. Black (“●”) and hollow circles (“○”) show the presence and absence of a condition, respectively. Moreover, large and small circles show core and peripheral conditions, respectively. Blank cells show a “do not care” situation.

TABLE 11: Sufficient configurations for the negation of CAVs’ acceptance.

Causal condition	Configurations						
	1	2a	2b	2c	3	4	5
PU	○	○	●		●	●	●
PEOU	○		●	●	●	●	●
PR		○	●		○		
IT	○			●	○	●	●
SI	○	○	○	○	●	○	
FC	○	○	○	○			○
Raw coverage	0.641	0.555	0.490	0.545	0.527	0.548	0.559
Unique coverage	0.125	0.013	0.005	0.003	0.022	0.0130	0.013
Consistency	0.950	0.934	0.924	0.907	0.875	0.876	0.840
Solution consistency				0.822			
Solution coverage				0.844			

(usefulness, ease of use, and risk) of CAVs is the most important significant condition for realizing consumers’ high willingness to adopt CAVs.

Solution 1a shows that the presence of PU and PEOU as core conditions combines with the presence of IT as peripheral conditions are sufficient for high CAVs adoption, which is in line with PLS-SEM results. Furthermore, solution 1a is the most important solution of the five causal paths, as it is the most empirically relevant (unique coverage = 0.104). Solution 1b demonstrates that the presence of PU and PEOU as core conditions, in case of the presence of PR and the absence of SI and FC, can fit together to produce the outcome. Solution 2 indicates that the configuration of the presence of PEOU as core conditions with the presence of IT as peripheral conditions, and the absence of SI and FC as peripheral conditions, is sufficient for high willingness to adopt CAVs.

Solution 3 demonstrates that the presence of PU and PEOU as core conditions and the absence of PR as core conditions, with the presence of SI as peripheral conditions, is sufficient for high intention to accept CAVs. Solution 4 indicates an important path to high CAVs adoption, combining the absence of PR as core conditions as well as PU, SI, and FC as peripheral conditions. Based on the two-factor theory [121], although PR, as the inhibitor

of IT adoption, can hinder adoption in case of the absence of enablers (PU, SI, and FC), the absence of inhibitor could also enable the adoption. Besides, the absence of PR is a core condition in solution 3 and solution 4 in fsQCA, while PR is not statistically significant on CAVs acceptance in PLS-SEM, suggesting fsQCA complements the net effect perspective.

4.2.4. Analysis of Sufficient Conditions for the Negation of CAVs’ Acceptance. Unlike conventional approaches, e.g., SEM and regression model, fsQCA is good at dealing with causal asymmetry [38]. Therefore, this study also explores which conditions work together on the negation of the outcome (\sim AD) by applying the same thresholds setting. The results of the negation of CAVs acceptance are shown in Table 11. Table 11 indicates that seven identified configurations are sufficient and empirically relevant, because each configuration’s consistency and coverage are more than 0.8 and 0, respectively. The causal conditions account for 84.4% of samples (negation of CAVs adoption). These findings also indicate causal asymmetry.

As seen in Table 11, seven configurations (divided into five types by the core conditions) were found for the negation of CAVs’ adoption.

5. Discussion and Conclusion

CAVs are emerging as a significant development in the automobile industry, potentially increasing safety, convenience, and efficiency in driving. Using a mixed-method within PLS-SEM and fsQCA, we sought to deeply understand CAVs' adoption by the net effect and combined effect of conditions.

It is found from PLS-SEM results that initial trust ($\beta = 0.41$) is one of the most significant factors that influence users' willingness to accept CAVs. The significantly net effect of initial trust in shaping adoption intention corroborates previous studies, e.g., mobile banking [108], autonomous vehicles [5, 24, 29, 30], and autonomous shuttle/bus [8, 17, 54]. This finding indicates that trust, as "a tool for the reduction of cognitive complexity," may help reduce cognitive complexity and simplify decision-making processes, particularly in situations involving risks or uncertainty [25]. As a result, initial trust is of particular importance for CAVs, as it indicates that the potential consumer must have confidence in CAVs in order to accept it. In addition, the results of fsQCA shows that "the presence of initial trust" is just a peripheral condition of configuration (solution 1a and 2) for CAVs adoption, and more importantly, "the absence of initial trust" is indeed a core condition in two of the seven configurations (solution 1 and 3) for the negation of CAVs adoption (i.e., the presence of AD), which indicates that the lack of initial trust in CAVs is likely to reduce the willingness to adopt CAVs. This finding of fsQCA is in accordance with previous studies that a major psychological barrier to the widespread adoption of CAVs is an inadequate sense of trust [24, 30]. Structural assurance ($\beta = 0.637$) and corporation reputation ($\beta = 0.300$) directly influence initial trust and indirectly influence CAVs adoption through initial trust, which concur with previous studies suggesting they are the important antecedents of technology adoption [99, 108]. In order to gain users' trust and promote the adoption of CAVs, providing structural assurance and building corporation reputation are necessary.

The results of PLS-SEM indicate that either perceived usefulness (PU) ($\beta = 0.184$), or perceived ease of use (PEOU) ($\beta = 0.163$) significantly affects users' willingness to adopt CAVs. The significantly net effect of PU is consistent with previous studies on various technologies, e.g., mobile payment [122], social commerce [123], IoT [124], autonomous vehicles [2, 6, 21, 24, 25, 53], and autonomous shuttle [8], which highlight the importance of the users' perception of usefulness to achieve the behavioral intention to use innovation. The relevance of PEOU is in line with similar studies of IoT [124], mobile payment [122], social commerce [123], and automated vehicles [2, 21, 29]. The findings from fsQCA reconfirm that PU (Consistency = 0.932) and PEOU (Consistency = 0.931) are necessary for CAVs' adoption. Moreover, "the presence of PU" and "the presence of PEOU" are core conditions in three (solution 1a, 1b, and 3) and four (solution 1a, 1b, 2, and 3) of the five configurations leading to the presence of CAVs adoption, respectively, providing additional support for the related hypotheses of PLS-SEM. Findings from these two distinct methods demonstrate that higher PU and PEOU could increase the intention to adopt

CAVs [24, 117]. In addition, it is found that automation and ubiquitous connectivity directly impact PU and PEOU, and indirectly impact CAVs' adoption. Environmental performance has a direct impact on PU, while no indirect impact on CAVs' adoption.

Despite perceived risk (PR) has been frequently cited as one major concern in adopting CAVs in surveys [125], PLS-SEM failed to identify its significant net effect on behavioral intention to accept CAVs. This result is aligned with the previous studies that find a nonsignificant direct effect of PR on the behavioral intention to use social commerce [123], autonomous vehicles [29, 30], and connected vehicles [31]. Interestingly, fsQCA results show that the absence of PR is indeed a core condition in two of the five configurations (solution 3 and 4) for user's willingness to adopt CAVs, which corroborates previous studies that observe a negative direct effect of PR on the behavioral intention of innovative products or services such as mobile payment [122], social media purchase [126], and autonomous vehicle [5, 6, 52, 53]. The empirical findings of previous studies are rather mixed, resulting in the argument that PR cannot be seen as a steady predictor of CAVs' adoption [5, 52], indicating the lower the risk perception by potential users, the higher the acceptance of CAVs. In addition, technological uncertainty ($\beta = 0.614$) as an antecedent of perceived risk is statistically significant, while it has no significant indirect influence on CAVs' adoption, which is consistent with previous studies [97]. As the CAV is a technology-intensive product, the more consumers feel uncertain about their technology, the more they will associate risk with CAVs.

Different from the significant net effect of social influence (SI) and facilitating conditions (FC) in previous studies [14, 52], PLS-SEM results show that SI and FC have no significant net effect on user's willingness to adopt CAVs, which is aligned with previous studies that find a nonsignificant direct effect of SI on user's intention [127] and nonsignificant direct effect of FC on user's intention [128]. However, SI, as peripheral conditions, is present in one configuration (solution 3) for AD in the fsQCA result, suggesting that the relevance of SI on AD is consistent with numerous studies in IoT [124] and autonomous vehicles [3, 4, 21]. In addition, fsQCA shows that the absence of SI (solution 1, 2a, 2b, 2c, and 4) and the absence of FC (solution 1, 2a, 2b, 2c, and 5) are core conditions in five of the seven configurations for the negation of behavioral intention to accept CAVs, showing the existence of causal asymmetry in a complex context [35, 41].

In short, results from PLS-SEM not only indicate that perceived usefulness, perceived ease of use, and initial trust increase user's willingness but also identify the predictors of perceived usefulness (automation, ubiquitous connectivity, and environmental performance), perceived risk (technological uncertainty), and initial trust (structural assurance and corporation reputation). Moreover, results from fsQCA which are used as supplementary analysis technique [129] reinforce the symmetric findings of PLS-SEM and offer additional novel, interesting, and more nuanced insights that indicate a combination of the conditions needs to be

taken into account to explain the outcome. Five configurations for “AD” and seven configurations for “~AD” are identified. This synergetic effect could not be captured by PLS-SEM since it examines the condition in isolation from the other conditions [130, 131].

5.1. Theoretical Implications. Firstly, our study uses a holistic and integrative approach to exploring CAVs’ acceptance, making important contributions to the literature on CAVs’ acceptance, and responding to the call for comprehensive approaches that integrate multiple theories to understand the adoption of advanced technologies [8, 17–20, 37, 101], due to single perspectives not being enough for comprehensive investigations [17]. Although previous literature has addressed CAVs’ adoption, the advantage of our study is that it combines the perceived, technological, and environmental factors from several technology adoption theories, e.g., TAM, perceived risk theory, initial trust model, and UTAUT. Empirical studies show that our integrated model overcomes the shortcoming of a single model, and explains 68.7% variance (R^2) of CAVs’ adoption, indicating a high explanatory power.

Secondly, from a methodological perspective, our study contributes to illustrating the complementarity of PLS-SEM and fsQCA in the context of CAVs’ acceptance [44]. Numerous studies on CAVs’ acceptance generally use the multiple regression model, SEM, and PLS-SEM techniques, and test the net effect of each isolated antecedent on the consumer’s willingness to accept CAVs. Hence, we responded to the call for applying the QCA methodology to complex behavioral studies [117]. Specifically, the PLS-SEM methodology is appropriate for identifying key “driver” constructs for CAVs’ acceptance. In contrast, fsQCA provides a deeper understanding of a configuration of the conditions that need to be considered to explain the complex, nonlinear, and asymmetric influences of causal conditions for the outcome (CAVs’ adoption).

5.2. Managerial Implications. Our study provides automotive manufacturers with several managerial implications for pushing CAVs into the wider mass market.

Firstly, the perceived usefulness and perceived ease of use of CAVs are very crucial to potential users. Hence, automotive manufacturers should focus on the core technology development of CAVs (e.g., higher automation, higher ubiquitous connectivity, and higher environmental performance) for improving the usefulness and ease of use of CAVs.

Second, lower perceived risk is also found to be crucial for CAVs’ acceptance. Therefore, automotive manufacturers should pay attention to reducing technological uncertainty and market uncertainty, by R&D of the hardware and software of autonomous driving technology (e.g., sensing and data input, computation, and decision-making).

Third, initial trust is of great significance in predicting CAVs’ acceptance, and the lack of initial trust is likely to result in lower willingness. Hence, consumers’ trust-building has become a top priority for automotive manufacturers [5].

Based on our research on the antecedents of consumers’ initial trust, structural assurance and motor corporation should be strengthened for building initial trust in CAVs.

Finally, a lack of social influence and facilitating conditions would result in a lower willingness to buy CAVs. Hence, marketers should display CAVs’ features and advantages through auto shows and advertising to form positive attitudes and a good reputation.

5.3. Limitations and Future Directions. First, our study only identifies and evaluates several key antecedents of CAVs’ acceptance, based on IT adoption theories and previous literature on CAVs’ acceptance. However, there may be several other factors influencing consumers’ willingness to buy CAVs. Therefore, future research should consider more comprehensive factors for CAVs’ acceptance. Second, this study relies only on a group of respondents in a single country, China. However, the consumer in other regions or countries may have different attitudes toward CAVs. Hence, future studies should conduct a comparative analysis across multiple regions, to enhance its generalizability.

Data Availability

The sample data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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