The Influence of Psychological Factors on Consumer Purchase Intention for Electric Vehicles: Integrating NCA Methodology from the Perspective of Self-Determination Theory

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Abstract: This paper examines the impact of psychological factors on consumer purchase intention for electric vehicles (EVs) through the lens of Self-Determination Theory (SDT). By integrating the three dimensions of autonomy, relatedness, and competence, this study addresses a research gap in consumer innovative consumption, offering a deeper understanding within the context of green transportation. The research reveals that psychological factors significantly influence innovative consumption and the purchase intention of EVs, aligning with existing literature. In the realm of sustainable transportation, psychological factors such as motivation, attitude, and inner activities increasingly drive purchase decisions. The findings provide new insights into the factors influencing purchase intention, thereby enriching the existing literature on consumer purchase behavior in the context of psychological factors. This paper uniquely positions the intention to purchase electric vehicles as a result of autonomy, competence, and relatedness, contrasting with traditional research. The results indicate that psychological factors positively impact innovative consumption, which in turn mediates the relationship between these factors and purchase intention. By employing Partial Least Squares Structural Equation Modeling (PLS-SEM) and Necessary Condition Analysis (NCA), the study examines both direct and indirect effects of psychological factors on purchase intention. It also considers the moderating role of driving experience in the relationship between psychological factors and innovative consumption. This combined data analysis approach provides a comprehensive understanding of the mechanisms influencing purchase intention, highlighting the intricate interplay between psychological determinants and consumer behavior in the adoption of electric vehicles.

Keywords: Self-Determination Theory; Psychological Factors; Innovative Consumption; Electric Vehicles; Purchase Intention

1. Introduction

The automobile industry is a crucial pillar of the national economic system. Since the dawn of the 21st century, China’s vehicle industry has experienced rapid growth, with annual sales surging from over 2 million vehicles at the start to 417 million vehicles in 2022, representing a growth of more than 20 times. China has been the world's largest producer and seller of vehicles for six consecutive years. However, traditional automobiles are significant sources of carbon dioxide emissions. As the number of vehicles continues to increase, energy supply and environmental pollution issues have become increasingly prominent. In 2022, global carbon dioxide emissions increased by 0.9%, adding 321 million tons compared to 2021, reaching 36.8 billion tons [1-3]. Vehicle exhaust emissions have become increasingly severe, with total motor vehicle pollutant emissions in 2022 reaching 11.73 billion tons, accounting for over 80% of total air pollutants (with nitrogen oxides and particulate matter exceeding 90% and hydrocarbons and carbon dioxide exceeding 80%). Vehicle exhaust emissions are a critical source of carbon dioxide, accounting for about 10% to 15% of total emissions. Particularly for PM2.5, motor vehicles contribute 25% to 40% of the emissions[4].

To address the challenges of resource scarcity and environmental pollution, there is a global advocacy for constructing an ecological civilization and developing green transportation [5]. Consequently, research on consumer purchase behavior of electric vehicles (EVs) has gained increasing attention in the academic community. As a pivotal product for developing sustainable supply chains, the industrialization and marketization of EVs are urgently needed [6]. Firstly, developing EVs helps reduce environmental pollution and promote sustainable development. Secondly, Electric vehicles (EVs) align with the goals of energy conservation, environmental protection, and sustainable development, making them a pivotal industry for the future [7,8]. The development of China’s EV industry can promote the structural optimization and consumption upgrade of the traditional automobile industry and further advance the growth of China’s vehicle industry. To accelerate the development of the EV industry, the Chinese government has introduced a series of supportive policies [9]. Simultaneously, EV manufacturers are intensifying their efforts in technological innovation [10]. However, consumer enthusiasm for purchasing EVs remains low, and there are still many shortcomings in the market's development level. In this context, the promotion and popularization of EVs are particularly important. By refining these elements, this paper aims to provide a more comprehensive understanding of the factors influencing consumer purchase intentions for EVs and the critical role of government policy and technological innovation in fostering a sustainable transportation ecosystem [11,12].

Previous studies have demonstrated that electric vehicles (EVs) can significantly reduce greenhouse gas emissions and decrease the concentration of air pollutants [13]. This is crucial for improving urban air quality and enhancing residents' health. Furthermore, the widespread adoption of EVs helps to reduce dependence on traditional energy sources, such as petroleum and promotes the transformation and optimization of the energy structure [7]. This study aims to investigate the key factors influencing the purchase behavior of EVs, particularly in the context of the Chinese market. By analyzing consumers' attitudes, perceptions, and behavioral patterns towards EVs [14], this research intends to provide valuable insights for policymakers, enterprises, and research institutions to foster the healthy development of the EV industry.

Previous literature has predominantly focused on the impact of green consumption benefit appeals on EV consumption behavior, considering individual differences such as environmental concern and self-responsibility awareness [15]. However, there is a paucity of research examining the relationship between consumer psychological factors and EVs' purchase intention and behavior. According to Leonov et al., research, consumer psychological factors play a pivotal role in the consumer decision-making process [3]. Motivation is the internal driving force that prompts consumers to take action. Consumer purchasing motivation can be functional, addressing needs such as safety and comfort, or emotional, involving the pursuit of pleasure, status symbols, and self-realization. Perception is the cognitive and interpretive process through which consumers understand products or brands, influenced by various factors such as advertising, word-of-mouth, brand image, and packaging. Consumers' perceptions of products directly affect their purchase decisions [16,17]. For instance, high-quality packaging and a positive brand image can enhance consumers' trust and favorability towards products, thereby increasing their purchase intention.

Drawing on a comprehensive review of existing literature, this study proposes a conceptual model based on Self-Determination Theory (SDT) to explore the relationships among autonomy, competence, relatedness, and consumer purchase intention of electric vehicles (EVs). The objective is to further validate the connections between psychological factors and the intention to purchase EVs, detailing the specific effects, underlying mechanisms, and formation processes of these psychological factors. This research aims to offer robust evidence to support governmental policy-making efforts aimed at encouraging EV consumption.

This paper integrates Partial Least Squares Structural Equation Modeling (PLS-SEM) and Necessary Condition Analysis (NCA) to analyze consumer intentions, exploring the primary factors influencing consumer purchase intentions. The findings will assist EV companies in forecasting market demand, investment, production, and planning marketing strategies. By formulating strategies based on different consumer needs and intentions, this research provides critical references for promoting the industrialization and marketization of EVs in China.

2. Theoretical foundation and hypotheses development

2.1 Self-determination Theory

Self-Determination Theory (SDT) is a seminal framework proposed by American psychologists Deci et al. in the 1980s to explain the motivation behind individual behavior [18,19]. The theory comprises four branches: basic psychological needs, organismic integration theory, cognitive evaluation theory, and attribution orientation theory. SDT elucidates the initiation and driving processes of individual behavior from a motivational perspective, positing that behavior is influenced by both intrinsic and extrinsic motivations. It emphasizes the degree to which behavior is voluntary or self-determined, highlighting the interplay between self-determination and external situational interventions in shaping motivation [20,21]. Unlike Maslow's hierarchy of needs, SDT views individuals as proactive organisms with inherent psychological growth and developmental potential. This potential propels individuals to engage in activities that are both interesting and developmentally beneficial, thereby achieving an organic alignment between the individual and society. SDT posits that individuals generate basic psychological needs essential for self-development, which are categorized into autonomy, competence, and relatedness needs [22,23].

Psychological needs constitute the theoretical core of SDT. When individuals' needs for autonomy, competence, and relatedness are fulfilled, their intrinsic motivation is effectively activated. Autonomy refers to the desire to autonomously determine one's behavior rather than being controlled by external factors. Individuals whose autonomy needs are satisfied tend to perceive autonomy (PEA) when faced with challenges, exhibiting greater initiative and creativity [24]. Competence needs, also known as ability needs, pertaining to the desire for control over tasks and issues, representing a universal experience of utility. When competence needs are met, individuals perceive competence (PER) [25], believing they can effectively manage situations and make sound decisions in dynamic environments. Relatedness needs to involve seeking attention, recognition, and support from others within relational contexts. When these needs are satisfied, individuals perceive relatedness (PER), feel integrated into a group [26], and are more inclined to engage in altruistic intentions for the group's benefit.

SDT asserts that individuals whose basic psychological needs are met can autonomously determine their behavior and perceive a high degree of control over their actions, with a desire for widespread support and recognition [27]. This results in robust intrinsic motivation. Such intrinsic motivation significantly impacts consumers' purchase intentions, including their intention to purchase electric vehicles. Consequently, understanding and fulfilling these psychological needs is crucial in influencing consumer behavior towards adopting sustainable technologies like electric vehicles.

2.2 Hypothesis development

2.2.1 Perceived Autonomy (PEA)

Perceived autonomy, a fundamental element of Self-Determination Theory (SDT), signifies the degree to which individuals believe their actions are self-initiated and personally endorsed [28]. In the context of adopting electric vehicles (EVs), perceived autonomy significantly influences consumer attitudes and behaviors. Autonomy pertains to the sense of control individuals feel over their actions and decisions. When individuals perceive a high level of autonomy, they are more inclined to pursue activities that resonate with their personal values and interests.

Deci and Ryan (2000) argue that when individuals perceive a high level of autonomy, they are more likely to engage in behaviors that resonate with their personal values and interests. In the context of EVs, this means that consumers who feel they have control over their decision to purchase an EV are more likely to experience satisfaction and commitment to their choice. Gagné and Deci (2005) highlight that perceived autonomy enhances intrinsic motivation, leading to greater engagement and persistence in activities [29]. Applied to EVs, this suggests that when consumers feel autonomous in their decision-making, they are more likely to be intrinsically motivated to choose and advocate for EVs, driven by personal satisfaction and alignment with environmental values. Pelletier et al. (1998) demonstrate that perceived autonomy in environmental decision-making leads to more sustainable behaviors [30]. This finding is particularly relevant to EV adoption, as it suggests that consumers who perceive their decision to adopt EVs as autonomous are more likely to engage in pro-environmental behaviors and support sustainable transportation solutions. Barth, Jugert, and Fritsche (2016) explore the role of autonomy in green consumerism, finding that consumers who perceive high autonomy in their purchasing decisions are more likely to choose environmentally friendly products [31]. This is directly applicable to EVs, indicating that fostering a sense of autonomy can enhance the likelihood of consumers choosing EVs over traditional vehicles. Jansson, Marell, and Nordlund (2011) emphasize that perceived autonomy influences consumer attitudes toward EVs. They found that when consumers feel that their choice to purchase an EV is autonomous, they exhibit more positive attitudes and greater satisfaction with their purchase [32]. This reinforces the idea that autonomy is crucial for fostering positive consumer experiences with EVs.

Consumers who perceive greater autonomy in their decision to purchase an EV are likely to be more satisfied with their choice. This satisfaction stems from the belief that they are making an environmentally responsible decision that aligns with their personal values. EVs often come with advanced technology that allows for greater customization and control over the driving experience, which can enhance the sense of autonomy for the user.

It is evident that basic psychological needs promote consumers' intention to purchase electric vehicles. Specifically, individuals with higher levels of perceived autonomy indicate a higher degree of self-need satisfaction, stronger self-direction, and greater freedom of choice. This reflects a robust "autonomous form," where individuals can decide their behavior based on self-choice. When facing the decision to purchase an electric vehicle, consumers with high perceived autonomy will exhibit a positive and proactive green purchasing tendency, driven by strong autonomous motivation, and will follow their own will to implement the purchase behavior. Therefore, this study proposes the following hypothesis:

H1: Perceived Autonomy (PEA) significantly impacts on innovative consumption.

2.2.2 Perceived relatedness (PER)

Perceived relatedness, another core component of Self-Determination Theory (SDT), refers to the need to feel connected to others, to care for and be cared for by others, and to have a sense of belonging both with other individuals and within one's community. Deci and Ryan (2000) discuss how the need for relatedness drives individuals to engage in behaviors that foster connections with others. In the context of electric vehicle (EV) adoption, this suggests that consumers may be motivated to adopt EVs if it enhances their sense of belonging to a community of environmentally conscious individuals [18].

Baumeister and Leary (2022) propose that the need to belong is a fundamental human motivation that influences a wide range of behaviors [33]. Their research implies that EV adoption can be driven by the desire to belong to social groups that value sustainability and green technology. Heffner, Kurani, and Turrentine (2007) explore how social identity influences EV adoption. They find that consumers who identify with social groups that prioritize environmental sustainability are more likely to adopt EVs [34], underscoring the importance of perceived relatedness in motivating EV purchases. Noppers et al. (2014) examine the role of social norms in the adoption of sustainable innovations, including EVs [35]. Their study shows that perceived social support and belonging to pro-environmental communities significantly impact the likelihood of adopting EVs, highlighting the role of perceived relatedness.

The literature consistently shows that when consumers feel a strong connection to others who value sustainability, they are more likely to adopt EVs. By promoting initiatives that enhance social connectedness and emphasizing the community aspects of EV ownership, stakeholders can effectively increase the adoption rates of electric vehicles. This, in turn, contributes to a more sustainable and environmentally friendly transportation system. Perceived competence, another critical component of

SDT, refers to an individual's belief in their capability to handle challenges and solve problems [33,35]. Individuals with a strong sense of perceived competence believe they can effectively address the issues they encounter. When faced with the decision to purchase an electric vehicle, those with strong perceived competence are confident that their efforts can contribute positively to addressing environmental issues. Driven by competence motivation, they actively seek information about EV products, compare and evaluate the attributes of electric vehicles, assess the associated risks, and ultimately make the decision to purchase an electric vehicle.

Thus, perceived relatedness and perceived competence both play vital roles in influencing consumer behavior towards EV adoption. By understanding and leveraging these psychological needs, policymakers and marketers can devise strategies that enhance the appeal of electric vehicles, thereby fostering a more sustainable future. Therefore, this study proposes the following hypothesis:

H2: Perceived relatedness significantly impacts on innovative consumption.

2.2.3 Perceived competence (PEM)

Perceived competence significantly influences the adoption of electric vehicles (EVs) as it enhances consumers' confidence in understanding and using new technology, which is critical for the acceptance of innovative products.

Heffner, Kurani, and Turrentine (2007) found that consumers who perceive themselves as knowledgeable about EV technology are more likely to adopt EVs [36]. This suggests that increasing consumer competence through education can positively impact EV adoption. Ziegler (2012) suggested that enhancing consumer competence via educational initiatives and informational campaigns can drive the adoption of sustainable technologies, including EVs [37]. This indicates that when consumers feel competent in their ability to evaluate and use new technologies, their likelihood of engaging in innovative consumption behaviors increases. Noppers et al. (2014) investigated the role of perceived competence in the adoption of sustainable innovations, including EVs [35]. Their findings indicate that perceived competence significantly impacts the likelihood of adopting these technologies, reinforcing the importance of consumer education and awareness. A study by Coca-Stefaniak and Liébana-Cabanillas (2019) suggested that consumers' attitudes towards EVs are significantly influenced by their perceived competence in understanding the technical performance and value of these vehicles. [38]. Kaufmann, Kumar, and Carter (2020) discuss how consumer competence affects the adoption of innovative products [39]. They suggest that consumers who feel competent in their ability to evaluate and use new technologies are more likely to engage in innovative consumption behaviors, such as adopting EVs. Dutta and Hwang (2021) explored how perceived behavioral control, which is closely related to perceived competence, influences sustainable consumption intentions [40]. Their study indicates that higher perceived control and competence positively impact consumers' intentions to adopt EVs, as they feel more capable of managing the new technology. Mishra et al. (2023) analyzed factors influencing customer preference and adoption of EVs that technological competence, such as understanding the charging system and efficiency, plays a crucial role in consumer acceptance and loyalty towards EVs [41].

Research consistently highlights the pivotal role of perceived competence in adopting electric vehicles (EVs). Empirical studies suggest that when consumers feel more knowledgeable and capable of understanding EV technology, their likelihood of purchasing and using EVs increases. Educational programs and campaigns that demystify the technology, highlight the benefits, and provide practical usage scenarios can make a significant difference. For instance, detailed demonstrations, test drives, and interactive sessions can help consumers overcome uncertainties and foster a sense of competence, which is crucial for the decision-making process. Furthermore, creating supportive environments where consumers can engage with EV technology, directly and indirectly, enhances their perceived competence. By ensuring that consumers have ample opportunities to learn and experience the functionality and benefits of EVs firsthand, stakeholders can drive higher adoption rates and support the transition towards a more sustainable transportation system. Therefore, this study proposes the following hypotheses:

H3: Perceived competence (PEM) significantly impacts on innovative consumption.

2.2.4 the mediate effects of innovative consumption

Consumers with strong innovativeness have a greater propensity to accept new ideas and are more inclined to try, purchase, and use products with innovative attributes. Mishra suggest that consumer innovativeness plays a crucial role in the decision-making process [42]. Consumers with high levels of innovativeness focus more on the “novel” attributes of products during the pre-purchase information-gathering process, enhancing the influence of emotional information and forming stronger purchase intentions [43,44]. Li et al. found that highly innovative consumers prefer new experiences and are more willing to use new products to satisfy their pursuit of a high-quality life [45]. Therefore, electric vehicles (EVs), which embody sustainable innovation and provide a sense of achievement, security, and happiness through their green, environmentally friendly, energy-saving, safe, and healthy characteristics, will become the preferred choice for innovative consumers. Chao et al. pointed out that the continued use of green innovative products by consumers depends significantly on their level of innovativeness [46].

Electric vehicles' environmental attributes are often realized through innovations in green principles, technologies, processes, structures, and materials. Their novelty and advanced nature can better meet the consumption needs of innovative consumers, effectively stimulating consumer innovativeness and promoting purchase intentions. The continuous innovation of electric vehicle products can cater to consumers' tendencies to pursue new experiences, adopt new lifestyles, and accept new products, thereby encouraging the purchase of electric vehicles.

Huang & Qian investigating the factors influencing the adoption of new energy vehicles, including EVs, in China [47]. Their study suggests that innovative consumption behavior, such as openness to trying new technologies, mediates the relationship between individual characteristics and EV adoption. Sharmina et al. (2016) examine the role of innovation in sustainable energy transitions. While not specific to EVs, their study discusses how innovative consumption practices, such as adopting energy-efficient technologies, can mediate the transition to sustainable energy systems [48]. Sundararajan and González-Pernía (2020) explore the adoption of electric mobility in European cities. Their study suggests that innovative consumption behavior, such as the intention to try new transportation modes like EVs, can mediate the adoption of sustainable mobility solutions [49]. Chen et al. (2017) investigate the adoption of electric vehicles in China, finding that innovative consumption behavior, such as the intention to adopt new technologies, mediates the relationship between individual characteristics and EV adoption intentions [50].

According to Self-Determination Theory (SDT), when consumers exhibit strong perceived autonomy (PEA), perceived competence (PER), and perceived relatedness (PER), they show a higher interest in new experiences and products. This heightened interest translates into a greater intention to accept and try new innovations, demonstrating a stronger consumer innovativeness. Thus, fostering these psychological needs can enhance consumer engagement with innovative products such as electric vehicles, driving their adoption and supporting sustainable consumption patterns. Therefore, this study proposes the following hypotheses:

H4: Innovative Consumption significantly impact on electric vehicle purchase intention.

H5: Innovative Consumption plays a mediating role in the impact of PEA on EVs purchase intention.

H6: Innovative Consumption plays a mediating role in the impact of PEM on EVs purchase intention.

H7: Innovative Consumption plays a mediating role in the impact of PER on EVs purchase intention.

2.2.5 The moderate effects of driving experience

Experience primarily refers to the myriads of interactions and engagements individuals have in their daily lives. Holbrook et al. first introduced experience as a central concept in understanding consumer behavior within the marketing realm. Building upon this, Schmitt proposed the concept of experiential marketing, defining it as providing consumers with sensory, emotional, cognitive, associative, and action experiences through various media. Consumers' product experiences typically occur in consumption contexts consciously orchestrated by companies, where products and services deliver memorable experiences to consumers.

The experience of electric vehicle (EV) products underscores the consumers' interactions with the energy-saving, environmentally friendly, low-carbon, safe, healthy, and user-friendly attributes of the products, as well as the feelings of natural beauty, vitality, tranquility, and harmony these attributes evoke. The driving experience of EV products can not only stimulate consumers' sense of environmental responsibility and mission but also effectively enhance their intention to purchase EVs.

Rauh et al. investigate the impact of driving range and infrastructure on consumer preferences for electric vehicles (EVs). Their findings indicate that the overall driving experience, including aspects such as comfort and performance, plays a moderating role in alleviating range anxiety and subsequently influencing EV adoption [51]. Similarly, Graham-Rowe et al. (2012) investigate the impact of driving experience on the adoption of electric vehicles, suggesting that positive experiences, such as enjoying the driving experience of an EV [52], can alleviate concerns about range and charging infrastructure. Hardman et al. (2014) investigating the elements influencing the adoption of electric vehicles in the UK, discovering that driving experience, including aspects like vehicle performance and comfort, moderates the relationship between individual characteristics and EV adoption intentions [53]. Ho (2017) examine factors influencing consumer attitudes towards electric vehicles in Hong Kong, finding that driving experience, including vehicle performance and handling, moderates the relationship between environmental concerns and EV adoption intentions [54], thereby highlighting the importance of Self-Determination Theory (SDT) in understanding EV adoption. Wang et al. (2018) investigate the influence of driving experience on the adoption of electric vehicles, concluding that driving experience [55], encompassing factors like comfort and performance, moderates the relationship between perceived benefits and EV adoption intentions, supporting the role of SDT in understanding EV adoption. Similarly, N. Wang et al suggests that positive driving experiences, such as enjoying the driving performance of an EV, can moderate the impact of perceived barriers on EV adoption [56], further reinforcing the application of SDT. Li et al. (2020) explore the factors influencing the intention to purchase electric vehicles, they find that driving experience, including aspects like vehicle comfort and performance, moderates the relationship between perceived benefits and EV adoption intentions [57], underscoring the relevance of SDT in understanding EV adoption.

In summary, when individuals' basic psychological needs are satisfied, they develop perceived autonomy (PEA), perceived competence (PEM), and perceived relatedness (PER), which stimulate consumer innovativeness, thereby eliciting internal motivation for purchasing innovative products. The driving experience of electric vehicles (EVs) can serve as an external environmental cue. Consumers form a comprehensive evaluation of product value through their functional and hedonic experiences with EV products. When consumers' internal and external motivations are highly consistent, they experience higher psychological coherence, which fosters consumer innovativeness and drives them to make EV purchase decisions. Conversely, when there is a discrepancy between consumers' external environment and their internal inclinations, the inconsistency between internal and external motivations leads to psychological resistance, which restricts the generation of consumer innovativeness and limits green purchasing behavior. Therefore, this study proposes the following hypotheses:

H8: Driving Experience plays a moderating role in the effect of PEA on innovative consumption.

H9: Driving Experience plays a moderating role in the effect of PEM on innovative consumption.

H10: Driving Experience plays a moderating role in the effect of PER on innovative consumption.

Based on the above theoretical analysis, this study constructs the research model as shown in Figure 1.

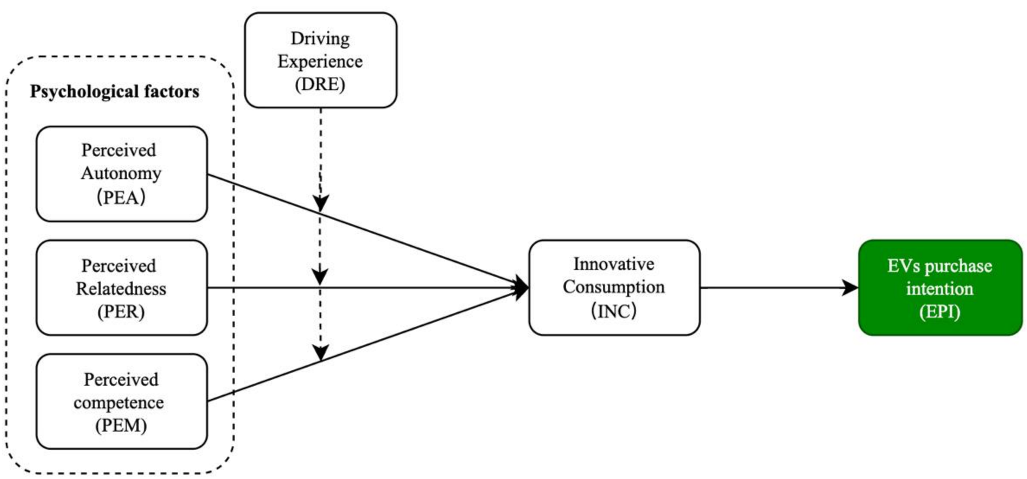

Figure 1. Conceptual Framework

3. Methodology

3.1 Data collection

The construction of a meticulously structured survey questionnaire was undertaken to garner quantitative data relevant to the green purchasing intentions of consumers within live-streaming contexts. The questionnaire was segmented into three discernible sections. The inaugural section encompassed screening queries, meticulously formulated to identify participants aligning with the eligibility prerequisites of the study.

To qualify, participants needed to not have electric vehicle products. The intermediary section comprised 30 meticulously crafted items, each aligned with a 5-point Likert scale, aimed at assessing the responses of the participants. These items were designed to delve into ten fundamental constructs delineated in the proposed theoretical framework. The concluding section integrated queries related to the demographic foundations of the participants, deploying a series of inquiries to extract information about the respondents' personal profiles and societal characteristics. Given the questionnaire's origination in English, it underwent translation into Chinese utilizing back-translation methodologies, ensuring seamless dissemination amongst the online respondent demographic. Subsequently, both the English and Chinese renditions of the questionnaire underwent meticulous review by two adept researchers specializing in consumer behaviors within live-streaming environments, fortifying the instrument's precision and dependability.

The survey was strategically deployed online, with data meticulously harvested in January 2024 via the WJX platform (www.wjx.cn). This platform is recognized as a leading online survey data collection platform in China, operating as a specialized platform for online surveys, assessments, and voting, with nearly 50 million users across the country [16,58,59]. The dependability of the data obtained from this platform has been validated by previous studies [10,60-62]. Data were amassed at disparate intervals and via diverse conduits to mitigate the potential for standard method variance. The online survey was disseminated across fan groups dedicated to purchasing sessions spotlighting electric vehicles. These assemblies consisted of viewers who participated in electric vehicle sessions revolving around green product acquisitions. The survey was allocated to each assembly on three separate instances throughout January 2024. Purposive sampling was utilized to ensure that respondents were mainland Chinese viewers engaged in electric vehicle driving experience sessions centered around green products within the past year. A cumulative of 505 responses were garnered, and after the exclusion of invalid entries, a total of 478 responses were deemed valid. Table 1 presents a synopsis of the demographic attributes of the respondents.

Table1. Respondent profiles

Respondent profiles (n = 478).

Variable	Category	Frequency	Percent	Cumulative Percent
Gender	M	247	51.7	51.7
	F	231	48.3	100

Age	18-25	63	13.2	13.2
	26-35	157	32.8	46
	36-45	143	29.9	75.9
	45-55	91	19	95
	55 above	24	5	100
Education level	College Diploma or below	193	40.4	40.4
	Bachelor’s degree	245	51.3	91.6
	Master's degree or above	40	8.4	100
income	3000-5000	244	51	51
	5001-10000	194	40.6	91.6
	10001-15000	33	6.9	98.5
	Above15000	7	1.5	100
Total		478	100	

3.2 Measures and data analysis

In this investigation, all employed items were sourced and adapted from prior research. The measures for Perceived Autonomy (PEA) were modeled after Charng, Piliavin, and Callero (1988) and encompassed 5 items. The scales for Perceived Relatedness (PER) were inspired by Hsiao, Chuan-Chuan Lin, Wang, Lu, and Yu (2010) and consisted of 5 items. The metric for Perceived competence (PEM) was formulated based on the scale delineated by [61] and included 5 items. Perceived competence (PEM) to Innovative Consumption (INC) have three moderate variables. Perceived Autonomy (PEA) to Innovative Consumption (INC) by 5 items each. Perceived Relatedness (PER) to Innovative Consumption (INC) by 5 items each, the work of [63,64]), comprising 5 items. Perceived competence (PEM) to Innovative Consumption (INC) was gauged through the scale articulated by [65-67], incorporating 5 items. The assessment for Electric Vehicle Intention (EPI) was adapted from the methodology of [3,68] and included 5 items. Each item was assessed utilizing a five-point Likert scale, spanning from “strongly disagree” to “strongly agree”. The detailed measurements are available in appendix.

This study identifies both the sufficient and necessary conditions for consumers' electric vehicle purchasing intentions in the context of psychological factors in electric vehicle purchasing. It utilizes two methodologies, PLS-SEM and NCA, adhering to academic standards. The PLS-SEM comprises a measurement and structural model; the former illustrates the relationship between latent and observed variables, while the latter depicts the associations among latent variables.

3.3 Survey Items Selection

In this survey, all items used were adapted from previous studies. The selection of these specific studies was based on several considerations:

Relevance to the constructs: The primary consideration for selecting specific studies was the relevance of their constructs to our research objectives. Each of the constructs in our model—Perceived Autonomy (PEA), Perceived Relatedness (PER), Perceived competence (PEM), Innovative Consumption (INC), Driving Experience (DRE), and EV purchase intention (EPI) are studied in the context of consumer behavior, environmental psychology, and sustainable consumption. The items selected from previous studies best capture the essence of these constructs as they relate to purchasing electric vehicles. Proven validity and reliability: The items adapted from previous studies have been empirically tested and validated, ensuring their reliability and validity. Using proven items reduces the risk of measurement error and increases the credibility of our findings. For example, the items measuring PEA, PER, and PEM are from studies that have successfully linked electric vehicle to consumer behavior, ensuring their suitability for assessing how green values affect electric vehicle purchase intention. Consistency with the theoretical framework: The selected studies are consistent with the theoretical framework of our study. Constructs such as PEA, PER, and PEM are based on psychological factors and Self-determination Theory (SDT), respectively. By adapting items from studies that apply these theories, we ensured the theoretical consistency and coherence of the measurement approach.

4. Result

4.1 PLS-SEM result

4.1.1 Assessing the outer measurement model

The robustness of measurement models is conventionally assessed through evaluations of reliability and validity. The core objective of reliability analysis is to scrutinize the internal consistency and stability of questionnaire scales, evaluated by the Cronbach's alpha coefficient and composite reliability (CR); a Cronbach's alpha and a CR value exceeding 0.7 are indicative of substantial reliability [69-72]. As delineated in Table 3, Cronbach's α coefficients for the utilized questionnaires in this study all surpass 0.7, with CR values also exceeding this threshold, denoting the high reliability of the questionnaire data. From the Table 2 and Figure 2 show that, PEA, PER, PEM, DRE, INS and EPI, all factor loading great than 0.7, inner model INS R^2 0.505 and EPI R^2 0.305 have very significantly effects.

Table 2. Reliability and convergent validity

Construct	Item	Loading	VIF	Cronbach's alpha	rho_A	CR	AVE
DRE	DRE1	0.864	2.407				
	DRE2	0.815	2.027				
	DRE3	0.784	1.738	0.855	0.86	0.897	0.635
	DRE4	0.743	1.598				
	DRE5	0.773	1.731				
EPI	EPI1	0.895	2.961				
	EPI2	0.80	2.031				
	EPI3	0.788	1.852	0.871	0.877	0.907	0.662
	EPI4	0.771	1.809				
	EPI5	0.809	1.969				
INS	INS1	0.853	2.421				
	INS2	0.816	2.141				
	INS3	0.753	1.758	0.852	0.854	0.895	0.63
	INS4	0.758	1.626				
	INS5	0.783	1.784				
PEA	PEA1	0.822	2.063				
	PEA2	0.814	1.982				
	PEA3	0.797	1.979	0.868	0.871	0.904	0.654
	PEA4	0.785	1.792				
	PEA5	0.824	1.961				
PER	PER1	0.829	2.057				
	PER2	0.822	2.016				
	PER3	0.773	1.874	0.859	0.864	0.899	0.64
	PER4	0.844	2.258				
	PER5	0.727	1.495				
PEM	PEM1	0.82	2.022				
	PEM2	0.803	1.947				
	PEM3	0.815	2.116	0.883	0.886	0.915	0.682
	PEM4	0.819	1.977				
	PEM5	0.872	2.617				

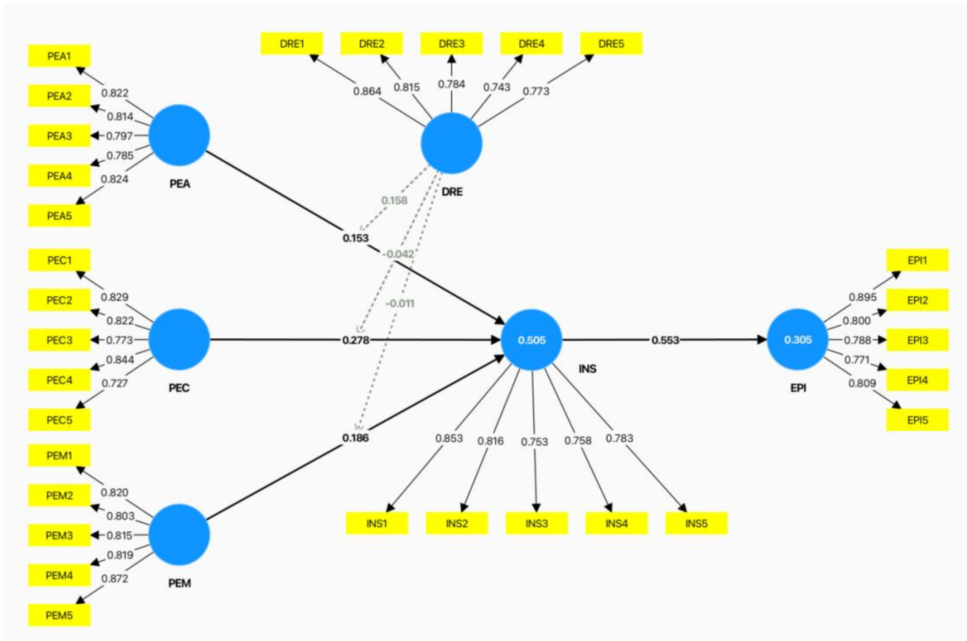

Figure 2. Measurement model.

The Path Coefficient illustrates the direct and indirect relationships between the PEA, PER, PEM, and EPI of consumers. The Figure 3 arrows represent hypothesized paths, with standardized path coefficients and their significance levels in parentheses. The R-squared values show the proportion of variance explained by the predictor variables for each endogenous construct. Relationships Between Latent Variables Path Coefficient: PEA to INS (β=0.153, p = 0.032), PER to INS: β=0.278, p = 0.000), PEM to INS: β=0.186, p = 0.004), INS to EPI: β=0.553, p = 0.000), R-squared values INS: 0.505, EPI: 0305.

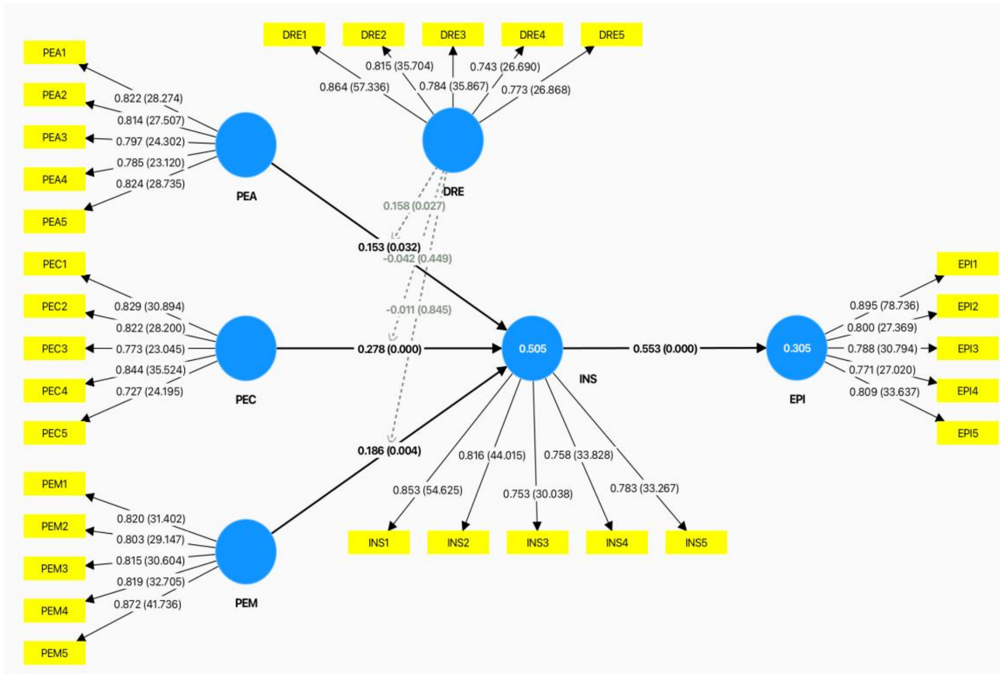

Figure 3. Structural model

The assessment of a measurement model's validity is bifurcated into convergent and discriminant validity. As per Table 2, all indicators exhibit AVE values exceeding 0.5, denoting robust convergent validity of the model [73]. Regarding discriminant validity, the outcomes of the Fornell-Larcker criterion and the HTMT ratio, derived from PLS-SEM software, are articulated in Tables 3, Table 4 and Figure 4. It is evident that, for the Fornell-Larcker criterion, the square root of AVE for each variable surpasses its correlation coefficients with other dimensions, and for the HTMT ratio, the values amongst variables are below 0.85 [74]. As a result, the measurement model exhibits notable discriminant validity.

Table 3. Forel-larcker criterion

	DRE	EPI	INS	PEA	PER	PEM	DRE x PEA	DRE x PER	DRE x PEM
DRE									
EPI	0.409								
INS	0.585	0.639							
PEA	0.317	0.55	0.543						
PER	0.353	0.613	0.652	0.635					
PEM	0.545	0.623	0.63	0.64	0.638				
DRE x PEA	0.06	0.045	0.133	0.126	0.033	0.128			
DRE x PER	0.065	0.114	0.02	0.016	0.118	0.032	0.399		
DRE x PEM	0.186	0.148	0.04	0.125	0.044	0.293	0.598	0.443	

Note: The off-diagonal values (bold) in the above matrix are the square correlations between the latent constructs and the diagonals are AVEs.

Table 4. HTMT

	DRE	EPI	INS	PEA	PER	PEM
DRE	0.797					
EPI	0.354	0.814				
INS	0.499	0.553	0.794			
PEA	0.275	0.481	0.47	0.809		
PER	0.305	0.532	0.561	0.553	0.8	
PEM	0.475	0.548	0.548	0.563	0.558	0.826

4.1.2 Inspecting the inner structural model

Initially, to assess collinearity, the variance inflation factors (VIFs) for all predictive constructs in the structural model were examined. As depicted in Table 6, all VIF values were between 1.069 and 2.479, which is substantially below the cut-off value of 3, establishing that collinearity did not pose an issue in the model [75-78]. Following this, bootstrapping, utilizing 5,000 subsamples, was conducted to evaluate the hypothesis significance [75,79].

The results indicated that the majority of the paths reached statistical significance at the 0.05 level, thus validating most of the proposed hypotheses. Specifically, the effects were as follows: DRE to INS (β= 0.296, t-value = 5.163), PEA to INS (β = 0.153, t-value = 2.145), PER to INS (β = 0.278, t-value = 4.745), PEM to INS(β = 0.186, t-value = 2.887), INS to EPI (β = 0.553,t-value=11.204),DRE and PEA to INS (β= 0.158,t-value=2.212).all variables are supported.

However, the paths from DRE and PER to INS (β = -0.042, t-value = 0.757), DRE and PER to INS (β= 0.011, t-value =0.195) were not significant.

Moreover, the model explained a substantial amount of variance in the dependent variables, with R^2 values ranging from 0.186 for PEM to 0.296 for DRE. The predictive relevance was further confirmed by Q^2 values, all of which were above zero, ranging from 0.442 f to 0.49 for INS. In terms of effect size (f^2), the model revealed that several predictor constructs had a substantial impact on the dependent variables. For example, INS had a large effect on DRE (f^2 = 0.1324) and PEA (f^2 = 0.028), while PER (f2=0.086) and PEM had a large effect on INS (f2 = 0.033).

Furthermore, Smart-PLS 4.0 was employed to investigate the moderation effect through a two-stage approach (Henseler & Fassott, 2010). The analysis results, depicted in Table 5 and Figure 4, demonstrated a statistically significant and positive influence of the interaction between DRE and PEA on INS (β = 0.158, t-value = 2.212), supporting the hypothesis. However, the interaction between DRE and PER impact on INS (β= -0.042, t-value = 0.757) and DRE and PEM impact on INS (β= -0.011, t-value = 0.195) did not significantly impact INS, thus not supporting the hypothesis.

Table 5. Assessment of Structural Model

Hypothesis and Path	Coefficient	Standard deviation	T statistics	P values	f-square	VIF	Result
DRE -> INS	0.296	0.057	5.163	***	0.134	1.324	Support
PEA -> INS	0.153	0.071	2.145	0.032	0.028	1.697	Support
PER -> INS	0.278	0.059	4.745	***	0.086	1.808	Support
PEM -> INS	0.186	0.064	2.887	0.004	0.033	2.125	Support
INS; R^2= 0.505; Q^2 predict= 0.442							
INS -> EPI	0.553	0.049	11.204	***	0.44	1	Support
EPI; R^2= 0.305; Q^2 predict=0.49							
DRE x PEA -> INS	0.158	0.071	2.212	0.027	0.056	1.941	Support
DRE x PER -> INS	-0.042	0.055	0.757	0.449	0.004	1.64	Not Support
DRE x PEM -> INS	-0.011	0.059	0.195	0.845	0	1.401	Not Support

4.2 Necessary condition analysis

NCA offers a novel approach to dissecting complex causal relationships by pinpointing indispensable conditions that influence outcome variables. Unlike traditional methods, it goes beyond mere identification to quantify the magnitude and constraints of these essential conditions. This technique is particularly adept at isolating the “indispensable yet insufficient” relationships between dependent and independent variables [80,81]. As an enhancement to conventional sufficiency-based analyses, NCA provides a numerical measure of the prerequisite conditions needed to reach a given outcome level, offering insights into their effect sizes and potential bottlenecks.

Initially, the PLS-SEM method was utilized to acquire scores for latent variables, as outlined by [74,81]. Subsequently, the NCA package available in PLS-SEM software was leveraged to execute the NCA analysis, following the guidelines set by [81]. The foundational step in an NCA involves plotting a ceiling line that intersects the upper-left data points on an x-y graph, as depicted in Figure 4, where scatter plots for all pertinent relationships are displayed.

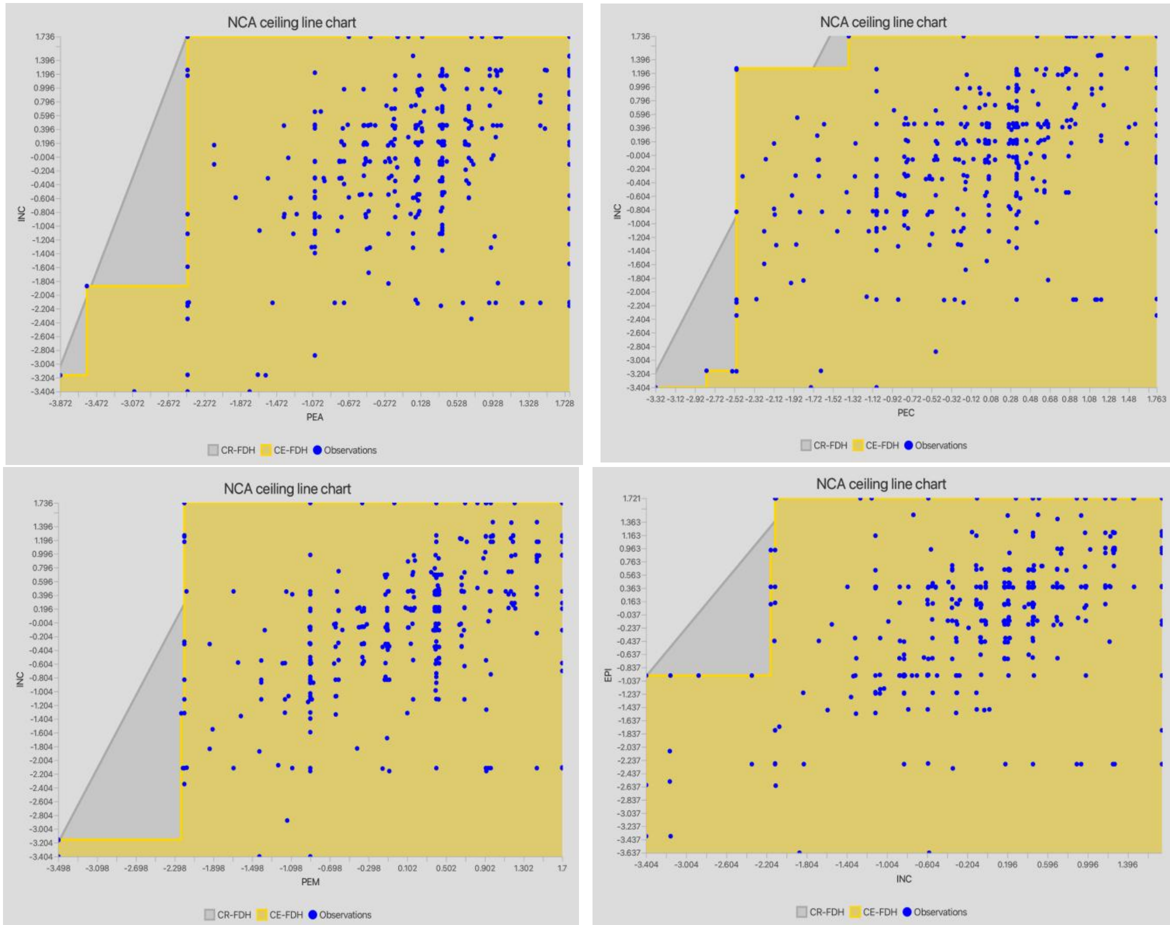

Figure 5. Scatter plots of necessary condition analysis

Subsequently, an analysis was conducted to assess the statistical significance of effect sizes (d) pertaining to the latent variable scores, employing a random sample size of 10,000 [53,80,81]. As the CE-FDH line is well-suited for survey data derived from a five-point Likert scale, the interpretation of the NCA results aligned accordingly. The findings, as presented in Table 6, reveal that PEA ($d = 0.11$, $p = 0.001$), PER ($d = 0.166$, $p < 0.001$), and PEM ($d = 0.171$, $p < 0.001$) are essential conditions for the Innovative Consumption (INC). Similarly, INC ($d = 0.072$, $p<0.001$), is essential conditions for EPI;

Table 6. Necessary condition analysis result (Method: CR-FDH)

	Effect size	Obs. above ceiling	Accuracy	Slope	Intercept	Condition inefficiency	Outcome inefficiency	Rel. inefficiency	Abs. inefficiency	p value
INC										
PEA	0.115	1	99.791	3.404	10.141	75.179	7.064	76.932	22.354	0.001
PER	0.166	10	97.908	2.786	6.061	65.233	4.225	66.702	17.427	***
PEM	0.171	13	97.28	2.666	6.127	64.397	4.026	65.83	17.588	***

EPI										
INC	0.072	5	98.954	1.824	5.24	71.302	49.776	85.587	23.571	***

Note:***,p<0.001.

The bottleneck technique for EPI further clarified the threshold levels necessary for achieving specific performance levels. As delineated in Table 7, to attain a 50% level of EPI, a minimum of 3% for INC, 2% for PEA, and 17% for PER,5% for PEM is required.to attain a 60% level of EPI, a minimum of 7% for INC, 2% for PEA, and 19% for PER, 5% for PEM is required. For a 100% level, the necessary conditions for EPI, at no less than 31%, for INC, PEA no less than 3%, and PER at no less than 41%, PEM at no less than 36%.

Table 7. Bottleneck table(CE-FDH).

EPI	INC	PEA	PER	PEM
0.00%	N	N	N	N
10.00%	N	1	1	5
20.00%	N	1	1	5
30.00%	N	2	1	5
40.00%	N	2	2	5
50.00%	3	2	17	5
60.00%	7	2	19	5
70.00%	8	3	25	6
80.00%	8	3	28	31
90.00%	10	3	34	34
100.00%	31	3	41	36

5. Conclusions and discussion

This study empirically examined the relationships among Perceived Autonomy (PEA), Perceived competence (PEM)and Perceived Relatedness (PER), electric vehicles (EVs) purchase intention and their interactions, leading to the following conclusions. First, Perceived Autonomy (PEA) positively promotes consumers' electric vehicle purchasing intention (EPI). There are also three indirect paths, constituted by the one mediating variable of Innovative Consumption (INC), that indirectly influence electric vehicle purchasing intention (EPI). The model confirms that Perceived Autonomy (PEA), Perceived competence (PEM), and Perceived Relatedness (PER) have a positive impact on Innovative Consumption (INC), Perceived competence (PEM), and Perceived Relatedness (PER), indicating that individuals with more substantial psychological factors have a stronger intention to purchase green products.

Second, Perceived Autonomy (PEA), Perceived Competence (PEM), and Perceived Relatedness (PER) positively promote electric vehicle purchasing intention (EPI) through the mediating roles of Innovative Consumption (INC). This demonstrates that Innovative Consumption (INC) play a mediating role in the transmission effect between Innovative Consumption (INC) and green electric vehicle purchasing intention (EPI). electric vehicle purchasing intention (EPI) can be achieved by reinforcing individuals' beliefs in achieving environmental goals and their perceived value of green products.

Third, by comparing the three moderation paths, it can be seen that Driving Experience (DRE) enhances consumers' electric vehicle purchasing intention (EPI) through promoting Perceived Autonomy (PEA), Perceived competence (PEM)and Perceived Relatedness (PER), which is the most essential psychological mechanism affecting consumers' Perceived competence (PEM)and Perceived Relatedness (PER). Some scholars have found that perceived green value plays a mediating role between environmental responsibility and green purchase intention. In comparison with existing studies, this study found that the mediating role of Innovative Consumption (INC) between psychological factors (Perceived Autonomy, Perceived Correlation, Perceived competence) and electric vehicle purchasing intention is more significant, indicating that individuals who are more concerned about environmental issues are more likely to believe in achieving environmental goals, forming a green purchase intention, and thus tend to implement green purchase behavior.

5.1 Theoretical implications

This study integrates psychological factors based on Self-Determination Theory (SDT) to investigate their influence on consumer decision-making. It examines the functions of autonomy, relatedness, and competence in different environments, such as their impact on consumer purchase intention and their mediating role in consumer acceptance of electric vehicles (EVs) (Dutta & Hwang, 2021). However, specific research on consumer innovative consumption under the background of SDT theory is still scarce. This study addresses this gap by identifying the three dimensions (autonomy, relatedness, competence) under psychological factors as key factors, providing a deeper understanding of the formation of consumer purchase intention in the evolving context of green transportation. Furthermore, this study is at the forefront of exploring the impact of innovative marketing under different psychological factor backgrounds. Our research indicates that psychological factors have a significant impact on innovative consumption and the purchase intention of EVs, which is consistent with existing literature.

In today's sustainable transportation environment, consumer psychological factors have become increasingly prominent. Consumer purchase decisions seem to be less influenced by environmental responsibility and self-efficacy, and more by motivation, attitudes, and inner activities. This can be attributed to consumers paying more attention to personal experiences, and purchase decisions are usually made spontaneously. In today's social culture, consumers increasingly value personal perceptions. These findings provide new insights into factors influencing purchase intentions, enriching existing literature on consumer purchase intentions under psychological factors backgrounds.

Unlike traditional studies, this study positions the intention to purchase EVs as a natural outcome of autonomy, competence, and relatedness. Sarkar's (2011) study shows that the structure, relationships, and cognitive dimensions of consumer psychological factors positively influence consumer purchase decisions, thereby cultivating consumer loyalty to products. Consistent with this result, our study promotes discussion by focusing on consumer psychological activities, which has been addressed in previous surveys on the impact of consumer psychological motivations and attitudes on intention to sustainably purchase, but our efforts are at the forefront of focusing on green purchase intentions, especially under the background of psychological factors. This not only expands the influence of psychological factors but also resonates with the increasing emphasis on ecological consciousness consumerism in contemporary markets. Our study is consistent with previous research results, emphasizing the ability of consumer motivation and attitudes toward products to influence consumer environmental purchasing tendencies. Additionally, our study reveals how and when innovative consumption influences sustainable consumer behavior. Our study resonates with previous academic research results by emphasizing innovative consumption as a mediator. This study is the first to explore how psychological factors influence consumer innovative consumption and purchase decisions. Uniquely, this study is the first to position innovative consumption as a mediating variable under the background of psychological factors. The fortunate result is that our study shows that psychological factors have a positive impact on innovative consumption. At the same time, innovative consumption plays an important mediating role between psychological factors and purchase intention. This study examines the direct and indirect paths of psychological factors on purchase intention, while also considering the moderating effect of driving experience on the relationship between psychological factors and innovative consumption. This not only emphasizes the complexity of this relationship but also helps to understand the mechanism that affects purchase intention more comprehensively, including direct and indirect paths. It also helps to clarify when this influence is enhanced or weakened.

5.2 Practical implications

Considering the results of this study, the first practical implication for the electric vehicle industry focuses on the positive impact of Perceived Autonomy (PEA), Perceived Competence (PEM), and

Perceived Relatedness (PER) on purchase intention. Therefore, platforms should prioritize establishing a sense of value perception among consumers. Conducting in-depth market research to understand environmental issues and values that resonate with the target consumer's is crucial. Based on this understanding, platforms can collaborate with influential figures advocating for sustainable practices to align with consumers' shared values. In the increasingly sustainable market, consumers are not only looking for products but also for platforms and products that align with their values. Therefore, in addition to showcasing eco-friendly products, platforms should also highlight their and their influencers' advocacy for sustainable practices and values to cultivate shared values and drive electric vehicle purchase intentions.

The second practical insight discusses the impact of psychological factors divided three dimensions (Perceived Autonomy, Perceived competence and Perceived Correlation). On the initial structure of purchase intentions. In the electric vehicle field, it is believed that a sufficient number of people recognizing the product can significantly promote the formation of purchasing behavior. Therefore, platforms should consider strategies to highlight green sustainable development, possibly through real-time product advertising, shared electric vehicles to enhance consumer awareness of the product. Additionally, platforms can encourage influential individuals to adopt more graceful and relevant ways to enhance the product's visibility. Furthermore, integrating features that promote customer interaction, such as community forums or real-time chat rooms focusing on sustainable development themes, can enhance customer engagement. By strengthening these social interactions, platforms can create a more cohesive and engaging community, which in turn can positively influence sustainable or electric vehicle purchase intentions.

The third practical implication revolves around the mediating role of Innovative Consumption (INC), psychological factors, and electric vehicle purchase intention. In the electric vehicle field, purchasing electric vehicles can not only save costs but also emotionally appeal to consumers and inspire them to consider sustainable choices. For example, influential individuals can showcase the long-term benefits of sustainable products, share personal stories or testimonials that evoke emotional resonance, or even collaborate with environmental experts to provide credible and inspiring information. Platforms can also consider incorporating interactive features, such as real-time polls or quizzes focusing on sustainable development themes, to maintain audience engagement and inspiration. By doing so, companies can not only enhance the social acceptance of products but also increase customer motivation, indirectly boosting electric vehicle purchase intentions. This multifaceted approach provides a more comprehensive strategic framework for encouraging sustainable consumer behavior.

6. Limitation

Undoubtedly, the potential for using autonomous vehicles, electric vehicles, and autonomous electric vehicles to enhance the sustainability of urban transportation is immense. Autonomous vehicles drive more conservatively; therefore, autonomous vehicles will significantly reduce gasoline and energy consumption during driving compared to traditional manually driven cars. However, this research does not consider autonomous vehicles and autonomous electric vehicles factors. In this paper has several limitations. Initially, this investigation focused on assessing the outlined framework using samples from Chinese consumers within perceived value, potentially limiting the results' applicability to the Chinese context. Therefore, a promising direction for future research could involve re-assessing the model of this study with geographically and ethnically diverse samples. Secondly, this study, grounded in robust theoretical underpinnings, employed a cross-sectional survey, rendering the data potentially vulnerable to method variance.

For subsequent research in the realm of consumer Perceived Autonomy (PEA), Perceived competence (PEM)and Perceived Correlation (PER) within perceived value, addressing such method variance can be achieved by administering data collection at varied time points and incorporating distractor items. Besides, this research probes into the precursor variables impacting consumer Perceived competence (PEM) examines through the lenses of psychological factors. Future studies could augment from diverse perspectives. Moreover, Perceived Autonomy (PEA), Perceived competence (PEM)and Perceived Correlation (PER) , are pinpointed as crucial conditions for consumer green purchasing in this research. Future investigations can extend this foundational understanding by examining varied configurations of consumer green purchasing utilizing complexity theory and the fsQCA method, thereby furnishing platform decision-makers with more streamlined and resource-efficient sustainability solutions.

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