MASTER

User Acceptance toward Performance Battery Electric Vehicles at the Backdrop of Sustainable Urban Mobility Transition

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at the Backdrop of Sustainable Urban Mobility Transition

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Shumeng Zhang
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Colophon

Master thesis

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Preface

Dear readers,

This master thesis is the final station of my dual master journey of Sustainable Urban Mobility Transitions (SUMT) in KTH Royal Institute of Technology (entry) and Eindhoven University of Technology (exit). It is also supported by Business Development & Digitalization team of Volkswagen R (GRX) in Volkswagen AG.

This graduation project is merged with my passion on automotive and my gains in urban mobility, while it is not easy to introduce adoption of cars in urban mobility during the sustainable transitions. The most fortunate thing along the journey is the endorsement and supervision from inspiring researchers and experts. I would like to express my sincere appreciation to my supervisor Feixiong Liao. His feedback and advice keep inspiring me from the beginning to the end of this thesis, helping me ensure the progress and quality of my thesis. I am also grateful to Aloys Borgers for his support and guidance during survey design. And I like to thank Gamze Dane for her suggestions to the presentation. Additionally, I would like to thank Henning Schindler (Volkswagen AG) for his recognitions and rich industrial experience, which gives this thesis project great practical significance. Moreover, special thanks to Senkai Xie, one of Feixiong's PhD students, for his support during modelling.

Besides those who have guided me on this thesis, there have been many other people supporting me mentally throughout the whole thesis project. I would like to thank my master program mates Peihang and Peiling for their accompany in the past two years, my work-out buddies Eli and Qiyu for necessary distraction in powerlifting and bouldering, and all others friends who would like to listen to my complains during my tough time. Finally, I would like to thank my parents for their consistent believe and support to me, which encourage me to get to where I am today step by step.

Shumeng Zhang,

Eindhoven, May 2024

Summary

The sustainable development of urban mobility faces new challenges as electric vehicles become more popular and come in multiple categories depending on their powertrain. With the development of electric vehicle technology and market expansion, the price of performance battery electric vehicles has gradually decreased, and the categories have gradually increased. Performance battery electric vehicles have become more and more accessible. However, as a combination of battery electric vehicle and performance car, the user acceptance towards performance battery electric vehicles in urban mobility is still unknown. In order to better integrate performance battery electric vehicles into users' urban mobility, it is critical to understand what kind of performance battery electric vehicles are recognized, accepted, and willing to be used by users in urban mobility. This study chooses China, the largest electric vehicle market, as the research region, because Chinese battery electric vehicles manufacturers and users are the most active and diverse. The objective of this study is to contribute to the implementation of performance battery electric vehicles in urban mobility, by providing insights on the purchasing intention of Chinese users, in order to support future car makers manufacturing and urban mobility planning.

As performance battery electric vehicles are already available in the market, it is necessary to understand the current comments from users before measuring user acceptance. Therefore, Kano model is applied to evaluation user satisfaction towards the existing and in-development user experience features in, around, and beyond the performance battery electric vehicles. The Kano model categorizes and prioritizes 34 existing or in-development user experience features. Afterwards, this study applied the Extended Unified Theory of the Use and Acceptance of Technology model and modified it according to characristics of performance battery electric vehicles. The modified model consists of purchasing behavioural intention towards performance battery electric vehicles, six psychological factors (performance expectancy, social influence, facilitating conditions, price value, concern-free experience, and vanity) which are hypothesised to have a positive effect on purchasing behavioural intention, and six socio-demographic factors (gender, age, car-ownership, income, education, and residence level) which are hypothesised to have an effect on behavioural intention and moderating effect of all six psychological factors on behavioural intention.

The responses of two models are collected through a online survey. A quantitative survey was conducted amongst 1290 Chinese battery electric vehicle and performance car users from one of the largest automotive forums. The results of Kano model show that user experience features related to energy usage (e.g., longer battery warranty, route recommendation according to energy consumption, faster charging, exclusive charging pile/time period) interconnectivity (e.g., real-time car data synchronization), and customizability (e.g., customizable car mode) are more satisfied and expected by users. The results of Extended Unified Theory of the Use and Acceptance of Technology model indicate that vanity is the most influential factor to purchasing intention toward performance battery electric vehicles, followed by performance expectancy, facilitating

conditions, and concern-free experience. Users with socio-demographic characteristics of female, young-age, owning more cars, high-income, and living in Chinese developing cities would have more intention to purchase performance battery electric vehicles for urban mobility. The overall results reveal that performance battery electric vehicles which can provide users with vanity need to have exclusive and concern-free experience and services in not only driving performance, but also energy usage, interconnectivity, and customizability. The advanced connectivity features on performance battery electric vehicles can integrate with smart city infrastructure to optimize traffic flow and reduce congestion. More performance battery electric vehicles in cities with advanced technologies like route recommendation according to energy consumption and longer-lasting battery can also promote and optimize overall energy usage planning in the cities. In terms of future research, it is recommended to investigate the application of the Kano model in more detail, to find confirmation for the influence of vanity and to replicate this research with a more representative sample.

Content

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Related abbreviations list

ACES	Autonomous, connected, electrified, sharing
AV	Autonomous vehicle
BEV	Battery electric vehicle
CFA	Confirmatory factor analysis
C-ITS	Co-operative intelligent transport systems
DI	Dissatisfaction index
EV	Electric vehicle
ICE	Internal combustion engine
OEM	Original equipment manufacturer
SI	Satisfaction index
UTAUT	Unified theory of acceptance and use of technology
UTAUT2	Extended unified theory of acceptance and use of technology
UX	User experience
UXA	User experience around the car
UXB	User experience beyond the car
UXI	User experience in the car

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Chapter 1: Introduction

In the past two decades, urban mobility has witnessed a paradigm shift, with rising concerns about environmental sustainability, air quality, and systematic traffic efficiency of urban transportation systems (Sheller and Urry 2016). To reduce urban mobility problems such as Greenhouse Gas emissions, air pollution, and traffic congestion, etc., low-carbon mobility alternatives have been encouraged for years. Amongst, electric cars, as the representative product of the electrification of the automotive industry, have become pioneers which are revolutionizing the way that citizens perceive and navigate urban mobility (Sopjani et al. 2019). Within the undergoing transformation of ACES (autonomous, connected, electrified, sharing) in the automotive industry, electrification has shown great potential in both technology and market for decades, and electric cars have been identified as a key technology in reducing future emissions and energy consumption in the mobility sector (IBM 2020; Sheller 2004). As Kanger & Schot (2016) found users play an important role in urban mobility transitions, user acceptance towards autonomous cars, connected cars, and car-sharing services have been widely studied in recent research (Rodwell et al. 2023; Curtale, Liao, and Rebalski 2022; Curtale, Liao, and Van Der Waerden 2021; Hutchins, Kerr, and Hook 2019). The vast majority of previous research has focused on electric vehicles which normally refer to battery electric vehicles (BEV), while there are also more segmented electric cars like plug-in hybrid electric vehicle (PHEV), range-extended electric vehicle (REEV) and fuel cell electric vehicle (FCEV) according to power system. Among all types of electric cars, BEV has the greatest contribution to the urban environment and emissions and are also the most suitable object for the other three ACES transformations (Helmers and Marx 2012). As electric motors have simpler mechanical structures than internal combustion engines, BEVs can provide full torque when motors are at zero revolutions per minute (rpm), resulting in instant acceleration. Hence, performance BEVs are BEVs equipped with dual/tri motors and four-wheel drive, which can easily match the acceleration performance of fuel-powered sports cars (Nguyen et al. 2023)**.** Since there are a growing number of affordable performance BEVs in market, it is necessary to consider how the increasing number of performance BEVs should be properly accepted in cities with stricter restrictions (Autohome Research Institute 2022; Nieuwenhuijsen and Khreis 2016; Yin et al. 2024).

1.1 Objective

In the manufacturing of Internal Combustion Engine (ICE) cars, the cost of mechanical structural parts increases with their technical complexity, with the engine being the most expensive. ICE cars with advanced engines are also treated as performance cars and labeled with higher prices. To align with their exceptional dynamic capabilities, elevated standards are also imposed on systems such as transmission, chassis, car body, electronic controls, etc. towards performance cars (Adams 1992; James 1928; Laohapensaeng, Chaisricharoen, and Boonyanant 2021; Suematsu et al. 1991). Grube et al. (2021) introduced a comprehensive manufacturing cost framework for passenger cars, including three primary components: the glider, drivetrain, and autonomous system. Within the drivetrain, the manufacturing costs can be further deconstructed into energy converters, energy storage, electric periphery, and other related elements. With ACES transitions, the manufacturing cost has been changed accordingly. For instance, energy converters and storage have been supplanted by electric motors and batteries in BEVs. Moreover, additional components such as cameras, Lidars, and automotive chips have been incorporated to support the autonomous system. Although users have become more and more accepting ACES applications such as autonomous cars and Co-operative Intelligent Transport Systems (C-ITS), performance BEVs still refer to fast acceleration, high top speed, and excellent handling, even if evolution in the manufacturing cost structure of BEVs has been changing the way Original Equipment Manufacturers (OEM) define performance BEVs (Luo, He, and Xing 2024; Rodwell et al. 2023; Steiner 2023). Davis (1993) indicates that the lack of user acceptance would be an impediment to the success of a new technology, it is critical to understand what extra features users would expect on performance BEVs and what factors influence users to use performance BEVs in urban mobility. Therefore, this study has an objective of to contribute to the implementation of performance BEVs in urban mobility, by providing insights on the purchasing intention of Chinese users, in order to support future OEM manufacturing and urban mobility planning.

Due to differences in urban development levels, car use behaviours, and car culture in different regions, the user acceptance of performance BEVs in urban mobility would vary greatly in different regions (Muzammel, Spichkova, and Harland 2024; Sheller 2004; Yang et al. 2017). In order to ensure the consistency of the results, one region should be selected. Among the three main regional markets for BEVs (Europe, United States, and China), which have collectively accounted for over 93% of global electric car sales since 2020, China has become a frontrunner in the electric car market with a rapidly growing industry, supportive government policies, and a large user base embracing electric urban mobility (Fu and Barbieri 2024; IEA 2022; Zhao, Jian, and Du 2024). Riding on the momentum of electrification, China not only has the highest sales of BEVs which accounts for more than 40% of global electric car sales, but also became the world’s top automobile exporter in 2023 (Balmer and Ricci 2024; IEA 2022). Chinese car users demonstrate a pronounced receptiveness to ACES transitions, exemplified by notable statistics such as 98% expressing intent to acquire BEVs as their subsequent cars and 75% anticipating the commercialization and on-road deployment of autonomous BEVs before the year 2030 (ADR 2023; Roland Berger and Autohome Research Institute 2023). The sales of performance electric cars in China remained strong after the automotive supply chain crisis since 2022 and still grew exponentially in 2023, of which more than 77% were BEVs (Autohome Research Institute 2022; 2023a; Ministry of Public Security of the PRC 2024). As an increasing number of individuals engage in additional car purchases and exchanges, the popularity of performance BEVs in China is anticipated to grow steadily (Aurora Mobile 2023; Sovacool et al. 2019). Considering that the population and size of China's megacities to those of Europe and the United States are comparable but a discernible gap persists in the per capita car ownership rate, performance BEVs have huge potential as a subsequent growth driver for urban cars (Chatziioannou et al. 2023; Leffel, Marahrens, and Alderson 2023). Consequently, China has been selected as the focus for this thesis to further explore and analyse user acceptance of performance BEVs within the context of urban mobility.

Informed by the findings of earlier investigations by Curtale et al. (2021, 2022), Shin et al. (2022) and Steckhan et al. (2023), this study applies Kano model to estimate users' satisfaction towards user experience (UX) features on performance BEVs, and the Extended Unified Theory of Acceptance and Use of Technology (UTAUT2) model to examine the factors that exert an influence on users' intentions to purchase and use performance BEVs within the context of urban mobility. Therefore, the main research question is formulated:

- ***What kind of performance BEVs are recognized, accepted, and willing to be used by Chinese users in urban mobility?***

Regarding the main research question, two more detailed research questions are formulated as follows:

- *What UX features in, around, and beyond the performance BEVs would make them attractive to purchase and use?*

- *What psychological and socio-demographic factors would affect users most when purchasing performance BEVs for use in urban mobility?*

1.2 Relevance

After formulating the research objective and questions, the relevance of this study will be addressed in societal and academical aspects. In society, Chinese car users indicate that better adaptability of urban family use is the foremost preference for purchasing performance BEVs (Autohome Research Institute 2022). Investigating user acceptance and feature expectation towards performance BEVs in urban mobility offers insights for corresponding car design. By applying an extended UTAUT2 model, these insights can lead OEMs to manufacture more urban-oriented and well-accepting performance BEVs, and help performance BEVs better contribute to sustainable urban mobility. Multiple previous studies have provided insights of consumers acceptance on various EVs as well as corelated features such as autonomous driving and C-ITS, (Haboucha, Ishaq, and Shiftan 2017; Hutchins, Kerr, and Hook 2019; Luo, He, and Xing 2024; Rodwell et al. 2023), while there are seldom studies focusing on more detailed sector of EV like performance BEVs. This study aims to shrink the literature gap by applying an advanced user acceptance model and integrate performance BEVs into urban mobility.

1.3 Outline

The remainder of this thesis is structured as follows. Chapter two demonstrates the theoretical framework of this thesis, including literature of performance BEVs, technology acceptance, and user research related to urban mobility and ACES transitions in automotive industry. Chapter three consists of theoretical models based on findings in chapter two, discusses the methodology including conceptual model, theoretical hypothesis, quantitative survey design, and data processing methods. After that, chapter four interprets results of survey in users' expectation towards UX features in, around, and beyond a performance BEV. Continuously, chapter five performs analysis of which factors to what extent have an effect on the intention of Chinese users to purchase performance BEVs in urban mobility scenario. Chapter six addresses conclusions for future urban mobility planning and performance BEV manufacturing, also discusses limitations and further research suggestions.

Chapter 2: Theoretical framework

Over the past decade, the academic discourse on the acceptance of technology in the context of electric cars within urban mobility has gained significant momentum (Ambak et al. 2016; Curtale, Liao, and Rebalski 2022). This chapter aims to construct a corresponding theoretical framework, comprising five integral parts. The first part consists of getting to understand performance BEVs and their characteristics. The second part entails an exploration of theories and models related to technology acceptance, with a specific emphasis on their applications in electric cars and related services. The third part extensively explores the Kano model in user satisfaction studies, offering a supplementary perspective to mainstream technology acceptance models. The fourth part provides a comprehensive elucidation of the Extended Unified Theory of Acceptance and Use of Technology (UTAUT2) model. The final part serves to synthesize the content of this chapter and outlines the methodology that will be employed in the ensuing study.

2.1. Performance Battery Electric Vehicle (BEV)

With the development of automobile technology, the term "performance car" has been widely used in the industry. Specific definitions are very rare in past research, but according to definitions in dictionaries and industry, a performance car is superior in acceleration and top speed, built for long distances, and designed with high thrust to weight ratio (Collins 2024; Hyundai N 2020). This is because the add-on value of a performance car mainly comes from the most valuable part, internal combustion engine (ICE), according to the manufacturing cost structure of passenger cars in Figure 2.1 (Grube et al. 2021). In addition, a performance car is also fun to drive and visually appealing, to match its above-average capabilities.

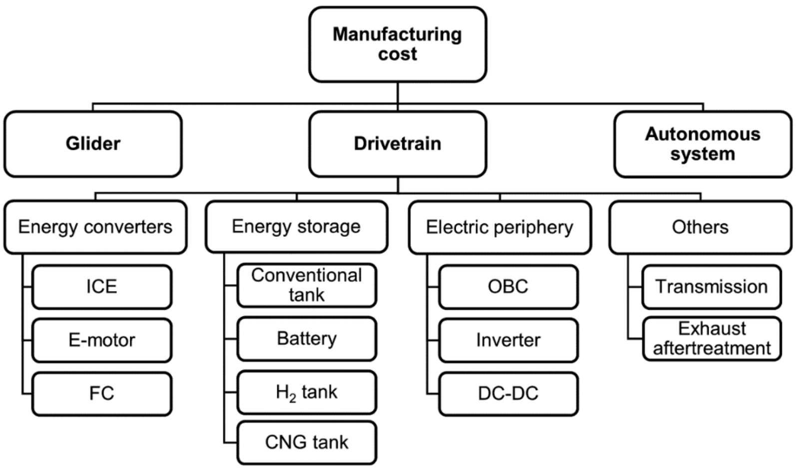


Figure 2.1 Manufacturing cost structure of passenger cars (Grube et al. 2021) (ICE: internal combustion engine; FC: fuel cell; CNG: compressed natural gas; OBC: on-board charger; DC-DC: direct current converter)

In the field of BEV, the ICE as an energy converter has been replaced by E-motor which has totally different performance characteristics. An electric motor can output high torque at zero rpm and continue to deliver almost constant torque at least up to 4000 rpm for city driving. While an ICE only has very little torque during low rpm, and reaches maximum torque at least above 4000 rpm (Eberhard and Tarpenning 2006). This characteristic allows BEVs to easily reach maximum performance, which is comparable to petrol performance cars. Since the powertrain configurations of BEVs are mainly divided into two categories: single-motor and multi-motor (dual-motor, tri-motor, and four-motor), the power gap between BEVs is also large. Single-motor BEVs have simpler powertrain configuration, of which both the front and rear wheels are driven by the same electric motor. In order to meet requirements in complex road conditions in daily use, the selected single motor needs to have a wide torque-speed range. While the motor has relatively low efficiency at low-rpm operation cases, which wastes most of the energy. The performance of single motor can hardly meet high power demands and sporty driving. As the most typical multi-motor BEVs, dual-motor BEVs with two electric motors are generally also equipped with all-wheel drive (AWD) drivetrain. Dual-motor powertrains can maximize torque, respond quickly to road conditions, and deliver power to both the front and rear axles. It gives more flexibility in torque vectoring to enhance traction and stability (Nguyen et al. 2023). With the popularity of multi-motor powertrain, BEVs are no longer psychologically synonymous with weakness among men (Viola 2021). Since BEVs equipped with multi-motor can easily exhibit excellent dynamic performance as petrol performance cars, the add-on value of performance for BEVs can be extended. Autonomous system can be more easily realized and augmented on BEVs since the whole powertrain system is electrified (Ouyang 2024). High-level Autonomous Driving Assistant System (ADAS) has been equipped on dual-motor all-wheel drive BEVs as a feature differentiating level of cars. Besides, Performance BEVs are considered as a green-luxury car and promoted to enhance users' materialism and vertical individualism, as petrol performance cars can satisfy users' vanity (Ali et al. 2019). These add-on value features provide BEVs with more convenience in urban mobility, which incentivizes the popularity of performance BEVs in cities. Considering the cognitive consistency of the survey and the implementation differences among add-on value features, this study defines performance BEVs as BEVs equipped with multi-motor and all-wheel drive.

2.2. Theories and models of technology acceptance

Over the years, technology acceptance research has produced a number of theories and models, each seeking to elaborate how users understand, accept, and utilize novel technologies. Momani & Jamous (2017) demonstrated a chronological graph for the technology acceptance theories evolution till 2000, indicating these theories and models hold different points of view on the constructs or determinants. Building upon this foundation, KUŁAK et al. (2019) extended this graph to the 2010s and introduced the UTAUT model combining multiple models which was proposed by Venkatesh et al. (2003). Table 2.1 summarizes the most valuable theories and models in technology acceptance research since 1950s.

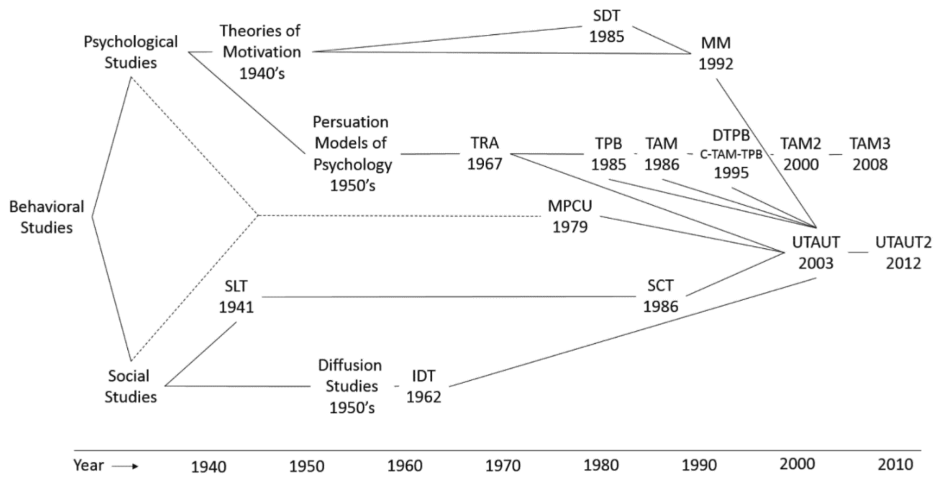


Figure 2.2 Chronological graph for the technology acceptance theories (KUŁAK, TROJANOWSKI, and BARMENTLOO 2019; Momani and Jamous 2017)

Table 2.1 Theories and models of technology acceptance (Bte A. Rahman et al. 2021; KUŁAK, TROJANOWSKI, and BARMENTLOO 2019)

Theory/Model (Abbreviation)	**Proposer(s) (year of first propose)**	**Core Constructs**
Innovation Diffusion Theory (IDT)	Rogers (1962), Moore and Benbasat (1991)	Relative Advantage, Compatibility, Ease of Use, Trialability, Visibility, Image, Voluntariness, Results Demonstrability.
Theory of Reasoned Action (TRA)	Fishbein & Ajzen (1967)	Behavioural Intention, Attitudes Towards Behaviour, Subjective Norms.
Technology Acceptance Model (TAM)	Davis (1986)	Behavioural Intention, Perceived Usefulness, Perceived Ease of Use.
Social Cognitive Theory (SCT)	Bandura (1986)	Outcome Expectations - Performance, Outcome Expectations - Personal, Self-Efficacy, Affect, Anxiety.
Theory of Planned Behaviour (TPB)	Ajzen (1985)	Behavioural Intention, Attitudes Towards Behaviour, Subjective Norms, Perceived Behavioural Control.
Model of Personal Computer Use (MPCU)	Triandis (1979), Thompson, Higgins and Howell (1991)	Job-Fit, Affect Towards Use, Facilitating Conditions, Complexity, Long-Term Consequences, Social Factors.
Motivational Model (MM)	Davis, Bagozzi and Warshaw (1992)	Extrinsic Motivation, Intrinsic Motivation.
A Combined Theory of Planned Behaviour/Technology Acceptance Model (C-TAM-TPB)	Taylor and Todd (1995)	Behavioural Intention, Attitudes Towards Behaviour, Subjective Norms, Perceived Behavioural Control, Perceived Usefulness, Perceived Ease of Use.
Extension of TAM (TAM 2)	Venkatesh & Davis (2000)	Perceived Usefulness, Perceived Ease of Use, Subjective Norm.
Unified Theory of Acceptance and Use of Technology (UTAUT)	Venkatesh, Morris, Davis and Davis (2003)	Behavioural Intention, Performance Expectancy, Effort Expectancy, Social Influence Facilitating Conditions.
Technology Acceptance Model (TAM3)	Venkatesh and Bala (2008)	Perceived Usefulness, Perceived Ease of Use, Subjective Norm.
Extended Unified Theory of Acceptance and Use of Technology (UTAUT2)	Venkatesh, Thong and Xu (2012)	Behavioural Intention, Performance Expectancy, Effort Expectancy, Social Influence Facilitating Conditions, Hedonic Motivation, Price Value, Habit.

These theories and models can be divided into two main branches, TAM and UTAUT, as shown in Figure 2.2. Technology Acceptance Model (TAM) is an adaptaion of Theory of Reasoned Action (TRA) in and Theory of Planned Behaviour (TPB). It estimates the degree to which a person believes that using a system would enhance the job performance (perceived usefulness) and be free from effort (perceived ease of use). As TAM does not specify any expectancies on influencing behaviour, it only considers the the acceptance from a psychological perspective in a specific work environment. Unified Theory of Acceptance and Use of Technology (UTAUT) has merged eight main technology acceptance theories considering four main drivers of behavioural intention: performance expectancy, effort expectancy, social influence, and facilitating conditions. On this basis, Extended Unified Theory of Acceptance and Use of Technology (UTAUT2) has extended considerations with three more factors: hedonic motivation, price value, and habit. Because UTAUT model takes into account both psychogical and social studies, it can evaluate acceptance both in a specific work environment and to a specific group of consumers.

With ACES transitions in the automotive industry, TAM series models and UTAUT series models have been widely applied to evaluate the acceptability of sundry electric cars and related services, such as battery electric cars (BEV), plug-in hybrid electric cars (PHEV), autonomous electric cars (AV), electric car sharing services (ECS), autonomous electric car sharing services (AECS), etc. Several researchers have investigated the factors influencing the adoption intention of electric cars and related services from the users' perspective. Table 2.2 summarizes recent studies with theories of TAM or UTAUT, which indicates that UTAUT and UTAUT2 are governing theories in this domain. As Kanger & Schot (2016) have proven that users play an important role in historical automotive transition, and users as customers are more salient than other user roles in the acceleration phase of transition, UTAUT2 theory which considers both work and consumer context is more suitable for this study with a background of ACES transition.

Considering that performance BEVs is still a niche branch that is accelerating to a larger use base, the definition of performance BEVs also differs among users. In order to reduce the impact of subjects' cognitive biases on this study, it is necessary to introduce what features a performance BEV can provide, and to assess user satisfaction with existing performance BEVs. Kano model, as a classic model in functionality and satisfaction study, has been applied in studies of ACES transition in mobility sector. Shin et al. (2022) applied Kano model when studying the user acceptance towards specific features of autonomous driving as supplement of UTAUT, revealing the socio-demographic characteristics and drivers that affect acceptance. Münster & Grabkowsky (2023) also pointed out that Kano model can complement UTAUT2 and explain why users accept or reject a technology. Therefore, Kano model will be applied in this study to measure users' satisfaction towards the popular existing and in-development features.

Table 2.2 Review of literature on electric cars and related services using TAM and UTAUT models

Study	Theory	Construct	Country	Vehicle Type
Karpurapu & Venkata Raghuram (2024)	UTAUT2	Performance expectancy, effort expectancy, social influence, facilitating conditions, hedonic motivation, price value, habit, risk, behavioural intention	India	EV
Yavuz (2024)	UTAUT2	Performance expectancy, effort expectancy, social influence, hedonic motivation, perceived safety, personal innovativeness, behavioural intention	Turkey	AV
A. P. Sutarto et al. (2023)	UTAUT, TAM	Performance expectancy, effort expectancy, social influence, facilitating conditions, hedonic motivation, behavioural intention, Attitude towards behaviour, behavioural intention to use, Perceived ease of use, Perceived usefulness	Indonesia	AV
Farzin et al. (2023)	UTAUT, diffusion of innovation theory (DOI)	Performance expectancy, effort expectancy, social influence, Trialability, Observability, Perceived Risk	Iran	AV
Higueras-Castillo et al. (2023)	UTAUT2, value-belief-norm (VBN)	Performance expectancy, effort expectancy, social influence, facilitating conditions, hedonic motivation, environmental concern, awareness of consequences, ascription of responsibility, altruistic values, egoistic values, biospheric values, openness to change	India and Spain	EV
Liao et al., (2023)	TAM, TPB	Attitude, perceived usefulness, subjective norm, perceived behavioural control, initial trust, perceived safety risk, perceived privacy risk, face consciousness	China	Shared AV
Singh et al., (2023)	UTAUT2, norm activation model (NAM)	Performance expectancy, effort expectancy, social influence, facilitating conditions, hedonic motivation, price value, habit, awareness of consequences, ascription of responsibility	India	EV
Wang et al., (2023)	UTAUT	Performance expectancy, effort expectancy, social influence, facilitating conditions, price value, perceived risk, policy incentives	China	EV
Yu et al., (2023)	UTAUT	Performance expectancy, effort expectancy, social influence, anxiety-free experience, personal attitude, sustainability, functional value, conditional value, trust	China	ECS
Curtale et al., (2022)	UTAUT2	Performance expectancy, effort expectancy, social influence, hedonic motivation, safety concern	Netherlands, Italy, Spain, and France	ECS, AECS
Gunawan et al. (2022)	UTAUT2, TPB	Performance expectancy, effort expectancy, subjective norm, facilitating conditions, price value, habit, perceived behaviour control, attitude towards use, risk perceptions	Indonesia	EV
Jain et al., (2022)	UTAUT	Performance expectancy, effort expectancy, social influence, facilitating conditions, perceived risk, environmental concern, government support	India	EVs
Manutworakit & Choocharukul, (2022)	UTAUT	Performance expectancy, effort expectancy, social influence, facilitating conditions, hedonic motivation, price value, policy measures, environmental concerns	Thailand	EV
Vafaei-Zadeh et al., (2022)	TAM, TPB	Attitude, environmental self-image, perceived behaviour control, perceived ease of use, perceived risk, perceived usefulness, price value, subjective norm, infrastructure barrier	Malaysia	EV

Table 2.3 (Continued) Review of literature on electric cars and related services using TAM and UTAUT models

Study	Theory	Construct	Country	Vehicle Type
Abbasi et al., (2021)	UTAUT	Performance expectancy, effort expectancy, social influence, technophilia, perceived environmental knowledge, purchase intention	Malaysia	EVs
Bhat et al. (2021)	UTAUT	Performance expectancy, facilitating conditions, technological enthusiasm, technological enthusiasm, perceived benefits, social image, social influence, anxiety	India	EV
Curtale et al., (2021)	UTAUT2	Performance expectancy, effort expectancy, social influence, anxiety-free experience, personal attitude, trust	Netherlands	ECS
Khazaei & Tareq, (2021)	UTAUT	Social influence, facilitating conditions, range anxiety, and perceived enjoyment	Malaysia	EV
Korkmaz et al. (2021)	UTAUT2	Performance expectancy, effort expectancy, subjective norm, facilitating conditions, price value, habit, trust and safety, perceived risk, behavioural intention	Turkey	AV
Park et al., (2021)	UTAUT, TAM	Perceived usefulness, Perceived ease of use, social influence, facilitating conditions	South Korea	AV
Zhou et al., (2021)	UTAUT2	Performance expectancy, effort expectancy, social influence, facilitating conditions, hedonic motivation, price value, habit, incentive policies	China	EVs
Kapser & Abdelrahman, (2020)	UTAUT2	Performance expectancy, effort expectancy, social influence, facilitating conditions, hedonic motivation, price sensitivity, perceived risk	Germany	Autonomous Deliver Vehicle (ADV)
Nordhoff et al., (2020)	UTAUT2	Performance expectancy, effort expectancy, hedonic motivation, social influence, facilitating conditions, behavioral intention	Finland, France, Germany, Italy, Spain, Sweden, Hungary, and the United Kingdom	AV

2.3. Kano model

The Kano model, developed by KANO et al. (1984), serves for validating users' needs in the context of product development. It categorizes the product quality into six attributes: Attractive (A), One-dimensional (O), Must-be (M), Indifferent (I), Reverse (R), and Questionable (Q) considering user satisfaction and object implementation (fully fulfilled/not fulfilled). Four quadrants are divided by these two considerations, where the curves of five meaningful attributes except Questionable are distributed in Figure 2.3.

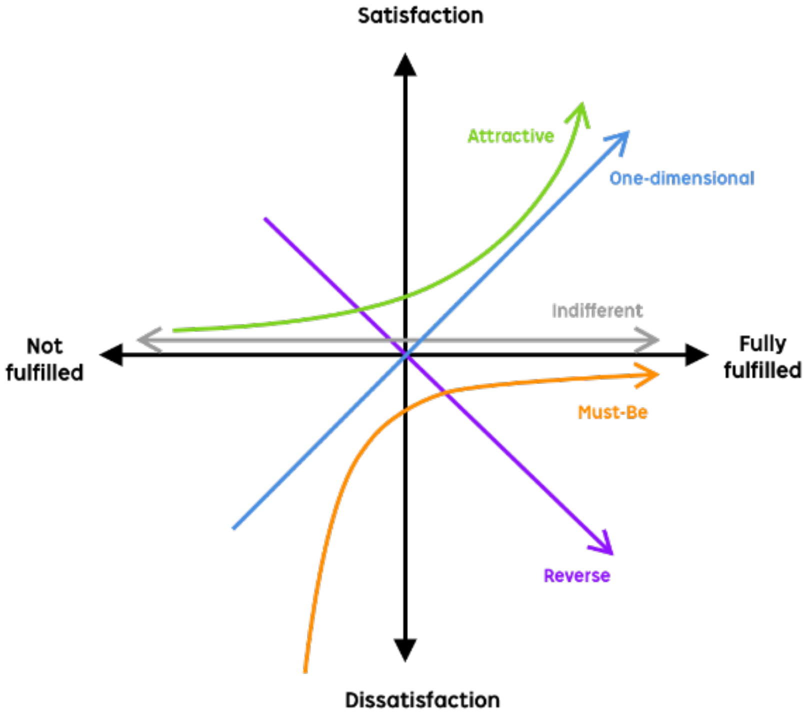


Figure 2.3 Kano model diagram (Bhardwaj et al. 2021)

Table 2.4 Definition and characteristics of the six attributes of Kano model

Quality Attributes	**Definitions**	**Characteristics**
Attractive (A)	A quality attribute that offers high satisfaction when fully fulfilled while does not cause dissatisfaction when not fulfilled.	Attributes are not apparently expected by users, but can significantly improve objects' acceptance once fulfilled.
One-dimensional (O)	A quality attribute that offers satisfaction when fully fulfilled and also causes dissatisfaction when not fulfilled.	Attributes are with proportional relations between satisfactions and implementation, which needs continuous iteration to meet users' expectation.
Must-be (M)	A quality attribute that does not offer satisfaction when fully fulfilled while causes severe dissatisfaction when not fulfilled.	Attributes are always highly expected by users, so that can have adverse effects on objects' acceptance once not fulfilled.
Indifferent (I)	A quality attribute that neither offers satisfaction when fully fulfilled nor causes dissatisfaction when not fulfilled.	Attributes are not currently expected by users, or are without clear preferences whether it is fulfilled based on users' current cognition.
Reverse (R)	A quality attribute that causes dissatisfaction when fully fulfilled and also offers satisfaction when not fulfilled.	Attributes are with inversely proportional relations between satisfaction and implementation, which needs to be abandoned to meet users' expectation.
Questionable (Q)	A quality attribute that causes exactly same non-neutral satisfaction when both fully fulfilled and not fulfilled.	Responses corresponding to attributes are considered questionable.

Table 2.5 Kano model survey sample question

	Sample question	Answer
Functional form of the question	What if a performance BEV **has better drivability** than a regular BEV.	- I like it - I expect it - I am neutral - I can tolerate it - I dislike it
Dysfunctional form of the question	What if a performance BEV does **not have better drivability** than a regular BEV.	- I like it - I expect it - I am neutral - I can tolerate it - I dislike it

Table 2.6 Original Kano model evaluation criteria

		Dysfunctional				
		Like	**Expect**	**Neutral**	**Can tolerate**	**Dislike**
Functional	**Like**	Q	A	A	A	O
	Expect	R	I	I	I	M
	Neutral	R	I	I	I	M
	Can tolerate	R	I	I	I	M
	Dislike	R	R	R	R	Q

A: Attractive, O: One-dimensional, M: Must-be, I: Indifferent, R: Reverse, Q: Questionable.

Table 2.7 Conservative Kano model evaluation criteria

		Dysfunctional				
		Like	**Expect**	**Neutral**	**Can tolerate**	**Dislike**
Functional	**Like**	Q	A	A	A	O
	Expect	R	Q	I	I	M
	Neutral	R	I	I	I	M
	Can tolerate	R	I	I	Q	M
	Dislike	R	R	R	R	Q

A: Attractive, O: One-dimensional, M: Must-be, I: Indifferent, R: Reverse, Q: Questionable.

In order to classify each feature on performance BEVs, paired questions on functional/dysfunctional form will be evaluated as sample questions shown in Table 2.5. Each pair of questions only differs in whether the feature is available or not. According to the 25 possible paired answers, every response to the paired questions will be categorized into one attribute according to the evaluation criteria. The original Kano model evaluation criteria is shown in Table 2.6, which is the most common used criteria. Therefore, each pair of questions will have a frequency matrix of each pair of answers. The original evaluation criteria focuses on absolute preferences such as likes and dislikes. The one-dimensional, attractive, and must-be attibutes all require users to at least like the feature when it is available or dislike it when unavailable. As long as users like the feature when it is unavailable or dislike it when available, the feature will be categorized into reverse.

Absolute preferences are also mutually exclusive, so when users both like or both dislike a feature at the same time no matter it is available or not, the responses will be defined as questionable answers. All the other answer combinations that do not contain any absolute preference (like and dislike) are classified as indifferent.

Even though the original criteria is popular, there is another more conservative criteria emphasizing the differences in paired answers. It has been implemented more often in statistical applications and market research (SapioResearch 2024; Qualtrics XM 2024). The conservative Kano model evaluation criteria is shown in Table 2.7. The conservative evaluation criteria also emphasizes absolute preferences but classified more carefully for indifferent attribute. It indicates that both expecting or both tolerating a feature at the same time no matter it is available or not are also questionable as expect and can tolerate also refer to slight preferences.

Because the original Kano model proposed a statistics method to categorize, the frequency of each attribute is the sum of the corresponding attribute in the matrix. The attribute of each feature is the attribute with the maximum frequency. It can be derived as Eq. 2.1, where A, O, M, I, R, and Q represent the frequency of corresponding attribute.

$$\text{Attribute} = \text{Max}\,\{A, O, M, I, R, Q\} \qquad \textit{Eq. 2.1}$$

In order to comprehensively represent the statistical distribution of attributes, especially when differences among attributes are not obvious. Timko (1993) proposed two indexes to calculate the effects on customer satisfaction and dissatisfaction, which quantify the degree of user satisfaction and dissatisfaction towards the product or service. The accumulated number of each attribute determines the satisfaction and dissatisfaction indices shown as Eq. 2.2 and Eq. 2.3. Each feature can be positioned in the customer satisfaction coefficient matrix and be prioritized accordingly. The Satisfaction Index is high if the feature has high frequency A and O scores. The Dissatisfaction Index becomes more negative if a missing feature has higher O and M Frequencies.

$$\text{SI: Satisfaction Index} = \frac{A + O}{A + O + M + I} \qquad \textit{Eq. 2.2}$$

$$\text{DI: Dissatisfaction Index} = (-1)\left(\frac{O + M}{A + O + M + I}\right) \qquad \textit{Eq. 2.3}$$

Even though the evaluation criteria of Kano model are controversial on wide adoption of indifferent attributes, especially for the results with both “expect” and “can tolerate” for functional and dysfunctional questions, Kano model is still an effective model that can prioritize features according to needs. Shin et al. (2022) found that features that improve safety and awareness such as accident prevention, mitigate traffic congestion, and situational awareness ability are one-dimensional features for autonomous vehicles, and preferences of these features may vary according to different socio-demographic characteristics like gender and age. Dash (2019) focused on the users’ needs of EVs and indicated more than 5-year battery longevity and availability of sufficient charging stations are must-be features, low maintenance cost is a one-dimensional feature, and Fast charging that can fully charge in less than 15 minutes is attractive to users. Steckhan, Spiessl, and Bengler (2023) explained that lane change, target speed change, and change of headway distance to front cars are three must-be features for autonomous driving system.

2.4. Extending Unified Theory of Acceptance and Use of Technology (UTAUT2)

As UTAUT2 is iterated from its predecessor theory UTAUT, it is necessary to explain the original UTAUT first. The theory of UTAUT (Figure 2.4), proposed by Venkatesh et al. (2003), was synthesized from eight main theories and models of technology acceptance.

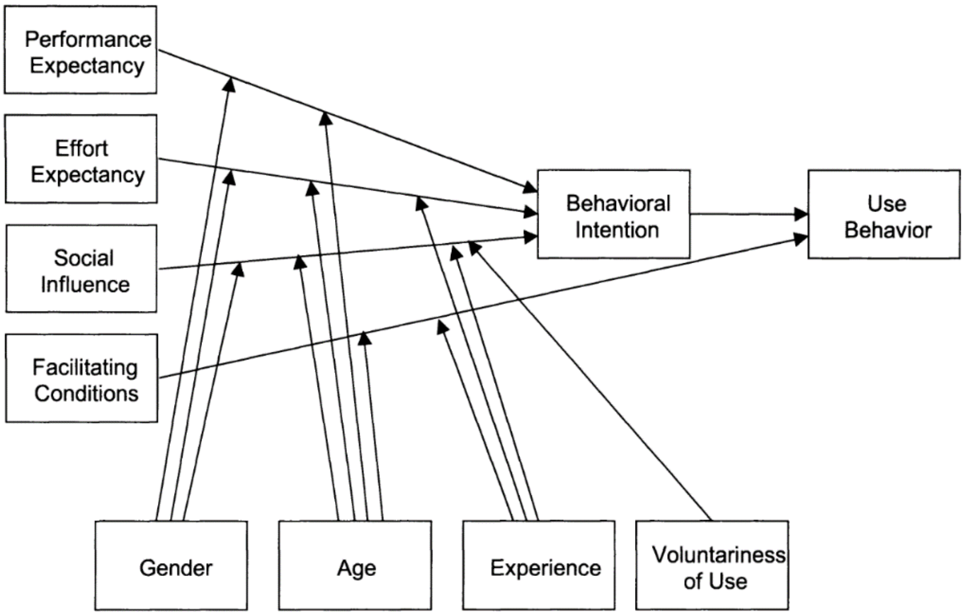


Figure 2.4 Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al. 2003)

It introduces four psychological factors which have direct impacts on behavioural intention or use behaviour and four socio-demographic factors which have moderating effects on behavioural intention or use behaviour by moderating the relations between psychological factors and behavioural intention or use behaviour. The four psychological factors are performance expectancy (PE), effort expectancy (EE), social influence (SI), and facilitating conditions (FC). The four socio-demographic factors are gender, age, experience, and voluntariness of use. Table 2.8 below specified psychological factors in definition, base constructs, influenced variables, affecting socio-demographic factors, and findings.

Table 2.8 Psychological factors of UTAUT (Venkatesh et al. 2003)

Psychological Factor	Definition	Base Constructs	Influenced Variables	Affecting Socio-demographic Factor	Findings
Performance Expectancy (PE)	The degree to which an individual believes that using the system will help him or her to attain gains in job performance	Perceived usefulness (TAM/TAM2/C-TAM-TPB), extrinsic motivation (MM), job-fit (MPCU), relative advantage (IDT), outcome expectations (SCT)	Behavioural Intention	Gender, Age	Factor has stronger effect on men, particularly for young men
Effort Expectancy (EE)	The degree of ease associated with the use of the system	Perceived ease of use (TAM/TAM2), complexity (MPCU), ease of use (IDT)	Behavioural Intention	Gender, Age, Experience	Factor has stronger effect on women, particularly young women, and particularly at early stages of experience
Social Influence (SI)	The degree to which an individual perceives that important others believe he or she should use the new system	Subjective norm (TRA/TAM2/TPB/DTPB/C-TAM-TPB), social factors (MPCU), image (IDT)	Behavioural Intention	Gender, Age, Experience, Voluntariness of Use	Factor has stronger effect on women, particularly older women, particularly in mandatory settings in the early stages of experience
Facilitating Conditions (FC)	The degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system	perceived behavioural control (TPB/DTPB/C-TAM-TPB), facilitating conditions (MPCU), compatibility (IDT)	Use behaviour	Age, Experience	Factor has stronger effect on older users, particularly with increasing experience

Although UTAUT integrates some psychological factors that have influences on technology use and studies their moderators, it is mainly aimed at an organizational context. Venkatesh et al. (2012) extended the generalizability of UTAUT to a consumer context, with the following adjustments: (1) an additional relation between Facilitating Conditions and behavioural intention; (2) three additional psychological factors: hedonic motivation (HM), price value (PV), and habit (HB); (3) abandon of voluntariness of use as a socio-demographic factor; (4) an additional moderating impact of experience on relation between behavioural intention and use behaviour (Figure 2.5). Table 2.9 specified the additional psychological factors in UTAUT2.

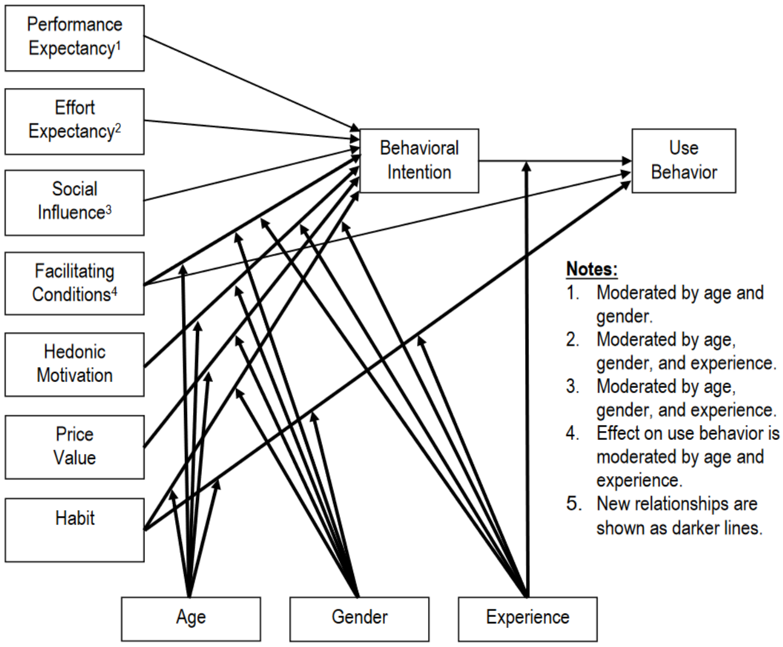


Figure 2.5 Extending Theory of Acceptance and Use of Technology (UTAUT2) (Venkatesh, Thong, and Xu 2012)

Table 2.9 Additional psychological factors of UTAUT2 (Venkatesh, Thong, and Xu 2012)

Psychological Factor	**Definition**	**Previous Related Research**	**Influenced Variables**	**Affecting Socio-demographic Factor**	**Findings**
Facilitating Conditions (FC)	The degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system	Ajzen (1991)	Behavioural Intention	Gender, Age, Experience	Factor has stronger effect on older women in early stages of experience with a technology
Hedonic Motivation (HM)	The fun or pleasure derived from using a technology	Brown & Venkatesh (2005); Childers et al. (2001); Heijden (2004); Thong et al. (2006)	Behavioural Intention	Gender, Age, Experience	Factor has stronger effect younger men in early stages of experience with a technology
Price Value (PV)	Consumers cognitive trade-off between perceived benefits of the technology applications and the monetary costs for using a technology	Chan et al. (2008); Dodds et al. (1991); Zeithaml (1988)	Behavioural Intention	Gender, Age	Factor has stronger effect on among women, particularly older women
Habit (HB)	The extent to which people tend to perform behaviours automatically because of learning	Limayem et al. (2007)	Behavioural Intention, Use Behaviour	Gender, Age, Experience	Factor has stronger effect on older men with high levels of experience with technology

Above, the original UTAUT and UTAUT2 theories are explained in depth. Technologies, products, services, and features from various fields have been applied to UTAUT series models in recent years. There are also many variants of the UTAUT model according to the specific characteristics of study objects. In order to better refine the UTAUT2 model for performance BEVs, a review of the recent applications of UTAUT theories to products and services in the automotive industry under ACES transition is shown in Table 2.10 and Table 2.11.

Table 2.10 Review of UTAUT theories applied in the automotive industry

Study	**Vehicle type**	**Psychological factors**							
		PE	**EE**	**SI**	**FC**	**HM**	**PV**	**HB**	**Other**
Karpurapu & Venkata Raghuram (2024)	EV	BI (n.s.)	BI (n.s.)	BI (+)	BI (-) UB (+)	BI (n.s.)	BI (+)	BI (n.s.) UB (+)	RI → BI (+)
Yavuz (2024)	AV	BI (+)	BI (+)	BI (+)	N/A	BI (+)	N/A	N/A	PS → BI (+)
A. P. Sutarto et al. (2023)	AV	BI (+)	BI (+)	BI (+)	BI (n.s.)	BI (+)	N/A	N/A	N/A
Farzin et al. (2023)	AV	BI (+)	BI (+)	BI (+)	N/A	N/A	N/A	N/A	PR → BI (-)
Higueras-Castillo et al. (2023)	EV	BI (+)	BI (+)	BI (+)	BI (+)	BI (+)	N/A	N/A	EC → BI (+)
Singh et al., (2023)	EV	BI (+)	BI (+)	BI (+)	BI (+)	BI (+)	BI (+)	BI (+)	N/A
Wang et al., (2023)	EV	BI (+)	BI (n.s.)	BI (+)	PR (+)	N/A	BI (+)	N/A	PR → BI (-) PI → PV (+)
Yu et al., (2023)	ECS	BI (+)	BI (+)	BI (n.s.)	N/A	N/A	N/A	N/A	AE → BI (+) PA → BI (+) SUST → BI (+) FV → BI (n.s.) CV → BI (+) TR (n.s.)
Curtale et al., (2022)	ECS, AECS	BI (+)	BI (+)	BI (+)	N/A	BI (+) BI-A (+)	N/A	N/A	SC → BI-A (-)
Gunawan et al. (2022)	EV	BI (+)	BI (+)	N/A	PBC (+)	BI (+)	BI (+)	BI (+)	N/A
Jain et al., (2022)	EVs	BI (+)	BI (n.s.)	BI (n.s.)	BI (+)	N/A	N/A	N/A	PR → BI (n.s.) EC → PR (n.s.) GS → PR (-)
Manutworakit & Choocharukul, (2022)	EV	BI (+)	BI (+)	BI (+)	BI (n.s.) UB (n.s.)	BI (+)	BI (n.s.)	N/A	PM → BI (n.s.) EC → BI (+)
Abbasi et al., (2021)	EVs	BI (n.s.)	BI (+)	BI (+)	N/A	N/A	N/A	N/A	TEC → BI (+) PEK → BI (+)
Bhat et al. (2021)	EV	BI (+)	N/A	BI (n.s.)	BI (+)	N/A	N/A	N/A	EE* → BI (+) TE → BI (+) AN → BI (-) SI* → BI (+) PB → BI (+)
Curtale et al., (2021)	ECS	BI (+)	BI (n.s.)	BI (+)	N/A	N/A	N/A	N/A	AE → BI (+) PA → BI (+) TR → BI (n.s.)

Table 2.11 (Continued) Review of UTAUT theories applied in automotive industry

Study	Vehicle type	Psychological factors							
		PE	EE	SI	FC	HM	PV	HB	Other
Khazaei & Tareq, (2021)	EV	N/A	N/A	BI (+)	BI (+)	N/A	N/A	N/A	RA → BI (n.s.) PE* → BI (+) EC → BI (+)
Korkmaz et al. (2021)	AV	BI (+)	BI (n.s.)	BI (+)	BI (n.s.)	BI (n.s.)	BI (n.s.)	BI (+)	PU → BI (n.s.) TS → BI (+) PR → BI (n.s.)
Park et al., (2021)	AV	BI (+)	N/A	BI (+)	BI (+)	N/A	N/A	N/A	PEU → BI (n.s.)
Zhou et al., (2021)	EVs	BI (+)	BI (+)	BI (n.s.)	BI (+) UB (+)	BI (+)	BI (+)	BI (+) UB (n.s.)	SIP → BI (+) SIP → UB (+)
Kapser & Abdelrahman, (2020)	Autonomous Deliver Vehicle (ADV)	BI (+)	BI (n.s.)	BI (+)	BI (+)	BI (+)	N/A	N/A	PR → BI (-) PS* → BI (-)
Nordhoff et al., (2020)	AV	BI (+)	BI (n.s.)	BI (+)	BI (n.s.)	BI (+)	N/A	N/A	N/A

Note: N/A = Not Adopted, (+) = positive effect, (-) = negative effect, (n.s.) = not significant

Abbreviation notes of psychological factors:

AE: Anxiety-free experience
AN: Anxiety
BI: behavioural intention
CV: Conditional Value
EC: Environmental concern
EE*: Environmental Enthusiasm
EE: Effort Expectancy
FC: Facilitating Conditions
FV: Functional Value
GS: Government Support
HB: Habit
HM: Hedonic Motivation
PA: Personal Attitude
PB: Perceived Benefits
PBC: Perceived Behaviour Control
PE*: Perceived Enjoyment
PE: Performance Expectancy
PEU: Perceived Ease of Use
PR: Perceived Risk,
PS*: Price Sensitivity
PS: Perceived Safety,
PU: Perceived Usefulness
PV: Price Value
RI: Risk,
SC: Safety Concern
SI*: Social Image
SI: Social Influence
SIP: Satisfaction with Incentive Policies
SUST: Sustainability
TE: Technological Enthusiasm
TR: Trust
TS: Trust and Safety
UB: Use Behaviour

Since performance expectancy, effort expectancy, social influence, and facilitating conditions are the four original constructs in UTAUT model, they are the four most commonly adopted psychological factors. Among them, effort expectancy are found to have a less consistent correlation with behavioural intention. Hedonic motivation is the most popular constructs among the three additional psychological factors in UTAUT2 model, the other two, price value and habit, are more adapted to the constructs from other models in special contexts. For additional constructs, there are various according to the research region and object. The above results of UTAUT also show consistency with results of Kano model. Less safety concern or more anxiety-free experience will promote the adoption of autonomous vehicles, which meets the preferences of features that improve safety and awareness (Shin et al. 2022; Curtale, Liao, and Rebalski 2022; Curtale, Liao, and Van Der Waerden 2021; Yu et al. 2023). Better facilitating conditions would encourage the usage of EVs, which meet the preferences of long lasting battery and fast charging (Dash 2019; Higueras-Castillo et al. 2023; Singh et al. 2023; Jain, Bhaskar, and Jain 2022).

2.5. Summary

With the development of technology acceptance theories and models in the last decades, the UTAUT series has been proven to be one of the most comprehensive theories and models, also been widely applied in studies of electric cars, autonomous cars, car sharing services, etc. in the recent decade. The design, manufacture, iteration, etc. of these niche products derived from the ACES transition in the field of automotive and mobility will continue to receive vital feedback from users and be influenced. Within the context of consumers, multiple UTAUT2 variants have been developed by previous studies. Many studies have introduced new constructs when studying EVs and Avs, while there are no suggested constructs specifically for performance BEVs. Meanwhile, Kano model has also been applied to understand users' recognition and satisfaction towards new products as a supplement to the UTAUT2 model. So far, UTAUT2 is the most suitable base model for investigate user acceptance towards performance BEVs in urban mobility. Kano model is also selected as preceding model to reduce respondents' recognition bias and to comprehend user satisfaction towards performance BEVs. Additionally, some modification will be applied to UTAUT2 to better investigate Chinese user acceptance in urban mobility scenario based on the literature review. The detailed methodology will be discussed in the next chapter.

Chapter 3: Methodology

This chapter aims to explain the research methodology on how user acceptance of performance BEVs in urban mobility is measured. The first part establishes conceptual frameworks of the Kano model and UTAUT2, and specifically describes the modifications applied to the original UTAUT2 model concerning characteristics of users, regions, etc. The second part proposes the hypotheses towards user acceptance according to the framework. The third part describes the operationalization of the considered independent variables to test hypotheses. The fourth part introduces how quantitative survey research is designed and deployed, as well as how the data is collected and analysed.

3.1 Conceptual framework

As there are various add-on features on demand besides dual/tri motors and four-wheel drive from the current performance BEVs, it is necessary to categorize the features mentioned in the Kano model. Also, the original UTAUT2 model is proposed for general consumer technology acceptance, which needs to be modified according to characteristics of performance BEVs from the ACES transition. This section consists of the categorization of features in the Kano model and modifications on UTAUT2.

Kano model

Sheller (2004) proposed that "car consumption is never simply about rational economic choices, but is as much about aesthetic, emotional and sensory responses to driving, as well as patterns of kinship, sociability, habitation, and work." The interaction between the user and the car in the ACES transition has been not only limited to the car but also more around the car or even beyond the car. The full journey of experience in using cars is essential for BEV users. Therefore, the user experience (UX) and features introduced in this study will be classified into UX in the car (UXI), UX around the car (UXA), and UX beyond the car (UXB) as shown in Table 3.1. There are 34 UX features selected based on the current status of performance BEVs market. The specific questions in the survey are shown in Appendix A.

UX in performance BEVs refer to every experience that the driver or passenger can have about the car itself. It starts from the basis, better drivability (UXI1), which normal drivers would expect on a performance BEV. UX in the car also includes autonomous and connected in the ACES transition, such as autonomous driving scenarios (UXI4 and UXI5), in-car interaction (UXI2), and voice control (UXI9), etc. Additionally, in-car customized features are also introduced as gamification (UXI6) and route recommendation (UXI15 and UXI16), etc.

UX around performance BEVs refers to interactive experience between cars and users through infrastructure, car apps, etc. offered by car manufacturers. Most UX around performance BEVs are related to charging and battery usage, as the top three concerns to a BEV of Chinese users are safety concerns with battery technology, time required to charge, and lack of public BEV charging infrastructure (Deloitte 2023). Hence, the corresponding features are also measured, such as longer battery warranty (UXA4), faster charging (UXA1), and exclusive charging pile/time period (UXA5). Other features related to sustainability and connectivity are also introduced as carbon footprint notes (UXA7) and real-time car data synchronization (UXA8).

UX beyond performance BEVs refer to most of the services offered by the brand and dealer that car users can experience even without their cars. It aims to build up a community for users, which makes them feel special. Most UX beyond the car is reflected in exclusiveness, uniqueness, priority, and flexibility.

Table 3.1 Measured items in the Kano model

Dimension	**Definition**	**Features**	
UX in the car	Features and experience that users can have on the car itself	UXI1	Better drivability
		UXI2	Better car-interaction experience
		UXI3	More cameras, radars, Lidars for autonomous driving
		UXI4	Autonomous driving in the city
		UXI5	Autonomous driving outside the city
		UXI6	Gamification features*
		UXI7	Unique interior light
		UXI8	Unique avatar
		UXI9	Voice-control everything
		UXI10	Engine sound simulator
		UXI11	Customizable car mode (e.g. sleep mode)
		UXI12	Great experience as a passenger
		UXI13	Racing tutorial
		UXI14	Autonomous driving tutorial
		UXI15	Route recommendation according to driving preferences
		UXI16	Route recommendation according to energy consumption
UX around the car	Features and experiences that users can have on their interaction with their cars through car stores, car apps, infrastructure, etc. offered by the car manufacturer.	UXA1	Faster charging
		UXA2	Better charging service
		UXA3	Better maintaining service
		UXA4	Longer battery warranty
		UXA5	Exclusive charging pile/time period
		UXA6	Swappable battery
		UXA7	Carbon footprint note
		UXA8	Real-time car data synchronization
UX beyond the car	Features and experience that users can have when they are specific car users, even without their cars by their side.	UXB1	More owner rights**
		UXB2	More customization opportunities
		UXB3	More exclusive optional features
		UXB4	More payment options
		UXB5	Priority in services
		UXB6	Unique car app
		UXB7	Unique products from brand store
		UXB8	Exclusive owner community
		UXB9	Exclusive credits
		UXB10	User growth system

*Gamification features are elements or mechanisms in games to non-game environments, e.g., challenges, badges, storylines, etc.
**Owner rights beyond the car are rights provided to specific users by cooperation with OEMs and other merchants.

UTAUT2

As the acceptance of performance BEVs in urban mobility is directly reflected in the purchasing behaviour of users, which also leads to daily use, the initial modification of the original UTAUT2 model is to clarify the behavioural intention as purchasing behavioural intention (PBI) and the exclusion of use behaviour as a dependent variable. The exclusion of use behaviour also causes the exclusion of any relations pointed to it. Furthermore, some psychological factors and socio-demographic factors need to be replaced or excluded from previous literature review of UTAUT2 model.

Effort expectancy has been found to have less relevance in electric cars, autonomous cars, and electric car-sharing services (Curtale, Liao, and Van Der Waerden 2021; Jain, Bhaskar, and Jain 2022; Karpurapu and Venkata Raghuram 2024; Korkmaz et al. 2021; Nordhoff et al. 2020; Wang, Ozden, and Tsang 2023). Some studies on electric cars and autonomous cars also did not include Effort Expectancy based on past research (Bhat, Verma, and Verma 2021; Park, Hong, and Le 2021). Considering the definition of Effort expectancy, Chinese users are not concerned much about the ease associated with the use of electric cars (Deloitte 2023). Therefore, Effort expectancy is excluded from the model.

Instead, concern-free experience can be a supplement of effort expectancy. concern-free experience also refers to anxiety-free experience, describing the degree of being relieved from concern/anxiety with the use of the product or system. It is vital to understand how much concern can BEVs relieve from the users, especially for performance BEVs which represent the top level of each model. Previous studies have proven that concern-free experience has positive effects on adoption intention of electric cars, autonomous cars, and electric car sharing services (Curtale, Liao, and Van Der Waerden 2021; Deloitte 2023; Kennedy, James, and Hampson 2023). Thus, this study introduces Concern-free Experience as one of psychological factors.

Hedonic motivation has been found to have varying results on behaviroual intention. Karpurapu and Venkata Raghuram (2024) and Korkmaz et al. (2021) found that hedonic motivation does not have positive effects on adoption intention of EV and autonomous vehicles. While Singh et al. (2023) and Curtale, Liao, and Van Der Waerden (2021) have the opposite conclusions on adoption intention of EV, autonomous vehicles, and electric car sharing services. As a niche branch of BEVs, performance BEVs as the iterated product of high-performance cars in the ACES transition, are also positioned similarly in the market. High-performance cars are used to be representatives of luxury, wealth, and high social status, thus they will have vanity as hedonic motivation for users (Gil-Cordero et al. 2023; Aditama 2015). Previous studies show that users of performance cars concern quality, brand image, and status symbol mostly, therefore, the vanity of owning performance BEVs is one of the important factors of purchasing intention (Adityawarman and Purwanegara 2014; Ali et al. 2019). Because the similarity between vanity and hedonic motivation may cause multicollinearity in regression, there are no previous studies adopt vanity and hedonic motivation as psychological factors simultaneously. In order to make purchasing behavioural intention better match the characteristics of performance BEVs, this study includes vanity as one of the psychological factors and excludes hedonic motivation.

Price value are not very often adopted in past studies, while it has shown significant positive effects on behavioural intention in studies that have adopted price value in the past two years (Karpurapu and Venkata Raghuram 2024; Singh et al. 2023; Wang, Ozden, and Tsang 2023). Besides, as vanity is included in this study and price value is often used together with vanity as psychological factors in the study of premium products, this study keeps price value as one of psychological factors.

Habit are less frequently included in past studies on EVs and autonomous vehicles (Yavuz 2024; Farzin, Mamdoohi, and Ciari 2023; Wang, Ozden, and Tsang 2023; Curtale, Liao, and Rebalski 2022). Among the few studies adopted habit, the correlations to behavioural intention and use behavioural are also not consistent. Karpurapu and Venkata Raghuram (2024) found that habit has positive effects on use behaviour rather than behavioural intention, while Zhou et al. (2021) found that habit has positive effects on behavioural intention instead use behaviour. Habit is also neither the first nor the second expectation on performance BEVs for Chinese users, instead, family multifunctional uses and intelligence level are the top two expectations (Autohome Research Institute 2022). Hence, habit are also excluded from the model.

Experience as a socio-demographic factor is not easy to measure since it is continuously distributed in the use of performance BEVs. The definition bias of performance BEVs among respondents can also cause unexpected outliers. Instead, Car Ownership can replace Experience as a more suitable socio-demographic factor towards performance BEVs. Because more than 50% of Chinese car buyers are existing car owners who purchase additional cars or exchange their owned cars, performance BEVs are more suitable for additional purchasing or exchanging as a consumption upgrade (Aurora Mobile 2023). The differentiation of Car Ownership can more specifically distinguish groups of users with different car purchasing intentions, which is also valuable for this study.

Besides, there are some other socio-demographic characteristics, including income, education, and residence level, applied in the UTAUT2 model as socio-demographic factors in the studies of electric cars, autonomous cars, and electric car-sharing services. income, education, and city size had different impacts on adoption intention when electric cars offer autonomous driving features (Curtale, Liao, and Rebalski 2022). gender, education, and income were found to have moderating effects on the influence from performance expectancy and facilitating conditions to behavioural intention among Chinese users (Zhou et al. 2021). However, moderating effects may vary by region and country. behavioural intention among Indonesian users was shown to have fewer moderating effects from education and residency (Sutarto et al. 2023). Wang et al. (2023) also found that income and education do not significantly moderate the relationship among the psychological factors in China, which is different from the previous conclusions. Therefore, this study will make full assumptions on six socio-demographic factors and observe their direct effects on behavioural intention and moderating effects on psychological factors.

Based on the above modifications on the original UTAUT2 model, the proposed model will study the effects of six psychological factors (i.e., performance expectancy, social influence, facilitating conditions, price value, concern-free experience, and vanity), and six socio-demographics factors (i.e., age, gender, car ownership, income, education, and residence level) on behavioural intention toward performance BEVs in urban mobility. As the effects of these independent factors may be either direct or mediated by other constructs, both direct and indirect effects are evaluated in the analysis. A graphical representation of the conceptual model is depicted in Figure 3.1.

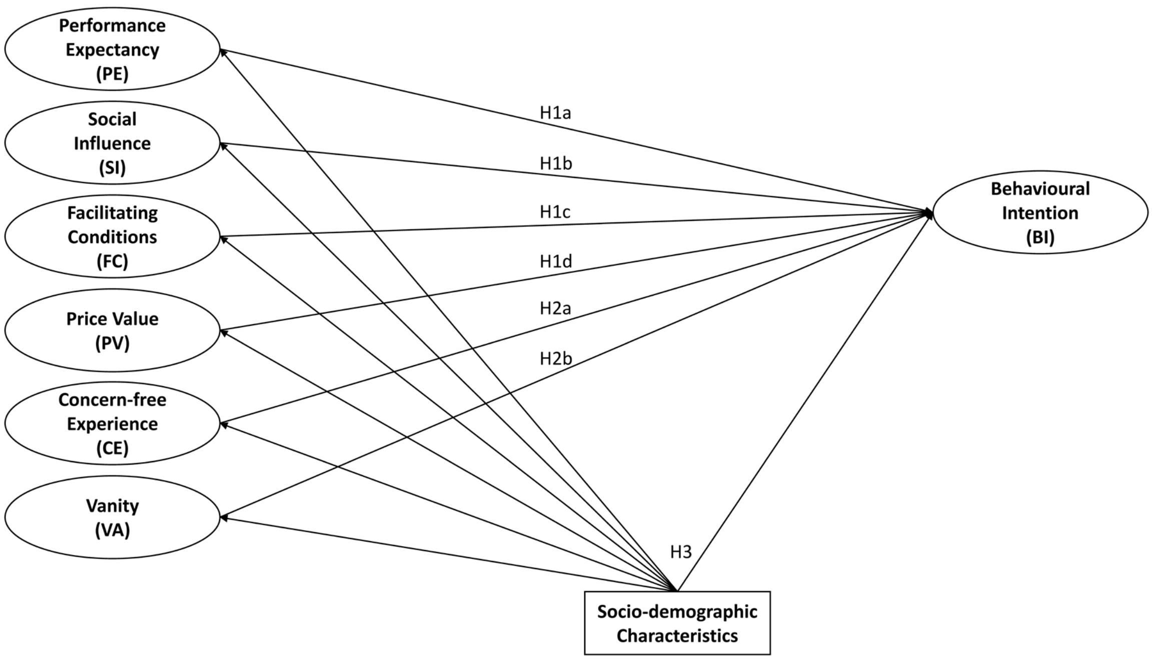


Figure 3.1 Conceptual model (arrows indicate directed effects)

3.2 UTAUT2 Hypotheses

In order to test the impacts of factors on behavioural intention in the revised UTAUT2 model, three major hypotheses are formulated and tested. Each hypothesis includes several sub-hypotheses within one context.

In the previous user acceptance studies using UTAUT2 models applied to electric cars, autonomous cars, and electric car-sharing services, it has been found that performance expectancy, social influence, facilitating conditions, and price value have significant effects on purchasing and adoption intention (Singh et al. 2023; Wang, Ozden, and Tsang 2023; Zhou et al. 2021; Ali et al. 2019; Abbasi et al. 2021; Xu et al. 2019; Vafaei-Zadeh et al. 2022). Based on these results, the first main hypothesis concerning the original UTAUT2 constructs is formulated below.

Hypothesis 1. The original UTAUT psychological factors have positive effects on purchasing behavioural intention on performance BEVs.

Hypothesis 1a. Performance expectancy has a positive effect on purchasing behavioural intention.
Hypothesis 1b. Social influence has a positive effect on purchasing behavioural intention.
Hypothesis 1c. Facilitating conditions has a positive effect on purchasing behavioural intention.
Hypothesis 1d. Price value has a positive effect on purchasing behavioural intention.

Two additional UTAUT2 constructs are expected to have positive impacts on behavioural intention: Concern-free Experience and Vanity. Concern-free Experience is also represented in previous studies as Anxiety-free Experience. In the context of performance BEVs, it refers to less concerned from the autonomous and intelligent features of performance BEVs in the future, which can offer smoother and safer driving, charging, parking, etc. Previous studies found that high concerns towards electric cars and autonomous cars can reduce their use (Curtale, Liao, and Van Der Waerden 2021; Yu et al. 2023). Therefore, Concern-free Experience should have a positive effect on behavioural intention.

Vanity was found to have a positive impact on adoption intention towards popular, luxury, and sports cars (Aditama 2015; Adityawarman and Purwanegara 2014; Gil-Cordero et al. 2023; Workman and Lee 2011). In the context of performance BEVs, the vanity construct represents the more materialistic self-satisfaction of users on physical appearance and social status when owning performance BEVs (Ali et al. 2019; Hung et al. 2011). As performance BEVs are treated as alternatives for petrol performance cars, and users of petrol performance cars have high vanity attributes on adoption intention, vanity should have a positive effect on behavioural intention towards performance BEVs. Therefore, the second main hypothesis concerning the additional UTAUT2 constructs are formulated as follow.

Hypothesis 2. The additional UTAUT psychological factors have positive effects on purchasing behavioural intention on performance BEVs.

Hypothesis 2a. Concern-free experience has a positive effect on purchasing behavioural intention.
Hypothesis 2b. Vanity has a positive effect on purchasing behavioural intention.

Previous studies also indicate that socio-demographic characteristics affect the adoption intention towards electric cars, autonomous cars, and electric car-sharing services(Abbasi et al. 2021; Curtale, Liao, and Van Der Waerden 2021; Curtale, Liao, and Rebalski 2022; Korkmaz et al. 2021; Lashari, Ko, and Jang 2021; She et al. 2017; Wang, Ozden, and Tsang 2023; Xu et al. 2019). Depending on differences among the regions, respondents, and research objects, the six socio-demographic factors may have different moderating effects on the psychological factors and behavioural intention. Considering the user portraits of performance BEVs in China, this study defines the third main hypothesis as follow (Autohome Research Institute 2022).

Hypothesis 3. User with different socio-demographic characteristics have varied purchasing behavioural intention on performance BEVs.

Hypothesis 3a. User with different gender have varied purchasing behavioural intention on performance BEVs.
Hypothesis 3b. User with different age have varied purchasing behavioural intention on performance BEVs.
Hypothesis 3c. User with different car ownership have varied purchasing behavioural intention on performance BEVs.
Hypothesis 3d. User with different income have varied purchasing behavioural intention on performance BEVs.
Hypothesis 3e. User with different education have varied purchasing behavioural intention on performance BEVs.
Hypothesis 3f. User with different residence level have varied purchasing behavioural intention on performance BEVs.

3.3 UTAUT2 Operationalization

After establishing the conceptual frameworks and hypotheses, it is necessary to operationalise the influence of the six psychological factors on behavioural intention. The operationalization is based on the original study and modified according to the context of performance BEVs in the ACES transition and urban mobility scenario (Venkatesh et al., 2003, 2012). For the two newly added psychological factors: concern-free experience and vanity, the measured items come from the previous studies (Curtale, Liao, and Van Der Waerden 2021; Yu et al. 2023; Hung et al. 2011)

Table 3.2 Operationalization of the UTAUT2 model

Factor	Corresponding questions
Performance Expectancy	PE1: In urban mobility, performance BEVs offer better driving experience in acceleration and controllability. PE2: In urban mobility, performance BEVs can well balance my daily use convenience and sporty driving pleasure. PE3: In urban mobility, my driving experience would be enhanced by technologies on performance BEVs. PE4: In urban mobility, my driving performance would be enhanced by the connectivity of performance BEVs.
Social Influence	SI1: People who are important to me think that I should use performance BEVs in urban mobility. SI2: People whose opinions I value think that I should use performance BEVs in urban mobility. SI3: I would use performance BEVs in urban mobility if my friends/colleagues recommend it. SI4: I would be more likely to use performance BEVs in urban mobility if my friends/colleagues use it.
Facilitating Conditions	FC1: I expect there are enough fast-charging stations for me to use performance BEVs in urban mobility. FC2: I expect the battery technology is mature enough to use performance BEVs in urban mobility. FC3: I expect the maintenance of performance BEVs in urban mobility is easy with its advanced technologies.
Price Value	PV1: Performance BEVs is reasonably priced with its improved experience in urban mobility. PV2: Performance BEVs is more intelligent in urban mobility among other cars with the same price. PV3: Performance BEVs is a good value for money in urban mobility. PV4: I expect a part of performance BEVs price is paying for the environmental contribution in urban mobility.
Concern-free Experience	CE1: I no longer worry about the battery depletion in urban mobility after driving performance BEVs. CE2: I no longer worry about the parking and congestion in urban mobility after driving performance BEVs. CE3: I no longer worry about the noise to others in urban mobility after driving performance BEVs. CE4: I no longer worry about the traffic safety issues in urban mobility after driving performance BEVs.
Vanity	VA1: I concern my physical appearance in urban mobility so I use performance BEVs if I could. VA2: Using performance BEVs in urban mobility will make me look physically better. VA3: I concern my social status in urban mobility so I use performance BEVs if I could. VA4: Using performance BEVs in urban mobility will make me appear to have more achievements.
Behavioural Intention	BI1: I intend to purchase performance BEVs for urban mobility in the future. BI2: I am very likely to purchase performance BEVs soon for urban mobility if the opportunity arises. BI3: I intend to purchase performance BEVs for urban mobility although it is expensive. BI4: I would encourage friends/colleagues to purchase performance BEVs for urban mobility.

3.4 Quantitative Survey Research

In order to achieve the main objective of this study, quantitative analyses are applied to Chinese users. The following subsections will introduce the details of the survey, the sample, and the analysis method.

Survey

A survey is designed to measure the user satisfaction of current UX features on performance BEVs and to test the three main hypotheses as stated in paragraph 3.2. The survey consists of three parts: basic socioeconomic background, information about the user experience satisfaction of the performance BEV, and information about the acceptance of the performance BEV in urban mobility.

Before the survey, there are reading guide, informed consent form, and filtering questions ensuring respondents well-informed, voluntarily participating, and valid. Before the questioning part of performance BEVs, there is an introduction of performance BEVs with brief definitions and comparisons with petrol performance cars, reducing recognition bias of definition among respondents. After the survey, there is the ending part, asking respondents' comments on the survey and this study. There are 68 questions in total, asking questions as presented in measurement items in Table 3.1 and operationalisation in Table 3.2.

According to previous studies, both the Kano model and UTAUT2 model are measured on a five-point Likert-scale. The answers for both functional and dysfunctional questions in Kano model range from "I dislike it" to "I like it", with the middle answer of "I am neutral". The answers for all psychological factors and behavioural intention in UTAUT2 model range from "totally disagree" to "totally agree", with the middle answer of "neutral/uncertain". For socio-demographic characteristics, they are all measured in a binary way. The full survey is in Appendix A.

Considering the language proficiency of the respondents, the questionnaire was finally translated into Chinese. The translation of "concern-free experience" may lead to reverse understanding due to grammar differences. Therefore, the original collected response of concern-free experience in the 5-Likert scale was reversed to comply with the meaning of the original questionnaire.

Analysis method

With the collected data, the analyses will be conducted through IBM SPSS Statistics, IBM SPSS Amos, and Excel. Kano model will be analysed by both of the original and conservative evaluation criteria. The attibutes of features will be classified by both of criteria but be prioritized by SI and DI values only with the original criteria, considering the academical comparability and consistency with previous studies. Because the UTAUT2 model are modified according to the characteristics of performance BEVs, it is necessary to verify if constructs are measured by the observed variables and confirm the measurement model fits the data well. Confirmatory factor analysis (CFA) will be applied to UTAUT2 model to assess the reliability and validity of the measurement instruments. The internal consistencies of both models are assessed by Cronbach's alpha and composite reliability (CR). Besides, the relationships between the six psychological factors, six socio-demographic factors, and purchasing behaviroual intention on performance BEVs in urban mobility are estimated through structural equation modelling (SEM). All these results are gathered to test the hypotheses stated in this chapter and address the research question stated in Chapter 1.

3.5 Summary

In this chapter, the conceptual framework has been presented, which includes the operationalization of the Kano model for UX expectation and satisfaction and the modification of the UTAUT2 model according to the specific urban mobility scenarios for performance BEVs. The operationalization of the UTAUT2 model is based on the hypotheses which are set on the effects of psychological variables and moderating variables on behavioural intention. Both models are operationalized via questions and conducted in one quantitative survey research. The survey design, sample composition, and analysis methods are also introduced in this chapter. With the collected data, the verification of the data and the corresponding analyses will be applied in the next two chapters.

Chapter 4: User Satisfaction Results

This chapter aims to analyse the user satisfaction of UX features according to the Kano model specified in the previous chapter. The first part of this chapter presents the descriptive statistics of the measurement items. The second part validates the reliability of items in each UX construct. The third part consists of the Kano model analysis of each item based on the frequency method. The fourth part applies the satisfaction and dissatisfaction indexes to each item. The fifth part finally delivers the conclusion of UX satisfaction of each UX feature. At the end of this chapter, it answers the first research sub-question:

- *What UX features in, around, and beyond the performance BEVs would make them attractive to purchase and use?*

4.1 Sample analysis

As there are more than 500 million Chinese holding a valid driving license who can be regarded as potential users of performance BEVs, a minimum of 384 respondents is required according to the Krejcie and Morgan table (Memon et al. 2020; Ministry of Public Security of the PRC 2024). The survey was deployed in one of the Chinese greatest automotive forums, DongCheDi, in November 2023. The automotive forum is a suitable community to provide empirical evidence of proposed models because the active users in the forum are experienced in using BEVs and performance cars, which ensures they can understand some basic car-related terms in the survey. The survey was digitalized in the Tencent Survey platform and was spread via a link which leads the respondent to the online survey. The link was shared in the DongCheDi forum, specifically to BEV users' communities and performance car users' communities. Within the two-week data collection, 1568 respondents in total completed the survey. After filtering their answers by screening and verification questions, there are 1290 valid responses left and considered for the final analysis.

As all socio-demographic characteristics are categorised in a binary way, it is necessary to clarify the criteria of each variable. Gender is classified as male and female. The original survey has a third option of "others" for those respondents who have non-binary gender-identification. Since there is only 1 respondent replied with "other" gender, it is omitted in this study. Age is classified as young (< 35) and old (>= 35) because the trend of younger Chinese car consumers is the most obvious (Roland Berger and Autohome Research Institute 2023). Car buyers below 35 years old account for more than 40% and are still continuously increasing (Autohome Research Institute 2023b). Car Ownership is classified as "2 car or more" and "1 car or less". Because more than 90% of users in the automotive forum have at least one car, categorisation of yes or no owning a car can no longer clearly differentiate respondents, the users with one car also have different purchasing preferences from users with two or more cars (Aurora Mobile 2023). Income is classified with high (above 10k CNY/month net) and low (below 10k CNY/month net) and Education is classified with high (university bachelor degree or higher) and low (college degree or lower), both according to the classification in previous studies in China as well as considering the high value of performance BEVs (Ali et al. 2019; F. Liao et al. 2020; Zhou et al. 2021). Residence Level is classified as high (Tier 1 cities or New Tier 1 cities) and low (Tier 2 cities or lower). The classification of cities is based on the business resource concentration, urban hubness, urban people's activity, lifestyle diversity and future plasticity (YICAI 2023). There are four Tier 1 cities in China: Shanghai, Beijing, Guangzhou, and Shenzhen, which are the most developed cities in China. The fifteen New Tier 1 cities represent the most active cities with high development potential, including Chengdu, Chongqing, Hangzhou, Wuhan, Suzhou, Xi'an, Nanjing, Changsha, Tianjin, Zhengzhou, Dongguan, Qingdao, Kunming, Ningbo, and Hefei in 2023. These 19 cities in China account for only 5.6% of the total number of cities but have 29.3% of the urban population.

The final sample (Table 4.1) is representative of Chinese car users in terms of income and residence level (Autohome Research Institute 2023b). There are over-representations of male in gender, young users in age, users owned 1 or less cars in car ownership, and highly educated users in education. These uneven distributions are due to the current user characteristics of BEVs and performance vehicles, which are reasonable and acceptable for this study. Overall, the statistics are suitable for study in user acceptance towards performance BEVs in urban mobility in China.

Table 4.1 Sample Composition (sample size = 1290)

Socio-Demographic Characteristics	**Criteria**	**Number (Percentage)**
Gender	Male	994 (77.1%)
	Female	296 (22.9%)
Age	Young (< 35)	989 (76.7%)
	Old (>= 35)	301 (23.3%)
Car Ownership	2 or more	399 (30.9%)
	1 or less	891 (69.1%)
Income	High (above 10k CNY/month net)	623 (48.3%)
	Low (below 10k CNY/month net)	667 (51.7%)
Education	High (university bachelor degree or higher)	950 (73.6%)
	Low (college degree or lower)	340 (26.4%)
Residence Level	High (Tier 1 cities or New Tier 1 cities)	666 (51.6%)
	Low (Tier 2 cities or lower)	624 (48.4%)

4.2 Item statistics

Descriptive statistics show that UX feature items have mean values around four and three when items are available and not available respectively, which deviates slightly from the median level but shows a significant difference between functional and dysfunctional forms. Almost every standard deviation has a value above one for both functional and dysfunctional forms, indicating heterogeneous responses for every item. Skewness, when items are available, is mostly less than negative one, indicating highly asymmetric left-skewed distribution for functional form. Skewness, when items are not available, is larger than zero, indicating asymmetric right-skewed distribution for dysfunctional form. Kurtosis, when items are available, is mostly positive, indicating heavy tails for functional form. Kurtosis, when items are not available, is mostly less than negative one, indicating platykurtic with a flatter peak and thinner tails for dysfunctional form. Therefore, functional items present a heterogeneous and asymmetric distribution with a high frequency of extreme values, indicating users showed high acceptance of most features when available. Dysfunctional items present a heterogeneous and asymmetric distribution with a low frequency of extreme values, indicating users have neutral attitudes towards most features when not available.

Table 4.2 Item statistics of Kano model constructs (if items are available)

Construct	Item		Mean	St. Dev.	Skewness	Kurtosis	Constr. Avg.
UX in the car	UXI1	Better drivability	4.278	1.070	-1.374	0.701	4.202
	UXI2	Better car-interaction experience	4.235	1.031	-1.248	0.601	
	UXI3	More cameras, radars, Lidars for autonomous driving	4.240	1.060	-1.306	0.633	
	UXI4	Autonomous driving in the city	4.200	1.059	-1.125	0.174	
	UXI5	Autonomous driving outside the city	4.308	1.059	-1.395	0.759	
	UXI6	Gamification features*	4.091	1.121	-0.937	-0.322	
	UXI7	Unique interior light	4.211	1.061	-1.158	0.193	
	UXI8	Unique avatar	4.124	1.087	-0.929	-0.315	
	UXI9	Voice-control everything	4.163	1.127	-1.072	-0.094	
	UXI10	Engine sound simulator	4.060	1.151	-0.960	-0.200	
	UXI11	Customizable car mode (e.g. sleep mode)	4.350	1.003	-1.500	1.272	
	UXI12	Great experience as passengers	4.291	1.037	-1.368	0.832	
	UXI13	Racing tutorial	3.990	1.237	-0.938	-0.301	
	UXI14	Autonomous driving tutorial	4.216	1.091	-1.190	0.281	
	UXI15	Route suggestion according to driving preferences	4.175	1.107	-1.112	0.043	
	UXI16	Route suggestion according to energy consumption	4.303	1.088	-1.433	0.849	
UX around the car	UXA1	Faster charging	4.301	1.047	-1.457	1.066	4.262
	UXA2	Better charging service	4.270	1.058	-1.398	0.911	
	UXA3	Better maintaining service	4.247	1.048	-1.296	0.621	
	UXA4	Longer battery warranty	4.312	1.028	-1.435	0.962	
	UXA5	Exclusive charging pile/time period	4.253	1.067	-1.316	0.638	
	UXA6	Swappable battery	4.297	1.030	-1.390	0.923	
	UXA7	Carbon footprint note	4.166	1.071	-1.070	0.073	
	UXA8	Real-time car data synchronization	4.251	1.080	-1.330	0.638	
UX beyond the car	UXB1	More owner rights	4.306	0.994	-1.439	1.314	4.203
	UXB2	More customization opportunities	4.212	1.089	-1.166	0.179	
	UXB3	More exclusive optional features	4.176	1.103	-1.062	-0.090	
	UXB4	More payment options	4.131	1.099	-1.058	0.071	
	UXB5	Priority in services	4.212	1.079	-1.219	0.387	
	UXB6	Unique car app	4.186	1.079	-1.174	0.319	
	UXB7	Unique products from brand store	4.136	1.073	-1.017	-0.041	
	UXB8	Exclusive owner community	4.174	1.089	-1.096	0.091	
	UXB9	Exclusive credits	4.206	1.065	-1.123	0.132	
	UXB10	User growth system	4.291	1.068	-1.326	0.575	

(St. Dev.: standard deviation, Constr. Avg.: average of the construct)

Table 4.3 Item statistics of Kano model constructs (if items are not available)

Construct	Item		Mean	St. Dev.	Skewness	Kurtosis	Constr. Avg.
UX in the car	UXI1	Better drivability	2.560	1.394	0.530	-0.967	2.833
	UXI2	Better car-interaction experience	2.643	1.378	0.471	-0.980	
	UXI3	More cameras, radars, Lidars for autonomous driving	2.843	1.492	0.299	-1.340	
	UXI4	Autonomous driving in the city	2.756	1.398	0.331	-1.167	
	UXI5	Autonomous driving outside the city	2.806	1.423	0.262	-1.243	
	UXI6	Gamification features*	2.962	1.285	0.198	-0.920	
	UXI7	Unique interior light	2.917	1.430	0.231	-1.260	
	UXI8	Unique avatar	2.912	1.362	0.172	-1.131	
	UXI9	Voice-control everything	2.837	1.417	0.240	-1.258	
	UXI10	Engine sound simulator	3.009	1.337	0.118	-1.110	
	UXI11	Customizable car mode (e.g. sleep mode)	2.803	1.506	0.276	-1.346	
	UXI12	Great experience as passengers	2.819	1.431	0.253	-1.269	
	UXI13	Racing tutorial	3.012	1.294	0.144	-0.966	
	UXI14	Autonomous driving tutorial	2.808	1.441	0.255	-1.271	
	UXI15	Route suggestion according to driving preferences	2.868	1.399	0.193	-1.228	
	UXI16	Route suggestion according to energy consumption	2.775	1.456	0.284	-1.271	
UX around the car	UXA1	Faster charging	2.796	1.538	0.302	-1.389	2.805
	UXA2	Better charging service	2.721	1.430	0.374	-1.147	
	UXA3	Better maintaining service	2.796	1.504	0.305	-1.343	
	UXA4	Longer battery warranty	2.684	1.561	0.387	-1.373	
	UXA5	Exclusive charging pile/time period	2.855	1.504	0.249	-1.363	
	UXA6	Swappable battery	2.785	1.416	0.265	-1.233	
	UXA7	Carbon footprint note	2.974	1.353	0.178	-1.124	
	UXA8	Real-time car data synchronization	2.828	1.492	0.267	-1.342	
UX beyond the car	UXB1	More owner rights	2.834	1.421	0.194	-1.267	2.876
	UXB2	More customization opportunities	2.846	1.404	0.213	-1.218	
	UXB3	More exclusive optional features	2.843	1.363	0.193	-1.143	
	UXB4	More payment options	2.891	1.382	0.211	-1.134	
	UXB5	Priority in services	2.843	1.425	0.287	-1.209	
	UXB6	Unique car app	2.843	1.447	0.270	-1.248	
	UXB7	Unique products from brand store	2.851	1.332	0.189	-1.076	
	UXB8	Exclusive owner community	3.029	1.427	0.092	-1.268	
	UXB9	Exclusive credits	2.939	1.422	0.175	-1.223	
	UXB10	User growth system	2.839	1.377	0.265	-1.088	

(St. Dev.: standard deviation, Constr. Avg.: average of the construct)

4.3 Classification by occurrence frequency

For each UX feature on performance BEVs, respondents' inputs of both functional form and dysfunctional form are combined and classified under each Kano attribute (O, A, M, I, R, or Q). The Kano attribute of each UX feature will be classified according to the highest occurrence frequency among all Kano attributes. In Table 4.4, there are no UX features classified most frequently under M; therefore, no UX features in this study are classified as Must-be features for performance BEVs. It also indicates that performance BEVs are still at a nascent development stage without a specific UX feature preference in China (Lu, Lu, and Chen 2022).

Table 4.4 Kano model results by occurrence frequency according to original evaluation criteria

Dimensions	**Functions**	**O (%)**	**A (%)**	**M (%)**	**I (%)**	**R (%)**	**Q (%)**	**Kano Category**
UX in the car	UXI1	20.6%	26.1%	7.6%	**28.9%**	3.3%	13.4%	I
	UXI2	16.5%	25.7%	7.8%	**32.6%**	4.2%	13.2%	I
	UXI3	17.3%	25.3%	5.2%	**26.7%**	11.4%	14.2%	I
	UXI4	16.9%	25.0%	5.2%	**34.4%**	4.9%	13.6%	I
	UXI5	16.8%	**31.5%**	5.7%	26.1%	5.3%	14.6%	A
	UXI6	10.2%	26.9%	3.6%	**39.5%**	4.8%	15.0%	I
	UXI7	14.9%	26.8%	3.7%	**30.4%**	9.8%	14.3%	I
	UXI8	14.3%	25.3%	3.6%	**36.7%**	6.4%	13.7%	I
	UXI9	15.1%	28.3%	5.8%	**30.1%**	6.7%	14.0%	I
	UXI10	11.5%	25.8%	2.9%	**37.4%**	8.1%	14.3%	I
	UXI11	21.2%	**26.8%**	5.1%	22.8%	9.3%	14.8%	A
	UXI12	16.1%	28.3%	6.1%	**28.8%**	5.0%	15.7%	I
	UXI13	10.2%	27.4%	2.9%	**36.1%**	9.3%	14.2%	I
	UXI14	17.8%	26.5%	5.6%	**29.1%**	6.7%	14.4%	I
	UXI15	14.8%	28.9%	5.6%	**30.7%**	7.4%	12.6%	I
	UXI16	20.2%	**30.2%**	4.8%	23.9%	7.4%	13.4%	A
UX around the car	UXA1	20.1%	**25.9%**	7.1%	21.1%	11.5%	14.4%	A
	UXA2	19.1%	26.2%	6.0%	**28.5%**	7.1%	13.2%	I
	UXA3	19.1%	24.0%	6.4%	**26.1%**	10.7%	13.6%	I
	UXA4	**25.5%**	21.1%	7.0%	22.3%	10.4%	13.7%	O
	UXA5	18.2%	**25.5%**	5.7%	25.0%	10.5%	15.0%	A
	UXA6	17.7%	**29.2%**	5.4%	28.8%	5.9%	13.0%	A
	UXA7	11.3%	30.1%	3.8%	**32.7%**	9.5%	12.6%	I
	UXA8	19.2%	**27.6%**	5.0%	23.9%	12.1%	12.2%	A
UX beyond the car	UXB1	17.4%	27.3%	5.3%	**30.5%**	5.7%	13.8%	I
	UXB2	16.4%	**29.7%**	4.8%	29.4%	7.5%	12.2%	A
	UXB3	16.4%	28.0%	3.6%	**34.1%**	4.9%	13.0%	I
	UXB4	14.9%	27.1%	3.7%	**32.5%**	10.5%	11.3%	I
	UXB5	15.8%	**29.1%**	4.8%	27.9%	10.5%	11.9%	A
	UXB6	16.4%	26.4%	5.3%	**28.6%**	11.2%	12.1%	I
	UXB7	14.8%	28.1%	3.8%	**36.2%**	7.9%	9.1%	I
	UXB8	13.3%	**28.7%**	4.3%	27.6%	12.3%	13.7%	A
	UXB9	15.7%	26.7%	3.9%	**29.8%**	9.6%	14.3%	I
	UXB10	16.4%	**32.5%**	3.6%	26.9%	6.4%	14.1%	A

O: One-dimensional; A: Attractive; M: Must-be; I: Indifferent; R: Reverse; Q: Questionable.

Only one UX around the car (i.e., longer battery warranty) is classified most frequently under O; therefore, this UX feature is classified as a one-dimensional feature. The one-dimensional attribute (O) is relatively inclined to concern on battery warranty. Chinese users are sensitive to the battery quality guarantee. They expect a longer battery warranty on performance BEVs than normal BEVs, which allows them to drive and use performance BEVs with less battery aging concerns. They will also be anxious when performance BEVs do not have a longer battery warranty than normal BEVs as battery safety is the greatest concern among Chinese BEV users (Deloitte 2023).

Three UX in the car (i.e., autonomous driving outside the city, being able to lie down comfortably and sleep well, route recommendation according to energy consumption), four UX around the car (i.e., faster charging, exclusive charging pile/time period, swappable battery, real-time car data synchronization), and four UX beyond the car (i.e., more customization opportunities, priority in services, exclusive owner community, user growth system) are classified most frequently under A; therefore, these UX features are classified as Attractive features. The attractive attribute (A) is relatively inclined to energy usage and replenishment, autonomous driving, vehicle connectivity, and user exclusiveness. Performance BEV users do not only have similar concerns as BEV users in energy usage and replenishment, but also expect more exclusive features on BEVs rather than petrol cars like autonomous driving and high connectivity (Autohome Research Institute 2022). To increase Chinese users' satisfaction with performance BEVs, more concern-free experiences and exclusive services or options related to energy usage and intelligent features should be introduced.

Thirteen UX in the car (i.e., better drivability, better car-interaction experience, more cameras, radars, Lidars for autonomous driving, autonomous driving in the city, gamification features, unique interior light, unique avatar, being able to voice-control everything, engine sound simulator, great experience as a passenger, Racing tutorial, autonomous driving tutorial, route recommendation according to driving preferences), three UX around the car (i.e., better charging service, better maintaining service, Carbon footprint note), six UX beyond the car (i.e., more owner rights, more exclusive optional features, more payment options, unique car app, unique products from brand store, exclusive credits) are classified most frequently under I; therefore, these UX features are classified as Indifferent features. The indifferent attribute (I) is inclined to various UX features in, around, and beyond the performance BEVs. OEMs not only provide features that petrol performance cars should have (e.g., better drivability, engine sound simulator, better maintaining service, more exclusive optional features), but also provide features that make performance BEVs stand out from normal BEVs (e.g., more cameras, radars, Lidars for autonomous driving, better charging service, exclusive credits), even provide more novel features as experiment on performance BEVs (e.g., gamification features, unique avatar, carbon footprint note). Chinese users know that such features are outstanding and exclusive, while in comparison with safety in energy usage and practicality in intelligent application, they show a relatively conservative attitude towards these features.

As the conservative evaluation criteria narrows the scope of indifferent attribute, most of indifferent features by original criteria have become attractive features. While there are still four features remaining indifferent: UXI4 (autonomous driving in the city), UXI6 (gamification features), UXI8 (unique avatar), and UXI10 (engine sound simulator). Thus, these four UX features are the least attractive features on performance BEVs for Chinese users. Considering the consistency, the prioritization will not refer to the conservative results.

Table 4.5 Kano model results by occurrence frequency according to conservative evaluation criteria

Dimensions	**Functions**	**O (%)**	**A (%)**	**M (%)**	**I (%)**	**R (%)**	**Q (%)**	**Kano Category**
UX in the car	UXI1	20.6%	**26.1%**	7.6%	21.2%	3.3%	21.2%	A
	UXI2	16.5%	**25.7%**	7.8%	25.0%	4.2%	20.7%	A
	UXI3	17.3%	**25.3%**	5.2%	19.1%	11.4%	21.7%	A
	UXI4	16.9%	25.0%	5.2%	**27.4%**	4.9%	20.6%	I
	UXI5	16.8%	**31.5%**	5.7%	20.1%	5.3%	20.6%	A
	UXI6	10.2%	26.9%	3.6%	**32.3%**	4.8%	22.2%	I
	UXI7	14.9%	**26.8%**	3.7%	22.2%	9.8%	22.6%	A
	UXI8	14.3%	25.3%	3.6%	**30.1%**	6.4%	20.4%	I
	UXI9	15.1%	**28.3%**	5.8%	23.0%	6.7%	21.1%	A
	UXI10	11.5%	25.8%	2.9%	**26.0%**	8.1%	25.7%	I
	UXI11	21.2%	**26.8%**	5.1%	16.6%	9.3%	21.0%	A
	UXI12	16.1%	**28.3%**	6.1%	17.8%	5.0%	26.7%	A
	UXI13	10.2%	**27.4%**	2.9%	29.2%	9.3%	21.1%	A
	UXI14	17.8%	**26.5%**	5.6%	24.3%	6.7%	19.1%	A
	UXI15	14.8%	**28.9%**	5.6%	23.9%	7.4%	19.5%	A
	UXI16	20.2%	**30.2%**	4.8%	18.4%	7.4%	18.9%	A
UX around the car	UXA1	20.1%	**25.9%**	7.1%	15.1%	11.5%	20.4%	A
	UXA2	19.1%	**26.2%**	6.0%	21.5%	7.1%	20.2%	A
	UXA3	19.1%	**24.0%**	6.4%	20.3%	10.7%	19.5%	A
	UXA4	**25.5%**	21.1%	7.0%	15.4%	10.4%	20.6%	O
	UXA5	18.2%	**25.5%**	5.7%	18.3%	10.5%	21.7%	A
	UXA6	17.7%	**29.2%**	5.4%	18.1%	5.9%	23.7%	A
	UXA7	11.3%	**30.1%**	3.8%	24.4%	9.5%	20.9%	A
	UXA8	19.2%	**27.6%**	5.0%	17.2%	12.1%	18.8%	A
UX beyond the car	UXB1	17.4%	**27.3%**	5.3%	20.2%	5.7%	24.0%	A
	UXB2	16.4%	**29.7%**	4.8%	22.3%	7.5%	19.3%	A
	UXB3	16.4%	**28.0%**	3.6%	26.9%	4.9%	20.2%	A
	UXB4	14.9%	**27.1%**	3.7%	26.7%	10.5%	17.1%	A
	UXB5	15.8%	**29.1%**	4.8%	22.4%	10.5%	17.4%	A
	UXB6	16.4%	**26.4%**	5.3%	23.6%	11.2%	17.1%	A
	UXB7	14.8%	**28.1%**	3.8%	24.8%	7.9%	20.5%	A
	UXB8	13.3%	**28.7%**	4.3%	23.2%	12.3%	18.1%	A
	UXB9	15.7%	**26.7%**	3.9%	24.4%	9.6%	19.8%	A
	UXB10	16.4%	**32.5%**	3.6%	21.0%	6.4%	20.0%	A

O: One-dimensional; A: Attractive; M: Must-be; I: Indifferent; R: Reverse; Q: Questionable.

4.4 Prioritization by satisfaction and dissatisfaction indexes

Since it is necessary to prioritize the UX features with the same attributes, while some attributes have similar attribute occurrence frequency, satisfaction and dissatisfaction indexes have been used for more detailed prioritization (Shin et al. 2022; Lu, Lu, and Chen 2022). According to Eq. 2.2 and Eq. 2.3, satisfaction and dissatisfaction indexes of each UX feature can be calculated. For example, UXA4 (longer battery warranty) has 329 responses as one-dimentional, 272 responses as attractive, 90 responses as must-be, 288 responses as indifferent, 134 responses as reverse, and 177 responses as questionable, the SI of UXA4 is calculated by 0.614 = (329 + 272) / (329 + 272 + 90 + 288).

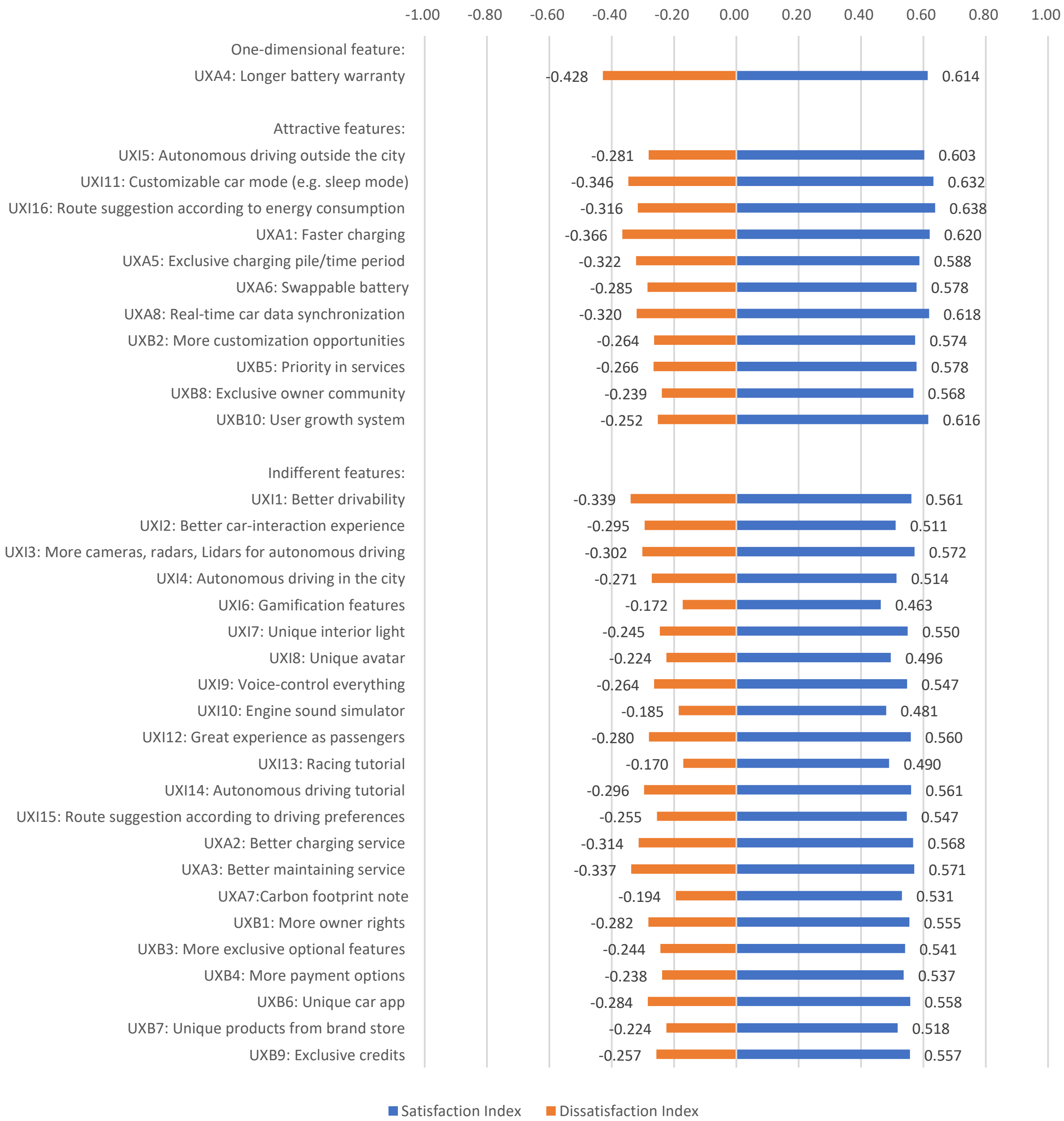


Figure 4.1 SI and DI distribution of UX features on performance BEVs

As Figure 4.1 show, the SI for performance BEVs UX features ranges from 0.638 to 0.463, with an average of 0.561; the DI for performance BEVs UX features ranges from -0.172 to -0.428, with an average of -0.278. Since the absolute value of average SI is closer to 1 than the absolute value of average DI, Chinese users are generally satisfied with the listed UX features on performance BEVs. Specifically, the only one-dimensional feature UXA4 (longer battery warranty) has the largest absolute value of DI. Among the eleven attractive features, the SI values of all of the these features are higher than the average, while DI values of all the UX features beyond the car are lower than the average. The indexes distribution of indifferent features are various, but the three features with the lowest SI value and the lowest DI value are the same.

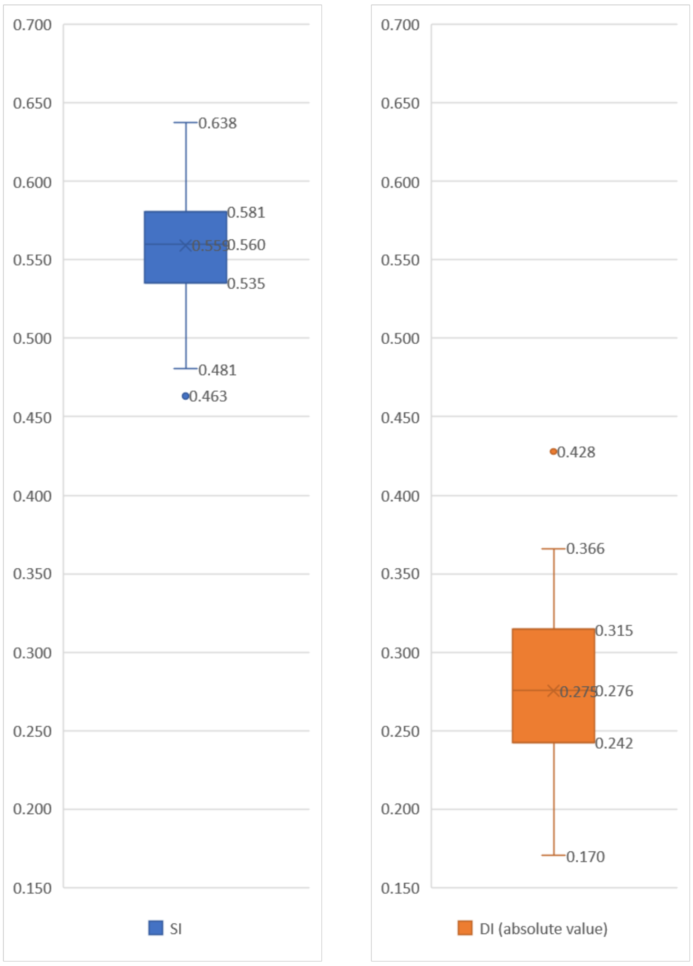


Figure 4.2 Box plot of SI and DI

In terms of the SI, there are eight UX features with SI higher than the upper quartile value (0.583) from Figure 4.2: route recommendation according to energy consumption (0.638), customizable car mode (e.g. sleep mode) (0.632), faster charging (0.620), real-time car data synchronization (0.618), user growth system (0.616), longer battery warranty (0.614), autonomous driving outside the city (0.603), and exclusive charging pile/time period (0.588). The implementation of items with an SI value closer to 1 can more significantly improve user satisfaction. Therefore, these eight UX features should be given priority to improve user satisfaction.

In terms of the DI, there are eight UX features with DI absolute value higher than the upper quartile absolute value (0.315) from Figure 4.3: longer battery warranty (0.428), faster charging (0.366), customizable car mode (e.g. sleep mode) (0.346), better drivability (0.339), better maintaining service (0.337), exclusive charging pile/time period (0.322), real-time car data synchronization (0.320), and route recommendation according to energy consumption (0.316). Not implementing items with a DI absolute value closer to 1 can more significantly reduce user satisfaction. Therefore, these eight UX featuresshould be given priority by OEMs to avoid a negative impact on user satisfaction. Specifically, considering the negativity bias in consumer adoption of technology, UX features with larger DI absolute values should be more prioritized (Frank, Chrysochou, and Mitkidis 2023).

Therefore, the UX features on performance BEVs can be prioritized as follow: the only one-dimensional feature UXA4 (longer battery warranty) undoubtedly has the highest priority among all features. OEMs should give it the highest priority in their performance BEV design and development processes. UXA4 also has the largest DI absolute value, indicating the lack of longer battery warranty for performance BEVs may cause the most dissatisfaction among all of the UX features.

Among the 11 attractive features, the highest priority should be given to UX features with larger DI absolute values. Therefore, two UX in the car and three UX around the car with DI absolute value larger than upper quartile DI absolute value are Tier1 features in attractive attibutes, i.e., UXI11 (Customizable car mode (e.g. sleep mode)), UXI16 (Route recommendation according to energy consumption), UXA1 (Faster charging), UXA5 (Exclusive charging pile/time period), UXA8 (Real-time car data synchronization). Specifically, UXI11 and UXI16 have the top two SI value among all the UX features, indicating the implementation of these features can significantly improve users' satisfaction on performance BEVs. For UX beyond the car which has not been mentioned before, only UXB10 (user growth system) has the SI value larger than the upper quartile SI value. It is worthy to be prioritized since implementation of UXB10 can significantly improve performance BEVs users' satisfaction.

For the rest 22 indifferent features, there is less necessity to focus on them since indifferent features are not currently expected by users, or are without clear preferences whether it is fulfilled based on users' current cognition. However, there are two indifferent features with DI absolute value larger than upper quartile DI absolute value: UXI1 (better drivability) and UXA3 (better maintaining service). These two indifferent features can be treated as exemptions and need to be focused on, since the lack of these two features may cause obvious dissatisfaction among users.

4.5 Summary

As a technology product that has been launched and is continuously iterating, the user acceptance of a performance BEV is affected by the user satisfaction of its features. This chapter uses the Kano model to analyse Chinese users' satisfaction with 34 UX features in, around, and beyond the performance BEVs. The result classifies and prioritizes these features according to the Kano category, and answers the first research sub-question:

- *What UX features in, around, and beyond the performance BEVs would make them attractive to purchase and use?*

Since the development of performance BEVs is still in a nascent development stage, there are no Must-be features for performance BEVs to Chinese users yet according to the Kano model. The only 1 one-dimensional UX feature (longer battery warranty) is the most important feature on performance BEVs for Chinese users. According to the evaluation criteria, 11 features are attrative and 22 features are indifferent. 5 of 11 attractive features with larger DI value (customizable car mode (e.g. sleep mode), route recommendation according to energy consumption, faster charging, exclusive charging pile/time period, and real-time car data synchronization) are considered as key features as the lack of these features will cause users' dissatisfaction more significantly. 2 of 22 indifferent features (better drivability and better maintaining service)can be treated as exemptions and need to be taken seriously, because they may also cause obvious dissatisfaction if they are not implemented on performance BEVs. Since there are no UX beyond the car discussed before, the attractive feature user growth system is the most worthy of implementation among the UX features beyond the car. It has the SI value larger than upper quartile value, thus, performance BEVs with user growth system can significantly improve users' satisfaction.

It is worth noting that the Kano model evaluation criteria used in this study are original from KANO et al. (1984). Even though previous studies on applications in EVs applied the original criteria, there may still be bias by this model due to wide classification of indifferent attribute (Shin et al. 2022; Steckhan, Spiessl, and Bengler 2023; Dash 2019). The results of Kano model is more suitable as supplement of UTAUT2 model in identifying changes in technology acceptance or satisfaction. Specifically, the UX features related to battery quality, charging efficiency, and data synchronization are highly expected by Chinese users, which are related to measured items of facilities conditions and concern-free experience.

Chapter 5: User Acceptance Results

Following the previous chapter, this chapter continues to analyse results derived from the survey, including both psychological and socio-demographic factors in user acceptance towards performance BEVs in urban mobility. The first part demonstrates reliability and validity analysis of collected data by CFA. The second part consists of structural equation modelling results and hypotheses testing results. The third part consists of a summary of the empirical findings and statistical difficulties. At the end of this chapter, the second sub-question is answered by the analysis results:

- *What psychological and socio-demographic factors would affect users most when purchasing performance BEVs for use in urban mobility?*

5.1 Item statistics

The descriptive statistics of the items are shown in Table 5.1, including the mean, standard deviation, skewness, kurtosis, and construct average. The means of all the items are around four, which deviates slightly from the median level of the five-Likert scale. All standard deviations are positive and around one, therefore the responses for items are heterogenous. The skewness values are negative, and the kurtosis values are positive, suggesting that the distributions are left-skewed and exhibit heavy tails. Consequently, the measured items demonstrate a heterogeneous and asymmetric distribution with a notable frequency of extreme values. In general, all the items display sufficient variation to perform CFA.

Table 5.1 Item statistics of UTAUT model construct

Construct	Item	Mean	St. Dev.	Skewness	Kurtosis	Constr. Ave.
Performance	PE1	4.330	0.786	-1.029	0.790	4.256
Expectancy	PE2	4.148	0.851	-0.817	0.383	
	PE3	4.241	0.791	-0.993	1.189	
	PE4	4.306	0.763	-1.031	1.236	
Social Influence	SI1	4.113	0.929	-0.884	0.443	4.096
	SI2	4.043	0.980	-0.937	0.482	
	SI3	4.141	0.895	-1.087	1.266	
	SI4	4.088	0.936	-0.954	0.686	
Facilitating	FC1	4.067	0.983	-0.972	0.525	4.073
Conditions	FC2	4.083	0.949	-1.012	0.725	
	FC3	4.070	0.992	-1.003	0.633	
Prive Value	PV1	4.119	0.932	-1.100	1.055	4.185
	PV2	4.248	0.816	-1.059	1.200	
	PV3	4.257	0.825	-1.170	1.574	
	PV4	4.117	0.911	-1.017	0.972	
Concern-free	CE1	4.250	0.842	-1.116	1.204	4.159
Experience	CE2	4.036	0.950	-0.746	0.030	
	CE3	4.263	0.791	-1.144	1.682	
	CE4	4.086	0.943	-0.873	0.298	
Vanity	VA1	4.130	0.938	-1.069	0.944	3.998
	VA2	3.988	1.000	-0.975	0.609	
	VA3	3.958	1.065	-0.951	0.397	
	VA4	3.916	1.083	-0.973	0.403	
Behavioural	BI1	4.278	0.868	-1.368	2.099	4.085
Intention	BI2	4.019	1.015	-0.912	0.290	
	BI3	4.018	1.024	-1.022	0.654	
	BI4	4.026	0.967	-0.882	0.442	

(St. Dev.: standard deviation, Constr. Avg.: average of the construct)

5.2 Reliability and validity analysis

Table 5.2 Reliability and validity analysis of UTAUT2 model construct

Construct	Item	Factor loadings	Cronbach's alpha	CR	AVE
Performance Expectancy	PE1	0.728	0.705	0.710	0.451
	PE2	0.649			
	PE3	dropped			
	PE4	0.633			
Social Influence	SI1	0.766	0.818	0.819	0.531
	SI2	0.695			
	SI3	0.704			
	SI4	0.747			
Facilitating Conditions	FC1	0.741	0.788	0.789	0.554
	FC2	0.725			
	FC3	0.767			
Prive Value	PV1	0.693	0.741	0.743	0.491
	PV2	dropped			
	PV3	0.672			
	PV4	0.735			
Concern-free Experience	CE1	0.704	0.754	0.778	0.539
	CE2	0.727			
	CE3	dropped			
	CE4	0.769			
Vanity	VA1	0.797	0.853	0.855	0.595
	VA2	0.758			
	VA3	0.776			
	VA4	0.755			
Behavioural Intention	BI1	0.705	0.815	0.812	0.519
	BI2	0.733			
	BI3	0.699			
	BI4	0.744			

(CR: Composite Reliability, AVE: Average Variance Extracted)

The CFA results of the UTAUT2 model are shown in Table 5.2, in which factor loadings of each item, Cronbach's alpha, Composite Reliability (CR), and Average Variance Extracted (AVE) are applied. To ensure good reliability, the items with factor loading below 0.63 should be dropped (Comrey and Lee 1992; Tabachnick, Fidell, and Ullman 2013). Therefore, the CFA is finally conducted without items PE3, PV2, and CE3 to test the fitness of the data. According to previous studies, Cronbach's alpha and CR should both exceed 0.7, and AVE should exceed 0.5, but it can be acceptable if it exceeds 0.38 while the composite reliability is above the recommended level as the AVE is a more conservative estimate of the validity (Anderson and Gerbing 1988; Fornell and Larcker 1981; Hair 2009; Lam 2012). As all measures are within the above-suggested range, the reliability and validity of constructs are confirmed. Finally, the goodness-of-fit of the model is evaluated. Regarding to the previous studies, the recommended values for each index to ensure good model fitting are as follows: Comparative Fit Index (CFI), Goodness-of-Fit Index (GFI), Tucker-Lewis Index (TLI) should all exceed 0.90, Root Mean Square Error of Approximation (RMSEA) should not exceed 0.06, Standardized Root Mean Square Residual (SRMR) should not exceed 0.05. The final CFA results show that the proposed model fits the data with acceptable goodness-of-fit (CFI = 0.940, GFI = 0.921, TLI = 0.926, RMSEA = 0.060, SRMR = 0.031) (P. M. Bentler 1990; Peter M. Bentler and Bonett 1980; Cho et al. 2020; Hu and Bentler 1999; Jöreskog and Sörbom 1989; Marsh, Hau, and Wen 2004; Tucker and Lewis 1973).

5.3 Structural Equation Modelling (SEM) results

As this study adds two new constructs (Concern-free Experience and Vanity) into the proposed model, three cumulative models will be applied in order to observe the impact of the newly added constructs following the study design of Curtale, Liao, and Van Der Waerden (2021). Model 1 only investigates the relations between four original UTAUT2 constructs (performance expectancy, social influence, facilitating conditions, and price value) and behavioural intention. Model 2 introduces two new constructs (Concern-free Experience and Vanity) and investigates the relations between all the psychological factors and behavioural intention. Model 3 further adds the socio-demographic factors. Table 5.3 reports the regression results of three cumulative models on the impacts of explanatory variables on behavioural intention.

Table 5.3 Regression results of SEM – relations to behavioural intention

Dependent Variable	**Model 1**		**Model 2**		**Model 3**	
	β	p-value	β	p-value	β	p-value
Performance Expectancy	0.194***	0.002	0.390***	<0.001	0.424***	<0.001
Social Influence	0.409***	<0.001	-0.002	0.987	-0.055	0.720
Facilitating Conditions	0.253***	0.001	0.400***	<0.001	0.407***	<0.001
Price Value	0.162	0.223	0.159	0.269	0.172	0.268
Concern-free Experience			0.259***	<0.001	0.322***	<0.001
Vanity			0.401***	<0.001	0.426***	<0.001
Gender (male)					-0.030	0.126
Age (below 35)					-0.017	0.422
Car Ownership (2 or more cars)					0.072***	<0.001
Income (above 10k CNY/month net)					0.025	0.232
Education (university bachelor degree or higher)					-0.001	0.962
Residence Level (Tier 1 cities and New Tier 1 cities)					-0.026	0.212
R-square	0.937		0.973		0.977	

***: p-value < 0.01; **: p-value < 0.05; *: p-value < 0.10.

Note: Texts in the parethesis for each socio-demographic factors represent the controlled conditions, e.g., negative result in Gender (male) represents

Model 1 explains 93.7% of the variability in purchasing behavioural intention towards performance BEVs in urban mobility. Social Influence is the strongest predictor of behavioural intention (coefficient of the path from social influence to behavioural intention (β) = 0.409, p-value (p) < 0.001), followed by Facilitating Conditions (β

= 0.253, p = 0.001) and Performance Expectancy (β = 0.194, p = 0.002). While Price Value (β = 0.162, p = 0.223) does not have a significant impact on behavioural intention.

In model 2, the variability of behavioural intention is increased and explained for 97.3% by the combination of four original UTAUT2 psychological factors and the addition of Concern-free Experience and Vanity. Vanity becomes the strongest predictor of behavioural intention (β = 0.401, p < 0.001), followed by Facilitating Conditions (β = 0.400, p < 0.001), Performance Expectancy (β = 0.390, p < 0.001), and Concern-free Experience (β = 0.259, p < 0.001). However, Social Influence (β = -0.002, p = 0.987) as the strongest predictor in Model 1 does not show a significant impact on behavioural intention in Model 2. Price Value (β = 0.159, p = 0.269) remains insignificant to behavioural intention.

The results of model 3 show that model 3 explains more of the variability compared to model 1 and 2 and up to 97.7% after adding socio-demographic factors. For psychological factors, Vanity remains the strongest predictor of behavioural intention (β = 0.426, p < 0.001), followed by performance expectancy (β = 0.424, p < 0.001), Facilitating Conditions (β = 0.407, p < 0.001), and Concern-free Experience (β = 0.322, p < 0.001). Social Influence (β = -0.055, p = 0.720) and Price Value (β = 0.172, p = 0.268) remain insignificant. The results of psychological factors in Model 3 show that the relations between psychological factors and behavioural intention towards performance BEVs adoption become steady. For socio-demographic factors, only Car Ownership (β = 0.072, p< 0.001) has a significant positive direct effect on behavioural intention. None of the other socio-demographic factors have significant relevance to behavioural intention, including Gender (β = -0.030, p = 0.126), Age (β = -0.017, p = 0.422), Income (β = 0.025, p = 0.232), Education (β = -0.001, p = 0.962), and Residence Level (β = -0.026, p = 0.212).

Even though not many socio-demographic factors have direct effects to behavioural intention, they still have indirect effects mediated by the other psychological factors. As reported in Table 5.4 and Table 5.5, every socio-demographic factor has certain effect to behavioural intention in relations to psychological factors, thereby indirectly affecting the total effect. Specifically, males have negative effects on performance expectancy, social influence, price value, and vanity, while they have positive effects on concern-free experience. Young people have positive effects on performance expectancy and vanity. Users who owner two or more cars have negative effects on performance expectancy, price value, and vanity. High-income people have positive effects on performance expectancy, social influence, facilitating conditions, and vanity, while they have negative effects on concern-free experience. Highly educated people have positive effects on price value. And users living in developed Chinese cities (top 19 tier 1 and new tier 1 cities) have negative effects on performance expectancy, social influence, facilitating conditions, price value, and vanity, while they have positive effects on concern-free experience. The detailed diagrammatic results including direct effects and indirect effects are shown in Figure 5.1. The total effects of socio-demographic factors are the sum of the direct effects and the effects mediated by other constructs. The final regression results of the direct and total effects of socio-demographic factors are reported in Table 5.6.

Table 5.4 Regression results of SEM – effects on psychological factors (PE, SI, FC)

Variables	**PE**		**SI**		**FC**	
	β	p-value	β	p-value	β	p-value
Gender (male)	-0.056*	0.092	-0.054*	0.081	-0.043	0.174
Age (below 35)	0.121***	<0.001	0.049	0.125	0.046	0.161
Car Ownership (2 or more cars)	-0.069**	0.039	-0.035	0.252	-0.052	0.101
Income (above 10k CNY/month net)	0.069*	0.057	0.084**	0.012	0.093***	0.007
Education (university bachelor degree or higher)	-0.010	0.772	0.017	0.600	-0.013	0.704
Residence Level (Tier 1 cities and New Tier 1 cities)	-0.082**	0.013	-0.149***	<0.001	-0.081**	0.011

***: p-value < 0.01; **: p-value < 0.05; *: p-value < 0.10.

PE: performance expectancy; SI: Social Influence; FC: Facilitating Conditions.

Table 5.5 Regression results of SEM – effects on psychological factors (PV, CE, VA)

Variables	**PV**		**CE**		**VA**	
	β	p-value	β	p-value	β	p-value
Gender (male)	-0.065**	0.048	0.105***	<0.001	-0.057*	0.061
Age (below 35)	0.044	0.193	-0.031	0.341	0.054*	0.082
Car Ownership (2 or more cars)	-0.055*	0.093	0.042	0.179	-0.074**	0.014
Income (above 10k CNY/month net)	0.056	0.114	-0.078**	0.023	0.099***	0.003
Education (university bachelor degree or higher)	0.064*	0.062	0.032	0.326	-0.018	0.572
Residence Level (Tier 1 cities and New Tier 1 cities)	-0.096***	0.003	0.095***	0.003	-0.096***	0.002

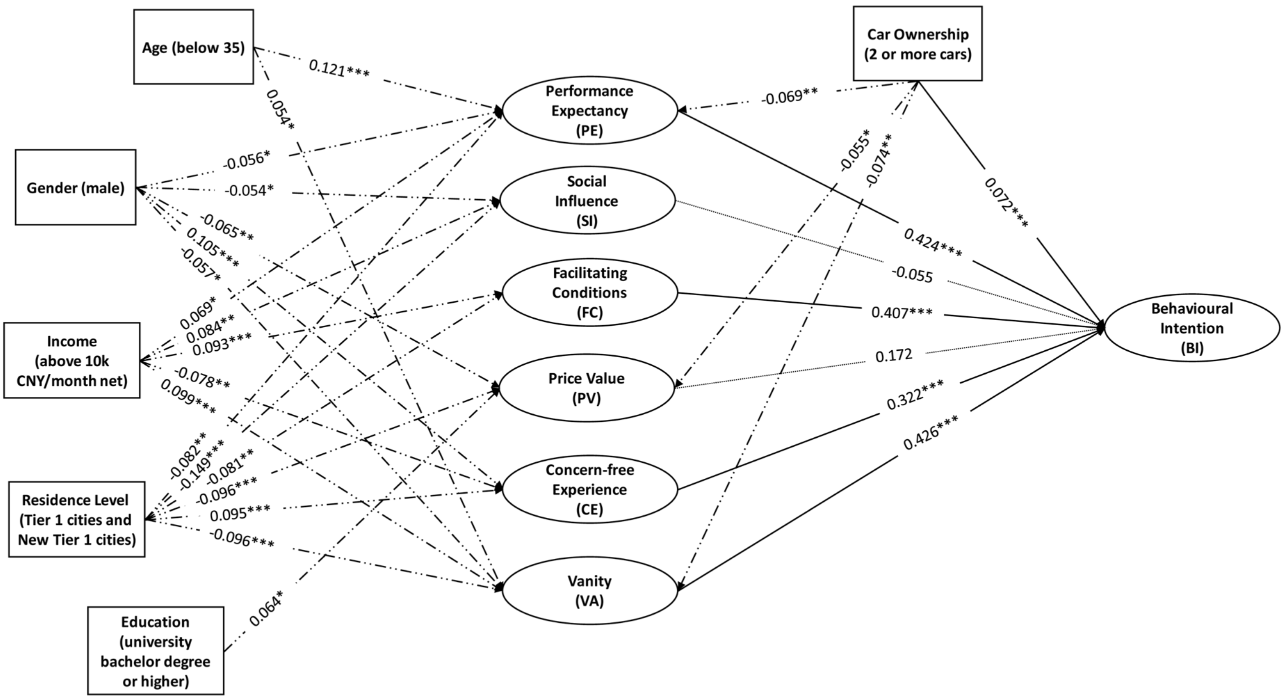
***: p-value < 0.01; **: p-value < 0.05; *: p-value < 0.10.

PV: Prive Value; CE: Concern-free Experience; VA: Vanity.

Table 5.6 Regression results of SEM – direct and total effects of socio-demographic factors on behavioural intention

Variables	**Behavioural Intention**			
	Direct effect		**Total effect (direct + indirect)**	
	β	p-value	β	p-value
Gender (male)	-0.030	0.126	-0.070**	0.026
Age (below 35)	-0.017	0.422	0.070**	0.042
Car Ownership (2 or more cars)	0.072***	<0.001	-0.003	0.919
Income (above 10k CNY/month net)	0.025	0.232	0.115***	0.001
Education (university bachelor degree or higher)	-0.001	0.962	0.002	0.929
Residence Level (Tier 1 cities and New Tier 1 cities)	-0.026	0.212	-0.113***	0.001

***: p-value < 0.01; **: p-value < 0.05; *: p-value < 0.10.



Note: ***: p-value < 0.01; **: p-value < 0.05; *: p-value < 0.10. Solid lines represent direct effects, dashed lines represent indirect effects, and dotted lines represent insignificant effects.

Figure 5.1 Diagrammatic results of direct and indirect effects of UTAUT2 model constructs

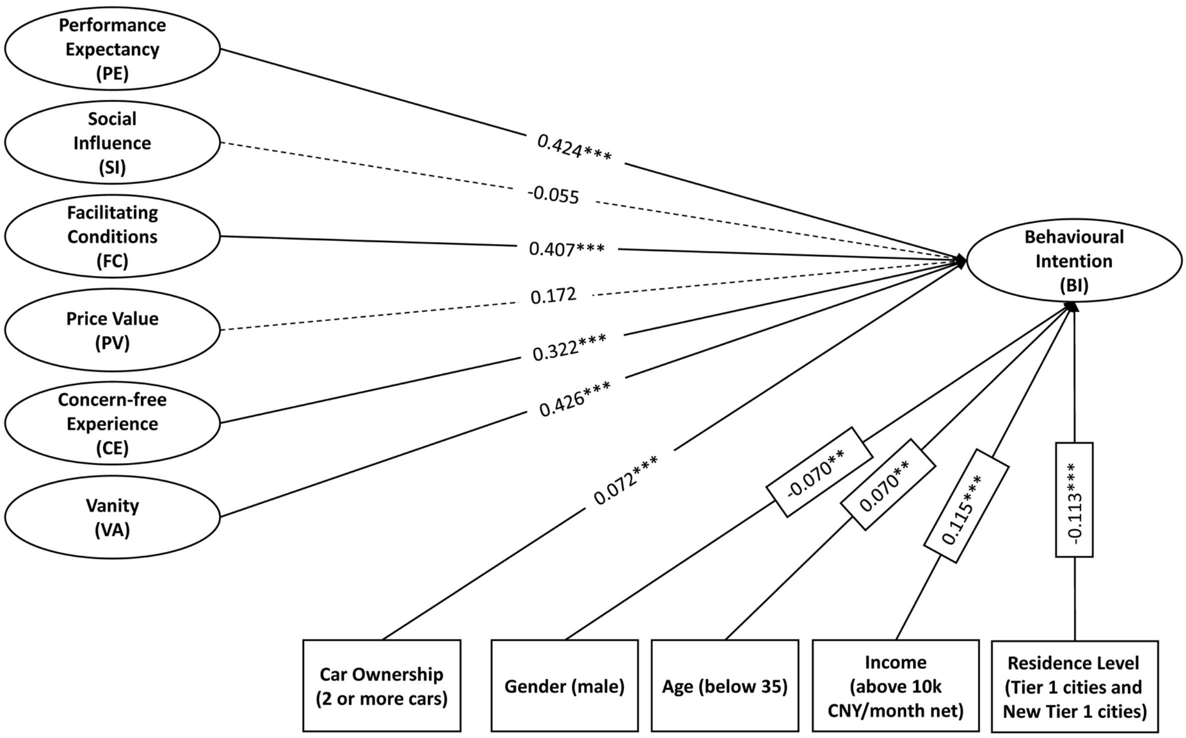
The regression results finally test the previously proposed hypotheses. As shown in Table 5.7 hypotheses 1a, 1c, 2a, 2b, 3c of the conceptual framework are supported by the direct effects on behavioural intention; hypothesis 3a, 3b, 3d, 3f is supported the total effects on behavioural intention; hypotheses 1b, 1d, 3e are rejected.

To summarise, vanity, performance expectancy, facilitating conditions, and concern-free experience are the four psychological (psychological) factors that have significant impacts on behavioural intention in the UTAUT2 model. Social influence and price value do not explicitly significantly impact on behavioural intention, thus these two constructs also do not have mediating effects on socio-demographic factors. Considering the indirect effects of socio-demographic factors, gender, age, income, and residence Level are the four socio-demographic factors that have significant impacts on behavioural intention. Car Ownership has high significance only in direct effect on behavioural intention, while showing no relevance in total effect. This may be because owning more than 2 cars will promote users to purchase performance BEVs, but it has significant negative effect on the top two psychological factors of purchasing behavioral intention (performance expectancy and vanity). Finally, significant direct effects and total effects on behavioural intention are diagrammatically shown in Figure 5.2.

Table 5.7 Summary of hypothesis testing

Hypothesis	Path	Proposed effect	β and significance by direct effect	β and significance by total effect	Result
H1a	PE → BI	+	0.424***	0.424***	Supported
H1b	SI → BI	+	-0.055	-0.055	Rejected
H1c	FC → BI	+	0.407***	0.407***	Supported
H1d	PV → BI	+	0.172	0.172	Rejected
H2a	CE → BI	+	0.322***	0.322***	Supported
H2b	VA → BI	+	0.426***	0.426***	Supported
H3a	Gender (males) → BI	Sig. + or -	-0.030	-0.070**	Supported
H3b	Age (young) → BI	Sig. + or -	-0.017	0.070**	Supported
H3c	Car Ownership (2 or more cars) → BI	Sig. + or -	0.072***	-0.003	Supported
H3d	Income (high) → BI	Sig. + or -	0.025	0.115***	Supported
H3e	Education (high) → BI	Sig. + or -	-0.001	0.002	Rejected
H3f	Residence Level (developed cities) → BI	Sig. + or -	-0.026	-0.113***	Supported

***: p-value < 0.01; **: p-value < 0.05; *: p-value < 0.10; sig.: significant.



Note: ***: p-value < 0.01; **: p-value < 0.05; *: p-value < 0.10. Values without rectangle represent direct effects, values in the rectangle represent total effects.

Figure 5.2 Diagrammatic results of direct and total effects of UTAUT2 model constructs

5.4 Empirical findings

With the modification of the UTAUT2 model according to the context of performance BEVs and urban mobility, this study provides novel insights into the purchasing intention and user acceptance of performance BEVs. According to the regression results of SEM combined with the analysis results of the Kano model in Chapter 4, some empirical findings are discussed below.

The role of psychological variables

As an advanced product of BEV, performance BEV is becoming an option for more and more users when purchasing BEVs for urban mobility. This study reveals that Chinese users show acceptance of performance BEVs in urban mobility psychologically.

Amongst all the psychological variables, vanity is the most important factor affecting purchasing behavioural intention. As the attribute of vanity has two aspects of considerations: physical appearance and social status, driving a performance BEV in the city makes Chinese users think they are in a better appearance and more accomplished with a higher social status (Ali et al. 2019; Kasser 2003; Richins 2004). Since vanity is also one of the vital attibutes in purchasing petrol performance cars, performance BEVs can be alternatives for users who want to purchase performance cars (Adityawarman and Purwanegara 2014; Aditama 2015).

Performance Expectancy almost has the same effects as Vanity in positively affecting purchasing behavioural intention. Within this study, the “performance” of performance BEVs does not only refer to better driving experience in acceleration and controllability , but also refers to the balance between daily use convenience and sporty driving pleasure and driving enhancement by autonomous driving and connectivity. The high expectation on performance implies the open mind of Chinese users towards the application of ACES transitions, e.g., autonomous driving and C-ITS, to be on board. Meanwhile, Chinese users have not given up their pursuit of the driving performance of performance BEVs (Autohome Research Institute 2022; Roland Berger and Autohome Research Institute 2023; Wang, Ozden, and Tsang 2023; Yu et al. 2023; Zhou et al. 2021).

Facilitating Conditions is the third important factor affecting purchasing behavioural intention. It is also consistent with the analysis results in the Kano model. Performance BEVs need to not only be equipped with fast charging, but also be able to adapt to as many fast charging stations as possible. Chinese users also highly value the battery technology and easy maintenance when purchasing performance BEVs. Performance BEVs with longer warranty batteries, better maintenance service, and faster charging speed will have higher acceptance among Chinese users and generate stronger purchase intentions. This result confirms the previous findings in academia and industry (Autohome Research Institute 2023b; Deloitte 2023; Higueras-Castillo et al. 2023; Karpurapu and Venkata Raghuram 2024; Singh et al. 2023; Zhou et al. 2021).

Concern-free Experience also positively affects purchasing behavioural intention. Previous studies mainly provide evidence for the positive impact of Concern-free Experience on BEV sharing services. This study finds that it can be extended to purchasing intention on performance BEVs (Curtale, Liao, and Van Der Waerden 2021; Yu et al. 2023). Because the assistance of intelligent and connective features also reduces the concerns in both daily driving and sporty driving, performance BEVs equipped with longer lasting batteries and safer driving assistant system will be more accepted by Chinese buyers.

Social Influence and Price Value do not explicitly significantly affect purchasing behavioural intention of performance BEVs in China. The low relevance of Social Influence towards BEVs has been demonstrated in past studies mainly in regions with large populations like China and India (Bhat, Verma, and Verma 2021; Jain, Bhaskar, and Jain 2022; Yu et al. 2023; Zhou et al. 2021) but not in the Netherlands, Germany, and other European countries (Curtale, Liao, and Rebalski 2022; Nordhoff et al. 2020; Kapser and Abdelrahman 2020). One of the possible reasons is that the car purchasing habits in China are different from other regions. Chinese users are more willing to listen to reviews from owners of their intended cars in automotive forums than from their friends or family (Autohome Research Institute 2023c). However, the measured items in social influence construct come from the original study by Venkatesh et al. (2003), which rely more on the respondents' friends, families, and colleagues, rather than the current users. The effects of Price Value on adoption of BEVs are not consistent. The result confirms findings in some previous studies (Korkmaz et al. 2021; Manutworakit and Choocharukul 2022). Price Value has, expectedly, low impacts on luxury products with high vanity values because the value of luxury goods lies more in social status and material enjoyment rather than cost-effectiveness (Adityawarman and Purwanegara 2014; Ali et al. 2019; Gil-Cordero et al. 2023).

The role of socio-demographic characteristics

Since previous studies on the impact of socio-demographic characteristics on the adoption of BEVs had various results, this study made relatively open hypotheses: the six socio-demographic factors have effects on purchasing behavioural intention. After considering the indirect effects mediated by other psychological factors, the results of socio-demographic factors can establish a user profile of performance BEVs.

Gender (male) and Residence Level (Tier 1 cities and New Tier 1 cities) have negative effects on purchasing performance BEVs. It indicates that males and users living in Tier 1 and New Tier 1 cities (the 19 most developed cities in China) have less purchasing intention on performance BEVs in the context of urban mobility. The purchasing of performance BEVs is still considered as a compromise for family use when buying a performance car, especially for males (Autohome Research Institute 2022; Viola 2021). One reason for the relatively low interests for performance BEVs in more developed cities can be more road restrictions in developed urban area. The results of Kano model also indicates that autonomous driving on performance BEVs is more attractive outside the city.

Car-ownership (2 or more cars), age (below 35), and Income (above 10k CNY/month net) have positive effects on the behavioral intention of purchasing performance BEVs. It indicates that users with more cars, young adults, and users with higher incomes have more intention to purchase performance BEVs in the context of urban mobility. Although users have expectations for performance BEVs to have multiple uses, they still treat performance BEVs not as the perfect choices as their first choice when buying cars (Autohome Research Institute 2022). Young users, especially the Gen Z, are becoming the majority of car buyers in China. They have a high consumption preference for intelligent, green, and sustainable products (Chen, Li, and Yuan 2023; Guo and Luo 2023; Huang et al. 2022; Roland Berger and Autohome Research Institute 2023). This study confirms the popularity of performance BEVs representing intelligence and sustainability among young Chinese users. As performance BEVs have higher prices than normal BEVs, they are more accepted by high-income users.

Education does not have significant effects on purchasing behavioural intention directly. One of the reasons can be the survey differentiates education by whether the respondent have a university degree or not. Because although China's urban population has a relatively high level of education, the average proportion of the urban population with a university degree is only 15.47% (Central People’s Government of the PRC 2021). Further study in China may require more detailed segmentation of those who have not obtained university diplomas.

Practical implications

Considering the existence of performance BEVs in the current market, some practical implications can be formulated from the results. As a derivative and upgraded product of normal BEV, performance BEV carries users’ higher expectations for BEV. From the perspective of BEVs, concerns such as battery safety, full-battery range, and charging convenience on normal BEVs still exist on performance BEVs and are even amplified by users. In terms of product layout, performance BEVs belong to the luxurious version of normal BEVs and offer better experience around energy usage in order to allow users using performance BEVs more freely. The value of performance cars in improving personal physical image and social status is still reflected in performance BEVs. Although lacking the roar of engines, performance BEVs may catch the attention of passers-by in a newer way: more intelligent and connective features which are also more favoured by young Chinese consumers. As the user portrait of performance BEVs users in China seems to be young urbanites not living in the top 19 tier one and new tire one cities with high incomes. They expect their intended performance BEV can satisfy needs for daily travel, family use, and personal driving pleasure as much as possible.

Therefore, for OEMs, to increase the acceptance of performance BEVs and maintain their luxury appeal in the short term, they can focus on providing more reliable batteries, more convenient charging services, and more considerate energy usage experience services. Furthermore, compared with tapping the deeper potential of powertrain and drivability, increasing the car experience through intelligent and connective features like high-level ADAS and customizable modes in, around, and beyond the performance BEVs will bring more benefits to OEMs efficiently. However, excellent power and drivability performance are also essential characteristics of performance BEVs. Since the core feature of current performance BEVs on the market is still superior power performance to normal BEVs, users may not treat urban mobility as main applicable scenarios, and performance BEVs are even more limited by urban roads in developed cities.

For urban mobility policy-makers, to develop a more sustainable urban mobility environment, they can encourage performance BEVs with autonomous driving to optimize overall traffic flow. They can promote the use of performance BEVs by building more convenient fast charging stations and infrastructure for C-ITS to connect the connected performance BEVs. Although advanced features like autonomous driving, vehicle-road interconnection, and customizable modes are not standard features of performance BEVs like better driving experience in acceleration and controllability, with the enhancement of city infrastructure, performance BEVs will be able to serve more scenarios more comprehensively, especially in urban mobility, with the blessing of intelligence and connectivity.

5.5 Summary

As performance BEVs become more and more popular, they are gradually joining and affecting urban mobility. Young Chinese people show high acceptance towards performance BEVs, especially with the possible intelligent and connective features. This chapter applies the UTAUT2 model to investigate the effects on purchasing behavioural intention towards performance BEVs in urban mobility. The results answer the second research sub-questions proposed at the beginning:

- *What psychological and socio-demographic factors would affect users most when purchasing performance BEVs for use in urban mobility?*

Representing the combination of performance cars and BEVs, performance BEVs are accumulating a reputation among enthusiasts in both categories of cars. By testing the twelve hypotheses, the value of performance BEVs that Chinese users care about most can be formulated. Vanity as the top psychological factor indicates performance BEVs hold the users' expectation for a luxurious image. The purchasing behavioural intention on performance BEVs comes from the satisfactory in physical appearance and social status brought by performance BEVs. Performance expectancy, facilitating conditions, and concern-free experience are also highly valued attributes for performance BEVs. The advanced BEVs are not only expected on premium driving experience, but more on the general concerns on normal BEVs, such as battery loss, range anxiety, and energy replenishment issues. For socio-demographic characteristics, females and young people have more acceptance towards performance BEVs. A high income level and more car ownership will also encourage users to purchase performance BEVs. Considering heavy congestion and strict restrictions in the top 19 developed cities, performance BEVs are more accepted in Chinese developing cities for urban mobility.

Chapter 6: Conclusions and Discussions

This chapter concludes the results of this thesis, advises stakeholders, and discusses limitations and future work. The thesis focuses on the main research question proposed at the beginning and answered in this chapter:

- ***What kind of performance BEVs are recognized, accepted, and willing to be used by Chinese users in urban mobility?***

6.1 Conclusions

In the context of urban mobility transitions, cars are encouraged to be driven by electricity. BEVs are playing an important role in future urban mobility. As either a continuation of performance petrol cars or a premium version of normal BEVs, performance BEVs have the potential to become popular among the public. However, performance BEVs is a niche branch of EVs, there is currently a lack of studies investigating the psychological factors driving the purchasing of performance BEVs, especially with the background of ACES transitions in the automotive industry. This study provides empirical evidence on what kind of performance BEVs are accepted and willing to be used by Chiense users in urban mobility. By combining the Kano model and UTAUT2 model, this study firstly measured users' satisfaction of current and in-development UX features of performance BEVs, then revealed the psychological and socio-demographic factors influencing individuals' intention to purchase performance BEVs. The sample of both models is from representative users of BEVs and performance cars in China's largest automotive forum. The results of the Kano model reveal user experience satisfaction with current features on performance BEVs in three dimensions: in the car, around the car, and beyond the car. The results from the UTAUT2 model show that the psychological factors of the original UTAUT2, the newly added factors, and socio-demographic characteristics are all vital influencers of purchasing behavioural intention. These two results are combined to answer the main research question of this thesis from both the product and user perspectives.

The overall results show that performance BEVs still remain attractive while holding different concerns with performance cars by users in China. Performance BEVs are expected to have premium experience compared with normal BEVs, especially in the context of charging services, battery life, and recharge mileage. The top concerns regarding BEVs are related to energy usage and, in a Chines context, these concerns also apply to performance BEVs. Specifically, longer battery warranty, faster charging, exclusive charging time or piles, and route recommendation according to energy usage would encourage the intention to purchase performance BEVs. Besides, more intelligent and connective features can also be incentives toward Chinese users considering performance BEVs, such as real-time car data synchronization and autonomous driving outside the city. Better drivability is still essential to performance BEVs but no longer the only feature getting users' attention. Electrically driven powertrains come with more accessible dynamic performance but also new issues like range anxiety and long charging time. An appealing performance BEV must comprehensively exploit strengths and avoid weaknesses.

The results of the Kano model also support the conclusions from the UTAUT2 model. From the perspective of user psychology, performance BEVs are more like luxury options for normal BEVs. Users buy the luxury version for more advanced features like fast charging and ADAS, the superior performance by multi-motor and four-wheel drive is more like a bonus. In the context of urban mobility, there are seldom use cases for outperforming performance, while Chinese users still highly accept performance BEVs in the city for interesting reasons. Specifically, Vanity is found as the most important anticipator of intention to purchase performance BEVs for urban mobility scenarios, followed by performance expectancy, Facilitating Conditions, and Concern-free Experience. While Social Influence and Price Value are found irrelevant to purchasing intention towards performance BEVs. In order to demonstrate a user portrait for performance BEVs, some socio-demographic characteristics are also evaluated in a binary way. Chinese young urbanites living in developing cities with high income have higher intention to purchase performance BEVs for urban mobility. Considering the added value of performance BEVs with more intelligent and connective features and vanity attributes, females are more willing to purchase a performance BEV than males.

To answer the main research question, Chinese users expect their performance BEVs to satisfy both sporty driving and family use. Driving a performance BEV in the city represents a better physical looking and higher social status, which is similar to the vanity attributes of performance petrol cars. However, performance BEVs have special ways to show off, such as faster charging, energy usage optimization, and high-level ADAS with more Lidar and cameras and so on.

6.2 Discussions

According to the conclusions, some recommendations can be derived from this study for OEMs, urban mobility planners, and performance BEV users. For OEMs, it is worth noting that performance BEVs have gradually grown from a niche to a subcategory. OEMs who are hoping to enter the performance BEVs market need to realize the changes in the logic of product design, which can no longer follow the same methods as manufacturing performance petrol cars. Comprehensive experience improvement in, around, and beyond the performance BEVs should be provided by OEMs. Rather than pursuing the quality of the car itself, it would be more effective to build exclusive fast charging stations, offer exclusive ADAS services in more cities, customize route and driving according to navigation and energy usage. For urban mobility policy-makers, as performance BEVs with more intelligent and connected features can better adjust driving strategies based on road condition information and energy usage to optimize overall traffic efficiency, properly encouraging and establishing pilot areas for functions such as C-ITS and ADAS can promote urbanites to learn and use performance BEVs better. For performance BEVs users, some of them may not treat themselves as performance BEV users since they are purchasing for luxury rather than multi-motor or four-wheel drive. It might take time for the majority to change the inherent impression of performance cars in the context of BEVs. As the interconnection infrastructure of urban roads becomes increasingly complete, the characteristics of performance BEVs will gradually appear besides only dynamic performance (Autohome Research Institute 2023a).

Since performance BEVs are a novel research topic in urban mobility, there are some practical limitations in this study. The first limitation of this study is the lack of an academic definition of performance BEVs or performance cars. As performance cars are a relatively vague concept, sports cars, street cars, muscle cars, as well as sporty versions of some passenger cars can all be called performance cars because they all have powerful engines and solid chassis. The definition becomes more difficult to specify for BEVs since the electrified powertrain can easily generate lots of torque. Therefore, this study applied a plain definition by the number of motors and drive modes in order to reduce cognitive bias among respondents. However, the final conclusions also reveal that the performance BEVs are not limited to outperforming power, which still leaves uncertainty in definition among users. The second limitation is the data resource. Considering the time and budget constraints, the data were collected online via the Chinese largest automotive forum. Even though the users in each community are required to own at least one car, it is still impossible to avoid secondary dissemination of this online survey. The last limitation comes from the localization, i.e., translation. Because the language and original questionnaire of the Kano model and UTAUT2 model are in English, it could be possible that Chinese translation is not sufficient or sharp. These limitations should be noticed by the readers.

In order to reduce bias and get more insights in the future, further studies can be carried out in the following two aspects. As a niche branch of BEVs, this study mainly emphasizes the BEV identity of performance BEVs. After clarifying the definition of performance cars, it is meaningful to study whether the users who purchase performance BEVs are mainly BEVs buyers or performance cars buyers. Because users of BEVs and performance cars have different car usage habits, this is critical for the market positioning of performance BEVs. As the world’s largest EV market, China has the most diverse BEVs users, while this study still came up with some results that are different from previous studies, especially in different regions. Considering the differences in usage scenarios and usage habits of EVs, the purchasing intention of performance BEVs in urban mobility may have different influencing factors in other regions. It is necessary to investigate to study user acceptance and satisfaction in other regions for recommendations.

In terms of future research, it is recommended to investigate the application of the Kano model in more detail, to find confirmation for the influence of vanity and to replicate this research with a more representative sample.

Reference

Abbasi, Haider, Satirenjit Johl, Zullina Shaari, Wajiha Moughal, Muhammad Mazhar, Muhammad Musarat, Waqas Rafiq, Asaad Farooqi, and Alexey Borovkov. 2021. 'Consumer Motivation by Using Unified Theory of Acceptance and Use of Technology towards Electric Vehicles'. *Sustainability* 13 (21): 12177. https://doi.org/10.3390/su132112177.

Adams, Herb. 1992. *Chassis Engineering: Chassis Design, Building & Tuning for High Performance Cars*. Vol. 1055. Penguin.

Aditama, Brian. 2015. 'FACTORS INFLUENCING THE PURCHSE DECISION MAKING OF LUXURY COMPACT SPORTS CAR (CASE STUDY OF ABARTH INDONESIA)'. Tangerang: SWISS GERMAN UNIVERSITY.

Adityawarman, Haykel, and Mustika Sufiati Purwanegara. 2014. 'STUDY OF SUPERCAR COMMUNITY INFLUENCE ON ITS EFFECT TOWARDS SUPERCAR BUYER'S PURCHASE INTENTION'. *Journal ofBusiness and Management*.

ADR. 2023. 'Stability Returns. Uncertainty Eases as Electrification Race Hots Up'. https://www.automotive-disruption-radar.com/issues/stability-returns-uncertainty-eases-as-electrification-race-hots-up/.

Ajzen, Icek. 1991. 'The Theory of Planned Behavior'. *Theories of Cognitive Self-Regulation* 50 (2): 179–211. https://doi.org/10.1016/0749-5978(91)90020-T.

Ali, Afzaal, Guo Xiaoling, Adnan Ali, Mehkar Sherwani, and Farhan Muhammad Muneeb. 2019. 'Customer Motivations for Sustainable Consumption: Investigating the Drivers of Purchase Behavior for a Green-luxury Car'. *Business Strategy and the Environment* 28 (5): 833–46. https://doi.org/10.1002/bse.2284.

Ambak, Kamarudin, Nazzalyne Emira Harun, Naida Rosli, Basil David Daniel, Joewono Prasetijo, Mohd Ezree, and Munzilah Rohani. 2016. 'DRIVER INTENTION TO USE ELECTRIC CARS USING TECHNOLOGY ACCEPTANCE MODEL' 11 (3).

Anderson, James C., and David W. Gerbing. 1988. 'Structural Equation Modeling in Practice: A Review and Recommended Two-Step Approach.' *Psychological Bulletin* 103 (3): 411.

Aurora Mobile. 2023. '2023 Insight Report on Automobile Replacement Purchase Crowds'. Shenzhen.

Autohome Research Institute. 2022. '2022 China Performance Vehicle User Demand Insight Report'. https://m.autohome.com.cn/news/202211/1271788.html?from=pc&platform-key=m.

———. 2023a. '2023 Smart Car Development Trend Insight Report'. https://www.autohome.com.cn/news/202305/1284580.html?from=m&platform-key=pc.

———. 2023b. 'China Auto Insights of Comsumption'. https://m.autohome.com.cn/share/article/1291757.

———. 2023c. 'User Car Purchase Journey and Experience Insights'. https://mp.weixin.qq.com/s/4uq-OH6biTy9aJRNmx0tnQ.

Balmer, Etienne, and Sebastien Ricci. 2024. 'China Overtakes Japan As World's Biggest Vehicle Exporter'. China Overtakes Japan As World's Biggest Vehicle Exporter. 31 January 2024.

https://www.barrons.com/news/china-overtook-japan-as-world-s-top-vehicle-exporter-in-2023-f1ae31de.

Bentler, P. M. 1990. 'Comparative Fit Indexes in Structural Models.' *Psychological Bulletin* 107 (2): 238–46. https://doi.org/10.1037/0033-2909.107.2.238.

Bentler, Peter M., and Douglas G. Bonett. 1980. 'Significance Tests and Goodness of Fit in the Analysis of Covariance Structures.' *Psychological Bulletin* 88 (3): 588.

Bhardwaj, Janmejay, Ashu Yadav, Manvendra Singh Chauhan, and Avanish Singh Chauhan. 2021. 'Kano Model Analysis for Enhancing Customer Satisfaction of an Automotive Product for Indian Market'. *Materials Today: Proceedings* 46:10996–1. https://doi.org/10.1016/j.matpr.2021.02.093.

Bhat, Furqan A., Meghna Verma, and Ashish Verma. 2021. 'Measuring and Modelling Electric Vehicle Adoption of Indian Consumers'. *Transportation in Developing Economies* 8 (1): 6. https://doi.org/10.1007/s40890-021-00143-2.

Brown, Susan A., and Viswanath Venkatesh. 2005. 'Model of Adoption of Technology in Households: A Baseline Model Test and Extension Incorporating Household Life Cycle'. *MIS Quarterly* 29 (3): 399–426. https://doi.org/10.2307/25148690.

Bte A. Rahman, Faradewi Bee, Mohd Hanafiah, Mohd Salehuddin Mohd Zahari, and Lovelyna Benedict Jipiu. 2021. 'Systematic Literature Review on The Evolution of Technology Acceptance and Usage Model Used in Consumer Behavioural Study'. *International Journal of Academic Research in Business and Social Sciences* 11 (January). https://doi.org/10.6007/IJARBSS/v11-i13/8548.

Central People's Government of the PRC. 2021. 'Bulletin of the Seventh National Census'. 11 May 2021. https://www.gov.cn/guoqing/2021-05/13/content_5606149.htm.

Chan, Kwok, Min Gong, Yan Xu, and James Thong. 2008. *Examining User Acceptance of SMS: An Empirical Study in China and Hong Kong.*

Chatziioannou, Ioannis, Alexandros Nikitas, Panagiotis G. Tzouras, Efthimios Bakogiannis, Luis Alvarez-Icaza, Luis Chias-Becerril, Christos Karolemeas, Stefanos Tsigdinos, Pontus Wallgren, and Oskar Rexfelt. 2023. 'Ranking Sustainable Urban Mobility Indicators and Their Matching Transport Policies to Support Liveable City Futures: A MICMAC Approach'. *Transportation Research Interdisciplinary Perspectives* 18 (March):100788. https://doi.org/10.1016/j.trip.2023.100788.

Chen, Xiaohong, Tianhao Li, and Quan Yuan. 2023. 'Impacts of Built Environment on Travel Behaviors of Generation Z: A Longitudinal Perspective'. *Transportation* 50 (2): 407–36. https://doi.org/10.1007/s11116-021-10249-6.

Childers, Terry L., Christopher L. Carr, Joann Peck, and Stephen Carson. 2001. 'Hedonic and Utilitarian Motivations for Online Retail Shopping Behavior'. *Journal of Retailing* 77 (4): 511–35. https://doi.org/10.1016/S0022-4359(01)00056-2.

Cho, Gyeongcheol, Heungsun Hwang, Marko Sarstedt, and Christian M. Ringle. 2020. 'Cutoff Criteria for Overall Model Fit Indexes in Generalized Structured Component Analysis'. *Journal of Marketing Analytics* 8 (4): 189–202. https://doi.org/10.1057/s41270-020-00089-1.

Collins. 2024. 'Definition of "Performance Car"'. In *Collins English Dictionary*. HarperCollins Publishers. https://www.collinsdictionary.com/dictionary/english/performance-car.

Comrey, Andrew Laurence, and Howard Bing Lee. 1992. *A First Course in Factor Analysis, 2nd Ed.* A First Course in Factor Analysis, 2nd Ed. Hillsdale, NJ, US: Lawrence Erlbaum Associates, Inc.

Curtale, Riccardo, Feixiong Liao, and Ella Rebalski. 2022. 'Transitional Behavioral Intention to Use Autonomous Electric Car-Sharing Services: Evidence from Four European Countries'. *Transportation Research Part C: Emerging Technologies* 135 (February):103516. https://doi.org/10.1016/j.trc.2021.103516.

Curtale, Riccardo, Feixiong Liao, and Peter Van Der Waerden. 2021. 'User Acceptance of Electric Car-Sharing Services: The Case of the Netherlands'. *Transportation Research Part A: Policy and Practice* 149 (July):266–82. https://doi.org/10.1016/j.tra.2021.05.006.

Dash, Dr. Sanjit Kumar. 2019. 'Identification of Attributes in Battery Electric Vehicle Using Kano Model in India', November. https://doi.org/10.5281/ZENODO.3546472.

Davis, Fred D. 1993. 'User Acceptance of Information Technology: System Characteristics, User Perceptions and Behavioral Impacts'. *International Journal of Man-Machine Studies* 38 (3): 475–87. https://doi.org/10.1006/imms.1993.1022.

Deloitte. 2023. '2023 Global Automotive Consumer Study - Key Findings: CHINA'. https://www.deloitte.com/lu/en/Industries/automotive/perspectives/global-automotive-consumer-study.html.

Dodds, William, Kent Monroe, and Dhruv Grewal. 1991. 'Effects of Price, Brand, and Store Information on Buyers' Product Evaluations'. *Journal of Marketing Research* 28 (August). https://doi.org/10.2307/3172866.

Eberhard, Martin, and Marc Tarpenning. 2006. 'The 21st Century Electric Car Tesla Motors'. https://c2e2.unepccc.org/kms_object/the-21st-century-electric-car/.

Farzin, Iman, Amir Reza Mamdoohi, and Francesco Ciari. 2023. 'Autonomous Vehicles Acceptance: A Perceived Risk Extension of Unified Theory of Acceptance and Use of Technology and Diffusion of Innovation, Evidence from Tehran, Iran'. *International Journal of Human–Computer Interaction* 39 (13): 2663–72. https://doi.org/10.1080/10447318.2022.2083464.

Fornell, Claes, and David F. Larcker. 1981. 'Evaluating Structural Equation Models with Unobservable Variables and Measurement Error'. *Journal of Marketing Research* 18 (1): 39–50.

Frank, Darius-Aurel, Polymeros Chrysochou, and Panagiotis Mitkidis. 2023. 'The Paradox of Technology: Negativity Bias in Consumer Adoption of Innovative Technologies'. *Psychology & Marketing* 40 (3): 554–66. https://doi.org/10.1002/mar.21740.

Fu, Claire, and Rich Barbieri. 2024. 'China's Auto Giant BYD Sells More Electric Cars And Hybrids Than Ever'. *The New York Times*, 2 January 2024. Gale Academic OneFile.

Gil-Cordero, Eloy, Pablo Ledesma-Chaves, Sunghoon Yoo, and Heesup Han. 2023. 'Luxury Tourism and Purchase Intention Factors: A Mixed Approach Applied to Luxury Goods'. *Humanities and Social Sciences Communications* 10 (1): 472. https://doi.org/10.1057/s41599-023-01981-8.

Grube, Thomas, Stefan Kraus, Julian Reul, and Detlef Stolten. 2021. 'Passenger Car Cost Development through 2050'. *Transportation Research Part D: Transport and Environment* 101 (December):103110. https://doi.org/10.1016/j.trd.2021.103110.

Gunawan, Indra, Anak A. Redi, Ahmad A. Santosa, Meilinda F. Maghfiroh, Andante H. Pandyaswargo, and Adji C. Kurniawan. 2022. 'Determinants of Customer Intentions to Use Electric Vehicle in Indonesia: An Integrated Model Analysis'. *Sustainability* 14 (4). https://doi.org/10.3390/su14041972.

Guo, Wenshan, and Qiangqiang Luo. 2023. 'Investigating the Impact of Intelligent Personal Assistants on the Purchase Intentions of Generation Z Consumers: The Moderating Role of Brand Credibility'. *Journal of Retailing and Consumer Services* 73 (July):103353. https://doi.org/10.1016/j.jretconser.2023.103353.

Haboucha, Chana J., Robert Ishaq, and Yoram Shiftan. 2017. 'User Preferences Regarding Autonomous Vehicles'. *Transportation Research Part C: Emerging Technologies* 78 (May):37–49. https://doi.org/10.1016/j.trc.2017.01.010.

Hair, Joseph F. 2009. 'Multivariate Data Analysis'.

Heijden, Hans. 2004. 'User Acceptance of Hedonic Information System'. *MIS Quarterly* 28 (December):695–704. https://doi.org/10.2307/25148660.

Helmers, Eckard, and Patrick Marx. 2012. 'Electric Cars: Technical Characteristics and Environmental Impacts'. *Environmental Sciences Europe* 24 (1): 14. https://doi.org/10.1186/2190-4715-24-14.

Higueras-Castillo, Elena, Vedant Singh, Virender Singh, and Francisco Liébana-Cabanillas. 2023. 'Factors Affecting Adoption Intention of Electric Vehicle: A Cross-Cultural Study'. *Environment, Development and Sustainability*, September. https://doi.org/10.1007/s10668-023-03865-y.

Hu, Li-tze, and Peter M. Bentler. 1999. 'Cutoff Criteria for Fit Indexes in Covariance Structure Analysis: Conventional Criteria versus New Alternatives'. *Structural Equation Modeling: A Multidisciplinary Journal* 6 (1): 1–55. https://doi.org/10.1080/10705519909540118.

Huang, Qihao, Guanyu Mao, Yelu Liu, Ya Wang, Xiaojun Luo, and Jifang Wang. 2022. 'A Deep Dive into the China's Gen Z: How They Use and What They Expect for Their Cars'. In *HCI in Mobility, Transport, and Automotive Systems*, edited by Heidi Krömker, 13335:167–83. Lecture Notes in Computer Science. Cham: Springer International Publishing. https://doi.org/10.1007/978-3-031-04987-3_11.

Hung, Kuang-peng, Annie Huiling Chen, Norman Peng, Chris Hackley, Rungpaka Amy Tiwsakul, and Chun-lun Chou. 2011. 'Antecedents of Luxury Brand Purchase Intention'. Edited by Oriol Iglesias. *Journal of Product & Brand Management* 20 (6): 457–67. https://doi.org/10.1108/10610421111166603.

Hutchins, Nathan F., Alison J. Kerr, and Loyd R. Hook. 2019. 'User Acceptance in Autonomous Vehicles: The Evolution of the End User'. In *2019 International Symposium on Systems Engineering (ISSE)*, 1–8. https://doi.org/10.1109/ISSE46696.2019.8984492.

Hyundai N. 2020. 'What Is A High-Performance Car?' What Is a High Performance Car? 13 February 2020. https://www.hyundai-n.com/en/media/n-zine/what-is-a-high-performance-car.do.

IBM. 2020. 'Automotive Industry Outlook 2030 China Insights'. https://www.ibm.com/downloads/cas/13RJAGQE.

IEA. 2022. 'Global EV Outlook 2023 Catching up with Climate Ambitions'. https://iea.blob.core.windows.net/assets/dacf14d2-eabc-498a-8263-9f97fd5dc327/GEVO2023.pdf.

Jain, Nikunj Kumar, Kalyan Bhaskar, and Sourabh Jain. 2022. 'What Drives Adoption Intention of Electric Vehicles in India? An Integrated UTAUT Model with Environmental Concerns, Perceived Risk and

Government Support'. *Research in Transportation Business & Management* 42 (March):100730. https://doi.org/10.1016/j.rtbm.2021.100730.

James, W. S. 1928. 'Engine and Car Performance'. *SAE Transactions* 23:24–33.

Jöreskog, Karl G., and Dag Sörbom. 1989. 'LISREL 7: A Guide to the Program and Applications'. *(No Title)*.

Kanger, Laur, and Johan Schot. 2016. 'User-Made Immobilities: A Transitions Perspective'. *Mobilities* 11 (4): 598–613. https://doi.org/10.1080/17450101.2016.1211827.

KANO, Noriaki, Nobuhiko SERAKU, Fumio TAKAHASHI, and Shin-ichi TSUJI. 1984. 'Attractive Quality and Must-Be Quality'. *Journal of The Japanese Society for Quality Control* 14 (2): 147–56. https://doi.org/10.20684/quality.14.2_147.

Kapser, Sebastian, and Mahmoud Abdelrahman. 2020. 'Acceptance of Autonomous Delivery Vehicles for Last-Mile Delivery in Germany – Extending UTAUT2 with Risk Perceptions'. *Transportation Research Part C: Emerging Technologies* 111 (February):210–25. https://doi.org/10.1016/j.trc.2019.12.016.

Karpurapu, Sailatha, and J. Naga Venkata Raghuram. 2024. 'Synergizing Green Transitions: Exploring EV Usage Risks in South India through the UTAUT2 Model'. *Qubahan Academic Journal* 4 (1): 26–37. https://doi.org/10.58429/qaj.v4n1a370.

Kasser, Tim. 2003. *The High Price of Materialism*. MIT press.

Kennedy, Joshua, Kieran James, and Bonnie Hampson. 2023. 'Public Opinion and Understanding of the Impact of Electric Vehicles: A UK Experience'. *Advances in Social Sciences Research Journal* 10 (10): 248–77. https://doi.org/10.14738/assrj.1010.15615.

Khazaei, Hamed, and Mohammad Ali Tareq. 2021. 'Moderating Effects of Personal Innovativeness and Driving Experience on Factors Influencing Adoption of BEVs in Malaysia: An Integrated SEM–BSEM Approach'. *Heliyon* 7 (9): e08072. https://doi.org/10.1016/j.heliyon.2021.e08072.

Korkmaz, Huseyin, Akif Fidanoglu, Salih Ozcelik, and Abdullah Okumus. 2021. 'User Acceptance of Autonomous Public Transport Systems (APTS): Extended UTAUT2 Model'. *Journal of Public Transportation* 23 (1). https://doi.org/10.5038/2375-0901.23.1.5.

KUŁAK, JACEK PIOTR, MARIUSZ TROJANOWSKI, and EDYTA BARMENTLOO. 2019. 'A Literature Review of the Partial Unified Theory of Acceptance and Use of Technology 2 (UTAUT2) Model'. *UNIVERSITATIS MARIAE CURIE-SKŁODOWSKA LUBLIN – POLONIA* LIII, 4. https://doi.org/10.17951/h.2019.53.4.101-113.

Lam, Long W. 2012. 'Impact of Competitiveness on Salespeople's Commitment and Performance'. *Journal of Business Research* 65 (9): 1328–34. https://doi.org/10.1016/j.jbusres.2011.10.026.

Laohapensaeng, Teeravisit, Roungsan Chaisricharoen, and Phakphoom Boonyanant. 2021. 'Evaluation System for Car Engine Performance'. In *2021 Joint International Conference on Digital Arts, Media and Technology with ECTI Northern Section Conference on Electrical, Electronics, Computer and Telecommunication Engineering*, 322–26. IEEE.

Lashari, Zulfiqar Ali, Joonho Ko, and Junseok Jang. 2021. 'Consumers' Intention to Purchase Electric Vehicles: Influences of User Attitude and Perception'. *Sustainability* 13 (12): 6778. https://doi.org/10.3390/su13126778.

Leffel, Benjamin, Helge Marahrens, and Arthur S. Alderson. 2023. ‘Divergence of the World City System from National Economies’. *Global Networks* 23 (2): 459–77. https://doi.org/10.1111/glob.12405.

Liao, Feixiong, Qiong Tian, Theo Arentze, Hai-Jun Huang, and Harry J.P. Timmermans. 2020. ‘Travel Preferences of Multimodal Transport Systems in Emerging Markets: The Case of Beijing’. *Transportation Research Part A: Policy and Practice* 138 (August):250–66. https://doi.org/10.1016/j.tra.2020.05.026.

Liao, Yang, Hanying Guo, and Xinju Liu. 2023. ‘A Study of Young People’s Intention to Use Shared Autonomous Vehicles: A Quantitative Analysis Model Based on the Extended TPB-TAM’. *Sustainability* 15 (15): 11825. https://doi.org/10.3390/su151511825.

Limayem, Moez, Sabine Hirt, and Christy Cheung. 2007. ‘How Habit Limits the Predictive Power of Intention: The Case of Information Systems Continuance’. *MIS Quarterly* 31 (December):705–37. https://doi.org/10.2307/25148817.

Lu, Ming-Tsang, Hsi-Peng Lu, and Chiao-Shan Chen. 2022. ‘Exploring the Key Priority Development Projects of Smart Transportation for Sustainability: Using Kano Model’. *Sustainability* 14 (15): 9319. https://doi.org/10.3390/su14159319.

Luo, Chaojun, Menglin He, and Cai Xing. 2024. ‘Public Acceptance of Autonomous Vehicles in China’. *International Journal of Human–Computer Interaction* 40 (2): 315–26. https://doi.org/10.1080/10447318.2022.2115336.

Manutworakit, Phasiri, and Kasem Choocharukul. 2022. ‘Factors Influencing Battery Electric Vehicle Adoption in Thailand—Expanding the Unified Theory of Acceptance and Use of Technology’s Variables’. *Sustainability* 14 (14): 8482. https://doi.org/10.3390/su14148482.

Marsh, Herbert W., Kit-Tai Hau, and Zhonglin Wen. 2004. ‘In Search of Golden Rules: Comment on Hypothesis-Testing Approaches to Setting Cutoff Values for Fit Indexes and Dangers in Overgeneralizing Hu and Bentler’s (1999) Findings’. *Structural Equation Modeling: A Multidisciplinary Journal* 11 (3): 320–41. https://doi.org/10.1207/s15328007sem1103_2.

Memon, Mumtaz Ali, Hiram Ting, Jun-Hwa Cheah, Ramayah Thurasamy, Francis Chuah, and Tat Huei Cham. 2020. ‘Sample Size for Survey Research: Review and Recommendations’. *Journal of Applied Structural Equation Modeling* 4 (2): i–xx. https://doi.org/10.47263/JASEM.4(2)01.

Ministry of Public Security of the PRC. 2024. ‘The Number of Motor Vehicles Nationwide Reached 435 Million, the Number of Drivers Reached 523 Million, and the Number of New Energy Vehicles Exceeded 20 Million.’ 11 January 2024. https://www.gov.cn/lianbo/bumen/202401/content_6925362.htm.

Momani, Alaa M, and Mamoun M Jamous. 2017. ‘The Evolution of Technology Acceptance Theories’.

Münster, Pia, and Barbara Grabkowsky. 2023. ‘Kano Model Analysis of Digital On-Farm Technologies for Climate Adaptation and Mitigation in Livestock Farming’. *Sustainability* 16 (1): 268. https://doi.org/10.3390/su16010268.

Muzammel, Chowdhury Shahriar, Maria Spichkova, and James Harland. 2024. ‘Cultural Influence on Autonomous Vehicles Acceptance’. arXiv. http://arxiv.org/abs/2404.03694.

Nguyen, Chi T. P., Bảo-Huy Nguyễn, Minh C. Ta, and João Pedro F. Trovão. 2023. ‘Dual-Motor Dual-Source High Performance EV: A Comprehensive Review’. *Energies* 16 (20). https://doi.org/10.3390/en16207048.

Nieuwenhuijsen, Mark J., and Haneen Khreis. 2016. 'Car Free Cities: Pathway to Healthy Urban Living'. *Environment International* 94:251–62. https://doi.org/10.1016/j.envint.2016.05.032.

Nordhoff, Sina, Tyron Louw, Satu Innamaa, Esko Lehtonen, Anja Beuster, Guilhermina Torrao, Afsaneh Bjorvatn, et al. 2020. 'Using the UTAUT2 Model to Explain Public Acceptance of Conditionally Automated (L3) Cars: A Questionnaire Study among 9,118 Car Drivers from Eight European Countries'. *Transportation Research Part F: Traffic Psychology and Behaviour* 74 (October):280–97. https://doi.org/10.1016/j.trf.2020.07.015.

Ouyang, Minggao. 2024. 'The development of the automobile industry: electrification, intelligence, low carbonization and globalization: responding to various doubts about new energy vehicles'. Beijing.

Park, Jungkun, EunPyo Hong, and Hoang Tpm Le. 2021. 'Adopting Autonomous Vehicles: The Moderating Effects of Demographic Variables'. *Journal of Retailing and Consumer Services* 63 (November):102687. https://doi.org/10.1016/j.jretconser.2021.102687.

Qualtrics XM. 2024. 'Kano Analysis: The Kano Model Explained'. 2024. https://www.qualtrics.com/uk/experience-management/research/kano-analysis/.

Richins, Marsha L. 2004. 'The Material Values Scale: Measurement Properties and Development of a Short Form'. *Journal of Consumer Research* 31 (1): 209–19. https://doi.org/10.1086/383436.

Rodwell, David, Bonnie Ho, Michael T. Pascale, Francine Elrose, Alexandra Neary, and Ioni Lewis. 2023. 'In Their Own Words: A Qualitative Study of Users' Acceptance of Connected Vehicle Technology after Nine Months of Experience with the Technology'. *Transportation Research Part F: Traffic Psychology and Behaviour* 97:73–93. https://doi.org/10.1016/j.trf.2023.07.004.

Roland Berger and Autohome Research Institute. 2023. 'Car Crowd Insights and Car Purchase Decision White Paper'. https://www.rolandberger.com/zh/Insights/Publications/%E6%B1%BD%E8%BD%A6%E4%BA%BA%E7%BE%A4%E6%B4%9E%E5%AF%9F%E4%B8%8E%E8%B4%AD%E8%BD%A6%E5%86%B3%E7%AD%96%E7%99%BD%E7%9A%AE%E4%B9%A6.html.

SapioResearch. 2024. 'Kano Analysis'. 2024. https://sapioresearch.com/kano-analysis/.

She, Zhen-Yu, Qing Sun, Jia-Jun Ma, and Bai-Chen Xie. 2017. 'What Are the Barriers to Widespread Adoption of Battery Electric Vehicles? A Survey of Public Perception in Tianjin, China'. *Transport Policy* 56 (May):29–40. https://doi.org/10.1016/j.tranpol.2017.03.001.

Sheller, Mimi. 2004. 'Automotive Emotions: Feeling the Car'. *Theory, Culture & Society*. https://doi.org/10.1177/0263276404046068.

Sheller, Mimi, and John Urry. 2016. 'Mobilizing the New Mobilities Paradigm'. *Applied Mobilities* 1 (1): 10–25. https://doi.org/10.1080/23800127.2016.1151216.

Shin, Jong-Gyu, In-Seok Heo, Jin-Hae Yae, and Sang-Ho Kim. 2022. 'Kano Model of Autonomous Driving User Acceptance According to Driver Characteristics: A Survey Study'. *Transportation Research Part F: Traffic Psychology and Behaviour* 91 (November):73–86. https://doi.org/10.1016/j.trf.2022.10.002.

Singh, Harbansh, Vedant Singh, Tej Singh, and Elena Higueras-Castillo. 2023. 'Electric Vehicle Adoption Intention in the Himalayan Region Using UTAUT2 – NAM Model'. *Case Studies on Transport Policy* 11 (March):100946. https://doi.org/10.1016/j.cstp.2022.100946.

Sopjani, Liridona, Jenny Janhager Stier, Sofia Ritzén, Mia Hesselgren, and Peter Georén. 2019. ‘Involving Users and User Roles in the Transition to Sustainable Mobility Systems: The Case of Light Electric Vehicle Sharing in Sweden’. *Transportation Research Part D: Transport and Environment* 71 (June):207–21. https://doi.org/10.1016/j.trd.2018.12.011.

Sovacool, Benjamin K., Wokje Abrahamse, Long Zhang, and Jingzheng Ren. 2019. ‘Pleasure or Profit? Surveying the Purchasing Intentions of Potential Electric Vehicle Adopters in China’. *Transportation Research Part A: Policy and Practice* 124 (June):69–81. https://doi.org/10.1016/j.tra.2019.03.002.

Steckhan, Lorenz, Wolfgang Spiessl, and Klaus Bengler. 2023. ‘Maneuver and Parameter Interventions in Automated Driving to Enhance User Satisfaction: A Kano Method Application’. In *HCI International 2023 – Late Breaking Papers*, edited by Vincent G. Duffy, Heidi Krömker, Norbert A. Streitz, and Shin’ichi Konomi, 390–404. Cham: Springer Nature Switzerland.

Steiner, Michael. 2023. ‘Sports Cars from Porsche - Innovations as a Tradition’. *ATZ Worldwide* 125 (7): 24–29. https://doi.org/10.1007/s38311-023-1513-z.

Suematsu, Toshio, Tetsuomi Tamura, Mikio Nakajima, Mitsuyoshi Teramura, and Yoshihiro Iwashita. 1991. ‘Development of High Performance Engine for Passenger Cars’. SAE Technical Paper.

Sutarto, N. Ansori, A. Widyanti, F. Trapsilawati, A. P. Rifai, R. Erlangga, and R. Woodman. 2023. ‘Driving the Future: Using TAM and UTAUT to Understand Public Acceptance of Fully Autonomous Vehicles’. In *2023 10th International Conference on ICT for Smart Society (ICISS)*, 1–8. https://doi.org/10.1109/ICISS59129.2023.10291794.

Tabachnick, Barbara G., Linda S. Fidell, and Jodie B. Ullman. 2013. *Using Multivariate Statistics*. Vol. 6. pearson Boston, MA.

Thong, James Y.L., Se-Joon Hong, and Kar Yan Tam. 2006. ‘The Effects of Post-Adoption Beliefs on the Expectation-Confirmation Model for Information Technology Continuance’. *International Journal of Human-Computer Studies* 64 (9): 799–810. https://doi.org/10.1016/j.ijhcs.2006.05.001.

Timko, M. P. 1993. ‘An Experiment in Continuous Analysis’. *Central European Management Journal* 2:17–20.

Tucker, Ledyard R, and Charles Lewis. 1973. ‘A Reliability Coefficient for Maximum Likelihood Factor Analysis’. *Psychometrika* 38 (1): 1–10. https://doi.org/10.1007/BF02291170.

Vafaei-Zadeh, Ali, Teik-Kheng Wong, Haniruzila Hanifah, Ai Ping Teoh, and Khaled Nawaser. 2022. ‘Modelling Electric Vehicle Purchase Intention among Generation Y Consumers in Malaysia’. *Research in Transportation Business & Management* 43 (June):100784. https://doi.org/10.1016/j.rtbm.2022.100784.

Venkatesh, Morris, Davis, and Davis. 2003. ‘User Acceptance of Information Technology: Toward a Unified View’. *MIS Quarterly* 27 (3): 425. https://doi.org/10.2307/30036540.

Venkatesh, Thong, and Xu. 2012. ‘Consumer Acceptance and Use of Information Technology: Extending the Unified Theory of Acceptance and Use of Technology’. *MIS Quarterly* 36 (1): 157. https://doi.org/10.2307/41410412.

Viola, Fabio. 2021. ‘Electric Vehicles and Psychology’. *Sustainability* 13 (2): 719. https://doi.org/10.3390/su13020719.

Wang, Dingni, Mucahit Ozden, and Yung Po Tsang. 2023. ‘The Impact of Facilitating Conditions on Electric Vehicle Adoption Intention in China: An Integrated Unified Theory of Acceptance and Use of Technology Model’. *International Journal of Engineering Business Management* 15 (February):18479790231224715. https://doi.org/10.1177/18479790231224715.

Workman, Jane E., and Seung-Hee Lee. 2011. ‘Vanity and Public Self-consciousness: A Comparison of Fashion Consumer Groups and Gender’. *International Journal of Consumer Studies* 35 (3): 307–15. https://doi.org/10.1111/j.1470-6431.2010.00934.x.

Xu, Yueling, Wenyu Zhang, Haijun Bao, Shuai Zhang, and Ying Xiang. 2019. ‘A SEM–Neural Network Approach to Predict Customers’ Intention to Purchase Battery Electric Vehicles in China’s Zhejiang Province’. *Sustainability* 11 (11): 3164. https://doi.org/10.3390/su11113164.

Yang, Zhenshan, Peng Jia, Weidong Liu, and Hongchun Yin. 2017. ‘Car Ownership and Urban Development in Chinese Cities: A Panel Data Analysis’. *Journal of Transport Geography* 58:127–34. https://doi.org/10.1016/j.jtrangeo.2016.11.015.

Yavuz, Yigit Can. 2024. ‘Exploring University Students’ Acceptability of Autonomous Vehicles and Urban Air Mobility’. *Journal of Air Transport Management* 115 (March):102546. https://doi.org/10.1016/j.jairtraman.2024.102546.

YICAI. 2023. ‘2023 City Charm Rankings’. Shanghai. https://datayicai.com/report/detail/999881?origin=news.

Yin, Biao, Azise Oumar Diallo, Tatiana Seregina, Nicolas Coulombel, and Liu Liu. 2024. ‘Evaluation of Low-Traffic Neighborhoods and Scale Effects: The Paris Case Study’. *Transportation Research Record* 2678 (1): 88–101. https://doi.org/10.1177/03611981231170130.

Yu, Teng, Yajun Zhang, Ai Ping Teoh, Anchao Wang, and Chengliang Wang. 2023. ‘Factors Influencing University Students’ Behavioral Intention to Use Electric Car-Sharing Services in Guangzhou, China’. *SAGE Open* 13 (4): 21582440231210551. https://doi.org/10.1177/21582440231210551.

Zeithaml, Valarie. 1988. ‘Consumer Perceptions of Price, Quality and Value: A Means-End Model and Synthesis of Evidence’. *Journal of Marketing* 52 (July):2–22. https://doi.org/10.1177/002224298805200302.

Zhao, Yuntong, Zhaoquan Jian, and Yushen Du. 2024. ‘How Can China’s Subsidy Promote the Transition to Electric Vehicles?’ *Renewable and Sustainable Energy Reviews* 189:114010. https://doi.org/10.1016/j.rser.2023.114010.

Zhou, Min, Piao Long, Nan Kong, Lindu Zhao, Fu Jia, and Kathryn S. Campy. 2021. ‘Characterizing the Motivational Mechanism behind Taxi Driver’s Adoption of Electric Vehicles for Living: Insights from China’. *Transportation Research Part A: Policy and Practice* 144 (February):134–52. https://doi.org/10.1016/j.tra.2021.01.001.

Appendix A: Survey

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Reading guide

In today's urban mobility, battery electric vehicles (BEV) are one of the most common mobility elements. As almost every BEV has its performance edition with dual/tri motors and four-wheel-drive, a performance car is becoming more accessible and popular than before. Meanwhile, there are less room and stricter restrictions for cars in the city. To offer better experience in urban mobility, it is necessary to understand how will performance BEV be accepted and expected by public in the foreseen urban mobility. In this survey research, we study the user acceptance and user experience expectancy of "performance electric car". The survey involves three parts of data collection.

1. Basic socioeconomic background.
2. Information about the user experience satisfaction of the performance BEV.
3. Information about the acceptance of the performance BEV in urban mobility.

It takes about 15 minutes to complete the survey depending on your answers to some of the questions. We would like to thank you for your participation.

Requirements for the pre-selection of respondents include (i) age over 18; and (ii) with driving license.

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Below is the standard consent form to start the survey.

"I declare that I participate in this study voluntarily and I am aware that I have the right to stop answering the questionnaire or withdraw my data from the study at any time without the need for any argumentation. Data will be aggregated to a group level, evaluated, and published for scientific purposes such as scientific publications. After the research process, the personal data will be deleted by the research team. Aggregated data are stored on encrypted systems of the university. The data will not be accessible to external parties and only the responsible researcher and his team have the right to view the data. When the data are made public in any capacity, all personal information will be completely anonymized. For questions and/or comments I can contact the responsible researcher Shumeng Zhang (s.zhang@student.tue.nl) of the Eindhoven University of Technology.

I have read and understood the above text. My participation in this questionnaire is voluntary. "

- I agree to participate in this study (yes, no)

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Screening questions:

1. Age (17 years old or younger; 18 to 34 years old; more than 35 years old)
2. Do you have a car driving license? (yes; no)

Part 1 - Basic socioeconomic background

For the following questions, please choose the answers that fit you the most.

3. What is your gender (male; female; different from the above)
4. What is your education level (college degree or lower; university bachelor degree or higher)
5. Where is your main residence city?
6. What is your monthly net income level in CNY (less than 10000; more than 10000)
7. How many cars are there in your household? (1 or less; 2 or more)

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Introduction of performance BEV and performance petrol car

A performance BEV is generally the top model of the series, which is different from the petrol car who has an individual performance brand. Generally, it has the best functionalities in the series like high-level ADAS (Advanced Driver-Assistance System), while the price gap between performance and regular edition of a BEV is smaller than that of a petrol car. The performance BEV is also equipped with dual/tri motors and four-wheel-drive with a larger battery. Due to its heavier mass and stronger power, a performance electric car usually has faster acceleration but shorter travel range than a regular electric car.

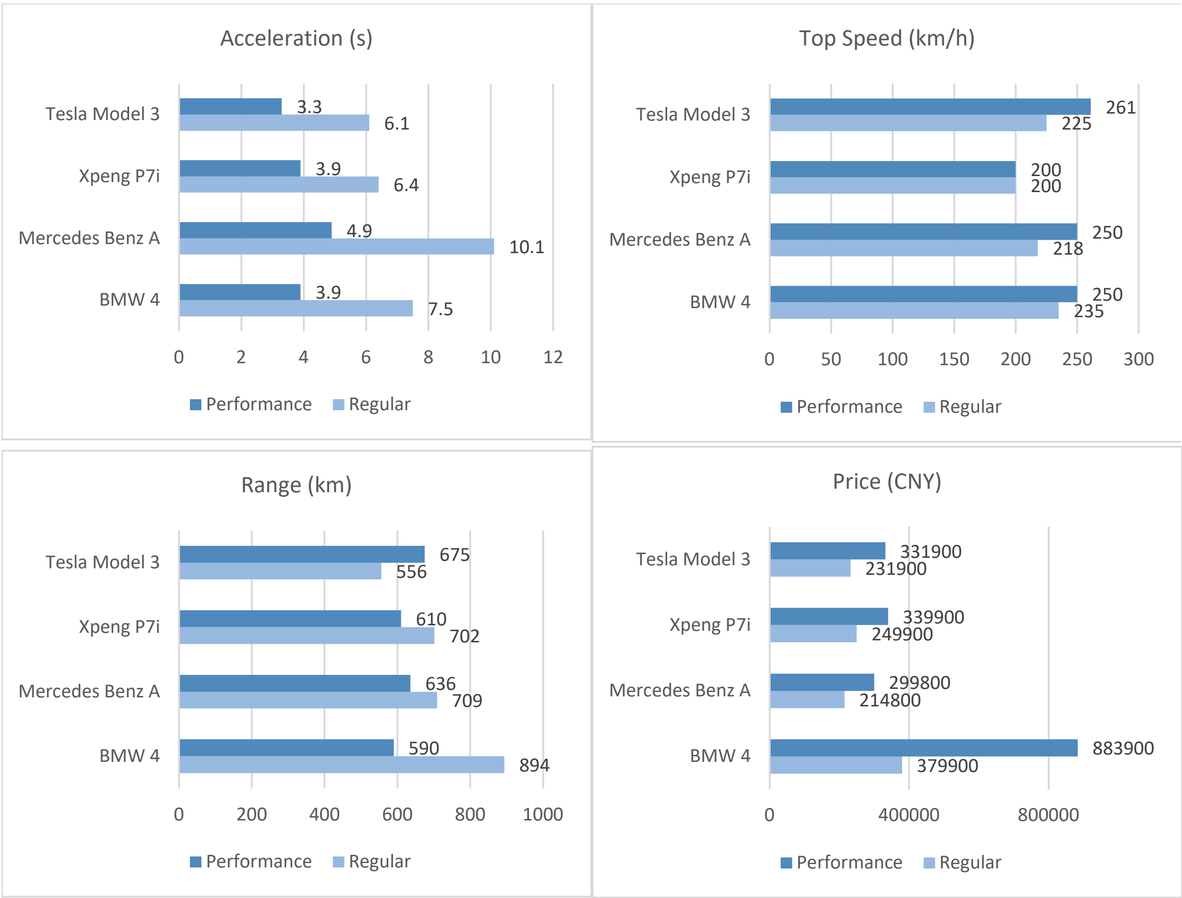
Currently, most of the BEVs have their performance edition. There are some photos of performance BEVs and performance petrol cars from their official websites and their data comparison of acceleration, top speed, range, and price.

Fig. 1 Tesla Model 3 Performance Edition 2022 (discontinued)

Fig. 2 Xpeng P7i Wing-door Performance Edition

Fig. 3 Mercedes Benz AMG A35L 4MATIC (Performance Edition)

Fig. 4 BMW M4 Coupe (Performance Edition)



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Part 2 - User experience (UX) satisfaction of the performance BEV

The UX features on a car can be categorised into three dimensions: in the car, around the car, and beyond the car. Specifically, there are some examples in each category:

- In the car: voice control system, HUD on wind screen, L4-level ADAS (Advanced Driver-Assistance System).
- Around the car: remote controllability, fast charging experience, car pick-up for maintenance.
- Beyond the car: car app, campaign for car owners, brand day, etc.

Please state how would you comment on the following UX features when both available and not available. (5-point scale: 1: I dislike it, 2: I can tolerate it, 3: I am neutral, 4: I expect it, 5: I like it that way)

UX: Better drivability

8. A performance BEV has better drivability than a regular BEV.
   A performance BEV does not have better drivability than a regular BEV.

UX: Better car-interaction experience

9. A performance BEV has better car-interaction experience than a regular BEV.

A performance BEV does not have better car-interaction experience than a regular BEV.

UX: More cameras, radars, Lidars for autonomous driving

10. A performance BEV has more camaras, radars, Lidars for autonomous driving than a regular BEV.
    A performance BEV does not have more camaras, radars, Lidars for autonomous driving than a regular BEV.

UX: Autonomous driving in the city

11. A performance BEV has higher level of autonomous driving in a city than a regular BEV.
    A performance BEV does not have higher level of autonomous driving in a city than a regular BEV.

UX: Autonomous driving outside the city

12. A performance BEV has higher level of autonomous driving outside a city than a regular BEV.
    A performance BEV does not have higher level of autonomous driving outside a city than a regular BEV.

UX: Gamification features *(gamification in the car: to apply elements or mechanisms in games to in-car interactive environment, e.g., challenges, badges, storylines, quests, leader boards, etc.)*

13. A performance BEV has gamification features.
    A performance BEV does not have gamification features.

UX: Unique interior light

14. A performance BEV can show its prestige by unique light features.
    A performance BEV cannot show its prestige by unique light features.

UX: Unique avatar

15. A performance BEV can show its prestige by a unique avatar.
    A performance BEV cannot show its prestige by a unique avatar.

UX: Voice-control everything

16. You can voice-control everything on a performance BEV.
    You cannot voice-control everything on a performance BEV.

UX: Engine sound simulator

17. A performance BEV can simulate the engine sound.
    A performance BEV cannot simulate the engine sound.

UX: Customizable car mode (e.g. sleep mode)

18. There are customizable car modes on performance BEV which can synchronize car lights, seat angle, music, temperature, fragrance. E.g., you can lie down comfortably and sleep well in a performance BEV when needed.
    There are no customizable car modes on performance BEV which can synchronize car lights, seat angle, music, temperature, fragrance, E.g., you cannot lie down comfortably and sleep well in a performance BEV when needed.

UX: Great experience as a passenger

19. Passengers also have great experience on a performance BEV.
    Passengers do not have great experience on a performance BEV.

UX: Racing tutorial

20. You can learn how to race in the track from a performance BEV.
    You cannot learn how to race in the track from a performance BEV.

UX: Autonomous driving tutorial

21. You can learn how to use autonomous driving properly from a performance BEV.
    You cannot learn how to use autonomous driving properly from a performance BEV.

UX: Route recommendation according to driving preferences

22. A performance BEV can suggest different routes according to your driving preferences for the day.
    A performance BEV cannot suggest different routes according to your driving preferences for the day.

UX: Route recommendation according to energy consumption

23. A performance BEV can suggest different routes according to your energy consumption for the day.
    A performance BEV cannot suggest different routes according to your energy consumption for the day.

UX: Faster charging

24. A performance BEV can charge faster than a regular BEV.
    A performance BEV cannot charge faster than a regular BEV.

UX: Better charging service

25. A performance BEV has better charging service than a regular BEV.
    A performance BEV does not have better charging service than a regular BEV.

UX: Better maintaining service

26. A performance BEV has better maintaining service than a regular BEV.
    A performance BEV does not have better maintaining service than a regular BEV.

UX: Longer battery warranty

27. A performance BEV has longer battery warranty than a regular BEV.
    A performance BEV does not have longer battery warranty than a regular BEV.

UX: Exclusive charging pile/time period

28. A performance BEV has its exclusive charging pile/time period.
    A performance BEV does not have its exclusive charging pile/time period.

UX: Swappable battery

29. A performance BEV can also swap the battery rather than charging only.
    A performance BEV can charge only rather than also swap the battery.

UX: Carbon footprint note

30. A performance BEV can note my carbon footprint when using it.
    A performance BEV cannot note my carbon footprint when using it.

UX: Real-time car data synchronization

31. A performance BEV can synchronize car data in real-time.
    A performance BEV cannot synchronize car data in real-time.

UX: More owner rights

32. You have more owner rights as a performance BEV than a regular owner.
    You do not have more owner rights as a performance BEV than a regular owner.

UX: More customization opportunities

33. You have more customization opportunities on a performance BEV than a regular BEV.
    You do not have more customization opportunities on a performance BEV than a regular BEV.

UX: More exclusive optional features

34. You have more exclusive optional packages for a performance BEV than a regular BEV.
    You do not have more exclusive optional packages for a performance BEV than a regular BEV.

UX: More payment options

35. You have more payment options like subscription for a performance BEV than a regular BEV.
    You do not have more payment options like subscription for a performance BEV than a regular BEV.

UX: Priority in services

36. You have priority in services as a performance owner among other owners in the same brand.
    You do not have priority in services as a performance owner among other owners in the same brand.

UX: Unique car app

37. There is a unique car app for performance BEV users.
    There is no unique car app for performance BEV users.

UX: Unique products from brand store

38. There are unique products in the brand store for performance BEV users.
    There are no unique products in the brand store for performance BEV users.

UX: Exclusive owner community

39. There is an exclusive community for performance BEV owners.
    There is no exclusive community for performance BEV owners.

UX: Exclusive credits

40. There are exclusive credits for performance BEV owners.
    There are no exclusive credits for performance BEV owners.

UX: User growth system

41. There is a user growth system to track how the owner use a performance BEV.
    There is no user growth system to track how the owner use a performance BEV.

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Part 3 - User acceptance of the performance BEV in urban mobility

Please state how much you agree or disagree with the following statements.
(5-point scale: 1: totally disagree, 2: disagree, 3: neutral/uncertain, 4: agree, 5: totally agree)

42. In urban mobility, performance BEVs offer better driving experience in acceleration and controllability.
43. In urban mobility, performance BEVs can well balance my daily use convenience and sporty driving pleasure.
44. In urban mobility, my driving experience would be enhanced by technologies on performance BEVs.
45. In urban mobility, my driving performance would be enhanced by the connectivity of performance BEVs.
46. People who are important to me think that I should use performance BEVs in urban mobility.
47. People whose opinions I value think that I should use performance BEVs in urban mobility.
48. I would use performance BEVs in urban mobility if my friends/colleagues recommend it.
49. I would be more likely to use performance BEVs in urban mobility if my friends/colleagues use it.
50. I expect there are enough fast-charging stations for me to use performance BEVs in urban mobility.
51. I expect the battery technology is mature enough to use performance BEVs in urban mobility.
52. I expect the maintenance of performance BEVs in urban mobility is easy with its advanced technologies.
53. Performance BEVs is reasonably priced with its improved experience in urban mobility.
54. Performance BEVs is more intelligent in urban mobility among other cars with the same price.
55. Performance BEVs is a good value for money in urban mobility.
56. I expect a part of performance BEVs price is paying for the environmental contribution in urban mobility.
57. I no longer worry about the battery depletion in urban mobility after driving performance BEVs.
58. I no longer worry about the parking and congestion in urban mobility after driving performance BEVs.
59. I no longer worry about the noise to others in urban mobility after driving performance BEVs.
60. I no longer worry about the traffic safety issues in urban mobility after driving performance BEVs.
61. I concern my physical appearance in urban mobility so I use performance BEVs if I could.
62. Using performance BEVs in urban mobility will make me look physically better.
63. I concern my social status in urban mobility so I use performance BEVs if I could.
64. Using performance BEVs in urban mobility will make me appear to have more achievements.
65. I intend to purchase performance BEVs for urban mobility in the future.
66. I am very likely to purchase performance BEVs soon for urban mobility if the opportunity arises.
67. I intend to purchase performance BEVs for urban mobility although it is expensive.
68. I would encourage friends/colleagues to purchase performance BEVs for urban mobility.

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This is the end of the survey. If you have any comments regarding the study or survey, please leave them in the box below. You are also welcomed to send emails to s.zhang@student.tue.nl if you would like to If follow up on the results of this study.

Thank you for participating in the survey!