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Push–pull–mooring framework for understanding heterogeneous electric vehicle replacement intentions

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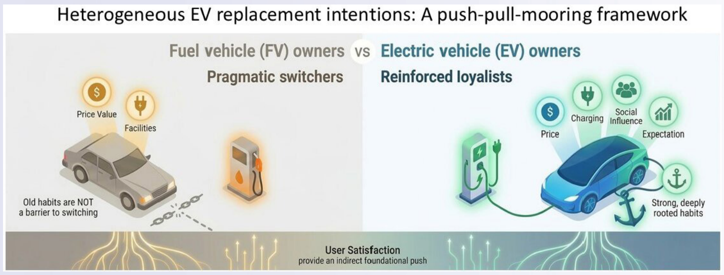
ABSTRACT: The replacement of existing private cars is crucial for the sustainable penetration of electric vehicles (EVs). However, the intentions of current fuel vehicle (FV) owners and EV owners are fundamentally different yet rarely compared within a unified framework. This study develops a novel hybrid model integrating the push-pull-mooring (PPM) framework with a user acceptance model and a customer satisfaction index to investigate these heterogeneous behavioral mechanisms. Applying multigroup structural equation modeling to a sample of 803 vehicle owners in China (386 FV, 417 EV), our analysis reveals a core asymmetry: FV owners' switching intention is driven by pragmatic pull factors (price value and facilitating conditions), whereas EV owners' continuance intention is supported by a crucial mooring anchor (habit) and a broader network of pull factors. Notably, as a push factor, user satisfaction (US) does not directly influence intentions for either group but operates through complex indirect pathways, shaping perceptions of value and habit. These findings yield segment specific recommendations for policymakers and industry stakeholders to design differentiated strategies that convert pragmatic switchers while retaining reinforced loyalists.



KEYWORDS: electric vehicle; switching intention; continuance intention; push-pull-mooring; user acceptance

1 Introduction

The rapid penetration of electric vehicles (EVs) is a cornerstone of global transport decarbonization, yet adoption rates remain heterogeneous (Wang and Witlox, 2025). As the market matures, academic and strategic focus shifts from initial adoption to the more complex dynamics of vehicle replacement: a fuel vehicle (FV) owner switching to an EV or an existing EV owner opting for another EV. Unlike first-time adoption, these decisions are profoundly shaped by accumulated experience, evolving user expectations, and embedded habits (Sovacool, 2017). Consequently, understanding the psychological asymmetry between switching and continuance decisions is critical for sustainable market growth.

While advanced choice models have captured the trade-offs in EV purchase decisions, extensive research grounded in frameworks such as the theory of planned behavior (TPB; Ajzen, 1991) and the extended Unified Theory of Acceptance and Use of Technology (UTAUT2; Venkatesh et al., 2012) has illuminated the drivers of initial EV adoption (Asadi et al., 2021; Curtale et al., 2021; Jain et al., 2022; Kapser and Abdelrahman, 2020; Schmalfuß et al., 2017). However, only limited studies have examined sequential behavioral intentions (Curtale et al., 2022). The study of continuance intention has often leveraged the expectation confirmation model (ECM) to underscore the pivotal role of user satisfaction (US) in fostering loyalty (Cruz-Jesus et al., 2023; Hasan, 2021; Ooi et al., 2025). More recently, the switching decision from FVs to EVs has been modeled using the push-pull-mooring (PPM) framework, which effectively captures the dynamics between push factors (e.g., dissatisfaction), pull factors (e.g., perceived value), and mooring factors (e.g., inertia) (Li et al., 2025; Yu et al., 2025). Despite these models being used to study either first-time purchase, continuance, or switching, little research compares the asymmetric behavioral drivers of FV-to-EV switchers and EV replacement continuers within a unified framework. Current PPM applications, while insightful, have yet to explore these two groups side by side. This leaves a critical question unanswered: how do the specific push, pull, and mooring factors differ in weight and relevance between those contemplating a switch and those deciding to continue with EVs?

To fill this gap, this study develops and empirically validates a novel hybrid framework considering PPM as the overarching structure. The PPM framework provides macrolevel accounts for the switching decision, identifying the three core forces at play, i.e., push factors motivating a departure from the status quo, pull factors attracting toward an alternative, and mooring factors

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facilitating or hindering the decision (Bansal, 2005). Crucially, this study applies this unified architecture to both FV switchers and EV continuers. By mapping distinct user groups onto a single structural model, we establish a standardized baseline to rigorously quantify the heterogeneity of their decision-making pathways. The unified approach enables direct statistical comparison of how identical forces exert asymmetric impacts across groups, a depth of analysis that separate models cannot achieve. However, PPM is a meta-theoretical framework that requires domain-specific constructs for empirical testing. Therefore, we operationalize its core tenets using validated microlevel models.

To specify the push factors, we employ a streamlined American Customer Satisfaction Index (ACSI) model. Unlike the ECM, which focuses on specific postpurchase confirmation, ACSI allows for a nuanced measurement of (dis)satisfaction rooted in the owner's cumulative lived experience (including perceived quality) with their current vehicle. Satisfaction is not modeled as a single item but as an outcome of prior expectations and perceived quality (Fornell et al., 1996; Yilmaz et al., 2021). Concurrently, we leverage core UTAUT2 constructs rather than generic models such as the TPB to articulate the pull and mooring dimensions, which are driven by the need to capture specific vehicular constraints. Pull factors, such as price value, facilitating conditions, and social influence, capture the perceived benefits and social validation of adopting EVs, while the mooring factor of habit operationalizes the behavioral inertia that can hinder switching (Venkatesh et al., 2012).

By embedding these domain-specific constructs within the PPM architecture, our model forms a complete explanatory chain, linking the motivation to change (push), the specific attractors and barriers (pull and mooring), and the resulting behavioral intention. The proposed model maintains the theoretical breadth of the PPM framework while strengthening its empirical precision and explanatory power, which has been increasingly recognized for its robustness in analyzing complex user switching behaviors (Chang et al., 2017; Kushwah et al., 2024). The resulting framework offers a stage-sensitive perspective on replacement decisions and delivers three principal contributions. First, we create the first PPM-based integration tailored for technology replacement scenarios, allowing simultaneous modeling of push, pull, and mooring dynamics in a unified framework. Second, we conduct a multigroup structural equation modeling (SEM) analysis to directly compare FV owners (potential switchers) and EV owners (potential continuers), revealing systematic heterogeneity in their decision-making drivers. Third, we provide segment-specific recommendations for policymakers and industry stakeholders to accelerate the conversion of pragmatic switchers and strengthen the retention of reinforced loyalists.

The remainder of this study is structured as follows. Section 2 develops the conceptual model and details the hypotheses derived from our integrated theoretical framework. Section 3 outlines the research methodology, including survey design, data collection, and processing procedures. Section 4 presents the results of the SEM and multigroup analysis. Section 5 discusses the theoretical and practical implications of our findings. Finally, Section 6 summarizes the key contributions and suggests directions for future research.

2 Theoretical framework and hypothesis development

2.1 PPM-based integrated framework

To develop a comprehensive framework for vehicle replacement decisions, this study integrates the PPM model with a streamlined ACSI and a modified UTAUT2. While the PPM framework robustly explains switching behavior through push, pull, and mooring forces (Bansal, 2005; Chang et al., 2017; Kushwah et al., 2024), it lacks domain-specific predictors. We operationalize these forces by embedding constructs from ACSI and UTAUT2. The conceptual framework Fig. 1 mirrors the cognitive progression of a switching decision: moving from a retrospective evaluation of the status quo to a prospective evaluation of the target alternative.

Specifically, the left part of the model operationalizes the push dimension. Push factors originate from the owner's cumulative experience with their current vehicle (FV or EV). To measure this, we adopt a streamlined ACSI model. Compared to the ECM (Cruz-Jesus et al., 2023; Ooi et al., 2025), ACSI better decomposes durable goods evaluation into user expectation (UE^1), user perceived quality (UPQ), and US (Fornell et al., 1996). We specifically focus on UPQ to capture direct ownership experience rather than complex quality-price trade-offs (Zeithaml, 1988) and omit downstream outcomes such as customer complaints (Fornell et al., 1996; Yilmaz et al., 2021). Here, satisfaction bridges past experience and future intentions, where a negative evaluation (dissatisfaction) generates the impetus to abandon the status quo.

Conversely, the right part of the model articulates the pull and mooring dimensions using a modified UTAUT2. We exclude hedonic motivation and actual use behavior, as pragmatic drivers and behavioral intention are more robust predictors for high-involvement durable goods replacement (van den Hurk et al., 2026; Kapser and Abdelrahman, 2020; Kapser et al., 2021; Venkatesh et al., 2012). Instead, the model incorporates user expectations for the new vehicle (UE^2), price value (PV),

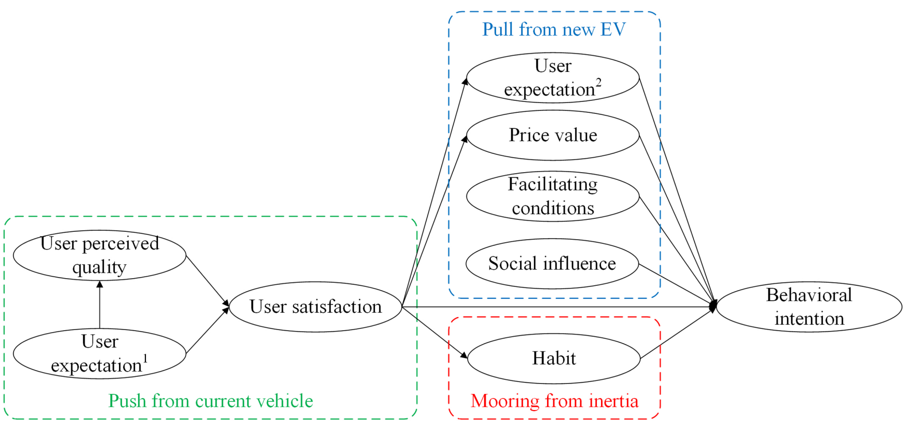

Fig. 1 Integrated PPM framework for vehicle replacement intention.

facilitating conditions (FC), and social influence (SI) as core pull factors. These represent the perceived attractiveness of the new EV, aligning with recent findings on EV switching intentions (Yu et al., 2025).

Simultaneously, habit (HA) acts as a classic mooring factor, representing behavioral inertia (Venkatesh et al., 2012; Wood and Neal, 2016). Crucially, habit operates asymmetrically across our two groups. For FV owners, ingrained routines (e.g., fueling) create mooring inertia, a psychological barrier hindering the switch to EVs. For EV owners, established charging routines create mooring reinforcement, increasing the psychological switching costs of reverting to FVs. By integrating ACSI and UTAUT2 within the PPM architecture, the proposed framework provides both conceptual breadth and domain relevance, enabling the direct comparison of heterogeneous pathways for FV switchers and EV continuers.

2.2 Hypothesis development

2.2.1 Push factors: Experience with the current vehicle

User expectation (UE^1) refers to the owner's prepurchase beliefs about the anticipated performance of their current vehicle, which serves as a cognitive anchor that positively shapes postpurchase evaluations in two distinct ways. First, expectations directly enhance perceived quality, as high initial expectations cognitively prime owners to evaluate performance more favorably (Fornell et al., 1996; Yilmaz et al., 2021). Second, expectations exert a direct positive impact on US. Based on assimilation theory, consumers tend to adjust their postpurchase feelings to align with their initial high expectations to reduce cognitive dissonance (Fornell et al., 1996). Consequently, higher prepurchase expectations directly translate into higher overall satisfaction. Therefore, the following hypotheses are proposed:

H1a: User expectation of the current vehicle has a positive impact on user perceived quality.

H1b: User expectations of the current vehicle have a positive impact on US.

UPQ is defined as a consumer's postpurchase judgment regarding a product's overall excellence or superiority (Zeithaml, 1988). It has been widely confirmed that user perceived quality has a direct positive impact on US (Fornell et al., 1996). A high perceived quality signifies that the vehicle's performance has met or exceeded the owner's expectations, leading to positive confirmation and thereby fostering higher levels of satisfaction. Conversely, experiences with poor quality, such as frequent malfunctions or subpar performance, are a primary source of dissatisfaction. This foundational relationship is particularly critical for high-cost, long-term assets such as automobiles. Thus, we propose:

H2: User perceived quality of the current vehicle has a positive impact on US.

US refers to an owner's overall affective evaluation based on their cumulative consumption experience (Anderson et al., 1994). In the traditional applications of the PPM model, satisfaction fundamentally dictates the choice between inertia and change. High satisfaction validates the initial purchase, fostering loyalty and strengthening continuance intention (Cruz-Jesus et al., 2023; Ooi et al., 2025). Conversely, dissatisfaction signals an expectation-performance gap, acting as a direct push factor that motivates users to seek better alternatives (Hsu, 2014; Oliver, 1980).

In this study, behavioral intention (BI) denotes the intention to purchase an EV during vehicle replacement. Consequently, US exerts a dual effect depending on the current vehicle type. For FV owners, high satisfaction with their current vehicle would theoretically act as a status quo anchor, decreasing their intention to switch to a new technology such as an EV. For EV owners, high satisfaction acts as a retention driver, increasing their intention to repurchase an EV. Therefore, we establish the following baseline direct-effect hypotheses:

H3a: US with the current vehicle has a negative impact on the intention to switch.

H3b: US with the current vehicle has a positive impact on the intention to continue.

2.2.2 Pull factors: The attraction of new EVs

As primary pull factors, performance and effort expectancy, rooted in TAM's perceived usefulness and ease of use (Venkatesh et al., 2003), can be combined into a unified expectation construct that significantly influences behavioral intention (Kapser and Abdelrahman, 2020). Building on this, we define the user expectation of a new EV (UE^2) as owners' prospective beliefs regarding EVs when considering a replacement. Distinct from the retrospective evaluation of current vehicles in ACSI, UE^2 explicitly targets future purchase intention. A strong positive expectation makes the EV alternative highly attractive, effectively pulling consumers toward it. Therefore, we propose:

H4: User expectation of a new EV has a positive impact on both the intention to switch and the intention to continue.

Beyond expectations, three domain-specific pull factors significantly attract users toward EVs: PV, FC, and SI. PV represents the critical trade-off between EV acquisition costs and long-term operational savings, acting as a powerful economic motivator for purchase/use intention (Pamidimukkala et al., 2024; Singh et al., 2023) and continuance intention (Maduku and Thusi, 2023). FC refers to consumers' perceptions of the resources and supports available to perform a behavior (Venkatesh et al., 2012). In this study, facilitating conditions are specifically defined as users' perceptions of available resources and support when using EVs. Previous research has shown that support from policies (Wang et al., 2017) and technology (Champahom et al., 2025; Cruz-Jesus et al., 2023) has a positive impact on users' behavioral intentions.

Social influence is the extent to which consumers believe that valued people suggest using a particular technology (Venkatesh et al., 2012). Usually, the opinions of valued people, such as family and friends, will affect users' behavioral intentions (Asadi et al., 2021; Champahom et al., 2025). For example, Jansson et al. (2017) confirmed that the intention of potential users to adopt alternative FVs is mainly influenced by neighbors, family, and colleagues, and neighbors have the strongest effect. In this context, for FV owners considering a switch, positive social cues of new EVs act as a pull factor, reducing uncertainty. For existing EV owners, integration into EV communities enhances pull factors, reinforcing their choice of new EVs.

In view of the above, we hypothesize the following:

H5: The price value of a new EV has a positive impact on both the intention to switch and the intention to continue.

H6: Facilitating conditions of a new EV have a positive impact on both the intention to switch and the intention to continue.

H7: Social influence of a new EV has a positive impact on both the intention to switch and the intention to continue.

2.2.3 Mooring factors: Anchors to the status quo

The dual mechanism suggests that habit exerts a bipolar influence on replacement intentions. On the one hand, ingrained usage patterns with a current vehicle reinforce the intention to continue, making repurchase a comfortable, low-effort choice. On the other hand, the same inertia creates a psychological barrier to change, thus hindering the intention to switch to an unfamiliar alternative. This dual role of habit is foundational to understanding replacement decisions. While the precise strength of these effects may differ across user groups, we first establish the following hypotheses:

H8a: Habit related to the current vehicle has a negative impact on the intention to switch.

H8b: Habit related to the current vehicle has a positive impact on the intention to continue.

2.3 Interplay between push, pull, and mooring factors

Beyond their direct effects, we theorize that the push factor of satisfaction also shapes pull and mooring factors. A satisfactory ownership experience is not a passive outcome but a dynamic input that calibrates future perceptions. Therefore, we propose three additional pathways to capture the interplay between past experience and future perception.

Satisfaction informs and raises the standards for evaluating future products in the same category (Hasan, 2021). An owner's cumulative experience with their current vehicle establishes a reference point against which all potential replacements are evaluated (Kahneman and Tversky, 1979; Oliver, 1980). Specifically, for satisfied EV owners, the experience with the current EV creates an expectation upshift, demanding that a future EV match or exceed their positive experience. For satisfied FV owners, the benefits of a prospective EV must be clear enough to justify the switch from a reliable incumbent technology. In both scenarios, a higher level of satisfaction with the current vehicle enhances the performance and quality standards expected from a new EV.

Moreover, US is a significant antecedent of perceived price value in the EV purchase context. Satisfaction reflects an accumulated, holistic evaluation of the benefits obtained from the ownership experience relative to the financial and nonfinancial costs incurred (Chen et al., 2017). For EV owners, satisfaction directly validates the economic efficiency of electric mobility. For FV owners, highly successful past vehicle ownership builds cognitive confidence; rather than blindly trapping them in the status quo, this confidence makes them more optimistic and receptive when evaluating the price-to-performance ratio of next-generation technologies such as EVs. Therefore, customers with highly positive ownership experiences are more likely to perceive a new alternative as delivering superior value.

Finally, positive experiences reinforce use behaviors, increasing automaticity and strengthening habit formation. In the EV context, a highly satisfactory ownership experience, encompassing daily driving, charging routines, and maintenance, reinforces these behaviors, gradually embedding them as habits. Such habitual use not only reduces the cognitive effort required for future decision-making (Wood and Neal, 2016) but also strengthens the user's attachment to their current transportation mode. Based on the above discussions, we propose the following hypotheses

H9a: US with the current vehicle has a positive effect on user expectation of a new EV.

H9b: US with the current vehicle has a positive effect on perceived price value.

H9c: US with the current vehicle has a positive effect on habits.

2.4 Heterogeneity hypotheses

By capturing both the drivers of change and the anchors that maintain the status quo, the PPM framework enables a nuanced, stage-dependent interpretation of market dynamics. We posit that the strength and function of these factors are contingent on the ownership stage (FV vs. EV owner).

The psychological impact of satisfaction versus dissatisfaction is inherently asymmetric, a concept rooted in prospect theory's negativity bias, which suggests that negative losses have a stronger psychological impact than positive stimuli of equal gains (Kahneman and Tversky, 1979). Therefore, for FV owners, the decision to switch is often driven by dissatisfaction, a negative experience they are actively seeking to escape, which is an urgent driver for change. For EV owners, the decision to continue is driven by satisfaction, a positive experience they wish to maintain, which is psychologically less potent than the impetus to flee a negative situation. Therefore, we hypothesize that the push from dissatisfaction will be stronger than that from satisfaction.

H10: The effect of satisfaction on behavioral intention is stronger for FV owners than for EV owners.

The importance of economic incentives shifts as consumers move from preadoption to postadoption. For FV owners, the high upfront cost of an EV represents a significant financial hurdle and perceived risk. A strong perception of price value is therefore a critical and powerful pull factor required to overcome this initial inertia and justify the investment. However, EV owners have already surmounted this primary financial barrier. While price value remains relevant for repurchase, its role shifts from a primary motivator to a confirmatory factor, validating their past decision and reinforcing loyalty. Its persuasive power is diminished, as the initial risk has already been resolved. Therefore, the following hypothesis is proposed:

H11: The positive effect of price value on behavioral intention will be stronger for FV owners than for EV owners.

Habit creates behavioral inertia, but the psychological force required to break a long-standing habit is greater than the force needed to maintain a newly formed habit. For FV owners, their ingrained habits (e.g., engine sound familiarity) constitute a formidable mooring barrier. Overcoming this deep-seated inertia requires significant cognitive effort and represents a high psychological switching cost. For EV owners, their newer habits (e.g., home charging, regenerative braking) act as a mooring reinforcement. While this makes continuing easier, the habit is less entrenched, and the force is one of reinforcement rather than resistance to fundamental change. Breaking a decades-old FV habit is a much larger psychological leap. Therefore, we hypothesize that:

H12: The negative effect of habit on the intention to switch for FV owners is stronger than the positive effect of habit on the intention to continue for EV owners.

3 Methodology

3.1 Measurement and survey design

To ensure the validity of the instrument for the specific context of vehicle replacement, the selection and modification of items followed rigorous principles of scenario-adaptability. First, push factors from ACSI that were originally designed for general consumption were adapted to the ownership lifecycle. For instance, satisfaction and quality items were framed to capture the cumulative driving and service experience of the current vehicle. Second, pull factors from UTAUT2 that were originally measuring system use were reframed to measure purchase intention for a high-value durable good. Specifically, facilitating conditions were modified to address the charging infrastructure, and price value was tailored to the trade-off between acquisition and operating costs. Third, items for habit were customized to reflect specific transportation routines (e.g., driving mechanics rather than abstract usage). This conceptual tailoring ensures that the items are not merely theoretical abstractions but are cognitively relevant to the respondents' actual decision-making scenarios. The final constructs and their corresponding measurement items are detailed in Table S1 in the Electronic Supplementary Material (ESM).

3.2 Data collection and sample profile

The survey was conducted online via the Sojump platform, utilizing a mandatory screening question to ensure that all participants were current private vehicle owners. After rigorous data screening (e.g., removing unrealistically short completion times or invariant responses), 803 valid questionnaires were retained, comprising 386 FV owners and 417 EV owners. While the sample is predominantly well-educated and falls into the middle-to-high-income bracket, its sociodemographic distribution aligns closely with the profile of Chinese new car buyers (CATARC, 2024), effectively capturing the core 26–40 age segment driving electric mobility. Detailed descriptive statistics for both groups are summarized in Table S2 in the Electronic Supplementary Material (ESM).

3.3 Common method and nonresponse bias

To ensure data quality, several diagnostic tests were conducted. Chi-square tests comparing early and late respondents revealed no significant differences in key demographics (e.g., $p_{\text{gender}} = 0.278$; $p_{\text{age}} = 0.439$), mitigating concerns of nonresponse bias. Furthermore, both procedural remedies (e.g., anonymity, reverse-coded items) and statistical checks were employed to address common method bias (CMB). Harman's single-factor test confirmed that the first unrotated factor accounted for less than the 40% variance threshold (in Table S3 in the ESM), indicating that CMB is not a significant concern in this study.

4 Empirical results

4.1 Measurement model validation

The measurement model demonstrated excellent overall fit to the data ($x^2/df = 1.065$, comparative fit index (CFI) = 0.998, Tucker-Lewis index (TLI) = 0.997, root mean square error of approximation (RMSEA) = 0.009), and all constructs rigorously satisfied the recommended thresholds for internal consistency, convergent validity, and discriminant validity (detailed evaluation results, including exploratory factor analysis cross-loadings, reliability indices, and the Fornell-Larcker criterion, are provided in Tables S4–S6 in the ESM).

4.2 Structural model

To validate the general framework, an SEM was estimated using the pooled sample (N = 803). The model demonstrated a good overall fit to the data ($x^2/df = 2.162$, CFI = 0.956, TLI = 0.951, RMSEA = 0.038), confirming its structural integrity (Hair et al., 2019). As summarized in Table 1, the results provide strong support for all hypothesized universal paths (excluding group-specific hypotheses H3a, H3b, H8a, and H8b, which were reserved for multigroup analysis). Specifically, the core ACSI relationships linking prior expectations to satisfaction were validated. Furthermore, all four pull factors (with price value and facilitating conditions exerting the strongest influence) significantly and positively predicted behavioral intention. Crucially, US proved to be a pivotal antecedent, significantly shaping future expectations, perceived value, and habit formation. These results confirm the fundamental theoretical linkages of the integrated model.

4.3 Multigroup and heterogeneity analysis

To validate the comparison between FV and EV owners, we performed a series of multigroup measurement invariance tests (Tables S7–S8 in the ESM). The results confirmed configural, metric, and scalar invariance, as indicated by acceptable goodness-of-fit indices (e.g., CFI, TLI, RMSEA), despite the significant chi-square tests attributable to our large sample size. Crucially, invariance was not supported at the level of measurement residuals ($p < 0.05$). This lack of residual invariance provides strong statistical evidence that while the constructs are measured equivalently, the structural relationships between them are moderated by ownership type. This establishes the presence of significant heterogeneity, justifying a separate examination of the causal paths for each group.

To further examine this heterogeneity, the core multigroup hypotheses (H3a and H3b, H8a and H8b, H10–H12) were tested by directly comparing path estimates for the two groups. The path models for each group Figs. 2 and 3 revealed critical asymmetries in the influential factors of switchers and continuers. First, regarding the direct influence of US, the path to behavioral intention was found to be nonsignificant for both FV owners and EV owners. Consequently, neither H3a (hypothesizing a negative effect on switching) nor H3b (hypothesizing a positive effect on continuance) was supported. This indicates that in the replacement context, satisfaction does not act as an immediate motivational force that directly pushes owners away from their current vehicles or pulls them toward a new EV. Instead, its influence emerges indirectly via its effects on future expectations, perceived price value, and habit. Thus, satisfaction functions more as a background evaluative state that shapes these forward-looking and behavioral mechanisms, rather than as a proximal determinant of behavioral intention.

Table 1 Analysis results of path coefficients of the structural model and subhypothesis testing

Hypothesis	Path			β	S.E.	C.R.	p	Test result
H1a	UE^1	→	UPQ	0.443	0.045	10.549	***	Supported
H1b	UE^1	→	US	0.355	0.050	8.055	***	Supported
H2	UPQ	→	US	0.317	0.047	7.247	***	Supported
H4	UE^2	→	BI	0.168	0.043	3.753	***	Supported
H5	PV	→	BI	0.222	0.044	4.732	***	Supported
H6	FC	→	BI	0.210	0.044	4.763	***	Supported
H7	SI	→	BI	0.160	0.044	3.446	***	Supported
H9a	US	→	UE^2	0.455	0.040	10.691	***	Supported
H9b	US	→	PV	0.510	0.042	11.492	***	Supported
H9c	US	→	HA	0.453	0.040	10.090	***	Supported

Note: ***, $p < 0.001$; **, $p < 0.01$; *, $p < 0.05$. S.E.: standard error, and C.R.: critical ratio.

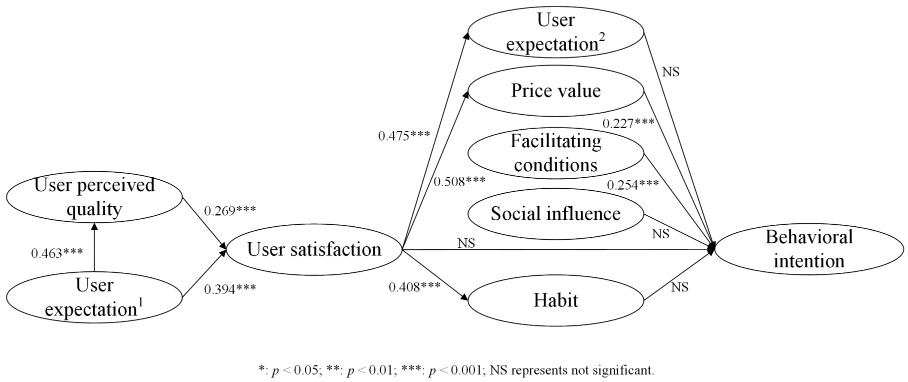

Fig. 2 Results of SEM for switching intention of FV owners.

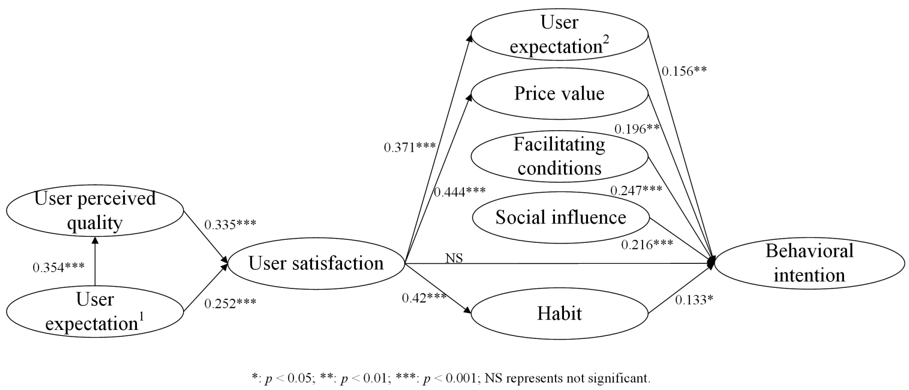

Fig. 3 Results of SEM for continuance intention of EV owners.

Second, the mooring effect of habit demonstrated significant heterogeneity. For FV owners, the path from habit to switching intention was nonsignificant. This finding fails to support H8a, which predicted a negative effect. In stark contrast, for EV owners, habit exerts a significant positive influence on continuance intention (β = 0.216, p < 0.001), thus supporting H8b. It can be inferred that while habit reinforces loyalty among existing EV users, it does not function as a significant psychological barrier preventing FV owners from considering a switch.

Third, the analysis of heterogeneity hypotheses yielded mixed results. Regarding H11, the positive effect of price value on behavioral intention was indeed stronger for FV owners (β = 0.227, p < 0.001) than for EV owners (β = 0.196, p < 0.01), supporting the hypothesis that economic incentives are a more potent pull factor for prospective switchers. However, H12 is not supported, as its core premise was invalidated. The hypothesis posited that the negative effect of habit for FV owners would be stronger than the positive effect for EV owners, but since the effect for FV owners was nonexistent, this comparison is not possible, directly refuting the hypothesized relationship.

To further elucidate the complex role of US, a mediation analysis was conducted using the bootstrapping method (5000 samples) with 95% bias-corrected confidence intervals. If the confidence interval does not include zero, the mediating effect is considered significant. Detailed results, including specific indirect effects and their proportions, are presented in Tables S9–S11 in the ESM. For FV owners, the analysis revealed that satisfaction operates through a single, focused indirect channel: higher satisfaction with their current vehicle significantly enhances their perception of a new EV's price value (indirect effect: β = 0.115, p < 0.01), which in turn drives switching intention. The other potential mediating paths were nonsignificant for this group. For EV owners, the indirect influence of satisfaction was both broader and stronger. It significantly boosted continuance intention through all three mediating pathways: strengthening expectations for a new EV, perceived price value, and existing use habits (total indirect effect: β = 0.201, p < 0.05). Among these pathways, strengthening perceived value contributed the most, while habit formation also played a notable role in reinforcing loyalty. The results showed that the total indirect effect for EV owners was larger than that for FV owners, indicating that H10 is not supported.

The mediation results confirm that although the direct satisfaction-intention paths are nonsignificant for both groups, satisfaction still exerts a meaningful total effect on behavioral intention through different indirect pathways. For FV owners, this effect is concentrated in the path US→PV→BI, which accounts for 100% of the total indirect effect. For EV owners, it is distributed across US→UE^2→BI, US→PV→BI, and US→HA→BI, contributing 28.86%, 43.28%, and 27.86% to the total indirect effect, respectively. The structural pattern explains why H3a and H3b are not supported at the direct level, while satisfaction remains theoretically and empirically important as an antecedent of key pull and mooring factors.

In summary, the results reveal the context-dependent role of satisfaction. For FV owners, satisfaction with their current vehicle does not deter switching; instead, it sets a higher benchmark for the value that an alternative must offer. For EV owners, satisfaction creates a powerful, multifaceted reinforcement loop, indirectly strengthening loyalty through cognitive, economic, and behavioral pathways. The decision model for switchers is thus highly pragmatic and parsimonious, while for continuers, it is a complex system of reinforcement.

5 Discussion and implications

The SEM results indicate that the predictors in our model explain

41.8% of the variance in owners' behavioral intention to purchase EVs as their next vehicles. The findings affirm the strong applicability of the integrated framework in the context of vehicle replacement decisions while also revealing several counterintuitive patterns that extend and refine prevailing theories of technology adoption. This section discusses the theoretical contributions and practical implications of these results.

5.1 Determinants of US and behavioral intention

Our findings first validate the applicability of the ACSI and UTAUT2 frameworks in the high-stakes automotive context. Consistent with ACSI, prior expectations significantly anchor subsequent perceptions of quality and satisfaction, a process likely amplified by the high financial and personal commitment of a vehicle purchase (Fornell et al., 1996). The results also confirm the multifaceted nature of the pull toward EVs, as theorized by UTAUT2 (Venkatesh et al., 2012). Price value and facilitating conditions emerge as the most potent predictors, reaffirming that economic rationality and ecosystem readiness are primary drivers of EV adoption (Wang et al., 2017). Concurrently, user expectation and SI exert comparable effects, highlighting a dual pathway where adoption is driven by both personal performance evaluation and social normative pressures (Kapser and Abdelrahman, 2020).

Furthermore, our model offers novel insights by linking satisfaction to habit formation. The strong positive path from US to habit suggests that positive ownership experiences are not passive; they actively forge behavioral routines that deepen loyalty. This finding bridges the gap between attitudinal models (such as ACSI) and behavioral inertia theories, positing satisfaction as a key mechanism in the entrenchment of consumer habits.

5.2 Asymmetric drivers of EV switching and continuance

The multigroup analysis identifies two distinct psychological pathways shaping the purchase intentions of current FV owners and existing EV owners. Switching intention is predominantly a pragmatic, pull-driven decision, while continuance intention reflects an emotional, mooringanchored commitment.

5.2.1 Switching intention of FV owners

For FV owners, the decision to switch is a highly pragmatic calculation, driven almost exclusively by the tangible pull of price value ($\beta = 0.227$, $p < 0.001$) and facilitating conditions ($\beta = 0.254$, $p < 0.001$). This reinforces the view that mainstream adoption hinges on a rational assessment of tangible benefits, aligning with total-cost-of-ownership logic where long-term savings and ecosystem readiness are paramount.

Equally revealing are the factors that lack influence. The absence of a direct push from US suggests that switching is a proactive search for superior utility, not a reactionary escape from deficiencies, a finding that contrasts with some PPM applications (Yu et al., 2025). Interestingly, our mediation results reveal that for FV owners, satisfaction actually exerts a positive indirect effect on switching intention via perceived price value. This implies that FV owners who are highly satisfied with their past vehicles possess higher consumer confidence, making them more optimistic about the value proposition of emerging EV technologies rather than remaining anchored to the status quo. Furthermore, their decision appears insulated from abstract influences; expected performance, social norms, and even long-standing habits were all nonsignificant. The nonsignificant effect of habit is particularly noteworthy and contrasts with findings from high-friction switching contexts, such as from cars to bicycles, where habit presents a major barrier (Gutiérrez et al., 2020). In our sample, over half of the FV owners are concentrated in the 26–40 age group and possess moderate driving experience. Combined with their relatively high education and income levels, this profile suggests a cohort that is more adaptable and less constrained by entrenched behavioral patterns. This demographic composition, together with the increasingly similar in-vehicle interfaces and driving dynamics of modern FVs and EVs, likely reduces the perceived cost of switching. As a result, the habitual use of FVs does not translate into a statistically significant mooring force hindering EV adoption in this group.

Likewise, the nonsignificant role of social influence suggests that FV owners in our sample do not rely on vicarious experience or peer endorsement when considering a fundamental technology shift. For high-stakes, high-cost transitions such as replacing a private car, personal economic affluence and infrastructure readiness appear to outweigh descriptive norms, which are often more decisive in lower-involvement or lower-risk domains. This result nuances the UTAUT2 assumption that social influence is a generic driver of technology use, indicating that its effect may attenuate when the perceived personal and financial stakes are high and when clear economic signals are available.

A similar pattern emerges for user expectation of a new EV (UE^2), which also fails to reach significance for FV owners. Although expectations of future EV performance are generally positive in the sample, they do not translate directly into switching intention once price value and facilitating conditions are taken into account. This suggests that for prospective switchers, abstract performance beliefs about EVs are overshadowed by concrete evaluations of affordability and charging convenience. In other words, positive expectations are necessary but not sufficient, and they may only become behaviorally consequential when anchored in a favorable cost-convenience structure.

5.2.2 Continuance intention of EV owners

In sharp contrast, the loyalty of existing EV owners isunderpinned by a complex and multifaceted support system. Central to this is the powerful mooring effect of habit ($\beta = 0.216$, $p < 0.001$), confirming that deep integration into the EV ecosystem, from charging routines to driving styles, forges strong behavioral retention (Liu et al., 2024). However, this loyalty is notmerely passive inertia. It is actively reinforced by the continued significance of all four pull factors: Facilitating conditions ($\beta = 0.247$, $p < 0.001$), price value ($\beta = 0.196$, $p < 0.01$), user expectation ($\beta = 0.156$, $p < 0.01$), and SI ($\beta = 0.216$, $p < 0.001$). This indicates that continuance is a dynamic process anchored by routine but constantly validated by ongoing practical benefits and social identity. A final, notable finding is the nonsignificant direct effect of satisfaction. In the postadoption stage, satisfaction seems to function as a necessary baseline for acceptance but is insufficient on its own to drive deep loyalty. The decision to remain appears to be driven more by forward-looking reinforcement from habits and perceived benefits than by retrospective evaluation.

5.3 Theoretical implications

This study offers three primary theoretical contributions that extend the explanatory power of the PPM framework in the context of technology replacement. First, we reveal the dynamic and stage-dependent nature of the PPM framework. Contrary to a static view, our findings show that the model's structure adapts to the consumer's context. For FV owners, it contracts to a parsimonious, pull-dominant logic where the switch is driven almost exclusively by tangible utility. For EV owners, it expands into a fully reinforced model where mooring (habit) and a full suite of pull factors (from economic value to SI) are complementary and significant. The results contrast with prior PPM applications in high-friction contexts (Gutiérrez et al., 2020), where habit or inertia emerges as a strong negative predictor of switching because the alternative requires substantial operational and routine changes (e.g., modal shifts or channel migration). In our replacement context, where FVs and EVs are operationally similar and users are relatively young and adaptable, habit is no longer a universal barrier but a stage- and context-contingent force.

Second, we reposition the nuanced role of US. Contrary to many continuance and repurchase studies, which report a strong direct effect of satisfaction on behavioral intention (Cruz-Jesus et al., 2023; Hasan, 2021; Ooi et al., 2025), our results show that satisfaction has no significant direct impact on behavioral intention for either FV or EV owners. Instead, its influence is exerted through indirect paths via future expectations, perceived price value, and habit (HA). In this sense, satisfaction acts as a benchmark for evaluating alternative options and as a background condition that shapes expectations and value perceptions rather than as an immediate behavioral driver. This suggests that in durable-goods replacement contexts, the commonly assumed universal satisfaction-loyalty link may be stage-dependent and structurally mediated, which calls for a more context-sensitive use of satisfaction in PPM-based models.

Third, we reconceptualize social influence as a stage-dependent construct. Challenging its monolithic treatment in models such as UTAUT2, we find it to be nonsignificant for prospective switchers, for whom the abstract pressure of validation is eclipsed by the pursuit of tangible benefits. Conversely, for existing EV owners, it transforms into a powerful pull factor. This transition signals a fundamental shift from weak external persuasion to robust in-group reinforcement, a dynamicity often nurtured within digital communities that fosters collective identity. Synthesizing these findings, the nonsignificant paths for FV owners, spanning SI, performance expectations, and habit, indicate that several canonical drivers in UTAUT2 and prior PPM studies do not operate universally in high-involvement replacement contexts. Instead, their efficacy is contingent upon the user's position in the adoption lifecycle and the salience of economic and infrastructural constraints. Consequently, the results should not be interpreted as statistical anomalies but as evidence of critical boundary conditions delineating when and for whom social norms, expectations, and habits exert influence.

Collectively, these findings establish the PPM model as a flexible, stage-contingent framework for diagnosing heterogeneous adoption behaviors and designing segment-specific transition strategies.

5.4 Practical implications

The findings yield differentiated strategies for policymakers and industry, which should be tailored to two key segments: the pragmatic switcher (current FV owners) and the reinforced loyalist (current EV owners).

To convert pragmatic switchers, the emphasis must be on tangible, utilitarian value. This group shows minimal response to aspirational messaging or SI, with purchase intention driven by clear evidence of functional and economic superiority. Policies and marketing should therefore focus on (1) transparently communicating the total cost of ownership, including savings and subsidies, and (2) maximizing convenience through a dense, reliable charging network. As supported by comparative studies, cost pressure and incentives are key drivers of switching (Yu et al., 2025). Crucially, the EV should be positioned not as a remedy for dissatisfaction but as a logical, superior upgrade to an already acceptable mode of transport, a rational progression rather than an emotional escape.

Retaining reinforced loyalists requires a multilayered strategy. While ongoing improvements to price and convenience are important, this group's commitment is more deeply anchored by mooring factors. Effective measures should therefore focus on (1) cultivating community engagement through owner clubs and events to create a powerful social lock-in and (2) seamlessly enhancing the ownership experience, from software to charging interoperability, to increase the psychological cost of defection. By anchoring community bonds while continuously delivering functional value, stakeholders can secure high retention rates and transform existing owners into organic advocates, reinforcing market momentum.

6 Conclusions and future work

This study set out to examine the heterogeneous behavioral intentions driving the vehicle replacement market, a critical frontier for the sustainable penetration of EVs. By integrating the PPM framework with the UTAUT2 and the ACSI, we developed and empirically validated a model that captures the distinct psychological pathways of potential switchers (current FV owners) and continuers (current EV owners). Our findings reveal a fundamental behavioral asymmetry in which FV owners are influenced predominantly by rational, pull-driven evaluations of price value and convenience, whereas EV owners' continued commitment is reinforced by a synergistic interplay of mooring factors (habit) and ongoing pull benefits (performance, convenience, price advantages, SI). This dual-path insight challenges overly linear technology-adoption models and offers a theoretically grounded, evidence-based roadmap for designing targeted market interventions to simultaneously accelerate mainstream conversion and strengthen loyalty within the existing EV user base.

Despite these contributions, several limitations provide opportunities for future research. First, the cross-sectional design limits our ability to capture the dynamic evolution of perceptions and intentions. Longitudinal studies tracking the same individuals across multiple years would help identify how external factors (e.g., fuel price volatility, charging infrastructure expansion) and personal circumstances reshape decision pathways. Second, while our model explains a substantial proportion of variance in behavioral intention, other constructs could improve explanatory power. Future research might explore perceived risks (e.g., battery degradation, resale value), environmental consciousness, perceived innovativeness, or the moderating role of specific policy instruments. Third, our sample was collected via an online platform using convenience sampling. While the socio-demographics align reasonably well with recent industry reports on Chinese new car buyers, the sample is not strictly representative of the entire population (particularly older or less digitally literate owners), which may affect the generalizability of the findings. Fourth, future research should extend the analysis from static purchase intentions to dynamic usage behaviors and associated spatiotemporal carbon emission patterns (Chen et al., 2025; Gao et al., 2025; Yang et al., 2026), potentially incorporating bounded rationality in activity-travel behavior (Wang and Liao, 2023) or employing physics-guided deep learning models for precise demand prediction (Zhang et al., 2024). Finally, integrating these microlevel behavioral insights into multimodal supernetwork models (Qin and Liao, 2022, 2024) would allow for a comprehensive assessment of system-wide accessibility and eqity.

Author contributions

Qing Li: Writing – original draft, Validation, Software, Methodology, Formal analysis, Data curation, Conceptualization. **Yuting Liu**: Software, Formal analysis, Data curation. **Feixiong Liao**: Writing – review & editing, Conceptualization, Supervision.

Replication and data sharing

The source codes and replication package are available on ETS-Data at https://doi.org/10.26599/ETSD.2026.9190008.

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Declaration of competing interest

The authors have no competing interests to declare that are relevant to the content of this article.

Electronic supplementary material

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