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Electric vehicle adoption intention in the Himalayan region using UTAUT2 – NAM model

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ABSTRACT

Electric vehicles (EVs) can significantly lower transport fuel consumption and carbon emissions. Therefore, the Indian Government is vigorously promoting the adoption of EVs. Himachal Pradesh has become one of the leading states to start the adoption of EVs for public transport in India. Based upon the unified theory of acceptance and use of technology (UTAUT2) and norm activation model (NAM), an integrated model of potential consumers' adoption intentions was built. A questionnaire survey was carried out among potential consumers in Himachal Pradesh, India. Data were obtained from potential consumers' (N = 309) and were assessed using structural equation modelling (SEM). The findings show that performance expectancy, facilitating conditions, hedonic motivation, price value, and personal norms have significant positive effects on consumers' intentions to adopt EVs. However, effort expectancy, social influence, and habit do not significantly impact adoption intention. In addition, the multi-group SEM analysis of different age groups showed significant differences in social influence and hedonic motivations in the path of consumer adoption intention. Finally, implications for policymakers and future research directions are discussed.

1. Introduction

In recent years, India has been facing problems with energy and the environment. On the one side, energy consumption and demand have been continuously increasing due to population rise and industrialization. In 2016, India's foreign oil dependence exceeded 80 % and this will exceed 90 % around 2025 (Li and Wang, 2019; Singh et al., 2021). On the other side, the issue of environmental pollution is becoming severe. In 2021, India had the 35 most polluted cities out of 50 of the world's most polluted cities list and New Delhi ranked one (IQAir, 2021). The Indian transport sector accounts for 55 % of the overall oil consumption and is responsible for 14 % of carbon emissions (Bhat et al., 2022). The road transport vehicles in India have grown from 17.6 crores in 2013 to 29.6 crores in 2019 with an annual average growth rate of 6 % (Statista, 2021), which caused rising fuel consumption and a large amount of carbon emission. Therefore, the carbon emission of road transport vehicles is becoming severe and the Government of India (GoI) is working on different strategies and policies to reduce the carbon emission. Electric vehicle (EV) mobility is one of the critical policies among them.

Adoption of EVs is crucial to reducing oil fuel consumption and environmental pollution (Singh et al., 2020). The literature has shown that EVs provide more energy-saving and pollution reduction benefits as compared with internal combustion engine vehicles (ICEVs) (Jaiswal et al., 2021; Dua et al., 2021; Vidhi and Shrivastava, 2018). Considering energy saving and pollution reduction advantages offered by EVs, the GoI has set a target of 100 % EVs by 2030 (Tarei et al., 2021). To achieve this target, the GoI started 'National Electric Mobility Mission Plan 2020. Also, for the adoption of EVs, the GoI implemented the 'Faster Adoption and Manufacturing of EVs (FAME)' scheme by giving subsidies to EV purchases in 2017 (Singh et al., 2021). Under the continuous efforts of GoI, in February 2022, EV sales grew by 297 % (FADA, 2022).

Himachal Pradesh is a hilly state located in the North-Western Himalayan ranges along with a famous destination; hence, anthropogenic pressure applied by tourists is immense. The concentration of suspended particulate matter (SPM) for the state is approximately 85 $\mu\text{g}/\text{m}^3$ for the year 2015–16, which is higher than the national standard limit of 60 $\mu\text{g}/\text{m}^3$ (PCB, 2016). In addition, the annual average temperature in the state is expected to rise by 2.7 ± 0.7 °C by 2030 compared to 1970 levels

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(Batta, 2016). Therefore, to reduce road transport emissions and conserve the sensitive Himalayan ecosphere, the state of Himachal Pradesh became one of the first states in India to run electric passenger transport buses (EPTBs). Presently, 1,175 EVs are running on the state's roads, mainly electric buses, electric taxis, e-rickshaws, and electric 2-wheelers. The state has set up nine dedicated charging stations, with ten more being sanctioned by the Ministry of Heavy Industries (MHI) and thirteen retail outlets where EV charging facilities are accessible (MHI, 2022). In addition, the state plans to set up at least one charging station within every kilometer of the grid in four model towns – Baddi, Dharmasala, Mandi, and Shimla. Also, the state targets at least one charging station on both sides of busy National Highways and State Highways every 25 km and 50 km, respectively (GoHP DOT, 2022). Finally, the state has set a target of 15 % new EVs by 2025 (GoHP DOT, 2022). To achieve this target, the state government is going to implement a series of incentive policy measures for EV adoption, such as purchase incentives, and tax and fee waivers. Also, the state government would pressure consumers to adopt EVs. Consequently, based on the literature review on various EV adoption studies, this study identifies “What are the main factors influencing EV adoption in the Himalayan region?” as a research question for detailed investigation.

Since EV is a comparatively new technology in India, few types of research have been conducted on the adoption intentions of EVs to analyze the individuals' acceptance and the consumers' adoption intentions towards this emerging technology (Bhat et al., 2022; Sahoo et al., 2022; Jaiswal et al., 2021; Shalender and Sharma, 2021; Khurana et al., 2020). Despite China, the USA, and Europe, EVs are a relatively new technology in the Indian automobile industry (Singh et al., 2021). At the same time, the GoI has observed the profits of EVs adoption, and strategies and policies have been framed toward upgrading their adoption (Sahoo et al., 2022). Although it is foremost to use EVs for worldwide concerns involving environmental and transportation system sustainability, acceptance by the public and consumers should be considered to speed up the adoption (Rezvani et al., 2015). The acceptance of individuals and consumers regarding EV adoption depends on individual decision-making. Therefore, identifying the factors encouraging and extending EV adoption at the personal level is of considerable significance (Singh et al., 2020). Moreover, local policy measures also play an essential role in enhancing EV adoption. Overall, adopting EVs could improve fuel efficiency, lower fuel prices, and reduce air pollution.

Electric vehicle adoption intentions (EVADINT) from the individual viewpoint have been investigated by several researchers in terms of factors impacting adoption behavior (Singh et al., 2020; Kumar and Alok, 2020; Huang and Ge, 2019). Moreover, these factors of EVADINT were expressed in terms of self-interest factors (Xia et al., 2022; Asadi et al., 2021; Singh et al., 2020) and socio-psychological factors (Jain et al. 2021; Shalender and Sharma, 2021; Adnan et al., 2018). Furthermore, these factors are primarily based on models that are self-regarding – that is, social cognitive theory (Jaiswal et al., 2022; Wang et al., 2021), theory of planned behaviors (TPB) (Asadi et al., 2021; Sahoo et al., 2022; Jayasingh et al., 2021; Shalender and Sharma, 2021; Huang and Ge, 2019; Hausteijn and Jensen, 2018), the theory of reasoned action (Malik and Yadav, 2021; Alzahrani et al., 2019; Nosi et al., 2017), innovation diffusion theory (Verma et al., 2020; Tu and Yang, 2019), consumption value theory (Han et al., 2017), and the technology acceptance model (Adu-Gyamfi et al., 2022; Jaiswal et al., 2021; Wu et al., 2019; Wang et al., 2018), and as well as a unified theory of acceptance and use of technology (UTAUT) (Zhou et al., 2021; Gunawan et al., 2022; Abbasi et al., 2021; Khazaei and Tareq, 2021; Bhat et al., 2022; Jain et al., 2021). Researches often point out at need for analyzing the adoption behavior and the social-psychological variables of EVADINT as well (Sahoo et al., 2022; Asadi et al., 2021), which gives an integrated investigation of psychological procedures that lead to behavioral intent. Consequently, there is necessary to recognize inspirations for EVs adoption that describe self-interest as well as altruistic interests. This study attempts to propose a self-interest model that is

UTAUT2 and a philanthropic behavior model—the norm activation model (NAM)—that permits us to explain the expectancy-value foundations of EV adoption, which fills this research gap. In addition, the age of individuals/consumers has a major impact on their behavior (Natarajan et al., 2018; Liébana-Cabanillas and Alonso-Dos-Santos, 2017). Some studies in mobile commerce such as Natarajan et al. (2018); and Liébana-Cabanillas et al. (2014) have examined that young respondents were more innovatory and happily accepted new technologies as opposed to older respondents. However, earlier studies in the field of EVADINT have not observed the moderation effects of age in general. Therefore, the moderating effect of age was used to examine whether EVADINT, will be decisive or not. To our best knowledge, these research gaps remain mostly understudied in the case of EVADINT.

The aims of this research were threefold: (1) to identify the constructs, theories, and models on EVADINT, (2) to evolve and test an integrated model (UTAUT2-NAM) that describes the major factors in EVADINT, and (3) to analyze the moderating impact of age on the integrated model. Further, this research contributes in several ways; first, this research critically reviewed and explored the most common constructs, theories, and models of the last 5 years in the context of EVADINT. Second, the factors influencing EVADINT within the UTAUT2-NAM model are explored. The UTAUT2 includes factors that describe personal value or self-interest and the NAM focuses on the well-being of others. Second, as it is suggested in (Singh et al., 2021), India is majorly dependent upon imported energy, experiencing the compulsion to reduce carbon discharge and develop energy-saving policies and strategies. Therefore, developing a framework for the minimization of carbon emissions appears crucial. Fourth, EVs have been recently launched in India and therefore, a more extensive informational framework is needed regarding the factors that may impact customers' decision-making regarding EVs adoption. Therefore, the proposed model will likely give an enhanced description and better understanding of EVADINT among consumers. Fifth, the significant differences in age group towards EVADINT are explored. Finally, In the context of India's EV policy, this research utilized the integrated UTAUT2-NAM model from the viewpoint of consumers' psychology and suggested some targeted policy recommendations. According to UTAUT2 and NAM consumers' adoption intention is an essential component in analyzing adoption behavior. The stronger consumers' adoption intention is, the probability they are to use EVs.

The rest of the article is ordered as follows: (2) overview of studies that present literature on EVADINT and theoretical background, (3) research hypotheses and the conceptual model, (4) data analysis methods, (5) results, (6) discussion and implication, and (7) conclusion and future scope.

2. Overview of literature

2.1. Review of EVADINT

Several researchers have investigated the factors of EVADINT from the individual and consumers' perspectives (Singh et al., 2020; Chu et al., 2019; Shankar and Kumari, 2019). These identified factors of EVADINT were expressed in terms of a variety of theoretical approaches as shown in Table 1. Also, Table 1 shows that UTAUT and NAM are two governing theories in several earlier studies (Bhat et al., 2022; Gunawan et al., 2022; Ashraf Javid et al., 2021; Abbasi et al., 2021; Asadi et al., 2021; Hamzah and Tanwir, 2021; Jain et al. 2021; Khazaei and Tareq, 2021; Zhou et al., 2021; Wahl et al. (2020a); He and Zhan, 2018; Rezvani et al., 2017). In the most recent study, Bhat et al. (2022) applied the UTAUT model to examine the EVs adoption by Indian consumers. Also, Jain et al. (2021) studied the integrated UTAUT model to forecast EVADINT in India combined with environmental concern, perceived risk, and government support. However, these studies did not discuss factors such as price value (PV), habit (HB), and hedonic motivations (HM). Zhou et al. (2021) employed the UTAUT2 model to analyze the

Table 1
Review of literature on EVADINT.

Study	Theory	Construct	Country	Vehicle type
Adu-Gyamfi et al. (2022)	TAM, TPB	Attitude, subjective norm, perceived behavior control, perceived risk, knowledge, perceived usefulness	China	EVs
Bhat et al. (2022)	UTAUT	Performance expectancy, facilitating conditions, technological enthusiasm, technological enthusiasm, perceived benefits, social image, social influence, anxiety	India	EV
Gunawan et al. (2022)	UTAUT2, TPB	Performance expectance, effort expectancy, subjective norm, facilitating conditions, price value, habit, perceived behavior control, attitude towards use, risk perceptions	Indonesia	EV
Jaiswal et al. (2022)	SGT	Subjective norm, environmental concern, perceived knowledge, Perceived incentive policy, attitude, adoption intention	India	EV
Korkmaz et al. (2022)	UTAUT2	Performance expectance, effort expectancy, subjective norm, facilitating conditions, price value, habit, trust and safety, perceived risk, behavioral intention	Turkey	AV
Sahoo et al. (2022)	• TRA, TPB, MM	Personal positive motive, social motive, personal negative motive, attitude, buying involvement, word of mouth	India	EVs
Vafaei-Zadeh et al. (2022)	• TAM, TPB	Attitude, environmental self-image, perceived behavior control, perceived ease of use, perceived risk, perceived usefulness, price value, subjective norm, infrastructure barrier	Malaysia	EV
Xia et al. (2022)	• IDT	Perceived compatibility, perceived complexity, perceived relative advantage, economic aspect, social aspect, functional aspect	China	EV
Abbasi et al. (2021)	• UTAUT	Performance expectancy, effort expectancy, social influence, technophilia, perceived environmental knowledge, purchase intention	Malaysia	EVs
Asadi et al. (2021)	• TPB, NAM	Perceived value, attitude, perceived behavioral control, subjective norm, personal norm, perceived consumer effectiveness, financial incentives, awareness of consequences, ascription of responsibility, personal norm, intention to use	Malaysia	EVs
Ashraf Javid et al. (2021)	• Extended NAM	Reliable factors, awareness of consequences, ascription of responsibility, social values, personal preferences, economic values, willingness to buy and willingness to use, personal norms	Pakistan	EVs
Featherman et al. (2021)	• TRA, RBM	Perceived risk, perceived benefits, vendor trustworthiness, vendor expertise	USA	EVs
Hamzah and Tanwir (2021)	• TPB, NAM	Environmental concern, perceived environmental responsibility, perceived green value, green purchase attitude, perceived behavioral control, subjective norm, environmental knowledge, green purchase intention	Malaysia	HV
Ho and Wu (2021)	• TRAM, NAM	Technology readiness, perceived usefulness, perceived ease of use, intention to adopt, awareness of consequences, personal norm	Taiwan	ES
Jain et al. (2021)	• UTAUT	Performance expectancy, effort expectancy, social influence, facilitating conditions, perceived risk, environmental concern, government support	India	EVs
Jaiswal et al. (2021)	• TAM	Perceived usefulness, perceived ease of use, perceived risk, attitude towards EVs, incentive policies	India	EVs
Jayasingh et al. (2021)	• TPB	Environmental concern, perceived economic benefit, social influence, charging infrastructure, attitude	India	EVs
Khazaei and Tareq (2021)	• UTAUT	Social influence, facilitating conditions, range anxiety, and perceived enjoyment	Malaysia	EC
Malik and Yadav (2021)	• TRA, TPB	Past green behavior, environmental concern, social influence, consumer environmental, attitude, awareness of EVs, attitude, perceived economic benefit, purchase intention	India	EVs
Park et al. (2021)	• TAM	Perceived usefulness, perceived ease of use, social influence, and facilitating condition, intention to use AVs	South Korea	AV
Shalender and Sharma (2021)	• Extended TPB	Attitude, subjective norm, perceived behavioral control, moral norm, environmental concern	India	EVs
Wang et al. (2021)	• SCT	Social norm, environmental concern, face consciousness, incentive policy perceptions, attitude, adoption intention	China	BEV
Zhou et al. (2021)	• UTAUT2	Performance expectancy, effort expectancy, social influence, facilitating conditions, hedonic motivation, price value, habit, incentive policies	China	EVs
Kapser and Abdelrahman (2020)	• UTAUT2	Performance expectancy, effort expectancy, hedonic motivation, perceived risk, social influence, facilitating conditions, perceived risk, price sensitivity, behavioral intention	Germany	ADVs
Nordhoff et al. (2020)	• UTAUT2	Performance expectancy, effort expectancy, hedonic motivation, social influence, facilitating conditions, behavioral intention	Eight European countries	AC
Verma et al. (2020)	• IDT	Perceived compatibility, perceived complexity, perceived relative advantage, observability, EV market share awareness	India	EV
Wahl et al. (2020a)	• UTAUT, NAM	Performance expectancy, effort expectancy, social influence, facilitating conditions, awareness of consequences, ascription of responsibility, personal norm, intention to adopt	Germany	BEV
Alzahrani et al. (2019)	• TRA	Subjective norm, environmental concern, HEV intention, attitude	Saudi Arabia	HEV
Higuera-castillo et al. (2019)	• PVT, TRA	Quality, emotion, price, social, acceleration, low noise, attitude, intention to adopt	Spain	EM
Huang and Ge (2019)	• TPB	Attitude, perceived behavioral control, subjective norm, cognitive status, product perceptions, non-monetary incentive policy measures, monetary incentive policy measures, purchase intentions	China	EV
Shankar and Kumari (2019)	• TPB	Environmental concern, attitude, social norm, perceived behavioral control, perceived obligation	India	EVs.
Tu and Yang (2019)	• TPB, TAM, IDT	Purchase intention, attitude towards behavior, perceived usefulness, perceived ease of use, compatibility, personal innovativeness, subjective norm, interpersonal influence, external influence, self-control ability, self-efficacy, facilitating conditions, perceived behavioral control	China	EV
Wu et al. (2019)	• TAM	Green perceived usefulness, environmental concern, perceived ease of use, behavior intention	China	AEV
Adnan et al. (2018)	• Extended TPB	Environmental concern, attitude, subjective norm, perceived behavioral control, personal norm, purchase intention, adoption of PHEV, hyperbolic discounting	Malaysia	PHEV
Haustein and Jensen (2018)	• TPB	Environmental concern, attitude, subjective norm, perceived functional barriers, busy life style, personal norm	Denmark, Sweden	EV

(continued on next page)

Table 1 (continued)

Study	Theory	Construct	Country	Vehicle type
He and Zhan (2018)	• NAM	Awareness of consequences, ascription of responsibility, personal norms, perceived consumer effectiveness, perceived complexity, perceived price, intention to adopt	China	EV
Wang et al. (2018)	• TAM	Perceived usefulness, attitude, knowledge, perceived risk, adoption intention	China	EV
Han et al. (2017)	• CVT	Monetary value, performance value, convenience value, emotional value, social value identity, social value responsibility, epistemic value, attitude, adoption intention	China	EV
Nosi et al. (2017)	• TRA	Subjective norm, attitude, technological service, barriers, benefits	Italy	EC
Rezvani et al. (2017)	• Extended NAM	Moral norm, awareness of consequences, ascription of responsibility, positive anticipated emotions, negative anticipated, intention to adopt	Sweden	EV
Rahman et al. (2017)	• TAM, TPB, UTAUT	Attitude, performance expectancy, effort expectancy, perceived behavioral control, social influence, behavioral intention	USA	AV
Schmalfuß et al. (2017)	• Extended TPB	Subjective norm, attitude towards BEVs, perceived behavioral control, evaluation of product attributes	Germany	BEV

Note: EV- electric vehicle, PHEV- plug in hybrid electric vehicle, BEV- battery electric vehicle, HV- hybrid vehicle, EC- electric car, EM- electro mobility, ES- electric scooter, AEV- autonomous electric vehicle, ADVs- Autonomous delivery vehicles, AC- automated car, TAM- technology acceptance model, TPB- theory of planned behavior, TRA- theory of reasoned action, MM- motivational model, SGT- social cognitive theory, UTAUT- unified theory of acceptance and use of technology, RBM- risk benefit model, IDT- innovation diffusion theory, CVT- consumption value theory, PVT- perceived value theory, TRAM- technology readiness and acceptance model.

EVADINT of taxi drivers from the perspective of China. Khazaei and Tareq (2021) used the UTAUT2 model to examine EVADINT in Malaysia. But the variables such as effort expectancy (EE), HB, and PV were not considered in this research. Gunawan et al. (2022) used an integrated model of UTAUT2-TPB to examine the EVADINT from the perspective of Indonesia. Wahl et al. (2020a) developed the integrated UTATU-NAM model and findings showed that the performance expectancy (PE), EE, facilitating conditions (FCs), social influence (SI), and personal norms (PNs) significantly influence the EVADINT. However, the factors such as HM, PV, and HB were not considered in this research. Also, the moderation effect of age on EVADINT was not estimated. While the study of Asadi et al. (2021) employed a combined TPB – NAM model to predict the EVADINT in Malaysia and the findings predicted that the ascription of responsibility (AR), SI, consumer effectiveness, PNs, and awareness of consequences (ACs) impacted the EVADINT positively. Also, Hamzah and Tanwir (2021) employed a combined TPB – NAM model to investigate the factors influencing EVADINT of Malaysians consumers. The results found that the perceived green value, perceived behavioral control, and SI impacted the EVADINT positively. Ashraf Javid et al. (2021) analyzed the EVADINT of travelers in Pakistan. The findings showed that the ascription of AR, ACs, socio-economic values, and PNs positively impacted the EVADINT. Similarly, He and Zhan (2018); and Rezvani et al. (2017) have used the NAM model to predict the EVADINT. These studies have identified the factors of NAM such as ACs, AR, PN, perceived consumer effectiveness, complexity, price, etc. As far as other fields are concerned, the application of UTAUT – NAM model was used by Maity et al. (2019) in information technology use. This study showed that the personal norm negatively impacted the behavioral intention and personal norms were not aligned with social influence. Also, Udo et al. (2016) used integrated UTAUT-NAM model in examining the factors of digital piracy across cultures. Therefore, all these studies have explored several factors of UTAUT- NAM models and by integrating UTAUT2 and NAM models, this research tried to bridge this gap.

2.2. Theoretical background

Venkatesh et al. (2003) formulated the UTAUT model based on eight theories of behavioral intention. This model explains users' intention to use new technology. This combines factors from eight theories of behavioral intentions earlier employed in technology acceptance contexts. It suggests that PE, EE, and SI impact technology use via behavioral intention. Moreover, FCs directly impact user behavior. Later, it was further enhanced to the UTAUT2 (Venkatesh et al. 2012) with the constructs of HM, PV, and HB, in addition to the moderation effect of age, gender, and experience. These additions and substitutes have built

the UTAUT2 model more comprehensive and acceptable in diverse application areas, including mobile banking adoption (Baptista and Oliveira, 2015; Chopdar et al., 2022), mobile application usage (Medeiros et al., 2022), e-learning adoption (Mehta et al., 2019), product acceptance with artificial intelligence (Gansser and Reich, 2021), tele-medicine application (Schmitz et al., 2022).

On the other hand, the NAM has been employed to estimate the impact of the PN on behaviors (Schwartz, 1977). The NAM has been successfully employed in pro-environmental behaviors, individual energy consumption, and other prosocial intentions (Asadi et al., 2021; Maity et al., 2019; Hamzah and Tanwir, 2021; Rezvani et al., 2017). PNs and behavior depend on how individuals explain an action situation. Categorically, the two conditions must subsist before individuals explain situations so that PNs are activated and influence behavior. On the one hand, the individual must be aware of the consequences for the well-being of others. On the other hand, they must feel responsible for their actions and consequences (AR).

Several researchers have examined the UTAUT2 model as an individual attributes model regarding consumer technology acceptance (Medeiros et al., 2022). UTAUT2 neglects the part of the rational and environmental class in technology adoption and takes only a self-interest point of view (Tamilmani et al., 2021). However, the NAM only deals with socio-psychological factors by considering environmental and rational class (Asadi et al., 2021). The studies of Hamzah and Tanwir (2021); Ashraf Javid et al. (2021); He and Zhan (2018); and Rezvani et al. (2017) confirmed that the NAM is acceptable for describing the altruistic part of the behavior, while UTAUT2 is appropriate for describing the self-regarding part of green behavior (Khazaei and Tareq, 2021; Gunawan et al., 2022). Therefore, integrating the UTAUT2 and NAM models could considerably upgrade the efficiency and extensiveness of the proposed model for explaining EVADINT.

3. Research hypothesis and proposed model

3.1. Intention to adopt

Individuals with the readiness to adopt new technology are those who made an intention to adopt (INT) or buy that in the future (Gunawan et al., 2022; Khazaei and Tareq, 2021). EVADINT has been proven to be one of the significant factors in various studies (Asadi et al., 2021; Wahl et al., 2020a; Venkatesh et al., 2012). In the case of EVADINT, INT is the adoption intention of potential customers to adopt EVs in the future.

3.2. Performance expectancy

PE is the degree to which an individual believes that adopting an EV will help them perform better than ICEV (Gunawan et al., 2022; Abbasi et al., 2021). It represents the belief that adopting EVs could be cost-effective, time-saving, a better alternative to ICEV, and environmentally friendly. Earlier studies by Gunawan et al. (2022); Abbasi et al. (2021); Jain et al. (2021); Lee et al. (2021); and Wahl et al. (2020a) have suggested that PE is one of the statistical significant components of EVADINT. When potential consumers think that adopting EVs can improve their performance in-vehicle use, they are probably to adopt it. Therefore, the subsequent research hypothesis was put forward:

Hypothesis H1. PE is positively related with INT to adopt EVs.

3.3. Effort expectancy

EE is the degree of ease related to using an EV (Abbasi et al. 2021; Jain et al. 2021). The consumer's intent to adopt the EVs is also impacted by the perceived ease of use of the EVs. The study by Abbasi et al. (2021) showed a significant relationship between EE and INT towards EV. Also, Lee et al. 2021 confirmed that EE positively affects the EVADINT. In addition, Gunawan et al. (2022) also found between EE and attitude toward the use of EV. In our study, EE consists of clear interaction, easy learning, ease of use, and skillfulness in using EVs. As a consequence, the perceived ease of use of an EV will expand its adoption process. Thus, the following research hypothesis was put forward:

Hypothesis H2. EE is positively associated with INT to adopt EVs.

3.4. Social influence

SI represents the degree of society or peers' belief in individuals' to adopt the EV or new technology (Bhat et al., 2022; Asadi et al., 2021). It consists of other people's opinions about the significance of using EVs, such as society, family and friends, and colleagues. As EVs are the most recent technology in the road transport sector, they give an identity, and it is observed as a social status symbol to own such a car (Zhou et al., 2021; Khazaei and Tareq, 2021; Schmalfuß et al., 2017). Therefore, the third research hypothesis was put forward:

Hypothesis H3. SI is positively linked with INT to adopt EVs.

3.5. Facilitating conditions

FC refers to which a potential customer believes an infrastructure or technical support exists to use a technology (Khazaei and Tareq, 2021; Venkatesh et al., 2012). EVs may include necessary resources, services, knowledge, compatibility with other technologies, and infrastructure facilities, which remain an essential consumer concern (Gunawan et al., 2022; Zhou et al., 2021). A user with access to a related set of facilities, such as charging stations, EVs guide, maintenance facilities, compatibility of EVs with other equipment, and parking lots with charging piles, will have a greater intention to use. Recent studies have found that FCs significantly predicted intention to adopt (Jain et al. 2021; Zhou et al., 2021; Wahl et al. 2020a). Therefore, FCs influence the intentions to adopt EVs. Therefore, the fourth research hypothesis was put forward:

Hypothesis H4. FCs are positively linked to INT to adopt EVs.

3.6. Hedonic motivation

HM refers to the fun, joy, playfulness, and enjoyment extracted from using an EV (Gunawan et al., 2022). HM, in the case of EVs pleasant to drive and differentiated from a conventional car, exciting technology, and preference to an EV. The literature has shown that hedonic factors strongly influence the antecedents of EV adoption (Zhou et al., 2021). Also, Gunawan et al. (2022) study found that the HM positively influenced intention to adopt EV. Therefore, the fifth research hypothesis was generated:

Hypothesis H5. HM is positively linked to INT to adopt EVs.

3.7. Price value

PV is the total evaluation of setting the price of a product or service at its perceived value to customers (Kim et al., 2018). In the case of EVs, it includes purchase price as compared to ICEV, value for money by using EV, and value at the current price (Zhou et al., 2021). The PV plays an essential part in consumers' decision-making regarding EVs, through which the EV with high perceived value will be purchased (Kim et al., 2018). PV has positively affected attitudes toward taxi drivers EVADINT (Zhou et al., 2021). Also, the earlier studies by Asadi et al. (2021) and (Kim et al., 2018) established that PV significantly influences EVADINT. Therefore, the research hypothesis was generated:

Hypothesis H6. PV is positively linked to INT to adopt EVs.

3.8. Habit

HB refers to the level to which individuals tend to execute behavior naturally because of learning (Zhou et al., 2021). Present behavior is based on the previous naturally repeated behavior (Venkatesh et al., 2012). In the case of EVs, it includes using an EV as a habit, addiction to an EV, limited use of ICEV, and environmental protection as the HBs. Gunawan et al. (2022) have hypothesized that HB positively affects the use of EVs. In addition, the research of Zhou et al. (2021) has shown the significant impact of HB on the taxi drivers' EVADINT. Therefore, the research hypothesis was put forward:

Hypothesis H7. HB is positively linked to INT to adopt EVs.

3.9. Personal norm

PN refers to the internal ethical rules or standards for engaging in pro-social behavior (Schwartz, 1977). PNs are a significant factor in environmentally-related behavior. The literature has shown that the PNs can describe the INT to adopt conventional and alternative vehicles (Jansson et al., 2017). In the research by Asadi et al. (2021), the PN has shown a positive and significant impact on EVADINT. Also, the studies conducted by Wahl et al. (2020a) and He and Zhan (2018) have shown significant positive impacts on EVADINT. Moreover, according to (Westin et al., 2018), the PN is the crucial predictor influencing EVADINT. This factor was the most frequently influenced by environmentally friendly behavior and has been positively related to the strongest preference for EVs (Liao et al., 2017). Therefore, the eighth research hypothesis was put forward:

Hypothesis H8. PN is positively linked to INT to adopt EVs.

3.10. Awareness of consequences and ascription of responsibility

AC refers to persons' awareness of the negative consequences of non-environment-friendly behavior (Schwartz, 1977; Asadi et al., 2021). In the context of EVs, it refers to consumers being aware that using ICEVs can cause adverse environmental consequences. Several studies (Asadi et al., 2021; Wahl et al. 2020a; Maity et al., 2019; He and Zhan, 2018) indicated that the AC positively affects PN. Also, these studies predicted that the more customers know the consequences of using ICEVs, the more their PNs will be influenced. AC, in this study, is presented as a realization of the reality that using ICEVs will lead to unpleasant consequences, including environmental damage, exhaustion of fossil fuels, and global warming. Consequently, customers' awareness of these unpleasant consequences would guide to a perception of moral commitment toward the EVADINT. Therefore, AC is a crucial factor in activating PN.

On the other hand, AR is defined as the consumers' feeling of responsibility for the negative consequences of their behavior (Schwartz, 1977). In this case, consumers' use of ICEVs caused negative environmental consequences. However, to develop AR, the individual must be

aware of the consequences of his or her behavior. Similarly, as in the earlier case, when this happens, a perception of moral obligation regarding the environment is formed, and consumers develop PNs to behave in a pro-environmental way. As a consequence, AC has been observed a predictor of AR and, in turn, AR is a cause of PN's evolution. All three relationships have been tested positive in the field of EVADINT by Asadi et al. (2021); Wahl et al. (2020a); and He and Zhan (2018). Similarly, it is posited that consumers who feel AR and AC will be more willing to form a moral obligation to adopt EVs. As well that AC is a predictor of AR. Therefore, the following research hypotheses were put forward:

Hypothesis H9. AC is positively linked to PNs.

Hypothesis H10. AR is positively linked to PNs.

Hypothesis H11. AC is positively linked to AR.

3.11. Moderation effect of age

The analysis of the moderation effect of age has been studied in different fields. For example, in the adoption of mobile payment systems (Liébana-Cabanillas et al., 2014), e-learning acceptance (Tarhini et al., 2014), and Facebook commerce adoption (Liébana-Cabanillas and Alonso-Dos-Santos, 2017), etc.

In the adoption of EVs, some studies examine the effect of age, but not in a model as complete as the one proposed in this case. For example, Chen et al. (2020) state that young people are related to potential EVADINT. Higuera-Castillo et al. (2020) prove, through a cluster analysis, that younger people (under 45 years old) have a higher level of adoption. Also, Sovacool et al. (2018) announced that individuals below middle age (30–45) are the most likely to buy them. In turn, Priessner et al. (2018) state that the target population is middle-aged. Specialists argue that this may be because young people are more inclined to try innovative products and are more environmentally conscious. Hence, they generally have a friendly attitude and intention towards EVs.

In this research, 35 years old is used as the cut-off point because of the average age of the sample. In addition, some previous studies such as Schmitz et al. (2022); Natarajan et al. (2018); and Liébana-Cabanillas et al. (2014) also classified the respondents into young (≤ 35 years) and old (> 35 years) based on age. As a consequence, age is expected to moderate the relationships proposed in this research. Therefore, the moderation effect of age in the integrated UTAUT2-NAM model is proposed. Therefore, the research hypothesis was put forward as:

Hypothesis H12. Age moderates the relationships in the proposed behavioral model.

Based on these proposed twelve hypotheses, a conceptual model was put forward for EVADINT, as shown in Fig. 1. The proposed conceptual model consists of eleven constructs: PE, EE, SI, FC, HM, PV, HB, INT, PN, AC, AR, and the age of the respondents was taken as a moderator.

4. Methodology

4.1. Questionnaire and data gathering

A self-administered questionnaire was employed to test the conceptual research model. The questionnaire was examined for correctness by the EV experts to make sure that its language and arrangement were correct. To test the conceptual model, an organized questionnaire-based survey was conducted. This was split into two parts. The first part was used to gather demographic details, including gender, age, education, annual net income, EV knowledge, EV driving experience, and future EV purchase planning, as shown in Table 2. The second part was employed to survey the EVADINT of respondents. As shown in Appendix A, all scale items for the questionnaire were taken from earlier studies, mainly the study by Asadi et al. (2021), Gunawan et al. (2022), Zhou et al. (2021), Wahl et al. (2020a), Maity et al. (2019), He and Zhan (2018), and Udo et al. (2016), and revised in the context of EVADINT. A seven-point Likert scale that ranged from “Strongly disagree” (1) to “Strongly

agree” (7), was employed in answering the survey items.

The study was conducted in the Himachal Pradesh state of India from September 2021 to February 2022. Hierarchical random sampling was employed to enhance the accuracy of EVADINT research (Singh et al., 2018). The survey was only collected from those respondents who already knew about EVs and had a valid driving license. Finally, a total of 309 responses were collected after separating invalid responses. Based on the complication of the research model, the sample size was representative enough to reliably recognize the effects of size 0.3 and higher (Soper, 2021). Table 2 points to the demographic characteristics of the interviewees. About 85 % of the interviewee were male, and 15 % were female. 51 % of interviewees were aged between 18 and 35. 71 % of interviewees had an undergraduate degree or higher. Nearly 80 % of interviewee had a yearly income of < 10 lakh, and 68 % planned to purchase an EV in the future.

4.2. Data analysis techniques

The data was processed in three stages using exploratory factor analysis (EFA), confirmatory factor analysis (CFA), and structural equation modelling (SEM) approach. Firstly, EFA was used to prepare the grouping of factors based on the strong relationship among the items (Singh et al., 2019). Secondly, CFA was employed to frame one or more speculative models of factor structure to account for covariance (Hair et al., 2009). Finally, the SEM approach was used to test the relationships between factors of UTAUT2, NAM, and adoption intention, which permits to simultaneous estimation of multiple equations (Hair et al., 2009).

5. Results

5.1. EFA and reliability

Forty-four items of the EVADINT survey were loaded into EFA ($N = 309$) with Maximum Likelihood Estimation (MLE) and Promax rotation (Hair et al., 2009). This resulted in eleven factors, which described the 73.217 % of variance and eigenvalue above 1 for all the factors (Hair et al., 2009). The final pattern matrix comprised 43 items with factor loadings values > 0.50 (Appendix B). The item SI5 was not loaded adequately into their factor structure, hence removed (Singh et al., 2018). In addition, the non-redundant residuals in the reproduced matrix were < 5 %, which showed the adequacy of the 11-factor model (Singh et al., 2019).

Next, the reliability and validity were checked. The reliability was checked in terms of Cronbach's alpha (α), ranging from 0.830 to 0.930, showing that the scale was reliable (Hair et al., 2009). After this, the convergent and discriminate validity was analyzed. In addition, the factor scores were > 0.5 (Appendix B), indicating adequate convergent validity. Also, the factors were well defined and uncorrelated, as the correlation among them were not > 0.7 (Appendix C), which showed adequate discriminate validity (DV) (Singh et al., 2019). The DV was also checked by the Heterotrait–Monotrait (HTMT) ratio of correlations method, which confirmed the DV (Appendix C), as all the values were below 0.85 (Wang et al., 2020).

5.2. CFA results

AMOS 24 was used to conduct CFA. The reliability and structural validity of 43 measured variables were checked. For each construct, the reliability was checked in terms of composite reliability (CR), which was above the minimum threshold of 0.70 (Hair et al., 2009) for each construct as shown in Table 3. After that, structural validity was checked regarding convergent validity (CV) and discriminate validity. To check CV, the average variance extracted (AVE) was calculated. Table 3 showed that the AVE were ranging from 0.604 to 0.791, so all the figures were exceeding the lowest threshold of 0.50 (Hair et al., 2009). Also, CR

> AVE > 0.50 indicated that the CV of the measurement model was confirmed. The discriminate validity was checked in terms of mean shared variances (MSVs) < AVEs. Table 3 showed that all MSVs < AVEs, hence confirming the discriminate validity by the constructs of the study.

All the factors had significant loading above 0.50, and the modification indices were consulted for the model improvement. The various indicators such as CMIN/DF, p-value, GFI, Adjusted GFI, IFI, CFI, TLI, RMSEA, and PCLOSE were employed to check the goodness of fit of the model. Table 3 showed that the goodness of fit for the CFA model was adequate as per Byrne (2010) and Hair et al. (2009).

5.3. Integrated SEM model

After confirming the adequacy of CFA, the integrated SEM model of EVADINT was examined for the model's validity and proposed hypotheses (H1 to H11). The multiple correlation coefficients squared (R^2) were used to examine the validity of the SEM model. R^2 values of 0.35 and 0.30 were calculated for INT and PN constructs, respectively (Fig. 2), which confirms the validity of the SEM model as per Hair et al. (2009). To examine the validity of the hypotheses, standardized factor loadings (β), t -values and p -values were calculated. Table 4 and Fig. 2 show that all the hypotheses except H2, H3, and H7 were supported. Table 4 shows that EVADINT includes PE, FC, HM, PV, PN, AC, and AR, while EE, SI, and HB do not affect EVADINT.

5.4. Multigroup moderation of age

In multigroup analysis (MGA), the moderating effect of age was calculated between two groups: (1) 21 to 35 years ($N = 159$) and (2) Above 35 years ($N = 150$), as shown in Fig. 3. Therefore, the invariance test was conducted through a χ^2 difference test for the unconstrained and fully constrained model, showing that the samples are different at the model level (Table 5). After this, the path coefficient difference between the two groups was compared through critical ratios for difference (CRD). If the CRD were $\leq \pm 1.96$, the two groups were observed to be different (Kim et al., 2021). The group 1 (21 to 35 years) paths of SI to INT (CRD = 2.237) and HM to INT (CRD = 2.306) were found to be significantly different when compared with group 2 (above 35 years), as shown in Table 6.

6. Discussion and implications

Per the air pollution and energy conservation challenges associated with ICEVs in the road transportation sector, Indian policymakers are executing various strategies to abandon the use of ICEVs. An EV, which looks to be under the worldwide objective of zero-emission mobility, is one of the alternatives to ICEVs. It is important to take into account customers' reactions and perceptions towards EVs while updating and assuring the overall undertaking of EVs since this is essentially what drives their adoption purpose. Using Himachal Pradesh as a case study, this study used the integrated UTAUT-NAM model to describe the links between self-interest and socio-psychological aspects of EVADINT in India. To bridge the research gap in the situation of EV adoption consumer behavior, the suggested study additionally examined the moderating influence of age in EVADINT. In the proposed model built on the framework of "self-interest and altruism" derived from "UTAUT2" and "NAM" models, respectively, the path analysis was used to verify direct hypothesized associations, and the multi-group moderation approach was used to predict the indirect effect of age on EVADINT. The integrated model was effective in explaining the factors of EVADINT and hence how the adoption intentions could be enhanced. In the integrated model, the 8 paths were significant out of 11 paths.

6.1. Factors influencing EVADINT

PE had a positive and statistically significant relationship with EVADINT ($\beta = 0.348$, $p < 0.001$) in this study. These findings are consistent with earlier research on the EV perspective (Bhat et al., 2022; Gunawan et al., 2022; Jain et al., 2021; Lee et al., 2021; Jaiswal et al., 2021; Wahl et al. 2020a; Thananusak et al., 2017), indicating that PE is a strong predictor of EVADINT. In addition, the studies by Nordhoff et al. (2020), and Kasper and Abdelrahman (2020) regarding the automated car and automated delivery vehicles' acceptance respectively are in tandem with this study. The study by Ho and Wu (2021) has also shown the significant relation between PE and electric scooter adoption intention. Rahman et al. (2017) found PE as one of the strongest predictors among UTAUT factors in the adoption of an automated driving system. This implies that better performance, low operating cost, best alternative as compared to a conventional vehicle, and reliability with EVs provide significant benefits for customers, thereby increasing the positive insight of the EVs. Moreover, EVs have been identified a more effective, innovative, productive, and useful technology compared to ICEVs (Tarei et al., 2021; Kumar and Alok, 2020). However, this result is inconsistent with Vafaei-Zadeh et al. (2022) on the purchase intention among young generation consumers' in Malaysia. This may be since other influencing factors such as perceived price and perceived risk associated with alternatives could deter people from buying an EV. In this work, PE was found to be the strongest factor among all affecting EVADINT. This indicates that Indian consumers have higher outcome expectations from EVs as compared to ICEVs.

EE has not been found to have a significant association with EVADINT ($\beta = 0.018$, $p = 0.730$), therefore hypothesis H2 is unsupported. In the context of EVs, the study by Jain et al. (2021) likewise failed to support the significant effect of EE on EVADINT. Similarly, studies by Nordhoff et al. (2020) and Shaw and Sergueeva (2019) in other contexts were in line with this study. This implies that the interaction restricts the impact of EE on customers that are less acquainted with EVs and their understanding, learning, use, and skillfulness with EVs are difficult. Moreover, the longer charging time and sophisticated electronic system of EVs as compared to ICEVs extends the complexity for the potential consumers. However, this result contradicts the findings of Jaiswal et al. (2021) and Featherman et al. (2021) on EVADINT, which shows that the consumers' interactions with EVs are clear and understandable, and they are easy to learn and use. In addition, customers believe that EVs are emerging and sustainable technology products with similar operations as conventional vehicles.

There was no statistically significant ($\beta = 0.083$, $p = 0.105$) relation between SI and EVADINT. This implies that the potential users of EVs seem to be less interested in the viewpoints of their friends, family, colleagues, and society. The fact that EVs are still in their early stages in India is another explanation for this unsupported hypothesis. Moreover, the main and natural role of SI depends upon the nature of technology, the context of technology investigation, and individual attitudes (Alalwan et al., 2018). This outcome is consistent with earlier studies conducted by Jain et al. (2021); Lee et al. (2021); and Wahl et al. (2020a) on the EV situation. In addition, this is in tandem with the study by Alalwan et al. (2018) on the case of internet banking adoption in Jordan. However, there are researches where the impact of SI is found significant in the prediction of EVADINT (Gunawan et al., 2022; Khazaei and Tareq, 2021).

FC and EVADINT had a significant positive impact ($\beta = 0.128$, $p < 0.05$). These findings are in tandem with earlier studies by Bhat et al. (2022); Jain et al. (2021); Zhou et al. (2021); Khazaei and Tareq (2021); Wahl et al. (2020a); and Tu and Yang (2019) in the EV context, indicating that FC is a key predictor of EVADINT. Tarei et al. (2021) identified the infrastructural barriers to EVADINT in India: insufficient charging stations, shortage of maintenance, service, and repair facilities, absence of EV manufacturers, and lack of reliable electricity. Jain et al. (2021) examined that the EVADINT in India is influenced by factors such

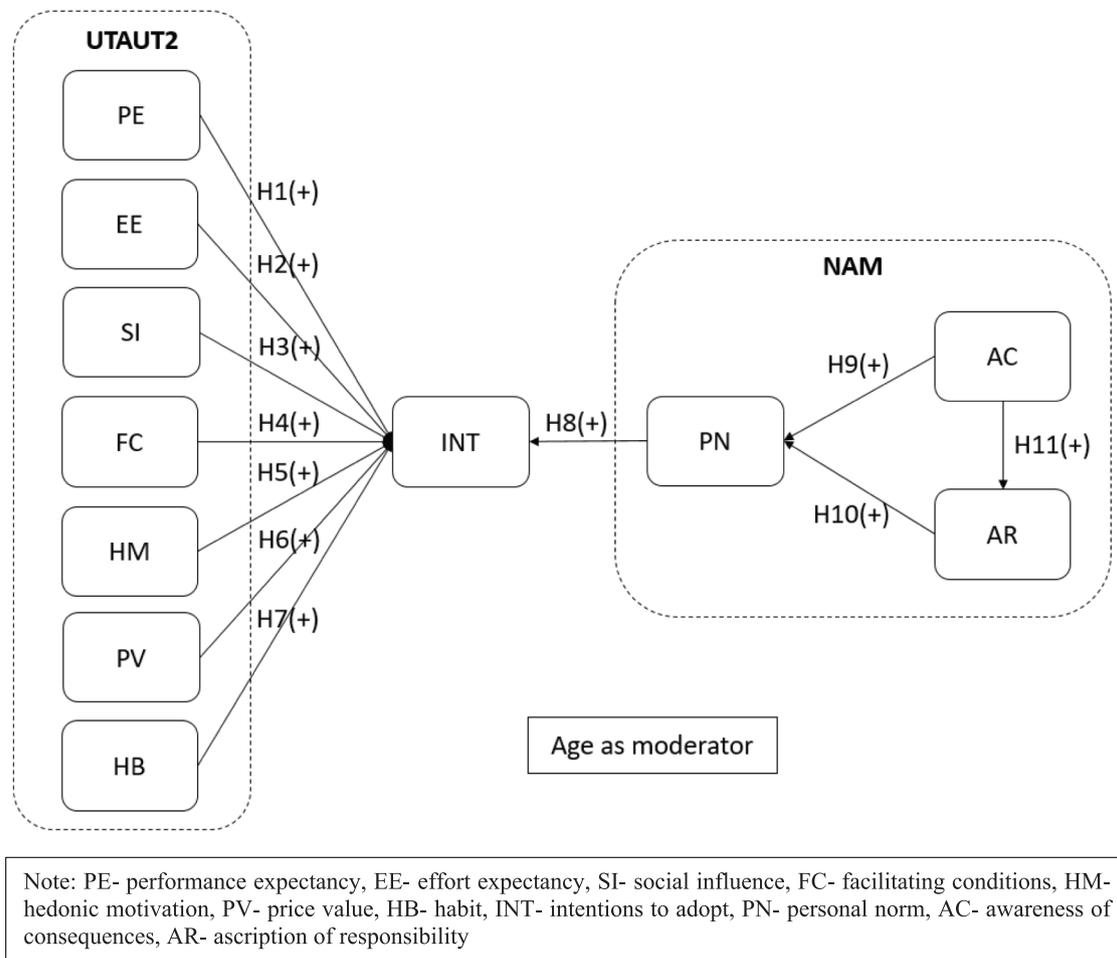


Fig. 1. Proposed conceptual model.

as charging facility, EV knowledge, EV compatibility, EV facilities, and resources. Therefore, those who believe that the GoI is working hard to provide EV infrastructure and other required resources while buying EVs are more confident regarding the future adoption of EVs. In other words, potential consumers are likely to adopt EVs when they think there are enough governmental resources, services, and facilities to use an EV. The outcomes also validate that the potential respondents were aware of EVs and the need for FCs such as charging stations, service, repair, and maintenance facilities. Consequently, the battery swapping stations to reduce the charging time, and availability of reliable electricity are crucial for policymakers to improve EVADINT. Therefore, the GoI should carry out a pilot design of battery swapping stations and renewable electricity grids in various popular cities of India, by motivating the investments from different public and private players through subsidies, to reduce the barriers to reliable electricity and EV charging in India.

The relationship between HM and EVADINT was significant ($\beta = 0.168, p < 0.01$). The findings are comparable with the literature by Bhat et al. (2022); Gunawan et al. (2022); Zhou et al. (2021); and Khazaei and Tareq (2021) in the EV context. These outcomes are in tandem with the studies by Nordhoff et al. (2020), and Kapser and Abdelrahman (2020) in the context of the automated vehicle. These outcomes show that the higher the positive feedback, the stronger the perception of exciting new technology and pleasure acquired while using EVs compared to ICEVs. In addition, compared to a normal vehicle, an EV's design is crucial, and users prefer to adopt an EV that is well-designed, comfortable, and fun to use. Khazaei and Tareq (2021) suggested that potential consumers value high acceleration, maximum

speed, and low noise for EV adoption. Zhou et al. (2021) examined that the acceleration performance, quietness, and flexible system were the main drivers for the adoption of EVs by taxi drivers in China. In addition, Higuera-castillo et al. (2019) also showed the significant impact of acceleration performance and low engine noise on the EVADINT in Spain. All these findings indicate that EVs are pleasant to drive as compared to ICEVs because their high-speed and low engine noise. Consequently, high-speed and the low engine noise of EVs as compared to ICEVs could enhance their profile in the perspective of potential customers to adopt EVs.

The hypothesis between PV and EVADINT was supported ($\beta = 0.234, p < 0.001$). The finding suggests that PV is a major predictor for potential users, directing their decision to adopt EVs. Previous research conducted by Gunawan et al. (2022); Asadi et al. (2021); and Zhou et al. (2021) are in line with these results. The potential users are probably to be inspired to purchase EVs because GoI has executed various subsidies to raise its PV, which is in tandem with the findings of Asadi et al. (2021). Vafaei-Zadeh et al. (2022) identified the PV as the strongest predictor of EVADINT and the young generation is well informed about the advantages and value of such technology. Moreover, the study by Kapser and Abdelrahman (2020) also identified the PV as one of the main predictors of behavioral intention in the context of the automated vehicle. These findings confirm that it is a cost-benefit relationship between the monetary benefits of using innovation and the price paid to acquire the innovation.

The hypothesis between HB and EVADINT was not statistically significant ($\beta = 0.037, p = 0.493$). The driving habits of EVs and ICEVs are not disruptive, and users can easily switch their HBs to driving EVs.

Table 2
Demographic profile of the respondents (N = 309).

Measure	Item	Frequency	Percentage (%)
Gender	Male	264	85
	Female	45	15
Age (Years)	18–35	159	51
	36–50	108	35
	Above 50	42	14
Education Level	Post-graduation and above	89	29
	Degree and equivalent	131	42
	Diploma and equivalent	73	24
	Basic Schooling	16	05
Annual net income (INR)	<5 Lakhs	83	27
	5–10 Lakhs	164	53
	>10 Lakhs	62	20
Do you have a driving license?	Yes	309	100
Did you know about the Electric Vehicles?	Yes	309	100
Have you ever driven an Electric Vehicle?	Yes	18	06
	No	291	94
Do you have planned to purchase an Electric Vehicle in future?	Yes	211	68
	No	98	32

There was no adequate difference in HB to decide its significance. The outcomes are consistent with the findings of [Gunawan et al. \(2022\)](#) in the EV context. [Moons and De Pelsmacker \(2015\)](#) also found a nonsignificant relationship between HB and EVADINT. Therefore, Indian potential consumers believe that driving EVs are not different from different driving ICEVs.

A statistically significant ($\beta = 0.170, p < 0.01$) relation was observed between PN and EVADINT. The findings indicate that the PN is an important element in analyzing eco-friendly behaviors, which is in line with previous studies by [Adnan et al. \(2018\)](#); [He and Zhan \(2018\)](#); and [Asadi et al. \(2021\)](#). Also, [Ashraf Javid et al. \(2021\)](#); [Ho and Wu \(2021\)](#); and [Shalender and Sharma \(2021\)](#) analyzed statistically significant relations between PN and EVADINT. Therefore, this outcome indicates that potential Indian consumers with additional social concerns will have a stronger personal and moral obligation to use energy wisely and a higher responsibility to protect the environment. Additionally, the person will drive as little as possible using fossil fuels. Moreover, this also shows that the EVADINT is predicted by PNs rather than SI.

In this study, the hypotheses of AC and AR-related with PN were supported (AC → PN: $\beta = 0.389, p < 0.001$; AR → PN: $\beta = 0.293, p < 0.001$). The outcomes are in tandem with the findings of [He and Zhan \(2018\)](#); and [Asadi et al. \(2021\)](#). First, the statistically significant impact of AC on PN is consistent with some of the previous studies by [Ho and Wu \(2021\)](#); [Ashraf Javid et al. \(2021\)](#); [Adnan et al. \(2018\)](#); and [Rezvani et al. \(2017\)](#). Also, these studies have shown that PNs mediate the significant relationship between AC and EVADINT. ACs in this study have included customers' understanding of the negative ecological impacts of using ICEVs, the problem of fossil fuel exhaustion, and global warming. These outcomes indicate that awareness of potential users of these unpleasant effects would provide them a perception of moral obligation to the EVADINT. Furthermore, the impact of AC on PN was highest among all path coefficients. This implies that India is a collectivist society

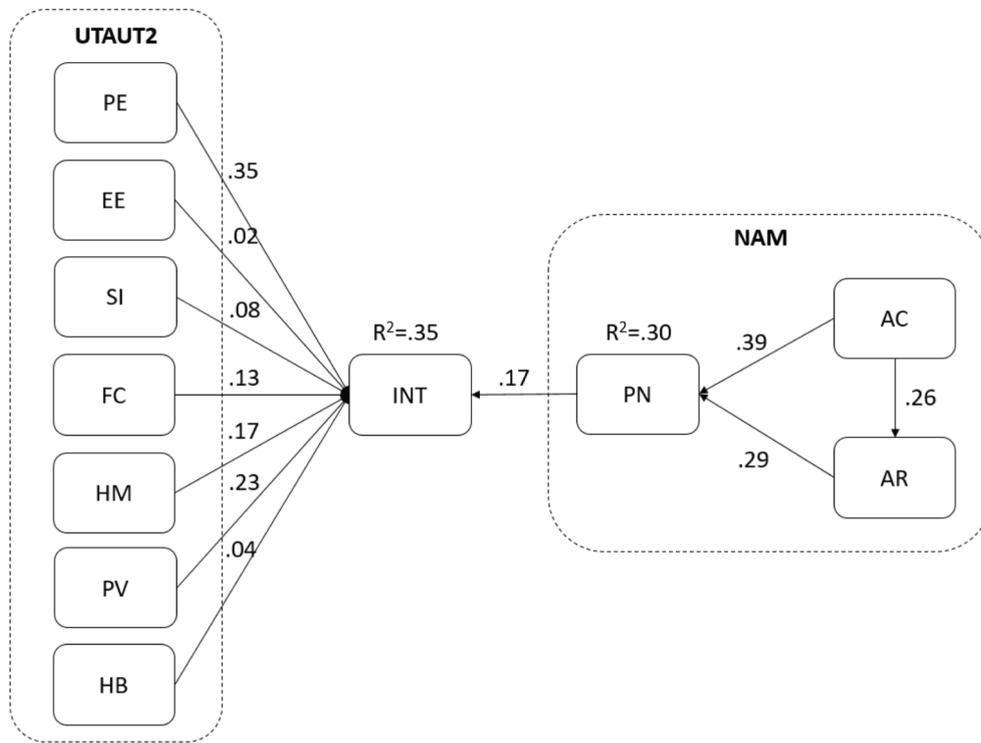
Table 3
CFA results.

Construct	Item	Factor loadings	CR	AVE	MSV	MaxR(H)
PE	PE1	0.877	0.920	0.742	0.215	0.921
	PE2	0.858				
	PE3	0.848				
	PE4	0.863				
EE	EE1	0.858	0.920	0.743	0.183	0.923
	EE2	0.863				
	EE3	0.899				
	EE4	0.826				
SI	SI1	0.883	0.938	0.791	0.049	0.939
	SI2	0.906				
	SI3	0.904				
	SI4	0.863				
FC	FC1	0.866	0.910	0.717	0.331	0.912
	FC2	0.841				
	FC3	0.866				
	FC4	0.814				
HM	HM1	0.784	0.832	0.623	0.213	0.833
	HM2	0.807				
	HM3	0.776				
PV	PV1	0.849	0.929	0.766	0.167	0.931
	PV2	0.892				
	PV3	0.895				
	PV4	0.863				
HB	HB1	0.776	0.866	0.618	0.103	0.867
	HB2	0.813				
	HB3	0.767				
	HB4	0.788				
INT	INT1	0.814	0.915	0.730	0.215	0.928
	INT2	0.922				
	INT3	0.885				
	INT4	0.790				
PN	PN1	0.804	0.896	0.683	0.217	0.899
	PN2	0.829				
	PN3	0.867				
	PN4	0.804				
AC	AC1	0.914	0.932	0.775	0.331	0.942
	AC2	0.930				
	AC3	0.838				
	AC4	0.835				
AR	AR1	0.841	0.858	0.604	0.147	0.868
	AR2	0.817				
	AR3	0.709				
	AR4	0.733				

Goodness of fit indices: Normed chi-square (CMIN/DF) = 1.376, p-value < 0.0001, Goodness-of-Fit Index (GFI) = 0.857, Adjusted GFI = 0.831, Incremental Fit Index (IFI) = 0.970, Tucker-Lewis's Index (TLI) = 0.966, Root Mean Square Error of Approximation (RMSEA) = 0.35, PCLOSE > 0.05.

Note 1: For Composite reliability (CR > 0.70); Convergent validity (CR > AVE > 0.50); Discriminate validity (MSV < AVE).

Note 2: PE- performance expectancy, EE- effort expectancy, SI- social influence, FC- facilitating conditions, HM- hedonic motivation, PV- price value, HB- habit, INT- intentions to adopt, PN- personal norm, AC- awareness of consequences, AR- ascription of responsibility, CR – composite reliability, AVE -average variance extracted, MSV- Maximum shared variance, MaxR(H) – reliability coefficient.



Note 1: PE- performance expectancy, EE- effort expectancy, SI- social influence, FC- facilitating conditions, HM- hedonic motivation, PV- price value, HB- habit, INT- intentions to adopt, PN- personal norm, AC- awareness of consequences, AR- ascription of responsibility
 Note 2: R²- multiple correlation coefficients squared

Fig. 2. SEM model of EVADINT.

Table 4
 Results of the integrated SEM model.

Hypotheses	Path	Standardized factor loadings	t-value	p-value	Support
H1	PE → INT	0.348	5.535	***	Yes
H2	EE → INT	0.018	0.344	0.730	Yes
H3	SI → INT	0.083	1.623	0.105	Yes
H4	FC → INT	0.128	2.150	0.032*	Yes
H5	HM → INT	0.168	2.263	0.008*	Yes
H6	PV → INT	0.234	4.117	***	Yes
H7	HB → INT	0.037	0.685	0.493	Yes
H8	PN → INT	0.170	3.058	0.002*	Yes
H9	AC → PN	0.389	6.547	***	Yes
H10	AR → PN	0.293	4.803	***	Yes
H11	AC → AR	0.264	4.389	***	Yes

Note: S = supported, NS = not supported.

*p < 0.05, **p < 0.01, ***p < 0.001.

Note: PE- performance expectancy, EE- effort expectancy, SI- social influence, FC- facilitating conditions, HM- hedonic motivation, PV- price value, HB- habit, INT- intentions to adopt, PN- personal norm, AC- awareness of consequences, AR- ascription of responsibility.

(Hofstede, 2022), likely to be more aware of the consequences of using fossil fuel vehicles. Second, the statistically significant impact of AR on PN is consistent with some previous studies by Asadi et al. (2021); Ashraf Javid et al. (2021); He and Zhan (2018); and Rezvani et al. (2017). Ascription of responsibility is successfully attributed when individuals are actively aware of the utilization of resources and purchases that are more environmentally friendly. Strong faith that EVs could reduce the road transport pollution problem and conserve energy resources increase the potential consumers’ perceptions of responsibility for the environment. Subsequently, this also increases their perception of EVs adoption. Finally, in this study AC has positive impact on AR ($\beta = 0.264, p < 0.001$). This is in tandem with the reported literature by He and Zhan (2018); Sang et al. (2020); and Asadi et al. (2021). It motivates the customers toward the unacceptable effects of using conventional vehicles on the environment, and the interest in adopting EVs would lead them to be more responsible for society.

6.2. Multigroup moderation

The results of MGA show that age has a moderating effect on EVADINT. Specifically, in terms of SI, the middle-aged and older groups are more affected by the opinion of their friends, family, and society, and they will be ready to adopt EVs in the future than the young group. This means that older groups need greater involvement in their social network EVs before their final adoption. On the contrary, the young group usually has more knowledge about EVs to make their own decision about adoption, which makes SI not a major influencing factor for them. Furthermore, in terms of HM, the young, middle-aged, and older groups may also have different adoption intentions toward using EVs. The middle-aged and the older groups want to adopt EVs for their fun

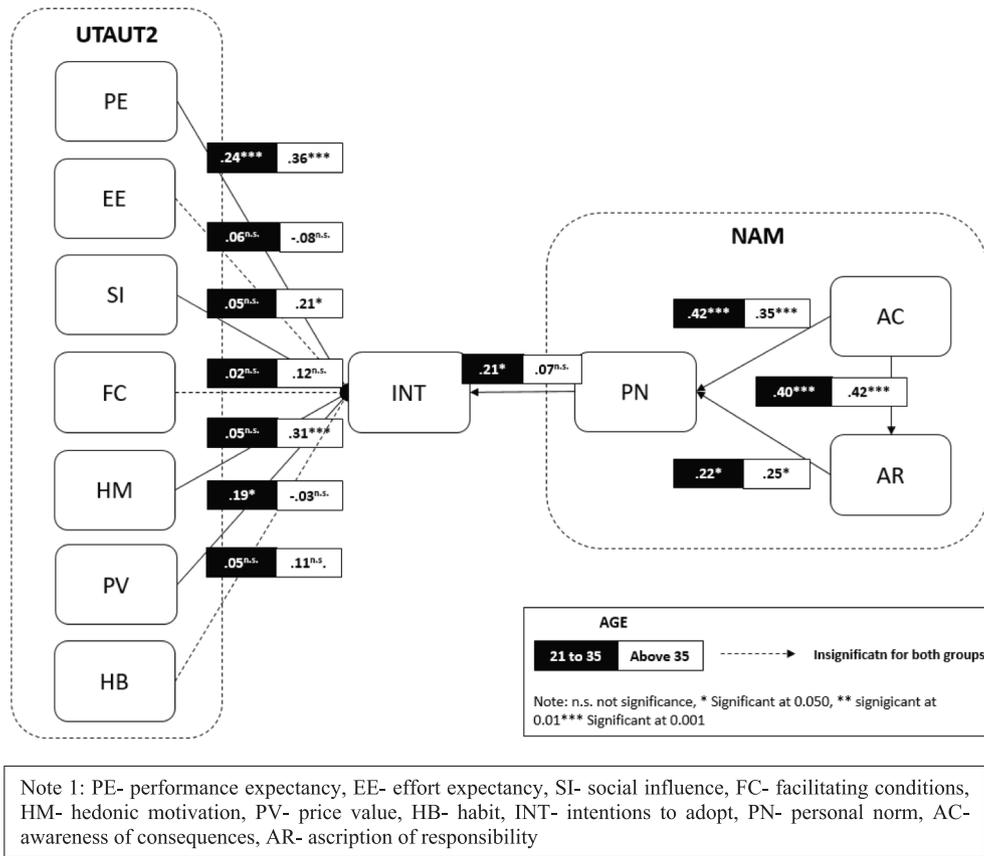


Fig. 3. Multigroup analysis of EVADINT.

Table 5
Invariance test.

Overall model	Chi-square	df	p-value	Invariant
Unconstrained	2099.2	1604	0.000	
Fully constrained	2270.9	1647	0.000	
Difference	171.7	43	0.000	No

and enjoyment because, for them, EVs are new and exciting technology. On the contrary, the young group usually wants to use EVs mainly to reduce the environmental impact. Therefore, the relationship is not significant.

Table 6
Multi-group analysis SEM results.

Hypotheses	Path	Age – 21 to 35 (N = 159)		Age – Above 35 (N = 150)		CRD
		Estimate	p-value	Estimate	p-value	
H1	PE → INT	0.242	0.000***	0.369	0.000***	1.164
H2	EE → INT	0.069	0.440	-0.119	0.288	-1.313
H3	SI → INT	0.027	0.500	0.238	0.005*	2.237**
H4	FC → INT	-0.020	0.807	0.166	0.148	1.320
H5	HM → INT	0.045	0.603	0.346	0.000***	2.306**
H6	PV → INT	0.114	0.020*	-0.041	0.687	-1.364
H7	HB → INT	0.054	0.571	0.113	0.145	0.475
H8	PN → INT	0.215	0.012*	0.065	0.341	-1.368
H9	AC → PN	0.294	0.000***	0.454	0.000***	1.131
H10	AR → PN	0.201	0.016*	0.333	0.010*	0.859
H11	AC → AR	0.303	0.000***	0.397	0.000***	0.856

Notes: *** p-value < 0.001; ** p-value < 0.01; * p-value < 0.05; CRD = critical ratio for difference.

Note: PE- performance expectancy, EE- effort expectancy, SI- social influence, FC- facilitating conditions, HM- hedonic motivation, PV- price value, HB- habit, INT- intentions to adopt, PN- personal norm, AC- awareness of consequences, AR- ascription of responsibility.

6.3. Implication

6.3.1. Theoretical contributions

This study includes self-interest and socio-psychological constructs that influence potential consumers' intentions toward EV adoption and gives a new research viewpoint for future studies. This work has several contributions to theory. First, this research critically reviews and analyzes the most common constructs, theories, and models (Table 1) of the last 5 years in the context of EV acceptance. Venkatesh et al. (2012) formulated the most common UTAUT2 model to analyze the consumers' intentions toward new technology adoption and this was selected as an appropriate model for this work. But this model was based only on the self-interest factors which seems not capable of explaining complete EVADINT. Therefore, NAM as developed by Schwartz (1977) was

integrated with the UTAUT2 model permitted us to explain the expectancy-value foundations of EVs use. Second, UTAUT2 and NAM were combined to extend the study on EVADINT from the facet of protecting the environment. The combination of the UTAUT2 with the NAM permits examining the influence of individual PNs and social norms on behavioral intention. However, in this research social norms have a higher influence on framing PNs than on INT. Third, this work contributes to the development of the informational framework of the antecedents of behavioral intentions of EV adoption in the Indian context. PE, FC, HM, and PV are significant factors of adoption intention; AC and AR are significant factors of PN. However, the EE, SI, and HB are not significant factors of adoption intention. In terms of direct impacts, PE has the strongest impact on EVADINT, succeeded by PV and PN. In this, relative advantages of EVs, reasonable pricing of EVs, and perceptivity toward environmental protection are the main levers in potential consumers' preferences from ICEVs toward EVs. In the case of direct effects of NAM, AC has the strongest impact on PN, followed by AR. In this, awareness regarding global warming, and responsibility toward energy conservation are the main levers toward EVs use. Moreover, AR works as a significant arbitrator in this research and manages three paths: from AC to PN, from AR to PN, and from AC to AR. Fourth, the study's findings raised a major query about the influence of demographic variables on EVADINT, i.e., "Who will be ready to adopt EVs in the future?". Moderating effect analysis of young (below 35 years) and older (above 35 years) groups have analyzed sub-group distinctions that affect consumers' adoption of EVs.

The moderation effect of age on the relationship of PE on the EVADINT is positive and significant for both groups. These findings are in tandem with the studies by [Natarajan et al. \(2018\)](#) and [Liébana-Cab-anillas et al. \(2014\)](#) in the mobile banking adoption context. In addition, the moderation effect of age in this relationship is higher for the older group than the young group. This shows that older people give more importance to relative advantages as benefits to the daily life they obtain from EV use such as saving time and cost-effectiveness, in comparison with the young group. Therefore, older potential consumers are more influenced by EV's benefits, which attracts them to have stronger adoption intention for such innovations. Based on the moderating effect of age among potential customers, the EV companies will design their marketing strategies to influence the customers. These marketing strategies will assure the customers, enhancing their loyalty, and consequently contributing to EVs adoption.

6.3.2. Practical implication

This paper uncovers several implications for policymakers and EV manufacturers in motivating potential consumers to adopt EVs. Some policies suggested in the previous literature have been reconfirmed: operational performance of EVs ([Jain et al. 2021](#)), sufficient investment in FCs, including EV purchase resources, maintenance services, and charging stations ([Bhat et al., 2022](#); [Wahl et al., 2020a](#)), financial policies including direct and indirect incentives, 50 % discount on road tax, value-added tax (VAT) rebates, free parking facility, toll exemption, EV license plate quota, and adequate funding on EVs research and development ([Singh et al., 2021](#)), are practical measures to enhance the adoption rate of EVs. Also, the state should provide support to EV manufacturers and research and development in the form of land, water, electricity, and road connectivity. Also, regarding the mandate to use EVs at institutional levels, the state government should develop a strategy for their existing vehicle fleet and public transport to switch to EVs. In addition, the state government should establish zero-emission zones such as Manali, Dharamsala, Shimla, etc., as these cities are also main tourist destinations and eco-sensitive areas of the Himalayas. Moreover, the state should have an aggressive vehicle scrap policy to eliminate unfit and polluting vehicles. Furthermore, there should be a governing body to check the progress of suggested policy measures and their practical implementation in the state. Even though these policies are essential and extensively executed, they are not always more

maintainable and productive than the adoption intention of potential EV customers.

The current findings show that PE, PV, PN, HM, and FC are significant factors in describing EVADINT. Thus, the focus should be on these aspects of marketing strategy development to influence potential consumers to use EVs. Sustainable and competitive policies integrating these five factors correctly will upgrade the probability that consumers will choose to adopt EVs.

Policymakers and marketers should need to prioritize how EVs are beneficial in the daily life of potential customers and attempt to educate them regarding the relative advantages of EVs such as saving time, cost-effectiveness, and a good alternative as compared to ICEVs instead focusing on how easy to use an EV, how the society would react while using EV, and how would an EV use become a habit. In addition, PV was analyzed as the second strongest construct of EVADINT at this point of innovation introduction. Therefore, EVs should be reasonably priced as compared to ICEVs. It is recommended that the price of EVs should be lower than ICEVs to attract more customers. For example, mostly used EV car Tata Nexon in India is priced almost double as compared to its petrol version, which may not be acceptable to potential customers. So, to reduce the manufacturing and technology development cost, the Indian EV manufacturer should collaborate with other International manufacturers. Moreover, the EV manufacturer should optimize their supply chain and demand the GoI regarding investment incentives to enhance the value for money and to reduce EV prices.

PN, HM, and FC were also found to be major predictors of EVADINT. Therefore, policymakers need to observe the policies such as E-campaigns and awareness regarding the advantages of using EVs and global warming, and consumers' realization and recurrent knowledge of detrimental results of adopting ICEVs, creating awareness about the performance of EVs, shortening the recharging time of EVs, demonstrating, and test-drive centers for EVs in the city, marketing and advertising the advanced and innovative features of EVs, and encouraging EV manufacture by providing them land and electricity, etc. Furthermore, the policymakers should examine the public's opinion regarding these strategies and then revise their conditions formed on the survey results.

The penetration of private EVs in Himachal Pradesh is almost zero. Himachal Pradesh is far behind other states of India, such as Uttar Pradesh, Karnataka, Tamil Nadu, Maharashtra, and Delhi. A probable reason for this may be that the government is not taking enough initiative for EV adoption. First, the government must mandate the EVs use in the state by incentivizing them and disincentivizing the ICEVs. Second, governments should try to upgrade consumers' perceptions of EVs and related incentive policies. Finally, MGA results may help policymakers to frame strategies according to consumer attributes. For the young group, the EE, SI, FC, HM, and HB are their significant concerns; interaction and understanding with EVs should be improved, and family, friends, and society should give positive feedback regarding EVs. The government should provide facilities such as charging, service facility, etc., perception of exciting new technology and comfortable seating should be improved, and driving habits should not be disruptive. For the older group, the interaction and understanding with EVs should be improved, purchase incentives might be more effective, and environmentally friendly behavior should be improved.

7. Conclusion and future scope

The move from traditional automobiles to EVs must be executed in India as part of its FAME scheme. This research was carried out to explore the factors that motivate consumers to adopt EVs in India. SEM approach is supposed to give a complete informational framework regarding the factors of EVADINT. This research also gives a new perspective that integrates UTAUT2 and NAM models. The result shows the various constructs for EVADINT, including PE, FC, HM, PV, PN, AC, and AR, can help prediction of interest in adopting EVs in India, while

only EE, SI, and HB factors have a non-significant effect on EVADINT.

This study had diverse limitations, which make upcoming studies essential. First of all, potential consumers' EVADINT was analyzed in this study. Even though it is feasible to analyze the real adoption behavior through real behavior adoption intention, therefore, in the future, the real adoption behavior could be analyzed by collecting the data from EV owners. Second, this study primarily used the factors from UTAUT2 and NAM to explain EVADINT, but some of the factors from these models were not considered. Therefore, future studies could consider these factors such as trust, perceived risk, perceived consumer effectiveness, altruistic values, bio-spheric values, egoistic values, and openness to change. Third, this research analyzed only the moderation effect of age. In future studies moderating effect of gender, income, experience, education, environmental concern, and incentive policies could be checked. Fifth, this study was conducted in the state of

Himachal Pradesh in the Indian context, with EV technology in its starting phase. Therefore, the results may differ in the context of other countries. In the future, more research is needed to analyze and validate the findings of this study in the situation of other nations. Furthermore, future studies could implement different techniques of data analysis such as artificial intelligence, machine learning, a differential equation model with agent-based modelling, and multi-criteria decision-making approaches to analyze EVADINT.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Measurement scale.

Construct	Item	Source
Intention to adopt (INT)	Next time I buy a vehicle, I would consider buying an Electric Vehicle.I expect to drive an Electric Vehicle in the near future.I have the intention to drive an Electric Vehicle in the near future.I intend to adopt Electric Vehicle because it is environmentally friendly.	(Gunawan et al., 2022); (Khazaei and Tareq, 2021); (Asadi et al., 2021);(Wahl et al. 2020a); (Venkatesh et al., 2012)
Performance expectancy (PE)	Using an Electric Vehicle will help me get to my destination on time.Using an Electric Vehicle would be more cost effective.Using an Electric Vehicle will serve as good alternative to conventional vehicles.Using Electric Vehicles would be useful for me.	(Jain et al. 2021); (Zhou et al., 2021);(Wahl et al. 2020a) ; (Udo et al., 2016)
Effort expectancy (EE)	My interaction with the Electric Vehicle would be clear and understandable.Learning to use Electric Vehicle would be easy for me.I could find Electric Vehicle easy to use.It would be easy for me to become skillful at using Electric Vehicle.	(Gunawan et al., 2022); (Zhou et al., 2021);(Wahl et al. 2020a) ; (Venkatesh et al., 2012)
Social influence (SI)	Using an Electric Vehicle would have positive impact in society. People who are important to me would think that I should use an Electric Vehicle.I would use an Electric Vehicle if a number of other people use it.My family and friends would be upset if I did not adopt an Electric Vehicle	(Asadi et al., 2021); (Khazaei and Tareq, 2021);(Wahl et al. 2020a) ;(Goularte and Zilber, 2019) ; (Venkatesh et al., 2012)
Facilitating conditions (FC)	I would have the necessary resources to purchase an Electric Vehicle.Using an Electric Vehicle would be compatible with other technologies I use.I would have knowledge, resources, services, and facilities to use an Electric Vehicle.I would be constrained by lack of infrastructure and other facilities to use an Electric Vehicle.	(Asadi et al., 2021); (Khazaei and Tareq, 2021); (Zhou et al., 2021);(Wahl et al. 2020a) ; (Venkatesh et al., 2012)
Hedonic motivation (HM)	Driving an Electric Vehicle would be pleasant to drive because of smoothness and high acceleration as compared to conventional vehicle.An Electric Vehicle would be a very exciting new technology.I would prefer to drive an Electric Car as compared to conventional car.	(Asadi et al., 2021); (Khazaei and Tareq, 2021); (Zhou et al., 2021); (Baptista and Oliveira, 2015)
Price value (PV)	Electric Vehicles are reasonably priced.Electric Vehicles are reasonably priced as compared with internal combustion engine vehicles.Using Electric Vehicle would be a good value for money.At the current price, Electric Vehicles would give a good value.	(Gunawan et al., 2022); (Zhou et al., 2021); (Goularte and Zilber, 2019); (Baptista and Oliveira, 2015)
Habit (HB)	The use of Electric Vehicle would become a habit for me.I would be addicted to use an Electric Vehicle.I must use an Electric Vehicle as the habit.Using an Electric Vehicle would become natural to me.	(Zhou et al., 2021); (Goularte and Zilber, 2019); (Baptista and Oliveira, 2015)
Personal norm (PN)	I feel a strong personal obligation to use energy wisely.I feel a moral obligation to protect the environment.I feel that it is important to travel as little as possible by car using fossil fuelI feel it is important that people in general protect the environment.	(Asadi et al., 2021); (Hamzah and Tanwir, 2021); (He and Zhan, 2018)
Awareness of consequences (AC)	Conventional Vehicles contributes to environment damage.Exhaustion of fossil fuel is a problem.Driving conventional vehicles has an effect on global warming.Global warming is a problem for society.	(Asadi et al., 2021); (Maity et al., 2019); (He and Zhan, 2018)
Ascription of responsibility (AR)	I have the responsibility to conserve energy resources and to ensure quality of life for future generations.I have the responsibility to influence the vehicle industry towards more environmentally friendly solutions.I feel personally responsible for environmental problems resulting from the type of vehicle I own.I feel joint responsibility for the negative consequences of conventional vehicles	(Asadi et al., 2021); (Maity et al., 2019); (He and Zhan, 2018); (Udo et al., 2016)

Appendix B. EFA results.

Variables	Standardized factor loading	Total variance explained (%)	Eigenvalues	Cronbach's alpha α
PE1	0.884	22.160	9.877	0.918
PE2	0.920			
PE3	0.830			
PE4	0.783			
PV1	0.881	11.266	5.231	0.920
PV2	0.879			

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Variables	Standardized factor loading	Total variance explained (%)	Eigenvalues	Cronbach's alpha α
PV3	0.879			
PV4	0.871			
SI1	0.870	7.690	3.733	0.937
SI2	0.930			
SI3	0.914			
SI4	0.841			
HB1	0.743	6.774	3.048	0.862
HB2	0.876			
HB3	0.768			
HB4	0.749			
HM1	0.821	6.110	2.767	0.830
HM2	0.775			
HM3	0.741			
FC1	0.884	4.476	2.206	0.910
FC2	0.796			
FC3	0.832			
FC4	0.849			
INT1	0.884	3.243	1.837	0.914
INT2	0.887			
INT3	0.893			
INT4	0.745			
PN1	0.721	3.597	1.725	0.895
PN2	0.813			
PN3	0.904			
PN4	0.846			
AC1	0.908	2.867	1.423	0.938
AC2	0.907			
AC3	0.855			
AC4	0.887			
AR1	0.817	2.620	1.330	0.876
AR2	0.769			
AR3	0.819			
AR4	0.805			
EE1	0.811	2.416	1.253	0.920
EE2	0.852			
EE3	0.944			
EE4	0.830			

Extraction Method: Maximum Likelihood, Rotation Method: Promax with Kaiser Normalization.

Note 4: PE- performance expectancy, EE- effort expectancy, SI- social influence, FC- facilitating conditions, HM- hedonic motivation, PV- price value, HB- habit, INT- intentions to adopt, PN- personal norm, AC- awareness of consequences, AR- ascription of responsibility.

Appendix C. Factor correlation matrix and discriminant validity Heterotrait–Monotrait (HTMT) ratio of correlations.

Factor correlation matrix

Factor	AC	AR	EE	FC	HB	HM	INT	PE	PN	PV	SI
AC	1.000	0.082	0.208	0.044	0.157	0.200	0.195	0.078	0.007	0.052	0.107
AR	0.082	1.000	0.232	0.096	-0.155	0.236	0.406	0.121	-0.190	-0.119	0.004
EE	0.208	0.232	1.000	0.394	0.263	0.362	0.578	0.459	0.169	-0.076	0.300
FC	0.044	0.096	0.394	1.000	0.189	0.248	0.354	0.414	0.245	0.222	0.208
HB	0.157	-0.155	0.263	0.189	1.000	0.446	0.262	0.214	0.141	0.135	0.430
HM	0.200	0.236	0.362	0.248	0.446	1.000	0.385	0.353	0.148	0.114	0.387
INT	0.195	0.406	0.578	0.354	0.262	0.385	1.000	0.302	-0.018	-0.171	0.283
PE	0.078	0.121	0.459	0.414	0.214	0.353	0.302	1.000	0.342	0.262	0.233
PN	0.007	-0.190	0.169	0.245	0.141	0.148	-0.018	0.342	1.000	0.316	0.218
PV	0.052	-0.119	-0.076	0.222	0.135	0.114	-0.171	0.262	0.316	1.000	0.208
SI	0.107	0.004	0.300	0.208	0.430	0.387	0.283	0.233	0.218	0.208	1.000

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Factor correlation matrix											
Factor	AC	AR	EE	FC	HB	HM	INT	PE	PN	PV	SI
Discriminant validity Heterotrait–Monotrait (HTMT) ratio of correlations											
AC											
AR	0.189										
EE	0.405	0.255									
FC	0.586	0.136	0.357								
HB	0.076	0.321	0.224	0.180							
HM	0.319	0.230	0.232	0.309	0.220						
INT	0.364	0.157	0.255	0.396	0.127	0.406					
PE	0.268	0.153	0.195	0.261	0.139	0.461	0.460				
PN	0.469	0.360	0.432	0.304	0.281	0.242	0.357	0.225			
PV	0.216	0.189	0.097	0.405	0.114	0.037	0.242	0.163	0.113		
SI	0.223	0.062	0.059	0.215	0.092	0.131	0.204	0.165	0.093	0.089	

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