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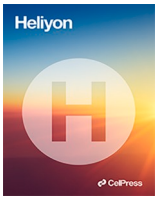

Research article

Examination of the adoption intention of new energy vehicles from the perspective of functional attributes and media richness

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ABSTRACT

Drawing on the theory of media richness, this paper aims to explore the impact of media richness on consumers' adoption intention through their perception of new energy vehicle (NEV) function attributes, and assess the moderation roles of brand familiarity and locus of control. A structural equation model is applied to analyze the data collected from 427 respondents. Empirical results demonstrate that consumers' perception of an electric attribute (i.e., charging efficiency) and two intelligent attributes (i.e., car networking and self-driving) are determinants of their adoption intention of NEVs. The other electric attribute (range) is trivial in consumers' perception. We also find that low, medium, and high-richness media significantly affect consumers' perception of NEVs' functional attributes. Compared to the high-richness, medium-richness correlates significantly with two types of NEV functional attributes. Regarding moderating effects, consumer familiarity with NEV's brand negatively impacts the relationship between media richness and adoption intention. Furthermore, low and medium-richness media effectively stimulate individuals with external control to adopt NEV, while high-richness media adversely influence individuals with internal control.

1. Introduction

Owning to the development of gasoline automobile industry, greenhouse gas emissions has brought great challenges to global warming, climate change, and air quality [1,2]. New energy vehicles (NEVs) are promoted as a solution to reduce the CO2 emissions [3]. Switching to electricity in the ground transportation sector is a promising way to achieve the energy transition and CO2 emission reductions to meet China's carbon-neutral target by 2060 [4]. Compared to fuel vehicles (FVs), the main factors impeding the massive adoption of NEVs are high acquisition costs and limited driving range due battery technologies [5]. Thereby, many countries have implemented different policies to accelerate the penetration of NEVs by either subsidizing consumers to reduce acquisition costs of NEVs, or supporting NEVs manufacturers [6,7]. China is a major market for NEVs, but also major global manufacturing country for NEVs, who ranks the first in the world for six consecutive years since 2015. In 2021, the production and sales of NEVs in China reached 3.545 million and 3.521 million, an increase of 159.52% and 157.57% year-over-year, but only accounting for 13.59% and 13.40% of the total production and sales of all vehicles, respectively.

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NEV manufacturers develop differentiation strategies such as including intelligent functions in NEVs to compete with FVs. Nowadays NEV include car networking and self-driving functions which are superior than FVs. More than 160 NEV manufacturers, including incumbents and new entrants, are actively campaigning to differentiate their NEVs' functional attributes and increase their market shares. Typically, Tesla and Xpeng focus on autonomous over-the-air software technology. Li Auto, one of China's leading NEVs manufacturers, emphasizes the extended range to ease consumers' range anxiety. Nio Auto stresses its swapping technology in contrast with conventional direct charging to solve the problem of long recharging time and high battery cost. Although NEVs' advanced functional attributes allow manufacturers to create a competitive advantage in the market, manufacturers often launch new models without considering the NEV functional attribute-media matching, which generally confuses consumers. Indeed, consumers cannot necessarily recognize the unique value of NEVs, because they perceive that NEVs and FVs share similar functions, hence impeding their adoption intention of NEVs. NEVs' functional attributes are either electric or intelligent. The electric attributes refer to the range and charging efficiency, while the intelligent attributes include car networking and self-driving. To this end, how to select proper media to deliver information efficiently and effectively about NEV's functional attributes to prospective consumers is still an open and important research topic.

Prior research on media characteristics and communication processes suggests that richness lowers the equivocality of media [8]. However, it is unclear whether the variation in media richness affects consumer's search processes and their NEVs purchasing decisions. Indeed, consumers who make purchases tend to seek information from online sources using personal computers and other handheld devices. Other consumers may still rely on relevant information from conventional media such as newspapers. Therefore, does media richness influence the consumers' perception of NEV's functional attributes? In this study, we focus on two specific research questions: (1) How do NEVs' electric and intelligent functional attributes influence consumer's intention to adopt NEVs? (2) How does media richness affect consumers' perception of NEVs' electric and intelligent functional attributes?

Several contributions were made in this study. First, this paper examines the impact of the relationship between media richness and consumer information search on the adoption intention of NEVs. Second, we provide evidence that perceived value of NEV attributes explains consumer response to variations in media richness. Third, we partially answer the question of whether marketers should always chase richer media to communicate with their customers as they migrate from conventional media to potentially rich media.

The remaining of this paper is organized as follows. In Section 2, we provide an overview of media richness theory and NEVs' adoption intention. In Section 3 and section 4, we present the research model with study hypotheses and the research methodology. Empirical tests were conducted in sections 5 and 6, followed by the interpretation of result discussions in section 7. Finally, we draw the practical and theoretical conclusions and implications in Section 8.

2. Theoretical background

2.1. Media richness theory

The media richness theory derives from the information processing theory and refers to communication efficiency among individuals affected by media fitness [9]. Media richness denotes a medium's ability to convey various information [8,10], and hence media types can be classified by placing them along a continuous scale. Communication media vary in the richness of information processed based on four particular features: (a) multiple channels, sight, sound and physical presence by exploiting gestures and body language; (b) language capacity variety via images, symbols and data; (c) personalization which can convey the emotion of the senders and the message can be tailored to satisfy the needs of recipients; (d) immediate feedback was provided as a mechanism to relief ambiguities through bidirectional communication [11].

From the perspective of the media richness theory, high performing managers should match media having the appropriate amount of information richness with the characteristics of a specific task [9]. Many researchers applied the media richness theory and suggest that the content of commercials determines their success [12]. Researchers further note that media richness can predict customers' choice of communication media [13], decision quality [14], user satisfaction, and usage of instant messaging applications [12]. In general, the richer the media content is, the greater is the advertising effect, because rich media is able to convey more information. Yiming et al. [15] notes that consumer's perception of value and willingness to pursue further engagement with the endorser are depend on the extent to which the medium can replicate high level of media richness. Besides, the richer the media is, the more authentic and genuine communication is, therefore pushing consumers to develop an increased perception of brand trust and perceived loyalty [16].

In the NEVs context, NEV marketers should especially design advertisements with adequate information, because different types of NEVs have different function attributes in this infant stage, which may enhance or hamper consumers' perception of NEVs. The

Table 1
Description of media richness.

Media features	Media richness		
	Low	Medium	High
Multiple channels	One	Two	Three or more
Language capacity variety	One	Two	Three or more
Personalization	None	Limited	Advanced
Immediate feedback	None	Limited	Rapid

propagandizing of NEVs to public should match media conveying the appropriate amount of information with the characteristics of NEVs' function. There is evident that media coverage made contribution to the sales of hybrid vehicles [17], it can imply that media play a key role in persuading consumers to choose NEVs by delivering various signals and features. To be best of our acknowledgement, there is a limited study on NEVs' adoption considering the NEV function attribute-media matching while it is prevalent among marketing related research.

Considering media richness and characteristics, this study identifies three typical media: low, medium and high-richness summarized in Table 1. Media with one channel via non-verbal cues are low-richness, such as text printed in the form of newspapers or magazines. Low-richness media is associated with outbound marketing or traditional marketing, where a company sends a message to an audience. Low-richness media makes use of one-way technologies without interactivity. The illustrative examples include print media such as handbooks, newspapers and magazines, and non-digital methods of advertising [18]. Low-richness media advertisement is naturally an effective way to bring new products into the public's vision [8]. argued consumers respond differently before making decision when facing different tasks, which are categorized into two types, i.e., uncertainty and equivocality. Uncertainty tasks refer to situations where consumers lack sufficient information to make decisions, while equivocal tasks are associated with multiple and possibly conflicting interpretations of the available information. The electric attributes of NEVs are associated with uncertainty, whereas the intelligent attributes are related to equivocality.

Medium-richness comprises two communication channels, such as audio and video. It can be expressed through symbols and signs to reflect the personalized tone of the sender. The medium-richness media offer graphic and dynamic communications such as websites, online video/audio streams and TV [19]. In the context of NEVs, the medium-richness media has significant influence on behavioural intentions and decision-making processes [20]. Consumers can obtain information about NEVs from multimedia sources. With text, sound, and animated images converging into electrical 'media forms,' consumers have a comprehensive organoleptic experience of NEV attributes. It enables consumers to acquire more related content, thus enlarging the horizon of consumers' perceptions and ability to process more information.

High-richness is characterized by virtual face-to-face allowing for the simultaneous observation of multiple informative cues, including text, video and audio, where a warm and personal experience is created, and it potentially provides feedback that allows understanding to be validated and interpreted. Access to highly rich media anytime and anywhere provides support and benefit for different activities among users in a large variety of approaches such as marketing and advertising [21]. The high-richness media is participatory, collaborative, user-generated media. It is based on Internet social media applications such as WeChat, MicroBlog, Tik Tok, and AAuto [22]. Yagci and Das [23] indicate that high-richness media contain a large amount of experienced-based information and shared product knowledge that consumers can use to make purchase decisions. In the context of NEVs, manufacturers and dealers are encouraging consumers to post their experiences, stories, pictures or videos on social media [24]. indicated that the effectiveness of online-informed interactions between the seller and buyer helps increase the purchase intention accompanied by real-time communication.

Numerous studies suggest that media richness can predict customers' choice of communication media, decision quality, user satisfaction, and usage of instant messaging applications [12]. Mahmud et al. [25] apply the media richness theory to suggest that commercials' content determines their success in appealing to consumers. In general, the richer the media content is, the greater the commercial effect, because rich media can convey valuable information. The richness of the media is also associated with more authenticity and genuine communication. Therefore, media richness contributes to increased consumers' perception of product attributes [16]. Our research postulates that marketing NEVs to the public might require varying degrees of media richness depending on different NEVs' functional attributes. It is worthwhile to apply the media richness theory to explore the influence of media richness on consumer behaviour in the NEV context. Therefore, this study investigates the mechanism of low, medium and high-richness media in conveying NEVs' functional attributes, influencing consumers' perceived value and adoption intentions of NEVs.

2.2. Using consumers' perceptions of NEV attributes to predict their adoption intention

Consumers' adoption of NEVs is closely related to their perception of the product value. Scholars have analyzed several factors influencing consumer perceptions, which can be categorized into three facets [26], namely, (1) Product attributes that include vehicle safety, brand, driving range, and charging time. (2) Consumer characteristics that involve demographics and personality such as dogmatism, risk-taking propensity, and anxiety level. (3) Context factors, such as government incentives, fuel price and charging infrastructures.

Most existing studies address NEVs' electric attributes rather than intelligent attributes. The limited range is a well-known electric deficiency of NEVs that can be overcome with NEV adopters' perception of the convenience to recharge. The lack of charging facilities, vehicle safety issues, and the 'mileage/range anxiety factor' still hinder massive adoption of NEVs [26]. Recharge mileage and charging times are major concerns by consumers [27]. Limited driving distance contributes to consumers' concerns. Therefore, the current study addresses the impact of the electric attributes of NEVs (i.e., perception of range and charging efficiency) on consumers' adoption of NEVs.

For the intelligent functional attributes, such as car networking and self-driving recently appeared in NEV function, few studies address their role in motivating purchasing decision-making. Car networking is about information interoperability between vehicles and drivers, vehicles and roads, vehicles and other vehicles, vehicles and transport facilities, using a web of information exchange infrastructure. Intelligent perception of NEVs refers to voice navigation system of whole journey, safety services, security services, remote diagnostics, information services, and multimedia entertainment services [28]. Self-driving is about autonomous driving or driverless technology, and it will cause fundamental changes to the transportation. Self-driving NEVs have received substantial

attention because of several advantages [29]. It allows hands-free trips possible, providing drivers more freedom to do other things. Self-driving NEVs also increase driving safety, reduce traffic congestion and improve the driving environment [30]. Moreover, compared with manually driven NEVs, self-driving function reduces electricity consumption, which is environmentally friendly [31]. Drivers with cars equipped with automated driving systems have already enjoyed some functions of self-driving NEVs, such as blind spot monitoring, lane keeping and brake assistance.

3. Hypotheses development

3.1. Impact of media richness on marketing NEV attributes

Consumers usually gather information through various media channels prior to purchase decision-making [32]. An effective media channel can stimulate consumers to adopt products [33]. Different studies establish the positive relationship between media richness and advertising effects. Media richness increases the number of options that consumers consider the amount and accuracy of information enabling customers to perceive the information quality. This study divide media into three types: low, medium and high-richness. In the NEV context, we consider four antecedent variables influencing consumers' perception of NEV functional attributes, namely, the electric attributes (range, charging efficiency) and the intelligent attributes (self-driving, car-networking).

3.1.1. The role of low richness media

Low richness media is mass media, makes use of one-way technologies without interactivity. Low richness media is associated with outbound marketing, or the traditional form of marketing where a company sends a message out to an audience. The illustrative examples include print media such as handbooks, newspapers and magazines, non-digital methods of advertising [18].

Typically, the most representative case is advertisement on magazines or newspapers, they are naturally a fast and effective way to bring new products into the public's vision. Lin and Yang [34] pointed that it is critical that consumers processing advertisement information, especially when consumers deeply processing advertising content, the advertisements are more impressive and persuasive, thus appeal positively convince consumers to make purchase decision [35]. In addition, Daft and Lengel argued when consumers face different tasks, they may respond to it differently before making decision, thus categorized tasks into two types, i.e., uncertainty and equivocality. Uncertainty tasks means consumers lacked sufficient information and could be executed by obtaining and sharing the needed information. Equivocal tasks, on the other hand, were those which had multiple and possibly conflicting interpretations of the available information, presenting a challenge for participants to arrive at one shared meaning of the information. In this regard, the electric attributes of NEVs belong to uncertainty tasks for consumers whereas the intelligent attributes are equivocality tasks. Based on media richness theory, low-richness media work better for uncertainty tasks, (learning about the electric attributes of NEVs). However, low-richness media do not support equivocality tasks (learning about intelligent attributes of NEVs). Therefore, we posit the following hypotheses:

Hypothesis 1a (H1a). Low-richness media has a significant effect on consumers' perception of range.

Hypothesis 1b (H1b). Low-richness media has a significant effect on consumers' perception of charging efficiency.

Hypothesis 2a (H2a). Low-richness media has no effect on consumers' perception of car networking.

Hypothesis 2b (H2b). Low-richness media has no effect on consumers' perception of self-driving.

3.1.2. The role of medium richness media

Compared to the low richness media as a static form, the medium richness media is graphic and dynamic kinds of communications comprised of websites, online video/audio streams, TV, and among others. The medium richness media is very easily processed, stored, transformed, retrieved, hyper-linked, and easily searched for and accessed [19]. Many medium richness forms are associated with inbound marketing, where the consumers find the business, mostly through various paid or unpaid and natural search engine marketing methods. An example of inbound marketing in the medium richness media would include a business working to improve its search engine results for terms relevant to the organization, and broadcasting that is pushed out from a single source to the masses such as a television show delivered by cable. When members of its audience search for these terms, they can more easily find what they're looking for. Additionally, advertisements not only present product pictures with message cues, contain symbol and appearance-resembling metaphors which induce shaping good advertisement memory, but also carry a vast of voices toward products from the pros and cons. However, there is an adverse effect that consumers resistant to commercial advertising even to ignore it except that great informative or entertaining value are perceived [36].

In the NEV context, the medium richness media has been a source of major interest and well-informed content, which also have a meaningful effect on consumers, specifically on behavioral intentions and decision-making processes. Consumers can obtain NEV information in the form of audio and video through desktop or smart phone at anytime and anywhere once they demand to learn about NEVs. With the text, sound and moving images all converged into electrical 'media forms' which means consumers can have a comprehensive organoleptic experience of NEV attributes. It enables consumers to acquire more the related content to know the NEV specific attributes, thus enlarges the horizon of consumers' perceptions, as well as their ability to process more information in a conscious manner. Therefore, consumers are exposed to various sources of NEV information which are generated by organization intentionally. There is no doubt that the medium richness media provides a much rich information environment for consumers with the NEVs function attributes, which give rise to them perceive the NEV electric attributes and intelligent attributes. Formally, we

formulate the following hypotheses:

Hypothesis 3a (H3a). Medium-richness media has an effect on consumers' perception of range.

Hypothesis 3b (H3b). Medium-richness media has an effect on consumers' perception of charging efficiency.

Hypothesis 4a (H4a). Medium-richness media has an effect on consumers' perception of car networking.

Hypothesis 4b (H4b). Medium-richness media has an effect on consumers' perception of self-driving

3.1.3. The role of high richness media

The high richness media is a participatory, collaborative, user-generated media, it based on Internet social media applications such as WeChat, MicroBlog, Tik Tok, AAuto, having access to high richness media anytime and anywhere provides support and benefit for different activities among users in a large variety of approaches such as marketing and advertising [21]. It is expansive, including technologists, entrepreneurs, investors, designers, startups, or choices about how we live, learn and care for each other to conduct marketing, advertising, education, work and our personal connections to individuals and organizations we trust such as friends or relatives, allowing creation and exchange of user-generated content [22]. The high richness media shape business model and the power of control.

Compared to the low and medium richness without interactivities, the high richness media are interactive, incorporate two-way communication. Customers' purchase intention is influenced by perceived value, peer communication, website design format. An intensive interaction through online social platforms can increase consumers' adoption intention of a product or service, as Yagci and Das [23] indicated that high richness media contain a large amount of experienced-based information and shared product knowledge that consumers can use to make purchase decisions. That is, interactions through high richness media have rapidly evolved into an influential peer-to-peer opinion and serve as a key determinant of success in persuading consumers to adopt NEVs. In turn, with the access to information and keep in touch with others, high richness media are considered valuable for practical reasons [37].

In the context of NEVs, NEV makers and retailers are inclined to encourage consumers to post their usage stories, pictures or videos on social media. Fang et al. [24] indicated that effectiveness of online-informed interactions between the seller and buyer help increase the purchase intention accompanied with real-time communication, these participatory activities will stimulate NEV consumers' adoption intention, meanwhile, the loyal NEV adopters generate their experience, which further attract NEV potential adopters' purchase intention, due to that consumers have access to not only basic vehicle information but also previous drivers' online reviews. The various rich expressions enable consumers to recognize and identify the attributes of NEV that they most concern thorough instant feedback, thus offers insights to consumers who are looking for a particular one specific attributes of NEV. High media-richness offers various rich expressions to enable consumers to recognize and identify the attributes of NEVs through instant feedback, thus offering insights to consumers looking for particular attributes of NEV. Several researchers argue that the high-richness of media helps build better communication among individuals, and consumers can better understand NEV attributes, which can motivate consumers' adoption intention of NEV. Therefore, we predict the following:

Hypothesis 5a (H5a). High-richness media has an effect on consumers' perception of range.

Hypothesis 5b (H5b). High-richness media has an effect on consumers' perception of charging efficiency.

Hypothesis 6a (H6a). High-richness media has a significant effect on consumers' perception of car networking.

Hypothesis 6b (H6b). High-richness media has a significant effect on consumers' perception of self-driving.

3.2. Perception of NEV attributes and consumer's adoption intention

Consumers are heterogeneous in perceptions of NEV functional attributes via different evaluation criteria, e.g., some pay attention to the criteria of the NEV electric functional attributes, while some focus on the criteria of intelligent attributes. Thus, it is not appropriate and applicable for all users to share the same criteria weights. However, the one-size-fits-all evaluation criterion is common in practice. Media richness theory is introduced to tackle the NEV adoption problem through individual consumers' perceptions of NEV electric attributes and intelligent attributes.

The technical attributes of NEVs have a critical effect on consumers' decision-making. The most essential technical attributes are range and charging efficiency, which imply the inherent limitation of the battery technology. Qian et al. [38] propose that the inconvenience caused by range restriction will deter consumers from adopting NEV because of difficulties in accessing charging facilities. Besides, consumers perceive the range of NEV is inferior to fuel vehicles that require frequent recharging. Consequently, NEV has competitively low driving ranges and long waiting times for charging in consumers' cognition, which are observed as the main obstacles to NEV diffusion. In other words, a lack of understanding of the electric attributes elicits consumers' anxiety, hampering their adoption intention of NEVs.

The NEV's intelligent attributes are car networking propulsion and self-driving symbols of the current NEVs' innovations. Many drivers want car networking function to estimate the deal because it can help them reach their destination in the most suitable route and in the shortest possible time, and the safety level is improved [39]. The advocates for self-driving vehicles claim that it could reduce drivers' stress and costs, increase the mobility of people, increase overall safety and others, in turn can influence consumers' decision-making processes [40]. Therefore, car networking and self-driving are NEV's intelligent attributes and potentially can improve public adoption intention of NEVs. As such, we posit that:

Hypothesis 7a (H7a). Consumers' perception of range positively affects consumers' adoption intention of NEVs.

Hypothesis 7b (H7b). Consumers' perception of charging efficiency positively affects consumers' adoption intention of NEVs.

Hypothesis 8a (H8a). Consumers' perception of car networking positively affects consumers' adoption intention of NEVs.

Hypothesis 8b (H8b). Consumers' perception of self-driving positively affects consumers' adoption intention of NEVs.

3.3. The moderators of brand familiarity and locus of control

Previous study on brand familiarity has shown that consumers rely on brand familiarity as a cue for choosing a product, which results in consumers making their adoption decisions more quickly than for an unfamiliar brand. Timo et al. [41] [][41][]note that brand name acts as a proxy for product choice by consumers. Similarly, Genfen [42] observed that brand familiarity is vital for consumers' perceptions of product value and promotes purchase intentions. We posit that brand familiarity is a prominent factor affecting consumers' decision-making. The interaction of brand familiarity and various media will affect consumers' willingness to adopt the product.

A NEV with low brand familiarity require more cognitive resources, including the time and cognitive effort of consumers to evaluate a number of its attribution information upon which to make their choice. Thus, we deduce that a NEV with low brand familiarity is challenging for customers' confidence when searching for their attributes. Conversely, a NEV with high brand familiarity requires less cognitive resources to evaluate the electric and intelligent attributes of NEVs for judging whether to buy NEVs. Cognitive resource allocation is therefore affected by the richness of the media to support consumers' searches for information regarding the NEVs' intelligent attributes. Therefore, we propose that the relationship between media richness and consumers' perceptions of NEV attributes impacts the adoption intention via the moderator of NEV brand familiarity. Thus, we propose the following hypothesis:

Hypothesis 9 (H9). The relationship between media richness and NEV brand familiarity has impact on the adoption intention.

Additionally, prior studies suggest that the locus of control as a psychological factor may play an essential role in individuals searching for information when making a purchase decision [43]. Consumers' different choices can be explained by the differences in an individual's perceived locus of control, that is, the extent to which people believe their actions can lead to the desired outcomes. Generally, individuals have either an internal or an external locus of control. Those with an internal locus of control tend to be less influenced by other's opinions. Those with an external locus of control attribute outcomes to circumstances or chance and are more prone to be influenced by the outside. Few studies in psychology show that individuals with an internal locus of control tend to react to a problem more constructively than those with an external locus of control [44], such as actively looking for solutions rather than relying solely on emotional support. Given the evidence that individuals with an internal locus of control tend to be more proactive at finding solutions for their problems, it is likely that they will also search more intensively for the most helpful information for a specific situation than individuals who are more external in their perceived locus of control. It is logical to expect that an individual's locus of control will affect their perception of purchase intentions. Thereby, we believe that:

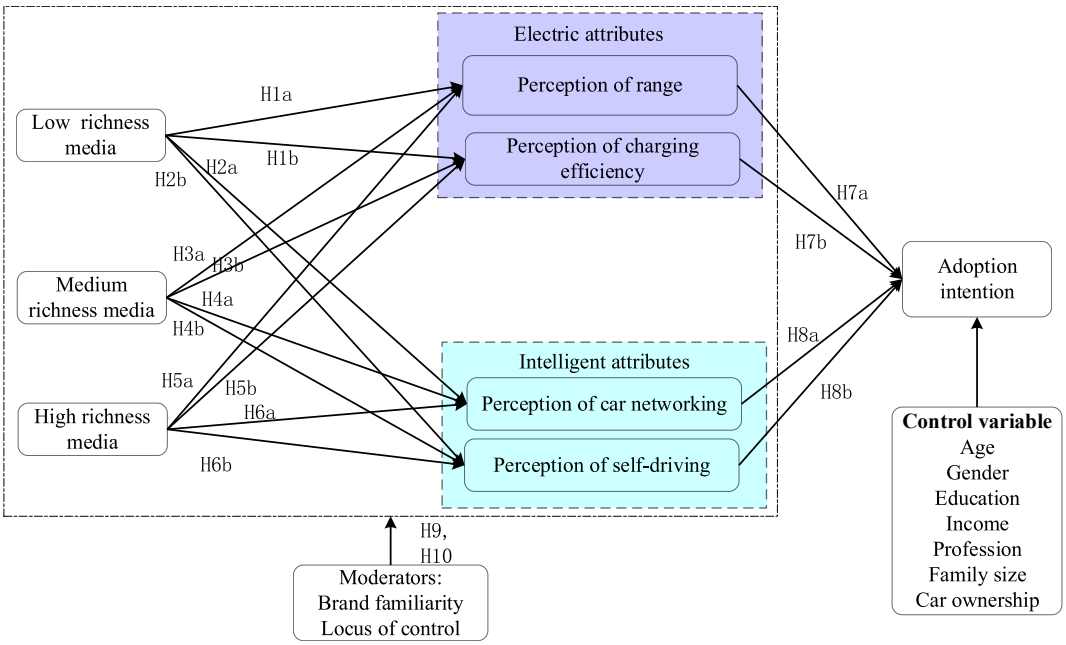

Fig. 1. Research framework and hypotheses.

Hypothesis 10 (H10). The relationship between media richness and locus of control has impact on the adoption intention.

3.4. Control variables

Consumer behaviour may be affected by demographics, such as gender, age, education, and income. Gender is a dummy variable taking 0 for females and 1 for males. The other control variables are on a quasi-interval scale. Specifying the context of NEVs based on previous research, other control variables acknowledged in this study were profession, household size and car ownership [45–47]. The research framework and hypotheses are presented in Fig. 1.

4. Research method

4.1. Questionnaire development and variable measures

To collect individual-specific data about media richness and NEV functional attributes, we designed a questionnaire based on tailored design method and previous relevant literature. The questionnaire includes socio-demographic aspects (age, education level, net monthly income), explaining variables, and explained variables. Two academic scholars from the automotive engineering faculty adjusted the measurement items to the context of China. Then, we invited two market managers from a famous NEV maker in China to evaluate and revise all items in the questionnaire.

Ten constructs were measured in this research: low-richness, medium-richness and high-richness media, perception of range, perception of charging efficiency, perception of self-driving, perception of car networking, brand familiarity, locus of control, and NEV purchase intention (see Appendix). For most items, the participants indicate their answers on a seven-point Likert scale, ranging from '1' (strongly disagree) to '7' (strongly agree). The interval-scaled items were presented in random order alongside several other items in the survey.

NEV adoption intention refers to the possibility for a consumer to buy NEVs. We adopted four levels of adoption intention from [48]. We developed the degree of confidence in an individual's NEV range from media channels using the scale from [49]. The influence of media on the feeling of a NEV consumer on the time and convenience of charging NEVs is adapted from the scale proposed by [50]. We use five measurements of the perception of self-driving as influenced by media channels, which are adapted from the scale proposed by [51]. We consider five items to measure the perception of car networking from media channels based on the scales proposed by [52]. We adopt four items from [53] to measure the perception of car networking from media channels. We use seven items from Refs. [44,54] to measure the internal and external locus of control.

Table 2
Demographics of survey respondents.

Respondents' characteristics	Item	Count (n = 427)	Percentage (%)
Gender	Male	199	46.6
	Female	228	53.4
Age	19–30 years old	109	25.5
	31–40 years old	208	48.7
	41–50 years old	63	14.8
	51–60 years old	47	11.0
Education level	Senior high school or below	23	5.4
	Junior college	58	13.6
	Bachelor	212	49.6
	Master or above	134	31.4
Individual monthly income (CNY)	Under 2000	48	11.2
	2000–5000	97	22.7
	5001–8000	118	27.6
	8001–15,000	114	26.7
	15,001–20,000	36	8.4
	Above 20,000	14	3.3
Family size	1 people	11	2.6
	2 people	98	23.0
	3 people	161	37.7
	4 people	112	26.2
	5 people or above	45	10.5
Car ownership	0 car	67	15.7
	1 car	266	62.3
	2 cars	83	19.4
	3 cars or above	11	2.6
Profession	Senior management	65	15.2
	General staff	222	52.0
	Students	57	13.3
	Civil servants	44	10.3
	Self-employed	10	2.3
	Others	29	6.8

We use five questions for low-richness media (LM1, LM2, LM3, LM4 and LM5) based on the construct of [55]. We use five questions for medium-richness media (MM1 MM2, MM3, MM4 and MM5) based on the work of [56]. We use five questions for high-richness (HM1, HM2, HM3 and HM4), which are adapted from the scale of [56].

4.2. Data collection

We carried an in-depth review to identify NVE attributes that consumers have paid close attention to in the Chinese context. Furthermore, a two-stage descriptive survey method is conducted as an appropriate method of data collection: the pilot study and questionnaire survey. A questionnaire survey helps to collect quantitative data in a standard way so that it is internally coherent and consistent for the utilization of analytical techniques [57]. The questionnaire survey comprised three parts. The first part provides a brief information about the aim of this research and assured the respondents of anonymity and confidentiality. The second part covers questions related to their demographics. The third part includes the specific questions set forth in this study. Before the quantitative non-experimental research, we conducted semi-structured informal interviews among the target population to identify the electric attributes of NEVs and evaluate the intelligent attributes that added insights to NEV's innovative construction. We designed a pilot questionnaire survey to test the reliability of the data before administering the questionnaire survey to respondents. Three industry-experienced experts and a professor of a public university in China reviewed the questions for clarity and relevance. A minimum Cronbach of 0.6 is required for the pilot study in accordance with [58]. We obtained 0.882 for the pilot study.

We exploited a self-administrated online survey in Chinese to test the hypotheses mentioned above in the theoretical framework to dispute data through a convenience sample of consumers in China. We promoted the survey using a convenience sampling approach, sending invitations to respondents via e-mail, WeChat and MicroBlog, NEV forum platforms of Asia New Energy Vehicle Network, Autohome and Sohu Auto were also utilized. The data collection took place in China from August 9th, 2021, to December 1st, 2021, for eighteen weeks. 427 valid responses were received, the sample distribution of the questionnaire is shown in Table 2.

4.3. Research technique

Structural equation modelling (SEM) techniques consist of a measurement model, which focuses on the correlation among each exogenous variable and its respective potential variables [59], and a structural model utilized to quantify the correlation between the

Table 3
Results of convergent validity and reliability analysis (N = 427).

Variable	Measurement Item	St. F L	α Value	CR Value	AVE Value
Low-richness Media (LM)	LM1	0.894	0.888	0.918	0.692
	LM2	0.791			
	LM3	0.847			
	LM4	0.857			
	LM5	0.762			
Medium-richness Media (MM)	MM1	0.816	0.840	0.885	0.607
	MM2	0.803			
	MM3	0.774			
	MM4	0.769			
	MM5	0.732			
High-richness Media (LM)	HM1	0.756	0.776	0.851	0.588
	HM2	0.719			
	HM3	0.783			
	HM4	0.807			
Perceived Cruise Distance (CD)	CD1	0.744	0.716	0.841	0.639
	CD2	0.862			
	CD3	0.789			
Perceived Charging Efficiency (CE)	CE1	0.791	0.785	0.874	0.699
	CE2	0.871			
	CE3	0.845			
Perceived Car Networking (CN)	CN1	0.843	0.877	0.911	0.672
	CN2	0.842			
	CN3	0.732			
	CN4	0.890			
	CN5	0.781			
Perceived Self-Driving (SD)	SD1	0.793	0.850	0.893	0.626
	SD2	0.809			
	SD3	0.770			
	SD4	0.762			
	SD5	0.820			
Adoption Intention (AI)	AI1	0.903	0.914	0.939	0.795
	AI2	0.905			
	AI3	0.899			
	AI4	0.858			

Note: St. FL=Standard Factor Loading; a = Cronbach's a Value; CR=Composite Reliability; AVE = Average Variance Extracted.

constructs as hypothesized [60]. This study adopts Smart PLS 3.0 and SPSS 25.0 for technical analysis. Our purpose is to judge the roles of media in communicating NEV functional attributes to stimulate consumers to adopt NEVs. The structural model allows us to study the main effects and mediating effects. Additionally, we used SPSS software to study the moderating effects such as familiarity and locus of control.

5. Empirical results

5.1. The measurement model

Before deriving the final structural model, we need to assess the reliability and validity of the measurement model as recommended by previous studies [60]. For questionnaire-based variables, the reliability of the measurement construct was evaluated by computing Cronbach's alpha (α) and composite reliability (CR). The result presented in Table 3 shows that all the value above 0.716 which are higher than the recommended marginal value of 0.7 by Nunnally (1967). Besides, all the CR values were above 0.851 which are higher than the suggested marginal value of 0.7 by [61], implying that the inherent quality of the construct is ideal and proper internal consistency is maintained. In this work, the validity of the measurement structure was measured by standard factor loading and the average variance extracted (AVE). The minimum value of standard factor loading of the measurement item is 0.719, and all the AVE of the extracted quantities was greater than 0.588 (Table 3). Thus, the convergent validity of the measures was supported, confirming the convergent validity of the constructs. In addition, the discriminant validity was tested by using the Fornell and Larcker criterion. As indicated in Table 4, the AVE square roots of all constructs were larger than the corresponding correlations among the latent constructs, demonstrating that the construct validity of the measures was robust. Another support for discriminating validity is the heterogeneity of the correlation, namely the Hetrotrait-Monotrait ratio (HTMT). As shown in Table 5, all values for HTMT are significantly lower than the threshold of 0.85 proposed in the literature [62]. This proves the discriminant validity of the measurement structure.

Therefore, all the measures satisfy the discriminant validity of the constructs. The assessment of the construct reliability, convergent validity and indicator reliability produce satisfactory results, indicating that all measurement items are retained for further analysis, and the constructs can be used to test the conceptual model.

5.2. Common method bias

Common method bias can be a severe problem when respondents are grading the measurement items of the self-reported questionnaire, which may threaten the validity of the empirical results and further yield potentially misleading conclusions. Therefore, we adopt process control and statistical control methods to reduce and test the common method bias [63]. During the process stage, all respondents were informed that our anonymous survey was a scientific research activity instead of a commercial business. This was done to eliminate potential privacy concerns for individuals, making it easier to report their authentic views or attitudes more accurately toward NEVs. In addition, a statement that no right or wrong answers to any of the questions were also included in the survey instructions to decrease respondents' apprehension. We use Harman's single-factor test in the statistical process. Common method variance can be a problem if a single factor explains over half of the variance of the factors. We found the different factors whose initial eigenvalues are greater than one criterion. The results indicate that the variance interpretation rate of the first factor accounted for 30.50%, lower than 50%; thereby, the common method bias has not existed. The last, the principal components factor test is conducted for all constructs, and the result did not yield an overarching factor. Those analyses and considerations guarantee that common method bias is not a serious issue in this study.

5.3. The structural equation model

Structural equation modelling allows unobservable variables to be measured based on multiple observable indicators. In terms of measurement scales, sample size, and residual distributions, Wynne et al. [64] pointed out that partial least squares-structural equation modelling (PLS-SEM) has slightly lower requirements. Thus, both formative and reflective indicators are analyzed together in the PLS-SEM technique. Based on the theoretical model and research hypotheses, this study uses Smart PLS 3.0 with the 5000-bootstrap procedure to analyze the structural models.

Table 4
Results of discriminant validity test (N = 427).

Variable	Mean	St.D	LM	MM	HM	CD	CE	CN	SD	AI
LM	3.546	1.070	**0.832**							
MM	3.916	0.978	0.641	**0.779**						
HM	3.844	0.855	0.494	0.695	**0.767**					
CD	3.852	1.097	0.100	0.324	0.271	**0.800**				
CE	4.735	0.822	0.532	0.522	0.416	0.377	**0.836**			
CN	4.918	1.002	0.029	0.274	0.211	0.566	0.229	**0.820**		
SD	4.655	1.000	0.171	0.442	0.342	0.498	0.333	0.682	**0.791**	
AI	4.481	1.136	0.270	0.475	0.359	0.453	0.406	0.565	0.531	**0.891**

Table 5
Correlation matrix of latent variables with the HTMT.

Variable	LM	MM	HM	CD	CE	CN	SD	AI
LM								
MM	0.733							
HM	0.619	0.841						
CD	0.285	0.388	0.329					
CE	0.631	0.644	0.523	0.487				
CN	0.082	0.299	0.214	0.717	0.280			
SD	0.198	0.504	0.385	0.638	0.408	0.786		
AI	0.295	0.532	0.410	0.556	0.476	0.628	0.599	

Using structural equation modelling, we analyze the impact of consumers' perception of range, charging efficiency, self-driving and car networking on NEV adoption intention. The significance of the relevant path coefficient determines the degree of influence of each variable. The rationality of the model is tested by the whole index for the model. The results in Table 6 show that the standardization path coefficients of hypotheses are statistically significant ($p < 0.05$), except for the coefficients of consumer perception of range to NEV adoption intention. Their standardized regression coefficients indicate the degree of direct influence. The R^2 of NEV adoption intention is 0.416.

The results support thirteen of the sixteen hypotheses as shown in Fig. 2 and the hypotheses testing results in this study are summarized in Table 6. Regarding media richness, both medium and high-richness positively impact consumers' perception of NEV's electric and intelligent attributes. In contrast, the effect of low-richness proved to be almost significantly negative except for the significantly positive effect on the perception of charging efficiency. We assumed that low richness media cannot sufficiently convey the intelligent aspects of NEVs, while the results turn out to be that low richness media adversely influence consumers' perception of car networking and self-driving attributes. It is in confirmation with the theory of media richness, communication efficiency increases as the increase of richness of the media.

Regarding the antecedents of adoption intention, the impact of perceived car networking on adoption intention is significant and the strongest relationship, followed by perceived charging efficiency and perceived self-driving. However, the impact of perceived range on adoption intention is weak and non-significant.

5.4. Mediation analysis

To test for the mediating role of perception of NEV attributes on the relationship between media richness and NEV adoption intention, this study applies the latest conventions [65], focused on bootstrapping to conduct mediation analyses. Gaskin et al. [66] suggest that the indirect effect must also be significant for mediating effect. A 95% confidence interval (CI) around the indirect effect of NEV attributes was employed, and it can be concluded that successful mediation occurs when the CI does not include zero [67]. The results of the model are given in Table 7. The perceived charging efficiency positively mediates the effect of low-richness on adoption intention. The perceived car networking and self-driving negatively mediate the effect of low-richness on adoption intention. The mediation effect of perceived range is insignificant. The perceived charging efficiency, perceived car networking and self-driving significantly and positively mediate the effect of medium-richness on adoption intention. The mediating effect of the perceived range is insignificant. The perceived charging efficiency, perceived car networking and self-driving significantly and positively mediate the effect of high-richness on adoption intention. The mediating effect of perceived range is insignificant. In other words, we

Table 6
Results of hypotheses testing.

Hypothesis	Path coefficient	T-value	P-value	Observations
H1a: LM→ CD	−0.183	2.240	0.025	Supported
H1b: LM→ CE	0.325	5.001	0.000	Supported
H2a: LM→CN	**−0.245**	**3.702**	**0.000**	Not supported
H2b: LM→ SD	**−0.185**	**2.808**	**0.005**	Not supported
H3a: MM→ CD	0.322	4.714	0.000	Supported
H3b: MM→CE	0.244	3.230	0.001	Supported
H4a: MM→CN	0.338	4.610	0.000	Supported
H4b: MM→ SD	0.452	7.055	0.000	Supported
H5a: HM→ CD	0.163	2.691	0.007	Supported
H5b: HM→ CE	0.109	2.069	0.039	Supported
H6a: HM→CN	0.124	1.962	0.049	Supported
H6b: HM→ SD	0.144	2.507	0.012	Supported
H7a: CD→AI	**0.080**	**1.427**	**0.154**	Not supported
H7b: CE →AI	0.239	5.051	0.000	Supported
H8a: CN→AI	0.345	5.351	0.000	Supported
H8b: SD →AI	0.177	2.755	0.006	Supported

Note: Insignificant effects are bold-printed.

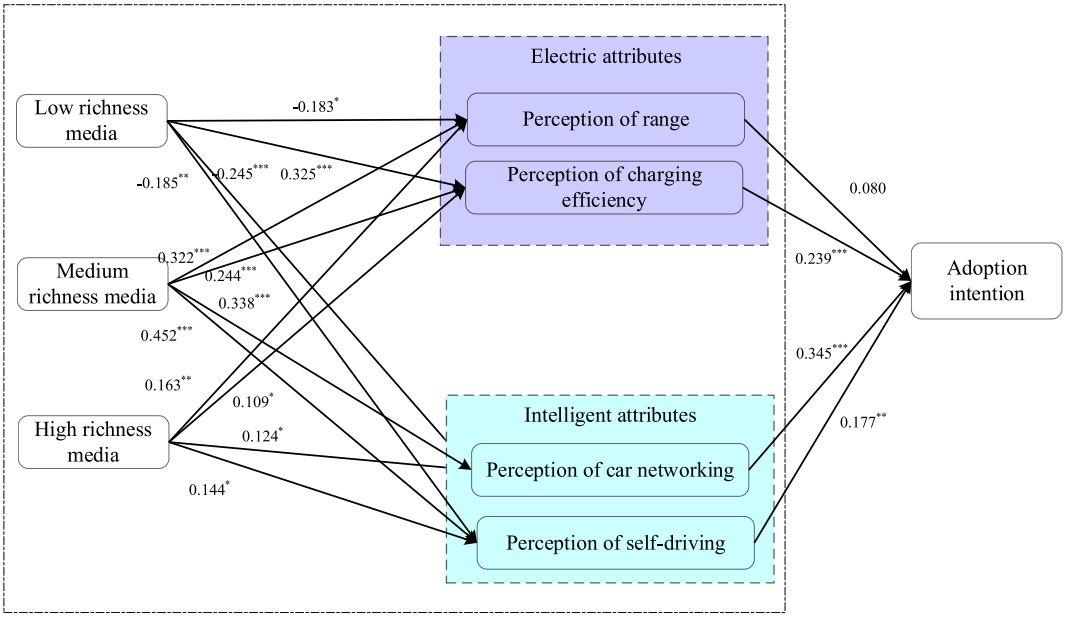

Fig. 2. Results of the theoretical model (*p < 0.05, p < 0.01, ***p < 0.001).

Table 7
Confidence intervals of the parallel multiple mediator model test.

Indirect effect	Estimate	Bootstrap 5000 times		Percentiles 95%	
		S.E.	Z	LLCI	ULCI
LM- > CD- > AI	**−0.015**	**0.014**	**−1.073**	**−0.048**	**0.005**
LM- > CE- > AI	0.078	0.021	3.721	0.067	0.110
LM- > CN- > AI	−0.084	0.030	−2.844	−0.092	−0.066
LM- > SD- > AI	−0.033	0.017	−2.062	−0.028	−0.051
MM- > CD- > AI	**0.026**	**0.020**	**1.282**	**−0.008**	**0.070**
MM- > CE- > AI	0.058	0.023	2.546	0.102	0.044
MM- > CN- > AI	0.117	0.036	3.260	0.101	0.123
MM- > SD- > AI	0.080	0.032	2.529	0.059	0.113
HM- > CD- > AI	**0.013**	**0.011**	**1.160**	**−0.004**	**0.039**
HM- > CE- > AI	0.078	0.014	5.537	0.033	0.037
HM- > CN- > AI	0.043	0.022	1.982	0.054	0.039
HM- > SD- > AI	0.025	0.013	1.977	0.022	0.031

Note: Percentile 95% confidence interval, n = 5000 bootstrap samples; LLCI = lower limit 95% confidence interval, UB = upper limit 95% confidence interval. Insignificant effects are bold-printed.

conclude that the perceived range is not a reliable mediator of the effect of low-richness, medium-richness or high-richness media on adoption intention.

Based on a thorough examination, we validate both models of measurement and structural models. Moreover, the outcomes show that the proposed models have significant predictive relevance and explanatory power.

6. The moderating roles of brand familiarity and locus of control

To extend this study, we designed a moderator to investigate how consumers' perceptions of brand familiarity and locus of control influence their adoption intention toward NEVs. Table 8 summarizes the results of our hierarchical regression analyses. Model (1) primarily examines the effect of control variables (age, gender, education, income, profession, family size and car ownership). It indicates that none of these demography variables is significant, except for the education level of respondents. Hence, the hypotheses are robust across variations in the control variables. As shown in Model (2), all three independent variables are significant predictors of adoption intention, low-richness (LM) ($\beta = 0.271$, $p < 0.001$), medium-richness (MM) ($\beta = 0.459$, $p < 0.001$) and high-richness (HM) ($\beta = 0.346$, $p < 0.001$) respectively, positively related to adoption intention. In addition, it revealed that brand familiarity (BF) ($\beta = 0.261$, $p < 0.001$) is also a significant predictors of adoption intention, except for the locus of control (LC) ($\beta = -0.058$, $p > 0.05$) which turn out to be insignificant and a negative effect.

Table 8
Hierarchical multiple regression analysis of NEV adoption intention.

	Control model	Direct effects model	Moderation model	Moderation model
	Model (1)	Model (2)	Model (3)	Model (4)
Independent variables				
Low-richness media (LM)		0.271*** (5.570)	0.161** (3.284)	0.146** (3.100)
Medium-richness media (MM)		0.459*** (10.498)	0.282*** (4.895)	0.271*** (5.204)
High-richness media (HM)		0.346*** (7.618)	0.201*** (3.551)	0.194*** (3.449)
Moderator				
Brand familiarity (BF)			0.261*** (5.514)	
Locus of control (LC)				−0.058 (−0.819)
Interaction:				
LM × BF			−0.074*(-2.30)	
MM × BF			−0.060 (−1.694)	
HM × BF			−0.084* (−2.04)	
LM × LC				0.009(0.163)
MM × LC				0.087 (1.310)
HM × LC				−0.073 (−1.200)
Control variables				
Age	−0.124 (−1.806)	−0.069 (−1.086)	−0.031 (−0.609)	−0.058 (−1.080)
Gender	−0.077 (−0.680)	0.001 (0.140)	0.014 (0.331)	−.001 (−0.029)
Education	−0.251* * (−3.160)	−0.103* (−2.002)	−0.106* (−2.106)	−0.091 (−1.753)
Income	−0.015 (−0.319)	−0.027 (−0.642)	−0.024 (−0.533)	−0.031(-0.671)
Profession	−0.001 (−0.039)	0.011 (0.312)	−0.002 (−0.036)	0.013(0.277)
Family size	−0.079 (−1.386)	−0.059 (−1.319)	−0.069 (−1.570)	−0.071(-1.567)
Car ownership	−0.144 (−1.749)	−0.209** (−2.828)	−0.106* (−2.480)	−0.121** (−2.762)
Adj. R^2	0.023	0.227	0.267	0.223
R^2 Change	0.041	0.206	0.010	0.004
F	2.418	37.806	40.693	28.760

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

6.1. Brand familiarity

Model (3) examines the moderating effects of brand familiarity. The two-way interaction of low ($\beta = -0.074$, $p < 0.05$), high-richness media ($\beta = -0.084$, $p < 0.05$) and brand familiarity on consumers' adoption intention to NEV are significantly negative in the samples. The interaction with medium-richness media ($\beta = -0.060$, $p > 0.05$) is insignificant. Hence, H9 is partially supported. Brand familiarity has a significant moderating effect on adoption intention in the context of low and high-richness. However, it does not have a significant moderating effect in the context of medium-richness. The negative and significant coefficient for the term LM × BF and HM × BF interaction implies that consumers perceived low-richness and high-richness have a worse association with adoption intention when they have a higher brand familiarity with NEVs.

6.2. Locus of control

We apply a hierarchical multiple regression to investigate the locus of control moderator effect on the relationship model between the variables of media richness and consumers' adoption intention of NEV. Model (4) reveals an insignificant interaction effect of media and locus of control on consumers' adoption intention of NEV, thus H10 is rejected. A further investigation is conducted to study the actual effect of locus of control in consumers' decision process by separating but identical models for the internal and external locus of control samples.

Cronbach's alpha is 0.93, suggesting that the different locus of control (internal and external locus of control) questions are closely related. This allows us to calculate a single index for the locus of control by adding the scores of questions 1 through 5 and reversing the scores of questions 6 and 7. The total score thus ranges from 12 to 46, with higher values indicating a lower (more external) locus of control. In order to compare the consumers under an external and internal locus of control, the present study used the

Table 9
Moderating differences between internal and external locus of control respondents.

	Respondents of internal locus of control	Respondents of external locus of control
Interaction:		
LM × LC	−0.108 (−1.649)	0.162 * (2.242)
MM × LC	−0.096(-1.380)	0.135* (2.015)
HM × LC	−0.220** (−2.868)	0.060 (0.852)
Adj. R^2	0.134	0.248
R^2 Change	0.034	0.036
F	5.971***	10.420***

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

K-means clustering algorithm to perform clustering to sort respondents. Finally, respondents in the experiment were divided into two groups: internal locus of control with 226 respondents (here referred to as internals) and external locus of control with 201 respondents (here referred to as externals). Specifically, the result of the samples' independent *t*-test and the nonparametric test proves a significant difference between the internal and external locus of the control category. Table 9 summarizes the different moderating effects between internals and externals that respondents watched. Our analyses reveal a significantly negative interaction effect of high-richness media and locus of control on consumers' adoption intention to NEV ($\beta = -0.220$, $p < 0.01$) for internals, but this interaction effect is non-significant for externals ($\beta = 0.060$, $p > 0.05$). The interaction effect of low and medium-richness media and locus of control on consumers' adoption intention is non-significant and negative for internals. While for externals, the significantly positive interaction of low-richness media ($\beta = 0.162$, $p < 0.05$) and locus of control on consumers adoption intention is slightly higher than medium-richness media ($\beta = 0.135$, $p < 0.05$). Regarding the separation of respondents into internals and externals, partially support H10.

7. Discussions

7.1. The effects of media richness on consumers' perception

The mechanism of media channels in delivering appropriate information is the latest research trend. Nevertheless, few studies have applied the media richness theory to explain the relationship between media richness and NEV adoption behaviour via NEV functional attributes. In this study, we consider three media richness levels (low, medium, and high-richness) in the context of NEVs. These three media levels are not equally important in the view of consumers when they search for information concerning different NEV functional attributes. Specifically, low-richness provides limited information and is a one-way transmission of information to consumers, which regards them as passive receivers. The results empirically revealed that low-richness negatively correlated to consumer perceived range, perceived car networking and self-driving but positively correlated to perceived charging efficiency. Hence, consumers rely less on information from low-richness media and neglect or even resist it with doubt. The results of this study confirm the limited contribution of low-richness in attracting consumers to learn about NEV attributes. The limitations of low-richness highlight the difficulty of persuading consumers to adopt NEVs because consumers do not have many choices within a specific low-richness. By contrast, medium and high-richness enable individuals to effectively search for information so that consumers' experience with NEV attributes can be accessed efficiently, especially for high-richness where immediate feedback can be received. This empirical study displayed a positive (significant) correlation between medium and high-richness with consumer perceived range, charging efficiency, car networking and self-driving. Thus, the medium-richness and high-richness are considered more reliable and valuable compared to a low-richness in consumers' search for information to learn more about NEV attributes.

7.2. NEV functional attributes concerns

The influencing factors to the adoption intentions of NEVs among different individuals share some standard features. Both perceived car networking and self-driving significantly impact consumers' adoption intention for the intelligent attributes. Contrarily, consumers' perception of NEV electric attributes has a less striking influence on the adoption intentions of NEVs. Specifically, perceived charging efficiency significantly impacts consumers' adoption intention, while consumer perceived range does not. Regarding the mediation effect, perceived charging efficiency, perceived car networking and self-driving have a significantly positive impact on mediating the relationship between various media richness and consumer adoption intention of NEVs, except for the perceived range. Two explanations can be shown in the following:

1) When it comes to the adoption of NEVs, their functional attributes are most commonly considered by consumers. Compared with conventional FVs, the functions of NEVs are generally less satisfactory in terms of range, while the range anxiety can be relieved by the construction of charging infrastructure. Moreover, the experience might decrease due to the long charging time, resulting in an indifferent attitude towards adopting NEVs.
2) The NEV attributes of car networking and self-driving are both considered to be essential factors by consumers due to the high attraction of NEVs' intelligent features.

7.3. Influence of NEV brand familiarity and locus of control

It is noteworthy that NEV brand familiarity is an essential source of information about NEVs, which is enhanced by accumulated experiences within a brand or frequent exposure to the brand. In this analysis, brand familiarity positively (significant) correlated to adoption intention, suggesting that brand familiarity may initially persuade individuals to adopt NEVs. However, the moderating roles of brand familiarity in various situations are revealed differently. Brand familiarity has negative moderating effect on media richness impact on adoption intention. The presence of brand familiarity significantly constrains the relationship between low, high-richness and adoption intention, and the moderating effect of brand familiarity on medium-richness and adoption intention was insignificant. Brand familiarity might stimulate consumers to devalue the function of media.

An extension to the internals and externals has been explored separately to test the moderating influences of the locus of control. This moderation relationship of locus of control with high-richness media is significantly and inversely related to adoption intention for a person with an internal locus of control but not significant for an individual with an external locus of control. It means that in the mental calculations of individuals with a strong internal locus of control, the higher richness media can widely convey NEV attributes,

which helps consumers achieve a comprehensive analysis procedure. This has suppressed consumers from engaging in adoption behaviour. While for consumers with an internal locus of control, the value of low and medium-richness media was not enough to significantly encourage them to increase their adoption intention of NEVs. For individuals with an external locus of control, the low and medium-richness media are associated with better psychological outcomes among consumers than internals. We conclude that the low and medium-richness media serve as a fundamental source for externals to evaluate NEV attributes. An interesting finding is that the high-richness media no longer significantly affect externals' adoption intention. When individuals are exposed to more information, they need to balance the good and bad information where information overloading happens, and confusion arises which will not stimulate the adoption of NEVs.

8. Conclusion and implication

8.1. Conclusion

This study surveyed 427 respondents to investigate the mechanism of media richness's impact on consumers' adoption intention of NEVs. NEV consumers are likelier to adopt NEVs, with the assistance of variance media in marketing NEV attributes. Medium-richness is proved to have the most substantial influence in marketing NEV attributes regardless of the electric attributes (range and charging efficiency) or the intelligent attributes (car networking and self-driving). High-richness media also positively publicises NEV attributes, but such an effect is weak in terms of perceived charging efficiency. Unfortunately, low-richness has an adverse effect than medium and high-richness. Empirical results show that intelligent attributes are essential factors in influencing respondents' acceptance of NEVs, signifying that consumers are also looking to advancing innovative attributes added to NEVs which strengthen their expectation for NEVs. However, empirical results do not support the hypothesis that consumers' perception of NEV range significantly affects public NEV adoption intention. The fact is that NEVs could meet human's regular travel distance to a great extent and benefit from a dense network of charging infrastructure were established on a specific scale.

Brand familiarity might enhance the inverse impacts of low-richness and high-richness media on adoption intention. In comparison, the moderating function of brand familiarity in the relationship between medium-richness and adoption intention is not statistically significant. In other words, under medium-richness media, brand familiarity might not influence consumer cognition consciousness of NEVs. For individuals with an external locus of control (externals), the interaction of the locus of control with low and medium-richness media enhances their adoption intention of NEV. However, there is no effect of this moderator for individuals with an internal locus of control (internals). While the interaction of locus of control and high-richness media influence individuals with internal locus of control, but not individuals with external locus of control.

8.2. Theoretical implication

This study makes several theoretical implications. First, we extended media richness theory to investigate empirically the influencing attributes of NEVs' adoption intention. Secondly, we identify two kinds of NEV functional attributes to predict consumer adoption intention. Previous studies focus on the obstacles of NEV diffusion, i.e. consumers' anxiety of range and charging efficiency, this study identify them as electric attributes. We further define intelligent attributes, including car networking and self-driving, which were less studied by previous studies. The empirical study confirms that understanding the NEV's electric and intelligent attributes should be considered when predicting consumers' adoption intention. Finally, the examination of the effects of brand familiarity and locus of control provides new insights into consumer behaviour. The effect of media richness will diverse to individuals with different level of locus of control, individuals with a higher level of external locus of control inclined to depend on the information provided by the media. Those findings contribute to a comprehensive understanding of the effects of consumer perception of NEV attributes.

8.3. Practical implication

This study leads to several practical implications. It reveals that medium and high-richness media could bring more positive message persuasiveness than low-richness. In this case, marketers can utilize the richness of media to make a combination of media in marketing NEV attributes, in line with the study by [68]. Medium and high-richness stimuli information exchange can expand the breadth of information communication and deepen information communication. In the current era of online interactive media, the synergies of medium and high-richness should be harnessed in NEV marketing. It is necessary to understand the critical role of interactive media where storability, interaction and broad reach of consumers can be attained. Thus, strong marketing communications effects augment consumers' adoption intention of NEV.

The significantly positive effects of perceived charging efficiency, perceived car networking and self-driving on NEV adoption intention demonstrate that innovative intelligent technologies could further stimulate the public to adopt NEVs. Therefore, measures can be taken to increase consumers' perception of car networking and self-driving. Moreover, a breakthrough in the bottleneck to drastically shorten NEV's charging time will significantly improve consumers' experience with NEVs. The industry could convey more information on these consumers' innovativeness and benefits of driving NEVs.

The moderating effect analysis indicate the significantly negative moderating effect of brand familiarity on the relationship between low, high-richness and adoption intention. This finding suggests that consumers more familiar with NEV brands will have more deterrent effects on their adoption intention of NEVs. In particular, the interaction of media should adapt to consumers' familiarity with the NEV brand, making consumers care more about the NEV brand and hence improve the public wiliness to adopt NEVs.

Consumers with different extents of locus of control might require a differentiated strategy. Accompanied by the locus of control and high-richness media, the adverse impact on the adoption intention of internals indicates their reliance rarely on the outside elements of promotion. More information led to more resistance. The firsthand experience of NEV benefits might be more straightforward to encourage individuals with internal locus of control to accept NEVs. However, the combination of locus of control with low and medium-richness media prove to be adequate to stimulate the adoption intention of individuals with external locus of control. Therefore, low and medium-richness media can be utilized for convincing consumers with external locus of control.

8.4. Limitations and prospects

Like all academic research, several limitations should be noted when interpreting the results of this study. First, NEV adoption intention is supposed to be dependent variable in the study, where it is hardly equal to actual behavior. Although previous literatures argued that actual behavior is closely related to behavioral intention, it would make the study results more reliable by measuring the actual behavior as dependent variable. Therefore, researches can future investigate NEV adoption by taking actual purchase behavior as dependent variable in the study model. Second, our study regard car networking and self-driving technologies as intelligent attributes associated with NEVs, other more intelligent innovations would be comprised in predicting consumers' perceptions of NEVs. Finally, the study was based on the data sourced from China in particular. Given the differences among countries, when applying the research model to other countries, the results may change. Thus, similar research may be conducted in other countries.

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Informed consent statement

Informed consent was obtained from all respondents before they answer the questions in the survey of this study.

Data availability statement

All analyzed data within this study can be obtained from the corresponding author on request.

CRediT authorship contribution statement

Yuping Zhou: Writing – review & editing, Writing – original draft, Validation, Methodology, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Jizi Li:** Writing – review & editing, Supervision, Project administration, Funding acquisition, Conceptualization. **Guitouni Adel:** Writing – review & editing, Supervision, Project administration, Investigation. **Chunling Liu:** Software, Resources, Methodology.

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. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2024.e25897.

Appendix B. Constructs and measurement

Variables	Measurement Items		Sources
Low-richness Media (LM)	LM1	I often read NEV newspapers;	[55]
	LM2	I often browse NEV magazines;	
	LM3	I often read NEV related information in newspapers and magazines;	
	LM4	I often read NEV related advertisements in newspapers and magazines;	
	LM5	I can remember the main contents about the NEV in newspapers and magazines.	
Medium-richness (MM)	MM1	I often watch TV for NEV information;	[56]
	MM2	I often surf the Internet (e.g., NetEase, Sina, Sohu) to follow the latest hot issues in NEV;	
	MM3	I often browse NEV information on Internet platforms (e.g., Autohome, Sohu Auto, Asia New Energy Vehicle Network);	
	MM4	I can remember the main contents of the NEV on the web page;	

(*continued on next page*)

(*continued*)

Variables	Measurement Items		Sources
	MM5	I think NEV related information on the web page is valuable.	
High-richness Media (HM)	HM1	I often share my views on NEV through social media (e.g., WeChat moments, Microblog);	[56]
	HM2	I often share NEV related information on social media (e.g., WeChat, Microblog, Tik Tok, AAuto);	
	HM3	I often comment on NEV information on social media (e.g., WeChat, Microblog, Tik Tok, AAuto);	
	HM4	I can remember the main contents about NEV on social media (e.g., WeChat, Microblog, Tik Tok, AAuto).	
Perception of Cruise Distance (CD)	CD1	I can accept the cruising range of NEVs;	[49]
	CD2	I think NEV meets my needs for short trips;	
	CD3	I think NEV meets my travel needs in the city.	
Perception of Charging Efficiency (CE)	CE1	I think NEV charging is convenient;	[50]
	CE2	I think NEV charges fast;	
	CE3	I think NEV has short charging time.	
Perception of Car Networking (CN)	CN1	I think the car-networking can improve the quality of my life;	[52]
	CN2	I think the car-networking makes cars more intelligent;	
	CN3	I think the car-networking function of NEVs can improve travel efficiency;	
	CN4	I know the car-networking function of NEVs is very useful;	
	CN5	I know the car-networking function of NEVs can improve vehicle performance.	
Perception of Self-Driving (SD)	SD1	NEV with self-driving function can enhance driving comfort;	[51]
	SD2	NEV with self-driving function can increase the pleasure of driving;	
	SD3	NEV with self-driving function can improve travel convenience;	
	SD4	NEV with self-driving function can shorten my driving time;	
	SD5	NEV with self-driving function can improve the flexibility of a car.	
Brand Familiarity (BF)	BF1	I have heard of NEV brands;	[53]
	BF2	I am familiar with some NEV brands;	
	BF3	Some NEV brands are very attractive to me;	
	BF4	Certain NEV brands are always on my mind.	
Locus of Control (LC)	LC1	I have little control over the things that happen to me;	[44,54]
	LC2	There is really no way I can solve some of problems I have;	
	LC3	There is little I can do to change many of the important things in my life;	
	LC4	I often feel helpless in dealing with the problems of life;	
	LC5	Sometimes I feel that I'm being pushed around in life;	
	LC6	What happens to me in the future mostly depends on me;	
	LC7	I can do just about anything I really set my mind to do.	
Adoption Intention (AI)	AI1	I am willing to adopt an NEV;	[48]
	AI2	I plan to adopt a NEV;	
	AI3	I will probably purchase a NEV;	
	AI4	I would recommend others to adopt NEVs;	

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