



Investigating the influence of augmented reality marketing application on consumer purchase intentions: A study in the E-commerce sector

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ABSTRACT

The rapid digitalization of e-commerce demands innovative solutions to enhance consumer engagement and address the sensory limitations of online shopping. Augmented Reality (AR) technology offers potential remedies by integrating virtual elements into real-world environments, enriching user experiences with interactive and immersive features. This study explores the impact of AR marketing applications on consumer purchase intentions in the e-commerce sector. Using a quantitative approach, data were collected from 315 participants with experience using AR in e-commerce contexts through a 5-point Likert scale questionnaire. The study employed Partial Least Squares Structural Equation Modeling (PLS-SEM) technique to analyze the relationships between AR characteristics (interactivity, vividness, novelty, and informativeness), consumer perceptions (perceived enjoyment, usefulness, and hedonic value), and outcomes (satisfaction, attitude, and purchase intentions). The findings indicate that AR features significantly influence consumer perceptions and experiences, with vividness and informativeness emerging as particularly impactful factors. Interestingly, while interactivity enhanced user engagement, it showed no significant impact on perceived usefulness. The study also revealed that perceived enjoyment and hedonic value significantly influenced consumer satisfaction and attitudes towards AR-enhanced e-commerce platforms, whereas the relationship between perceived usefulness and satisfaction was not supported. The results also confirmed the positive relationship of satisfaction and attitude on behavior intention. These findings provide valuable insights for e-commerce businesses and AR developers, highlighting the need to balance utility with engaging experiences in AR application design. The research contributes to the understanding of AR's efficacy as a marketing tool in e-commerce for future research in this rapidly evolving field.

1. Introduction

In today's rapidly evolving digital landscape, businesses in the e-commerce sector are under constant pressure to adapt and innovate to maintain their competitive edge (Zygiaris, 2022). Among the myriads of innovations, augmented reality (AR) technology stands out as a transformative force in marketing and consumer engagement (Du et al., 2022). AR signifies a profound shift, blurring the boundaries between physical and digital realms and presenting brands with unparalleled opportunities to engage with consumers in immersive and inventive ways (Dargan et al., 2023).

Augmented reality integrates virtual elements seamlessly into real-world environments, enriching physical surroundings with digital information and interactive experiences (Craig, 2013). This technology

has found widespread applications across various industries, including entertainment (Pucihar & Coulton, 2015), education (Bower et al., 2014), healthcare (De Paolis et al., 2011), and retail (Tan et al., 2021). In marketing, AR holds promise due to its ability to create captivating and personalized experiences that resonate deeply with consumers. For example, Virtual Try-On technology enables individuals to virtually sample clothes and footwear from home, enhancing their shopping experience and reducing uncertainty associated with online purchases (Sekhavat, 2017). Similarly, AR tools like the Furniture Planner allow customers to integrate virtual representations of products into their living spaces, helping them envision how items would fit and complement their rooms (Ozturkcan, 2020).

By their very nature, e-commerce platforms represent a paradigm shift in the retail landscape, fundamentally transforming the dynamics

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of consumer engagement and interaction (Bharti & Mahato, 2022, pp. 145–164; Joshi, 2020). Unlike traditional physical stores, these digital marketplaces operate within a virtual realm which offers convenience and accessibility but often at the expense of sensory richness and immersive experiences (Teller et al., 2019). The absence of physical presence and tactile interactions with products poses a significant challenge, as consumers rely heavily on visual and experiential cues to evaluate and select items (Schifferstein & Spence, 2008). In the absence of direct physical interaction, consumers may experience a sense of detachment, leading to uncertainty and hesitancy in their purchase decisions (Forsythe et al., 2006). Lim et al. (2006) suggested that the inability to inspect products firsthand, assess their quality, or gauge their suitability can create barriers to trust and satisfaction, ultimately impacting conversion rates and customer loyalty. As such, e-commerce businesses are compelled to explore innovative strategies to bridge this perceptual gap and augment the online shopping experience.

In this context, the integration of AR technology emerges as a promising solution that can overcome the limitations of traditional online shopping. AR, fundamentally, provides a dynamic and interactive platform for brands to present their products and services, surpassing the limitations of traditional marketing channels (Alimamy et al., 2017). Through the overlay of digital content onto real-world environments, AR empowers consumers to engage with virtual objects, envision products within their personal spaces, and even simulate real-life scenarios (Alimamy et al., 2017). This capability fosters a profound and immersive connection with brands and their offerings, facilitating deeper levels of engagement (Rauschnabel et al., 2019). One of the key advantages of AR in the context of e-commerce lies in its potential to address some of the inherent limitations of online shopping, particularly the lack of tangibility and sensory experience (Riar et al., 2022). Unlike brick-and-mortar stores, where consumers can touch, feel, and try out products before making a purchase, online shopping often entails a degree of uncertainty and hesitation (Zhou et al., 2019). AR mitigates this barrier by providing virtual try-on experiences, interactive product demonstrations, and 3D visualizations, enabling consumers to make more informed and confident purchase decisions from the comfort of their own homes (Kumar, 2021). Furthermore, AR offers a highly personalized and customized experience, tailored to individual preferences and needs. By leveraging AR technology, brands can deliver hyper-targeted content and promotions that resonate with specific consumer segments, thereby enhancing relevance and resonance. Whether it's personalized product recommendations, virtual fitting rooms, or interactive storytelling experiences, AR empowers brands to create meaningful connections with consumers and foster a sense of loyalty and affinity (Kumar, 2021).

AR technology has been introduced in developing countries for several years. Studies in countries like Malaysia (Ng & Ramasamy, 2018), Pakistan (Kazmi et al., 2021), Nigeria (Oke & Arowoija, 2021), and Vietnam (Dinh et al., 2020) have highlighted its emergence across different sectors. Despite its evident presence, the adoption of AR technology in marketing has remained relatively limited due to a lack of awareness about its potential applications (Oke & Arowoija, 2021). However, recent research suggests that AR technology is increasingly gaining recognition and traction in various industries, indicating its emergence as a promising tool for marketing purposes (Faqih, 2022). Studies conducted by Dinh et al. (2020) and Nguyen (2022) pointed out that the rapid spread of AR technology adoption across industries in Vietnam, particularly within the realm of retail entrepreneurship.

Despite the increasing adoption of AR in marketing, there remains a significant gap in understanding its impact on consumer behavior and purchase intentions within e-commerce. While prior studies have explored AR's potential in specific contexts, such as virtual try-ons and product visualization, research providing a systematic and theoretical framework to explain the psychological and behavioral mechanisms underlying AR adoption in online shopping is still limited. This gap is particularly critical given the rapid advancements in AR technology and

its growing role in shaping digital consumer experiences, as well as the increasing reliance of businesses on technological innovation to differentiate themselves in a crowded digital marketplace. The urgency of this study stems from the evolving nature of consumer engagement in e-commerce, where immersive and interactive technologies like AR are becoming key differentiators for businesses. However, the extent to which AR features influence consumer perceptions, attitudes, and purchase decisions remains underexplored. Existing literature offers fragmented insights, often lacking a comprehensive approach that integrates AR-specific attributes with established consumer behavior theories. To address this research gap, this study examines the interplay between AR marketing applications and consumer decision-making by incorporating insights from the Technology Acceptance Model (TAM) alongside AR-specific factors. By doing so, it provides a holistic framework to understand how AR enhances consumer engagement, influences perceptions of value, and ultimately drives purchase intentions.

The research objectives are to assess the impact of AR characteristics (interactivity, vividness, novelty, and informativeness) on consumer perceptions (perceived enjoyment, perceived usefulness, hedonic value), examine relationships between these perceptions and attitudes towards AR-enhanced platforms, and analyze how these attitudes affect satisfaction and purchase intentions. By exploring these variables, this study aims to provide a comprehensive understanding of AR's role in shaping consumer decision-making in e-commerce. The significance of this research lies in the growing investment by businesses in AR capabilities, necessitating evidence-based strategies for optimal implementation. The study contributes to the literature by extending technology acceptance models to include AR-specific factors, offering empirical evidence on AR's marketing effectiveness, and providing actionable insights for practitioners to design impactful AR experiences. This study also addresses a critical gap in the context of developing economies, where AR adoption is still in its nascent stages but holds immense potential for growth. By focusing on the e-commerce sector, this study provides actionable insights for businesses operating in developing markets, where digital transformation is accelerating but consumer behavior remains understudied. Ultimately, this research aims to advance understanding of AR's potential in transforming e-commerce and digital marketing strategies.

2. Literature review

2.1. Augmented reality in E-commerce

Augmented reality (AR) emerged in the 1950s when cinematographer Morton Heilig envisioned a cinematic experience that actively engaged viewers. AR enhances the real world by overlaying digital information onto it; this technology allows users to interact with both physical and virtual elements simultaneously (Carmigniani et al., 2011). According to Zagorc and Bernik (2022), AR technology overlays digital content onto the real world, transforming the e-commerce landscape by providing interactive, real-time product visualizations. Their research also assesses consumer purchase intent for products visualized through augmented reality applications and to evaluate the marketing potential of augmented reality advertising (Zagorc & Bernik, 2022).

Electronic commerce (e-commerce) encompasses business transactions conducted electronically, including business-to-business (B2B), business-to-consumer (B2C), and consumer-to-consumer (C2C) exchanges. The proliferation of personal computers, mobile devices, and robust telecommunications networks in the 21st century has propelled e-commerce into a central component of affluent economies (Williams, 2024). In the context of using AR, this technology has revolutionized e-commerce by seamlessly integrating digital elements into the physical shopping experience (Bhatia, 2024). This cutting-edge technology bridges the digital-physical divide, offering consumers immersive and interactive product visualizations.

AR technology's integration into e-commerce has redefined

consumer engagement by enabling immersive and interactive shopping experiences. AR allows users to visualize products in their real-world environment, enhancing their ability to make informed purchase decisions. This capability reduces the uncertainty associated with online shopping and increases consumer confidence (Carmigniani et al., 2011). By providing detailed and interactive product visualizations, AR enhances the sensory experience of online shopping, which is often limited compared to traditional in-store shopping (Zhou et al., 2019).

2.2. Impacts of AR characteristics on perceived enjoyment, perceived usefulness & hedonic value

2.2.1. Interactivity

Interactivity in Augmented Reality (AR) environment significantly enhances consumer engagement and experiences by allowing real-time manipulation and interaction with virtual objects. Chekembayeva et al. (2023) posit that increasing system speed, interactivity, and real-time user manipulation or modification of technology enhance customer involvement. This interactive capability of AR creates a more engaging and immersive experience, significantly influencing perceived enjoyment, which can subsequently affect consumer purchase intentions. Yim et al. (2017) demonstrated that AR's interactive features enhanced customer engagement and enjoyment in online shopping experiences. Similarly, Huang and Liao (2015) found that the interactivity of AR applications increased enjoyment and positively affected purchase intentions in e-commerce settings. Poushneh and Vasquez-Parraga (2017) further corroborated these findings, showing that interactivity positively affected enjoyment in retail contexts, ultimately influencing consumers' willingness to buy. These studies collectively suggest that the interactive nature of AR is a critical factor in enhancing perceived enjoyment during online shopping.

Perceived usefulness, in the context of technology adoption, refers to the degree to which a person believes that using a particular system would enhance their job performance or task completion (Davis, 1989). In e-commerce, the perceived usefulness of AR can be understood as the extent to which consumers believe AR enhances their online shopping experience and decision-making process. Interactivity in AR applications allow users to manipulate virtual products, view them from different angles, and place them in real environments, which can significantly increase the perceived usefulness of the technology. Several studies have explored this relationship. Rese et al. (2017) found that interactive AR features in mobile shopping apps positively influenced perceived usefulness, as users could better visualize products in their intended context. Similarly, Chaudhry et al. (2023) reported that the interactive nature of AR shopping apps led to increased perceptions of usefulness, particularly in helping consumers make more confident purchase decisions. Park and Yoo (2020) further demonstrated that AR interactivity enhanced perceived usefulness by providing a more informative and engaging product examination experience in online retail settings. These findings indicate that the interactivity of AR applications plays a pivotal role in enhancing the perceived usefulness of the technology in e-commerce.

Hedonic value in consumer behavior refers to the pleasure, enjoyment, or emotional worth derived from a product or experience, as opposed to its purely functional benefits (Holbrook & Hirschman, 1982). In AR applications for e-commerce, hedonic value can be understood as the fun, excitement, or entertainment that consumers experience while using AR features during online shopping. Interactivity in AR allows users to engage with virtual products in playful and immersive ways, potentially enhancing the hedonic aspects of the shopping experience. Several studies have explored this relationship. Javornik (2016a) found that the interactive elements of AR in beauty apps significantly increased users' hedonic responses, making the virtual try-on experience more enjoyable and emotionally engaging. Wu et al. (2024) noted that authenticity, entertainment, and interactivity collectively enhance consumers' flow experiences within the e-commerce domain, with

interactivity exerting the most pronounced influence. The flow experience mediates the relationship between e-commerce live streaming characteristics and purchase intentions, while hedonic shopping value modulates the impact of flow experience on purchase intention. These insights highlight the critical role of interactivity in enhancing the hedonic value of AR applications in online shopping.

Based on the above discussion, the following hypotheses are proposed.

- **H₁:** Interactivity significantly positively influences Perceived Enjoyment.
- **H₂:** Interactivity significantly positively influences Perceived Usefulness.
- **H₃:** Interactivity significantly positively influences Hedonic Value.

2.2.2. Vividness

Vividness in digital media refers to the richness, clarity, and realism of virtual content superimposed on the real world or a technologically mediated environment, emphasizing its capacity to provide a sensorially rich experience (Li et al., 2023; Steuer, 1992). Vivid information, as defined by McLean and Wilson (2019), encompasses any content, including audio, visual, or interactive elements, that stimulate the physical and experiential aspects of a purchase. Moreover, AR-based apps enhance product understanding by providing clear, detailed, and unique product presentations (McLean & Wilson, 2019). In e-commerce AR applications, vividness pertains to how realistically and clearly virtual products are presented, significantly influencing user perceptions and experiences.

Perceived enjoyment, in this context, is the extent to which using AR technology for shopping is considered inherently enjoyable. Recent studies have established a strong relationship between AR vividness and perceived enjoyment. McLean and Wilson (2019) found that highly vivid AR experiences in retail apps significantly enhanced user enjoyment, making the virtual try-on process more engaging and pleasurable. Iranmanesh et al. (2024) further supported these findings, reporting that the vividness of AR product visualizations in home furnishing apps increased enjoyment as users could more realistically imagine products in their space. These results underscore the importance of vividness in enhancing the enjoyable aspects of AR shopping experiences.

Perceived usefulness, as defined in technology acceptance models, is the extent to which a person believes that using a particular system would enhance their performance or decision-making (Davis, 1989). In e-commerce AR applications, vividness relates to the realism and detail of virtual product visualizations, which can significantly impact perceived usefulness. Boardman et al. (2020) reported that the vividness of AR in fashion retail apps led to increased perceptions of usefulness, as users could more accurately visualize how clothing items would look on them. Kim et al. (2021) also found that vividness exerted a significant positive influence on perceived usefulness and enjoyment, subsequently impacting attitudes towards technologies and corresponding behavioral intentions. These findings highlight the critical role of vividness in enhancing the practical benefits of AR applications in online shopping.

In consumer behavior, hedonic value refers to the pleasure, fun, or emotional worth derived from a product or experience. Vividness in AR applications enhance this value by making the shopping experience more immersive and enjoyable. Kowalczyk et al. (2021) found that highly vivid AR product visualizations significantly enhanced hedonic value by creating a more engaging shopping experience, especially for experiential products. Sung (2021) reported similar results in beauty and cosmetics apps, where the vividness of AR led to increased hedonic value, as users found the virtual try-on experience both entertaining and emotionally engaging. A comprehensive meta-analysis by Flavián et al. (2019) corroborated these findings, demonstrating that across various e-commerce categories, AR vividness consistently contributed to higher levels of hedonic value, enhancing the overall emotional and experiential aspects of online shopping.

Based on the above discussion, the following hypotheses are proposed.

- **H₄:** Vividness significantly positively influences Perceived Enjoyment.
- **H₅:** Vividness significantly positively influences Perceived Usefulness.
- **H₆:** Vividness significantly positively influences Hedonic Value.

2.2.3. Novelty

Novelty in the context of technology refers to the degree to which users perceive a new technology or feature as innovative, original, or different from their previous experiences (Wells et al., 2010). The novelty concept, as defined by McLean and Wilson (2019), refers to the unique, personalized, and novel content experiences continuously delivered through AR displays, rather than simply the novelty of AR itself. In AR applications for e-commerce, novelty can be understood as the uniqueness and innovativeness of the AR features compared to traditional online shopping methods. This sense of novelty plays a crucial role in shaping user experiences, influencing perceived enjoyment, perceived usefulness, and hedonic value in AR-enhanced online shopping experiences.

Perceived enjoyment relates to how much using a technology is perceived as enjoyable. Recent studies have highlighted the relationship between novelty and perceived enjoyment in AR-enhanced online shopping experiences. Pantano et al. (2019) found that the novelty of AR features in retail apps significantly enhances users' perceived enjoyment, making the shopping experience more exciting and entertaining due to the innovative nature of AR interactions. The initial exposure to new technology often triggers the well-documented novelty effect, commonly referred to as the "wow factor". Research consistently demonstrates that this phenomenon can significantly influence user experiences in various ways (Gonçalves et al., 2023). Iranmanesh et al. (2024) also found the positive relationship between novelty and perceived enjoyment in the context of using AR for shopping.

Novelty categorization theory suggests that exposure to novel stimuli prompts consumers to engage in cognitive processing that expands their mental frameworks, thereby enhancing their capacity for inspiration (Frasquet et al., 2024). Yim et al. (2017) assert that perceived usefulness is a critical determinant of technology adoption and usage. Supporting this, studies by McLean and Wilson (2019) and Kristi and Kusumawati (2021, p. 22) indicate a positive relationship between novelty and perceived usefulness. The innovative features of AR not only attract users' attention but also enhance their perception of the technology's utility in improving their shopping experience. As AR technology in retail becomes more widespread, its impact may evolve, potentially shifting consumer expectations, driving ongoing innovation in AR features, and fundamentally altering how consumers shop and interact with products.

Novelty, recognized as a core "collative" stimulus property, plays a crucial role in motivation theory, particularly in exploratory behavior, experimental aesthetics, developmental psychology, and personality studies (Berlyne, 1963). In consumer behavior, hedonic value refers to the pleasure, fun, or emotional worth derived from a product or experience. Javornik (2016a) found that the novelty of AR features in beauty and cosmetics apps significantly enhances hedonic value, as users experience excitement and pleasure from engaging with innovative virtual try-on technologies. The novelty concept, as defined by McLean and Wilson (2019), extends beyond the mere presence of AR technology to encompass the continuous delivery of unique, personalized, and innovative content through AR interfaces. This perspective highlights the importance of dynamic and customized AR experiences in sustaining user engagement and maximizing hedonic value.

Based on the above discussion, the following hypotheses are proposed.

- **H₇:** Novelty significantly positively influences Perceived Enjoyment.
- **H₈:** Novelty significantly positively influences Perceived Usefulness.
- **H₉:** Novelty significantly positively influences Hedonic Value.

2.2.4. Informativeness

Informativeness plays a crucial role in shaping consumer perceptions of the abundance and quality of information available. By delivering comprehensive and relevant details, businesses can significantly enhance consumer confidence in the richness and reliability of the information provided (Tang & Chen, 2020). This principle is particularly pertinent in the context of AR applications, where informativeness not only influences consumer confidence but also enhances the overall shopping experience. Similarly, Yim et al. (2017) demonstrated that informative AR features enhanced users' perceived enjoyment and usefulness, while also contributing to hedonic value by making the shopping experience more pleasurable. In AR applications within online retailing, perceived enjoyment and informativeness are identified as key antecedents of perceived usefulness (Rese et al., 2017). These findings highlight that informativeness serves a dual role, both enhancing the functional value of AR by delivering relevant and detailed product information and enriching the emotional aspect of the shopping experience. By offering engaging and informative content, AR technology can improve consumer decision-making while simultaneously increasing enjoyment, ultimately shaping more favorable perceptions of its usefulness.

Informativeness is a critical dimension in the context of AR brand shopping experiences, particularly when examining the integration of AR service technologies into marketing and information management applications (Plotkina & Saurel, 2019). For instance, Machdar (2016) found that users perceive accounting software as more useful when the information it provides is accurate, relevant, and reliable. This insight underscores the value of informativeness in enhancing the perceived usefulness of technological applications. In AR research, particularly within e-commerce contexts, the focus has been predominantly on experimental investigations of consumer behavior (Javornik, 2016a). AR technologies facilitate product visualization and fit assessment, offering a distinct consumer experience compared to traditional brick-and-mortar settings. AR provides virtual information about physical products, thereby increasing awareness and enhancing the perceived benefits of AR in shopping environments.

Online store informativeness and entertainment significantly influence consumer approach behaviors. Pleasure serves as a mediator in the relationship between these attributes and consumer behavior, while hedonic value moderates the impact of informativeness on approach behaviors (Wu et al., 2019). Informativeness enhances consumer confidence in the perceived richness of information through effective customer service. In a recent study, Negm (2024) found that informativeness has a significant impact on hedonic value. This study demonstrates that while AR informativeness fosters utilitarian value development, AR interactivity cultivates hedonic value among consumers. Subsequently, hedonic value influences purchase intentions, with both hedonic and utilitarian values driving brand content consumption. Notably, utilitarian value additionally predicts content contribution and creation.

Based on the above discussion, the following hypotheses are proposed.

- **H₁₀:** Informativeness significantly positively influences Perceived Enjoyment.
- **H₁₁:** Informativeness significantly positively influences Perceived Usefulness.
- **H₁₂:** Informativeness significantly positively influences Hedonic Value.

2.3. Impacts of perceived enjoyment on satisfaction and attitude towards AR

Perceived enjoyment refers to the extent to which an individual finds an activity or experience inherently pleasurable or satisfying (Davis et al., 1992). Perceived enjoyment is a transient emotional response that arises during the interaction with an AR application, whereas hedonic value represents the cumulative emotional and experiential benefits that consumers derive from the experience (Yim et al., 2017). For instance, a consumer may find an AR virtual try-on tool enjoyable in the moment - perceived enjoyment, but the overall hedonic value of the experience depends on factors such as the level of immersion, personalization, and emotional resonance (Flavián et al., 2019). In the context of AR in e-commerce, perceived enjoyment refers to the pleasure or fun derived from engaging with AR features during online shopping. Research has demonstrated that perceived enjoyment significantly impacts (2019) found that the enjoyment derived from AR features in retail apps markedly enhanced user satisfaction with the overall shopping experience. Users who reported higher levels of enjoyment from AR interactions also exhibited (2021) revealed that in the context of fashion e-commerce, the perceived enjoyment of AR try-on features positively influenced customer satisfaction. This increased satisfaction was associated with a higher likelihood of repeat usage and positive word-of-mouth recommendations, underscoring the role of enjoyment in fostering customer loyalty and advocacy.

Attitude towards technology, as defined by Fishbein and Ajzen (1975), reflects an individual's overall evaluation of a particular system or technology. Mekonnen (2024) reported that the perceived enjoyment of AR applications in luxury retail significantly improved users' attitudes towards both the technology and the brands utilizing it. The enjoyable nature of AR interactions led to more favorable evaluations of AR for online shopping. Flavián et al. (2019) further corroborated these findings across various e-commerce sectors, demonstrating a consistent positive relationship between perceived enjoyment of AR features and users' attitudes towards using AR in online shopping. This relationship was notably stronger for experiential products, highlighting the enhanced impact of enjoyment on attitudes in contexts where the sensory and emotional aspects of the experience are paramount. Iranmanesh et al. (2024) and Nah et al. (2011) suggested that AR technology has the potential to enhance brand perception by creating immersive, enjoyable, and engaging shopping experiences. When consumers interact with AR applications that provide seamless, interactive, and visually appealing product representations, they are more likely to associate the brand with innovation, convenience, and customer-centricity. This positive experiential engagement fosters stronger emotional connections with the brand, leading to more favorable brand attitudes.

Based on the literature, the following hypotheses are proposed.

- **H₁₃:** Perceived Enjoyment significantly positively influences Satisfaction.
- **H₁₄:** Perceived Enjoyment significantly positively influences Attitude.

2.4. Impacts of perceived usefulness on satisfaction and attitude towards AR

Perceived Usefulness is defined by Davis (1989) as the degree to which an individual believes that using a particular system will enhance their job performance. In the context of e-commerce, perceived usefulness reflects consumers' belief that online shopping, facilitated by technologies such as AR, improves their overall shopping experience. Research has consistently demonstrated that perceived usefulness significantly impacts consumer satisfaction. Do et al. (2020) found that perceived usefulness positively influences satisfaction in the context of using AR technology. Specifically, Rese et al. (2017) reported that the

perceived usefulness of AR features in online shopping led to significantly enhanced user satisfaction and improved overall shopping experiences. This finding is further supported by Poushneh and Vasquez-Parraga (2017), who observed that AR applications perceived as useful not only increased customer satisfaction but also positively influenced customers' willingness to make purchases. These studies collectively highlight the critical role of perceived usefulness in driving satisfaction within AR-enhanced online shopping environments.

Attitude towards technology, as defined by Ajzen and Fishbein (1980), refers to an individual's evaluative judgement of engaging in a specific behavior. Moriuchi (2019) suggested that perceived usefulness enhances consumer engagement with technology by encouraging increased usage. This perception significantly influences consumer attitudes and intentions toward online purchasing, supporting the notion that perceived usefulness positively correlates with technology attitudes and trust. Suri et al. (2003) found that users who perceive AR as useful in visualizing products develop more favorable attitudes towards the technology. This positive perception enhances their confidence in AR's ability to facilitate informed decision-making, reduce uncertainty, and improve the overall shopping experience. As a result, consumers who recognize the practical benefits of AR are more likely to embrace the technology and integrate it into their purchasing behavior. Moriuchi (2019) further posits that perceived usefulness positively affects consumer engagement with technology by stimulating usage, thereby explaining a significant portion of the variance in consumer technology engagement and attitudes.

Based on the literature, the following hypotheses are proposed.

- **H₁₅:** Perceived Usefulness significantly positively influences Satisfaction.
- **H₁₆:** Perceived Usefulness significantly positively influences Attitude.

2.5. Impacts of hedonic value on satisfaction and attitude towards AR

Hedonic Value, as introduced by Babin (1994), refers to the subjective and personal enjoyment derived from shopping experiences, characterized by fun, playfulness, and leisure, in contrast to utilitarian value which focuses on task completion. Hedonic value encompasses the pleasure and entertainment consumers seek beyond mere functional needs, driving innovations in products and services to enhance the shopping experience (Evelina et al., 2020). While perceived enjoyment is a component of hedonic value, the latter encompasses a broader range of emotional and sensory experiences. In the context of AR marketing, hedonic value is often associated with the immersive and entertaining qualities of AR applications that go beyond mere functionality (Flavián et al., 2019). Consumers who prioritize hedonic value view the shopping process as a source of enjoyment and recreation, valuing aesthetic and experiential aspects of products over their functional utility. Research has demonstrated that hedonic value significantly impacts consumer satisfaction. Poushneh and Vasquez-Parraga (2017) found that the hedonic value derived from AR experiences in retail settings markedly enhanced user satisfaction, leading to a greater willingness to purchase. This indicates that pleasure derived from AR technology can accelerate purchasing decisions, especially in e-commerce contexts where sensory experiences are mediated through digital interfaces.

The influence of hedonic values extends to consumer attitudes as well. Childers et al. (2001) established that the hedonic element of online shopping experiences strongly shapes consumers' attitudes toward new technologies. In the context of AR, Dacko (2017) reported that the hedonic value derived from AR applications in retail significantly improved users' attitudes towards both the technology and the shopping experience. Similarly, Huang and Liao (2015) observed that the hedonic value associated with AR in e-commerce positively affected users' attitudes, resulting in increased intention to use and purchase. McLean and Wilson (2019) further supported these findings, noting that the hedonic

value provided by AR features in mobile shopping apps not only enhanced attitudes towards the technology but also positively influenced overall brand perceptions and purchase intentions.

Based on these insights, the following hypotheses are proposed.

- **H₁₇**: Hedonic Value significantly positively influences Satisfaction.
- **H₁₈**: Hedonic Value significantly positively influences Attitude.

2.6. Impacts of Attitude on Satisfaction and purchase intention

AR has emerged as a transformative tool in marketing, significantly influencing purchase intention, app attitudes, user satisfaction, and overall user experience (Javornik, 2016a). AR enhances brand perception and product appeal by creating immersive and interactive experiences that improve consumer engagement with products and services (Voicu et al., 2023). The ability of AR to embed environmental elements and simulate physical control effectively reduces cognitive load and enhances cognitive fluency, thereby improving consumers' attitudes toward products (Fan et al., 2020). This enhancement in product attitude is associated with increased customer satisfaction. When consumers can interact with products in a more intuitive and immersive manner, they gain a clearer understanding of the product's features, benefits, and potential applications in their own lives. This enhanced understanding, coupled with the novel and engaging nature of AR experiences, contributes to a more satisfying customer journey from initial product discovery through to purchase decision.

Consumer Satisfaction, as defined by Oliver (2014), is a psychological state resulting from cumulative product or service experiences. The shift towards online shopping has introduced a new dimension of e-satisfaction, reflecting satisfaction in digital environments. AR technology, which overlays virtual elements onto the physical world, offers novel ways to engage with products by merging real and digital experiences. This integration captures consumer attention, facilitates product visualization, and stimulates purchase desire. Trivedi and Trivedi (2018) found a significant positive relationship between satisfaction and purchase intention, with satisfaction exerting a strong influence on the likelihood of making a purchase. Anifa and Sanaji (2022) investigate the influences of consumer satisfaction on purchase and repurchase intention in the context of using AR for online shopping.

Enhanced user experiences play a crucial role in shaping positive purchase attitudes, as the enjoyment and engagement derived from AR applications can significantly influence consumers' purchase intentions. The immersive and interactive nature of AR fosters deeper consumer involvement, making the shopping process more engaging and enjoyable, which, in turn, enhances their willingness to make a purchase. Kazmi et al. (2021) emphasized that familiarity with AR technology is a key factor in shaping user experiences and attitudes, underscoring the importance of cultivating positive online shopping experiences to encourage favorable perceptions of AR and increase the likelihood of repeat usage. Similarly, Daassi and Debbabi (2021) provided empirical evidence supporting a strong positive correlation between consumer attitudes toward AR and their intention to reuse AR-based applications. Their findings highlight that beyond a one-time novelty effect, sustained positive experiences with AR can foster habitual usage and long-term consumer engagement. Additionally, research by Lee et al. (2021) demonstrated that AR technology enhances both utilitarian and hedonic consumer experiences, playing a dual role in influencing purchasing attitudes and intentions. The ability of AR to provide detailed product information, improve decision-making, and enhance entertainment value creates a well-rounded shopping experience that appeals to both rational and emotional aspects of consumer behavior.

Based on these insights, the following hypotheses are proposed.

- **H₁₉**: Attitude significantly positively influences Satisfaction.
- **H₂₀**: Satisfaction significantly positively influences Purchase Intention.

- **H₂₁**: Attitude significantly positively influences Purchase Intention.

2.7. Theoretical framework

The integration of extended Technology Acceptance Model (TAM) models highlights the critical role of consumer perceptions as mediators between external stimuli and purchase intentions (Chang & Huang, 2015). Additionally, by applying the Stimulus-Organism-Response (SOR) theory (Buxbaum, 2016), this study demonstrates that external stimuli in the form of AR marketing, characterized by interactivity, vividness, novelty, and informativeness, as validated by Nikhashemi et al. (2021) and Gabriel et al. (2023), positively influence purchase intentions by shaping consumer perceptions. This framework underscores the complex interplay between AR marketing stimuli, consumer perceptions, and purchasing behaviors, emphasizing the importance of understanding and leveraging consumer psychology in marketing strategies. The model is illustrated in Fig. 1.

3. Methodology

3.1. Research design

The study adopted a quantitative research design to collect and analyze numerical data, enabling the identification of patterns, relationships, and trends among variables. The quantitative method was chosen for its ability to provide measurable and generalizable results, enabling researchers to quantify opinions, behaviors, and other defined variables. This approach is particularly relevant for studies aiming to evaluate the effectiveness of specific technologies or interventions, such as AR in e-commerce, and to establish correlations between different factors (Creswell & Creswell, 2017). Quantitative research is characterized by its structured methodology, which allows for the use of statistical tools to test hypotheses and theories. It provides a clear and systematic way to collect data that can be statistically analyzed to produce objective and reliable results. By employing structured instruments like surveys or questionnaires, the study was able to gather data from large samples, enhancing the external validity and generalizability of the findings (Bryman, 2016).

3.2. Population and sample size

The target population for this study included online consumers who were familiar with e-commerce platforms and had experience with AR technology, specifically focusing on individuals aged 18 years and older. This age criterion was established to ensure compliance with ethical standards and legal regulations regarding the participation of minors in research. The study encompassed a broad demographic, not limited to young individuals but extending to all adults who had engaged with AR marketing on e-commerce platforms.

The selection of this diverse group was strategic, as these individuals were often at the forefront of adopting new technologies, making them valuable sources of insight. Their previous exposure to AR technology allowed for the collection of meaningful and relevant data, thereby enhancing the overall reliability of the study. Previous studies had consistently shown that both young adults and older individuals played crucial roles in the acceptance and diffusion of new technologies (Lestari, 2019; Puiu et al., 2022). Therefore, by targeting this wide age range, the research aimed to capture a comprehensive view of the perspectives and behaviors of those who were likely to shape future trends in e-commerce and technology adoption.

To select participants for the study, a non-probability convenience sampling method was employed. This sampling method was chosen due to its practicality and efficiency in reaching a large and specific audience quickly (Etikan et al., 2015). Convenience sampling allows for the inclusion of readily available participants who meet the study's criteria, making it suitable for exploratory research where time and resources are

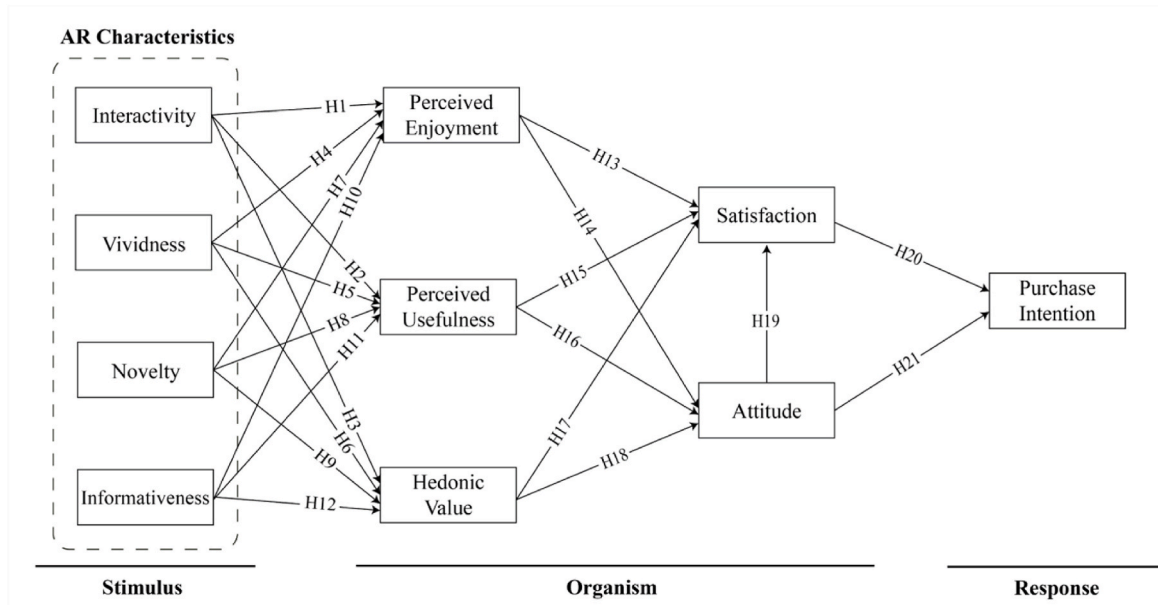


Fig. 1. Conceptual framework of the Stimulus-Organism-Response (S-O-R) model applied to AR marketing. The stimulus includes AR characteristics (interactivity, vividness, novelty, and informativeness) that influence the organism's internal states (perceived enjoyment, perceived usefulness, hedonic value, satisfaction, and attitude), which ultimately shape the response (purchase intention). The hypotheses (H1-H21) represent the relationships between these constructs.

limited. Participants were surveyed using an online questionnaire, with written informed consent obtained to confirm their voluntary participation before starting the survey. The criteria for inclusion were individuals aged 18 and above who had engaged in online purchases within the past six months. This requirement ensured that participants had recent online shopping experiences, enhancing the applicability of their insights to the study. Additionally, participants were required to have some familiarity with AR technology, although they did not need to be experts. This criterion ensured that participants could provide informed opinions on AR marketing applications. Exclusion criteria included individuals below the age threshold, those who had not participated in online shopping within the specified timeframe, or those lacking prior exposure to AR technology. This method of participant selection and the criteria set forth aimed to gather relevant data from a population that could offer valuable insights into the study's focus on AR technology in e-commerce. By ensuring participants had recent and relevant experiences, the study aimed to increase the validity and reliability of the findings (Patton, 2014).

Based on the recommendations of Hair et al. (2013), Memon et al. (2020), O'Rourke and Hatcher (2014), and Suhr (2006), a minimum sample size of 205 participants was required, following the five-times rule. The study collected 357 samples, of which 315 valid responses were used for analysis after thorough evaluation. To filter the initial 357 responses down to 315 valid ones, the process involved several key steps. First, incomplete responses, where essential data were missing or surveys were not fully completed, were excluded. Next, invalid responses, such as those showing random or inconsistent answers (e.g., selecting the same value for all questions or providing unreasonable responses), were identified and removed. Additionally, individuals who were not familiar with AR or who did not frequently shop on e-commerce platforms were excluded. Outlier analysis was then conducted to exclude responses that were significantly outside the normal range, such as those with unusually short or long completion times. Finally, data completeness was checked to ensure that all crucial variables required for analysis were fully answered. This filtering process ensured that the final 315 responses were valid and of high quality, enhancing the reliability and generalizability of the study's findings (Saunders et al., 2015). This filtering process ensured that the final 315 responses were valid and of high quality, enhancing the reliability and generalizability

of the study's findings (Saunders et al., 2015).

The collected demographic data indicated that the majority of respondents were young, low-income students. Specifically, 53.3 % of participants were male, 42.2 % were female, and 4.4 % identified as 'Other.' Most respondents, 94.6 %, were between 18 and 24 years old, with only 5.4 % aged 25 to 29. The dominant career group was students, representing 94.6 % of the sample, while other occupations like officers, and laborers were minimally represented. In terms of income, 78.7 % of participants reported earnings below 5 million VND per month, with only a small percentage earning more (See Table 1).

3.3. Questionnaire and data collection

The data collection for this study was executed through a structured online questionnaire, systematically divided into two principal sections to enhance data integrity and relevance. The first section was designed to collect fundamental demographic information, including age, gender, and income, which facilitated the segmentation of data and enabled a

Table 1
Demographic information.

Demographic Information (N = 315)		Frequency	Percentage
Gender	Male	168	53.3 %
	Female	133	42.2 %
	Other	14	4.4 %
Age	18–24 years old	298	94.6 %
	25–29 years old	17	5.4 %
Career	Student	298	94.6 %
	Officer	9	2.9 %
	Laborer	8	2.5 %
Monthly Income	Below 5 million VND	248	78.7 %
	From 5 million to below 10 million VND	47	14.9 %
	From 10 million to below 20 million VND	11	3.5 %
	From 20 million to below 30 million VND	1	0.3 %
	From 30 million to below 50 million VND	2	0.6 %
	Above 50 million VND	6	1.9 %

nuanced analysis of how various demographic groups interact with AR technology. This segmentation is crucial for understanding demographic influences on AR technology adoption and usage patterns.

The second section comprised 41 five-point Likert scale questions, meticulously crafted based on the integration of the Stimulus-Organism-Response (SOR) model and the extended Technology Acceptance Model (TAM) (See Table 2) These questions were designed to capture a comprehensive range of variables pertinent to AR technology in e-commerce. Specifically, it incorporated items on interactivity, vividness, informativeness, and novelty, drawn from studies by McLean and Wilson (2019), Kowalczyk et al. (2021), and Nguyen, Le, and Chau (2023). Additionally, it included measures of hedonic value from Nikhashemi et al. (2021), perceived usefulness from Venkatesh and Davis (1996), Thong et al. (2006), Kim et al. (2016), and Al-Sharafi et al. (2021), as well as perceived enjoyment outlined by Balog and Pribeanu (2010). Satisfaction was assessed by Thong et al. (2006), Kim et al. (2016), and Venkatesh et al. (2003), while attitude was measured using items from Eagly and Chaiken (1993), and Raska & Richter, 2017. Purchase intention was evaluated through items adopted from Raska & Richter, 2017, Fiore et al. (2005), and Koay et al. (2023).

The questions were categorized into three distinct parts to align with the theoretical framework: “Stimulus”, which assessed the intrinsic characteristics of AR technology; “Organism”, which measured key psychological responses including perceived usefulness, perceived enjoyment, and hedonic value; and “Response”, which evaluated the resultant behavioral intentions, specifically participants’ purchase intentions. To ensure the reliability and validity of the questionnaire in the study context, it was reviewed and advised by an expert in marketing research before finalization, thereby ensuring robust data analysis.

During the period from May 23 to July 25, 2024, data collection was employed using both online and offline approach to ensure a comprehensive range of responses. Online data was collected through Google Forms and distributed via social media platforms and email which facilitated wide-reaching and convenient participation. Besides, offline data was gathered through direct, face-to-face surveys conducted at selected physical locations. This method engaged individuals who might not be reached through digital channels. By employing this dual approach, the research aimed to capture diverse perspectives and provided a representative sample, helping to address potential biases and ensure a well-rounded dataset.

3.4. Data analysis

During the data analysis phase, the study employed Partial Least Squares Structural Equation Modeling (PLS-SEM), an advanced statistical method particularly advantageous for analyzing complex models comprising multiple constructs and indicators (Hair et al., 2021). PLS-SEM was selected due to its capacity to manage intricate models and its robust predictive capabilities, which were crucial for elucidating the influence of AR on consumer behavior. Furthermore, this method demonstrated greater flexibility with sample size requirements and resilience to non-normal data distributions, rendering it appropriate for the study’s sample of 315 valid responses.

The PLS-SEM analysis followed a systematic approach to ensure comprehensive evaluation and reliable results as proposed by Hair et al. (Hair et al., 2021). Initially, the structural and measurement models were meticulously defined. The dataset was then prepared, and model parameters were estimated using specialized software such as SmartPLS. The reliability and validity of the measurement model were rigorously assessed, incorporating both convergent and discriminant validity evaluations. Convergent validity was confirmed using Average Variance Extracted (AVE) and Composite Reliability (CR), ensuring that indicators of each construct shared a high proportion of variance. Discriminant validity was assessed using the Fornell-Larcker Criterion, ensuring that each construct was distinct from the others. Hypothesis testing through SEM involved examining path coefficients to determine

Table 2

Model components.

Interactivity (Kowalczyk et al., 2021; McLean & Wilson, 2019)	
IT1	“I have full control of the AR feature’s navigation menu.”
IT2	“I have complete control over the products and variations available through the AR feature.”
IT3	“I have full control over the duration to see the product through the AR feature.”
IT4	“I can interact with virtual product displays through AR features to get product-related information that fits my specific needs.”
Vividness (McLean & Wilson, 2019; Nguyen, Le, & Chau, 2023; Nikhashemi et al., 2021)	
VV1	“I feel the visual appearance of the product on the AR feature is clear.”
VV2	“I feel that the visual appearance of the AR feature is detailed.”
VV3	“I feel that the visual appearance of the AR on product is rich.”
VV4	“I feel that the visual appearance of the product on the AR feature looks realistic.”
VV5	“I feel that the visual appearance provided through this augmented reality app was well-defined.”
Informativeness (Kowalczyk et al., 2021)	
INF1	“I get detailed product information by using the AR feature of e-commerce platforms.”
INF2	“I get complete product information by using the AR feature in e-commerce platforms.”
INF3	“I can make shopping decisions from the information I get when using AR features in e-commerce platforms.”
INF4	“I can compare product information with other products when using the AR feature in e-commerce platforms.”
Novelty (McLean & Wilson, 2019)	
NV1	“I feel that the AR feature gives a new look to the user the first time they try the product.”
NV2	“I feel that the AR feature gives a unique look to each product.”
NV3	“I feel that the AR feature makes a difference for each product.”
NV4	“I feel that the AR features show something unusual for each product.”
Hedonic value (Nikhashemi et al., 2021)	
PE1	“I feel that e-commerce platforms equipped with AR features are more fun.”
PE2	“I feel the time I spent using the feature was worth it.”
PE3	“The AR technology entertains me by seeing a new view when trying products virtually.”
PE4	“I feel happy when I use the AR feature.”
Perceived Usefulness (Al-Sharafi et al., 2021; Kim et al., 2016; Thong et al., 2006; Venkatesh & Davis, 1996)	
PU1	“The AR application is useful in my shopping.”
PU2	“The AR application provides useful information.”
PU3	“The AR application make my shopping experience better.”
PU4	“The AR application helps improve shopping efficiency.”
Perceived Enjoyment (Balog & Pribeanu, 2010)	
HV1	“AR make shopping more interesting.”
HV2	“I like interacting with AR.”
HV3	“Overall, I enjoy shopping with AR.”
HV4	“Overall, I find AR exciting.”
Satisfaction (Kim et al., 2016; Thong et al., 2006; Venkatesh et al., 2003)	
STS1	“I am satisfied with using the AR application.”
STS2	“I am not complaining about using the AR application.”
STS3	“The AR application fulfills my demand.”
STS4	“The AR application do a good job.”
Attitude (Eagly & Chaiken, 1993; Raska & Richter, 2017)	
ATT1	“AR can improve my shopping productivity.”
ATT2	“AR can enhance my effectiveness in shopping.”
ATT3	“AR can be useful in buying what I want.”
ATT4	“AR can improve my shopping ability.”
Purchase Intention (Fiore et al., 2005; Koay et al., 2023; Raska & Richter, 2017)	
PI1	“The AR experience in the application would be helpful in helping me to make a purchase decision if I am considering buying the product.”
PI2	“The AR experience increased my intention to buy the product I visualized in the application.”
PI3	“I would be willing to recommend to my friends to use the AR in the application as a decision aid when considering what product to buy.”
PI4	“I want to purchase products when experiencing it through AR.”

the significance and strength of relationships between constructs, with significance assessed via bootstrapping. The study also evaluated the model's explanatory power through the coefficient of determination (R^2) and its predictive relevance using Q^2 , validating the model's efficacy and accuracy.

4. Results

4.1. Measurement model assessment

The assessment of construct reliability and validity is crucial for ensuring the robustness and accuracy of the measurement model. To this end, Confirmatory Composite Analysis (CCA) was employed using PLS-SEM (Hair et al., 2020). This comprehensive analysis incorporated Cronbach's Alpha (C_α), Composite Reliability (CR), Average Variance Extracted (AVE), and Variance Inflation Factors (VIF) to evaluate convergence validity and construct reliability (See Table 3). Additionally, the Fornell-Larcker criterion was utilized to assess discriminant validity.

The results indicated that C_α values for all constructs ranged from

Table 3
Convergent validity results.

Construct	Items	Loadings	VIF	C_α	CR	AVE
IT	IT1	0.848	2.132	0.873	0.913	0.725
	IT2	0.880	2.595			
	IT3	0.822	1.952			
	IT4	0.876	2.518			
VV	VV1	0.883	2.551	0.892	0.921	0.699
	VV2	0.861	2.279			
	VV3	0.866	2.346			
	VV4	0.839	2.056			
	VV5	0.850	2.104			
NV	NV1	0.855	2.194	0.875	0.915	0.728
	NV2	0.848	2.116			
	NV3	0.834	1.978			
	NV4	0.860	2.481			
INF	INF1	0.868	2.428	0.868	0.910	0.717
	INF2	0.861	2.282			
	INF3	0.816	1.884			
	INF4	0.849	2.167			
PE	PE1	0.862	2.293	0.884	0.920	0.743
	PE2	0.856	2.184			
	PE3	0.846	2.077			
	PE4	0.847	2.264			
PU	PU1	0.836	2.016	0.877	0.916	0.731
	PU2	0.840	2.160			
	PU3	0.854	2.180			
	PU4	0.870	2.328			
HV	HV1	0.892	2.761	0.885	0.921	0.744
	HV2	0.880	2.574			
	HV3	0.827	2.081			
	HV4	0.894	2.719			
STS	STS1	0.862	2.279	0.859	0.905	0.704
	STS2	0.843	2.126			
	STS3	0.843	2.126			
	STS4	0.853	2.119			
ATT	ATT1	0.851	2.137	0.879	0.917	0.734
	ATT2	0.871	2.323			
	ATT3	0.779	1.657			
	ATT4	0.830	2.181			
PI	PI1	0.849	2.389	0.878	0.917	0.733
	PI2	0.853	2.395			
	PI3	0.818	2.113			
	PI4	0.830	2.113			

Note: IT: Interactivity; VV: Vividness; NV: Novelty; INF: Informativeness; PE: Perceived Enjoyment; PU: Perceived Usefulness; HV: Hedonic Value; STS: Satisfaction; ATT: Attitude; PI: Purchase Intention.

0.859 to 0.892, demonstrating high internal consistency among the items within each construct. Notably, constructs such as HV and VV exhibited strong reliability, with α values of 0.885 and 0.892, respectively. According to Hair et al. (2021a), Hair et al. (2021b) elevated C_α values indicate that the items consistently measure the same underlying construct. This high level of reliability suggests that respondents uniformly understand and respond to the items within these constructs, thereby ensuring the stability and consistency of the measurements. Consequently, the high C_α values reinforce the validity of the constructs used in the survey. Further supporting the reliability of the constructs, the CR values for all constructs were remarkably high, ranging from 0.905 to 0.921, and all surpassed the 0.70 threshold proposed by Hamid et al. (2017). The highest CR values were recorded for VV and PE, both at 0.921. Unlike C_α , CR provides a more comprehensive measure of construct reliability by incorporating the actual loadings of the items, thereby offering a thorough assessment of how well the items reflect the underlying constructs (Cheah et al., 2018). These elevated CR values indicate excellent reliability, suggesting that the constructs are measured consistently and accurately, which further reinforces confidence in the integrity of the measurement model.

In addition to the high CR values, the AVE values for all constructs were above the recommended threshold of 0.50, ranging from 0.699 to 0.744. This indicates that more than 50 % of the variance in the indicators is captured by the latent constructs (Hair et al., 2020). Constructs such as HV and PE had AVE values of 0.744 and 0.743, respectively, demonstrating substantial convergence validity. AVE measures the proportion of variance captured by a construct from its indicators relative to the variance due to measurement error. These high AVE values confirm that the constructs are well represented by their indicators, reflecting strong construct validity and ensuring that the indicators accurately reflect the underlying constructs.

The assessment of outer loadings and Variance Inflation Factors (VIF) is critical for evaluating the convergent validity of the measurement model in PLS-SEM. Outer loadings, representing the correlations between indicators and their respective latent constructs, range from 0.779 to 0.894. These values indicate strong and consistent relationships across all indicators, exceeding the commonly accepted threshold of 0.70. This high level of correlation confirms that the indicators accurately reflect their constructs, thereby enhancing the model's reliability (Hair et al., 2021). Furthermore, VIF values, which measure the degree of multicollinearity among indicators, range from 1.657 to 2.761. Values below the critical threshold of 5 suggest the absence of severe multicollinearity, ensuring that each indicator provides unique and valuable information to the model, thereby maintaining the model's integrity (Hair et al., 2021). The use of outer loadings and VIF in PLS-SEM is essential as they collectively ensure the robustness of the measurement model by verifying the indicators' reliability and independence. High outer loadings affirm that the indicators effectively represent their constructs, while acceptable VIF values prevent excessive overlap among indicators. This dual validation significantly contributes to the model's predictive capability and overall credibility (Hair et al., 2021).

The Fornell-Larcker criterion is a widely recognized method for assessing discriminant validity, ensuring that each construct in a model is distinct and measures a unique aspect of the conceptual framework (Hair et al., 2020). According to this criterion, a construct should share more variance with its indicators than with other constructs within the model. This is achieved by comparing the square root of the AVE for each construct with the correlations between that construct and all other constructs in the model (Fornell & Larcker, 1981). The matrix presented shows the square roots of the AVE values along the diagonal, with the inter-construct correlations occupying the off-diagonal elements. To establish discriminant validity, the diagonal values, which represent the square root of AVE, must be greater than the corresponding off-diagonal correlation values in the same row and column. In Table 4, the diagonal values, representing the square roots of AVE, range from 0.847 to 0.879, indicating high internal consistency for each construct. All correlations

Table 4

Fornell larker criterion results.

	ATT	HV	INF	IT	NV	PE	PI	PU	STS	VV
ATT	0.857									
HV	0.837	0.862								
INF	0.832	0.776	0.847							
IT	0.808	0.810	0.804	0.852						
NV	0.790	0.769	0.824	0.806	0.853					
PE	0.850	0.848	0.836	0.835	0.858	0.862				
PI	0.801	0.825	0.790	0.804	0.784	0.842	0.856			
PU	0.850	0.819	0.845	0.789	0.834	0.883	0.840	0.855		
STS	0.829	0.837	0.827	0.788	0.784	0.858	0.854	0.822	0.879	
VV	0.797	0.805	0.841	0.846	0.885	0.831	0.813	0.836	0.799	0.856

Note: The highlighted values represent the diagonal values in the matrix.

with other constructs are lower than their respective diagonal values, thus establishing discriminant validity across the model. This pattern is consistent across constructs such as ATT, HV, INF, IT, NV, PE, PI, PU, STS, and VV, where each construct's square root of AVE surpasses its highest inter-construct correlation.

4.2. Structural model assessment

In this research, evaluating the structural model within PLS-SEM is crucial for elucidating the relationships among constructs. Emphasis is placed on hypothesis testing, which is fundamental for assessing the magnitude and direction of these relationships through the model's path coefficients (See Table 5 and Fig. 2).

The relationship between IT and PE was supported (H_1 , $\beta = 0.178$, p -value = 0.003), indicating that interactivity in AR applications significantly enhanced perceived enjoyment among users. This suggested that engaging and interactive features were crucial for improving user enjoyment, a key aspect in the adoption of AR technology. Contrary to expectations, the relationship between IT and PU was not supported (H_2 ,

$\beta = 0.099$, p -value = 0.191). This finding implied that while interactive features contributed to enjoyment, they did not necessarily enhance the perceived usefulness of the AR application. Users may have perceived the interactive features as entertaining; however, they did not view these features as contributing practical value or utility to their decision-making process. IT also had a significant impact on HV (H_3 , $\beta = 0.368$, p -value = 0.000), suggesting that interactive elements in AR applications were perceived as valuable for hedonic purposes. This highlighted the importance of interactivity in providing an enjoyable and pleasurable experience.

The findings revealed that VV significantly affected PE, PU, and HV. The positive association between VV and PE (H_4 , $\beta = 0.213$, p -value = 0.005) suggested that vivid, immersive content significantly enhanced user enjoyment, making the AR experience more engaging and pleasurable. Moreover, VV's influence on PU (H_5 , $\beta = 0.176$, p -value = 0.041) indicated that vividness improved users' perception of the application's usefulness, likely due to the clarity and accessibility provided by high-quality visuals. Additionally, the significant impact of VV on HV (H_6 , $\beta = 0.247$, $STD = 0.092$, p -value = 0.007) highlighted that vivid

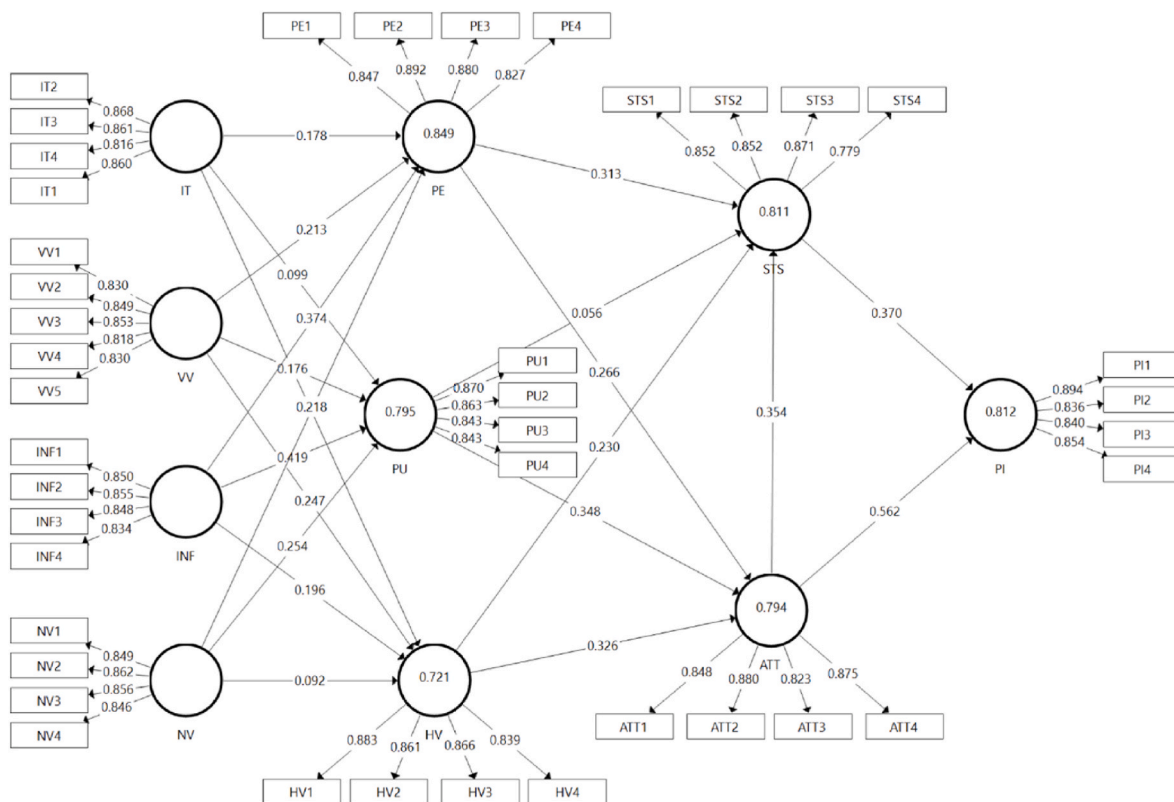


Fig. 2. PLS-SEM Results depicting the relationships between latent variables and their indicators. The diagram shows path coefficients, outer loadings, and R-squared values, illustrating the structural and measurement model's performance.

Table 5
Structural modeling results.

Hypothesis	Structural Path	Coefficient (β)	Standard Deviation (STD)	T Statistics	p-value	f^2	Result
H1	IT \rightarrow PE	0.178	0.060	2.949	0.003	0.052	Accepted
H2	IT \rightarrow PU	0.099	0.076	1.309	0.191	0.012	Rejected
H3	IT \rightarrow HV	0.368	0.089	4.145	0.000	0.121	Accepted
H4	VV \rightarrow PE	0.213	0.076	2.793	0.005	0.046	Accepted
H5	VV \rightarrow PU	0.176	0.086	2.051	0.041	0.023	Accepted
H6	VV \rightarrow HV	0.247	0.092	2.689	0.007	0.034	Accepted
H7	NV \rightarrow PE	0.218	0.068	3.206	0.001	0.060	Accepted
H8	NV \rightarrow PU	0.254	0.083	3.051	0.002	0.052	Accepted
H9	NV \rightarrow HV	0.092	0.088	1.043	0.298	0.006	Rejected
H10	INF \rightarrow PE	0.374	0.080	4.655	0.000	0.225	Accepted
H11	INF \rightarrow PU	0.419	0.083	5.023	0.000	0.209	Accepted
H12	INF \rightarrow HV	0.196	0.094	2.084	0.038	0.034	Accepted
H13	PE \rightarrow STS	0.313	0.103	3.032	0.003	0.085	Accepted
H14	PE \rightarrow ATT	0.266	0.082	3.231	0.001	0.059	Accepted
H15	PU \rightarrow STS	0.056	0.070	0.790	0.430	0.003	Rejected
H16	PU \rightarrow ATT	0.348	0.064	5.455	0.000	0.225	Accepted
H17	HV \rightarrow STS	0.230	0.068	3.381	0.001	0.064	Accepted
H18	HV \rightarrow ATT	0.326	0.082	3.958	0.000	0.133	Accepted
H19	ATT \rightarrow STS	0.354	0.088	4.014	0.000	0.137	Accepted
H20	STS \rightarrow PI	0.370	0.065	5.687	0.000	0.190	Accepted
H21	ATT \rightarrow PI	0.562	0.060	9.347	0.000	0.438	Accepted

Note: IT: Interactivity; VV: Vividness; NV: Novelty; INF: Informativeness; PE: Perceived Enjoyment; PU: Perceived Usefulness; HV: Hedonic Value; STS: Satisfaction; ATT: Attitude; PI: Purchase Intention.

content delivered substantial hedonic value, enriching the user experience by making it more enjoyable and satisfying.

The results demonstrated that NV exerted significant positive effects on PE and PU. Specifically, the relationship between NV and PE (H7, $\beta = 0.218$, p -value = 0.001) indicated that novel and unique features in augmented reality applications significantly enhanced user enjoyment. Similarly, the significant impact of NV on PU (H8, $\beta = 0.254$, $p = 0.002$) suggested that these innovative features also increased the perceived usefulness of the application, likely due to their ability to offer fresh and engaging experiences that met user needs. However, the lack of a significant relationship between NV and HV (H9, $\beta = 0.092$, p -value = 0.298) indicated that novelty alone did not necessarily enhance the overall pleasure and satisfaction derived from the AR experience. This finding suggested that while novel features could boost enjoyment and usefulness, they needed to be integrated with other elements to fully enhance the hedonic value for users. INF had a strong positive impact on PE (H10, $\beta = 0.374$, p -value = 0.000), PU (H11, $\beta = 0.419$, p -value = 0.000), and HV (H12, $\beta = 0.196$, p -value = 0.038). This emphasized the critical role of informativeness in enhancing enjoyment, perceived usefulness, and hedonic value, making it a key factor in user engagement with AR applications.

Moreover, the significant positive effect of PE on STS (H13, $\beta = 0.313$, STD = 0.103, $t = 3.032$, $p = 0.003$) and ATT (H14, $\beta = 0.266$, p -value = 0.001) indicated that the enjoyment users derived from AR applications significantly enhanced both their satisfaction and their overall attitude towards the application. In contrast, PU did not significantly affect STS (H15, $\beta = 0.056$, p -value = 0.430), though it had a significant positive effect on ATT (H16, $\beta = 0.348$, p -value = 0.000), suggesting that while users' perceptions of usefulness did not necessarily translate to increased satisfaction, they did enhance their attitudes towards the AR application.

HV was shown to have a significant positive impact on both STS (H17, $\beta = 0.230$, STD = 0.068, $t = 3.381$, $p = 0.001$) and ATT (H18, $\beta = 0.326$, p -value = 0.000), indicating that the hedonic value users derived from the AR experience contributed significantly to their satisfaction and positive attitudes. The strong influence of ATT on STS (H19, $\beta = 0.354$, p -value = 0.000) further underscored the importance of fostering positive user attitudes to drive satisfaction.

Finally, the significant positive effects of both STS and ATT on PI (H20, $\beta = 0.370$, p -value = 0.000; H21, $\beta = 0.562$, p -value = 0.000) demonstrated that user satisfaction and positive attitudes were crucial

determinants of purchase intention.

Additionally, R^2 and Q^2 are essential statistical measures used to evaluate the explanatory power and predictive relevance of a model, respectively (See Table 6). R^2 , or the coefficient of determination, indicates the proportion of variance in the dependent variable that is predictable from the independent variables (Hair et al., 2021b). High R^2 values for constructs such as Perceived Enjoyment (PE, $R^2 = 0.849$), Purchase Intention (PI, $R^2 = 0.812$), and Attitude (ATT, $R^2 = 0.794$) indicate that this study's model effectively explains 84.9 %, 81.2 %, and 79.4 % of the variance in these constructs, respectively. These high proportions demonstrate the model's effectiveness and the significance of the included factors in predicting these outcomes (Hair et al., 2021b).

On the other hand, Q^2 , or Stone-Geisser's Q^2 , assesses the predictive relevance of the model. Values greater than zero demonstrate that the model has predictive relevance, meaning it can effectively predict future data (Cohen, 1988). The high Q^2 values for the same constructs (PE, $Q^2 = 0.625$; PI, $Q^2 = 0.588$; ATT, $Q^2 = 0.577$) suggest that the model is not only explaining the current data well but also has strong predictability for future observations. This is particularly important for practical applications, as it indicates the model's utility in forecasting user behavior and informing strategic decisions (Cohen, 1988). This indicates the model's utility in forecasting user behavior and informing strategic decisions.

The analysis confirms the model's effectiveness, evidenced by high Cronbach's Alpha and Composite Reliability values indicating strong internal consistency, and AVE values demonstrating robust convergent validity. The Fornell-Larcker criterion confirms discriminant validity, ensuring clear construct distinctions. Significant path coefficients underscore the importance of various factors in shaping user attitudes and

Table 6
 R^2 and Q^2 results.

Constructs	R^2	Q^2
PE	0.849	0.625
PU	0.795	0.573
HV	0.721	0.530
STS	0.786	0.547
ATT	0.794	0.577
PI	0.812	0.588

Note: PE: Perceived Enjoyment; PU: Perceived Usefulness; HV: Hedonic Value; STS: Satisfaction; ATT: Attitude; PI: Purchase Intention.

satisfaction towards AR applications. High R^2 values illustrate the model's strong explanatory power, while substantial Q^2 values demonstrate its predictive relevance. Collectively, these metrics validate the model's reliability and utility in understanding and predicting user behavior in AR technology adoption.

5. Discussion

5.1. Impacts of AR characteristics on perceived enjoyment, perceived usefulness & hedonic value

5.1.1. Interactivity

Interactivity, a fundamental characteristic of AR applications, was found to significantly positively influence Perceived Enjoyment (H_1) and Hedonic Value (H_3). These findings underscore the importance of interactive elements in shaping users' experiences with AR in e-commerce contexts. The strong positive relationship between interactivity and perceived enjoyment aligns with the theoretical frameworks proposed by Yim et al. (2017), and McLean and Wilson (2019), suggesting that the ability to manipulate and interact with virtual objects in an AR environment significantly enhances the user's sense of pleasure and engagement during the shopping experience. Similarly, the significant influence of interactivity on hedonic value reinforces the notion that interactive AR features contribute substantially to the overall experiential and pleasure-oriented aspects of online shopping. This finding is consistent with the work of Poushneh and Vasquez-Parraga (2017), as well as Claffey and Brady (2019), who demonstrated that interactive AR experiences can evoke positive emotions and enhance the overall hedonic value of the shopping process. The ability to actively engage with virtual products, rather than passively viewing them, appears to create a more entertaining and emotionally rewarding experience for consumers. In the Vietnamese context, this finding is particularly relevant given the country's rapidly growing e-commerce market and increasing smartphone penetration (Ha et al., 2021). The Vietnamese consumer's affinity for technology and social media platforms suggests a predisposition towards interactive and engaging online experiences (Nguyen & Nguyen, 2024). However, it's worth noting that the collectivist nature of Vietnamese culture might influence how interactivity is perceived and valued in AR applications, potentially emphasizing shared experiences or social features.

However, the study did not find a significant relationship between Interactivity and Perceived Usefulness (H_2). This unexpected result presents an intriguing paradox that while users derive pleasure and entertainment from interactive AR features, they do not necessarily perceive these features as enhancing the practical utility of the application in aiding their purchase decisions. A possible explanation for the absence of this relationship is that while interactive features in AR applications enhance user engagement and entertainment, they may not directly contribute to the functional value required for purchase decisions. This suggests that users may distinguish between hedonic and utilitarian benefits, appreciating interactivity for its immersive experience but not necessarily linking it to increased efficiency or decision-making support. This contrasts with earlier studies that emphasized the utilitarian benefits of interactivity, suggesting that it can improve decision-making processes and provide practical value in digital marketing contexts (Javornik, 2016a). Several factors may contribute to this unanticipated finding. Firstly, the perceived usefulness of AR in retail contexts may be subject to an evolutionary process as consumers become more familiar with the technology (Dacko, 2017). In the early stages of AR adoption in e-commerce, consumers may be more attuned to the novelty and entertainment value of the technology, potentially overlooking its practical benefits. This finding highlights the need for a more nuanced approach to implementing interactivity in AR applications for e-commerce. As Hilken et al. (2017) argue, the perceived usefulness of AR in retail contexts is closely tied to its ability to facilitate decision-making and reduce uncertainty in the purchase process. If the

interactive features of an AR application are not effectively aligned with these practical goals, users may not perceive them as particularly useful, despite finding them enjoyable. This finding may be particularly pronounced in Vietnam, where practicality often guides consumer behavior (Nguyen et al., 2019). Vietnamese consumers, influenced by a history of economic challenges, tend to prioritize practical benefits in their purchasing decisions (Vo & Vo, 2018). Therefore, while interactive AR features may be enjoyable, their perceived usefulness might be more critically evaluated in terms of how they concretely assist in making informed purchase decisions.

5.1.2. Vividness

Vividness emerged as a robust and significant predictor across multiple dimensions of the AR experience in e-commerce. Specifically, it demonstrated strong positive relationships with Perceived Enjoyment (H_4), Perceived Usefulness (H_5), and Hedonic Value (H_6). These findings align closely with the seminal work of (Javornik, 2016b), who emphasized the critical role of vivid and realistic AR experiences in shaping consumer perceptions and behaviors in digital retail environments. The influence of vividness on perceived enjoyment suggests that highly realistic and immersive AR experiences contribute significantly to users' pleasure and engagement during the shopping process. This relationship underscores that enhanced vividness in AR can lead to increased sensory stimulation, thereby amplifying the enjoyment derived from virtual product interaction (Yim et al., 2017). The significant impact of vividness on perceived usefulness (H_5) indicates that more vivid AR experiences are not only more enjoyable but also perceived as more practical and beneficial in the context of e-commerce. This finding supports the work of Poushneh and Vasquez-Parraga (2017), who demonstrated that vivid AR presentations can enhance consumers' ability to evaluate products, thus increasing the perceived utility of the shopping experience. This finding not only reinforces the importance of vividness in AR applications, but also suggests that vividness plays an important role in shaping consumers' perceived usefulness of AR. In the Vietnamese market, where visual appeal plays an important role in consumer decision-making (Nguyen et al., 2024), the impact of vividness in AR applications could be particularly significant. The growing middle class in Vietnam, with its increasing disposable income and appetite for quality products (Hansen, 2022), may find vivid AR experiences especially appealing as they seek to make informed purchases in the online space.

The positive relationship between vividness and hedonic value (H_6) further reinforces the multifaceted impact of vivid AR experiences. This connection suggests that highly vivid AR not only serves utilitarian purposes but also contributes significantly to the pleasurable, experiential aspects of online shopping. As Trivedi (2024) argues, the hedonic value derived from vivid AR experiences can lead to increased consumer satisfaction and positively influence attitudes toward both the AR application and the e-commerce platform. These findings suggest that developers and marketers should prioritize creating highly vivid and realistic AR experiences to maximize both the functional and emotional benefits for consumers. The positive relationship between vividness and hedonic value (H_6) further reinforces the multifaceted impact of vivid AR experiences. This connection suggests that highly vivid AR not only serves utilitarian purposes but also contributes significantly to the pleasurable, experiential aspects of online shopping. As Trivedi (2024) argues, the hedonic value derived from vivid AR experiences can lead to increased consumer satisfaction and positively influence attitudes toward both the AR application and the e-commerce platform. These findings suggest that developers and marketers should prioritize creating highly vivid and realistic AR experiences to maximize both the functional and emotional benefits for consumers.

5.1.3. Novelty

The significant positive relationship between Novelty and Perceived Enjoyment (H_7) supports the notion that innovative AR features can

enhance the hedonic aspect of the online shopping experience. This suggests that new AR features could enable unexpected and enjoyable interactions, such as seeing a virtual product for the first time in one's real environment, as well as bring a sense of exploration and learning, contributing to enjoyment (Chen et al., 2023; Kim et al., 2024). This is consistent with research by Huang and Liao (2015), who found that new technological features can stimulate curiosity and excitement, leading to increased enjoyment. Besides, the positive relationship between Novelty and Perceived Usefulness (H_8) indicates that consumers also recognize the practical value of innovative AR features in enhancing their shopping experience. This finding is consistent with the study of Rese et al. (2017), who demonstrated that new AR features can improve product visibility and information accessibility. Innovative AR features can provide new ways to evaluate products, such as virtual try-ons or on-site visualizations that consumers find practically useful (Riar et al., 2022; Tzortzoglou & Sofos, 2023). The Vietnamese market's receptiveness to novelty in AR applications may be influenced by the country's rapid technological advancement and the population's enthusiasm for new technologies. However, it's important to note that Vietnam's diverse demographic landscape, with significant variations in technological literacy between urban and rural areas, may result in differing perceptions of novelty across different consumer segments (Pham et al., 2020).

Interestingly, the relationship between Novelty and Hedonic Value (H_9) was not supported, diverging from prior studies that suggest novel technological features inherently contribute to hedonic experiences. While novelty has been shown to enhance enjoyment and perceived usefulness, our findings indicate that it does not necessarily translate into a deeper sense of intrinsic pleasure within the AR shopping experience. One possible explanation for this unexpected result is that while novel AR features initially capture users' attention and stimulate curiosity, they may not sustain long-term enjoyment or engagement. Prior research has often linked novelty to hedonic value, assuming that new and unique experiences inherently create pleasure. However, our findings suggest that novelty alone is insufficient if the AR experience lacks depth, personalization, or meaningful interactivity. Consumers may be momentarily intrigued by novel AR elements, but if the experience does not offer sustained engagement, adaptive content, or a sense of user control, it may fail to generate a lasting hedonic response. This finding can be explained by the finding of Hilken et al. (2017), who suggested that the impact of novelty on hedonic value may be moderated by factors such as technology acceptance and individual differences. Several possible explanations for this difference can be considered. First, although new AR features may initially attract users and be perceived as enjoyable, their contribution to long-term hedonic value may be limited. The hedonic value of AR experiences may be more strongly influenced by factors such as personalization, social connection, and seamless integration with the user's environment than novelty alone (Rauschnabel et al., 2019). Furthermore, users' preconceived notions about AR technology, which may be influenced by media depictions or marketing messages, can create high expectations (Dey et al., 2018; Rauschnabel et al., 2019). Finally, the lack of relationship between novelty and hedonic value may also be due to the specific implementation of novel features in the AR applications studied (Rauschnabel et al., 2019). If these features are not well designed or smoothly integrated, they may not contribute to the overall hedonistic experience despite being novel. These findings imply that for AR applications to maximize their hedonic value, developers and marketers should focus not only on introducing novel features but also on ensuring these features are user-friendly, well-integrated, and provide ongoing value. Enhancing social connectivity, and seamless integration can make AR experiences more enjoyable and meaningful over the long term (Anselmsson et al., 2017; Fischer et al., 2023). In the Vietnamese context, where word-of-mouth and social influence play significant roles in consumer behavior (Le et al., 2022), the long-term hedonic value of AR applications might be more closely tied to their ability to facilitate social sharing and community engagement rather than novelty alone.

5.1.4. Informativeness

The substantial positive effect of informativeness on Perceived Enjoyment (H_{10}), Perceived Usefulness (H_{11}), and Hedonic Value (H_{12}) highlights the importance of providing relevant and valuable information through AR applications. Informative AR content enhances perceived enjoyment by making the application more fun and pleasurable to use (Holdack et al., 2022). It also increases perceived usefulness by helping users find the information they need, thereby making the application more practical and beneficial (Zheleva et al., 2021). Moreover, the provision of valuable information contributes to the hedonic value by adding to the overall satisfaction of the AR user experience (Yang, 2021). These findings are consistent with the study by Dacko (2017), which emphasized the role of AR in providing contextual and personalized information to consumers, thereby reducing uncertainty and facilitating purchase decisions. Our study extends this understanding by demonstrating that informativeness not only contributes to utilitarian value but also enhances enjoyment and hedonic value. This suggests that the provision of information through AR can be both functional and engaging, potentially leading to a more holistic and satisfying user experience, ultimately fostering more positive attitudes and intentions towards the product or service being showcased. Thus, by recognizing and harnessing the multifaceted benefits of informativeness in AR, stakeholders can design applications that not only meet the informational needs of users but also captivate and delight them, thereby fostering positive user attitudes, engagement, and loyalty. Vietnamese consumers, who often seek detailed product information before making a purchase (Le et al., 2022), may find AR applications that provide comprehensive and relevant information particularly useful and enjoyable. Therefore, e-commerce platforms in Vietnam should focus on enhancing the informativeness of their AR features to meet the high expectations of well-informed consumers.

5.2. Impacts of user perception on satisfaction and attitude towards AR marketing

The results confirm that perceived enjoyment, perceived usefulness, and hedonic value significantly influence both satisfaction and attitude. This supports and extends the Technology Acceptance Model (TAM) and its extensions in the context of AR marketing (Davis, 1989; Venkatesh & Davis, 2000). The strong relationship between Perceived enjoyment and Satisfaction (H_{13}) underscores the pivotal role of enjoyment in shaping consumers' overall satisfaction with AR interactions. When users find AR experiences enjoyable, whether through interactive product visualization, gamified elements, or personalized content, they are more likely to feel satisfied (tom Dieck et al., 2023). Rese et al. (2017) corroborates this finding, emphasizing that enjoyment acts as a catalyst for positive consumer responses in retail contexts. Furthermore, Perceived Enjoyment also has a strong impact on Attitude (H_{14}). Users who enjoy AR interactions tend to develop favorable attitudes toward the brand or product (Pinheiro et al., 2024). This finding aligns with the study of Lele and Shaw (2021), which demonstrated that enjoyments, such as those induced by engaging AR content, significantly influence consumer attitudes. This indicates that by designing AR interactions that evoke enjoyment, brands can foster positive attitudes and enhance overall satisfaction. Vietnamese consumers value positive emotional experiences (Le, 2021) and may respond more positively to AR applications that bring enjoyment and create memorable interactions. Therefore, focusing on the emotional aspect of AR experiences can be an important strategy to enhance consumer satisfaction and attitudes in the Vietnamese market.

The rejection of the hypothesized relationship between Perceived Usefulness and Satisfaction (H_{15}) presents a notable divergence from prior AR research, which often posits a direct positive link between these variables. While previous studies suggest that consumers derive satisfaction from AR applications due to their functional benefits, our findings indicate that perceived usefulness alone may not be a sufficient

driver of satisfaction in e-commerce contexts. One possible explanation is that perceived usefulness alone is insufficient to drive satisfaction if other experiential factors, such as ease of use, trust, or entertainment are not simultaneously met. Consumers may acknowledge that an AR feature provides valuable product information or enhances decision-making, but if the experience is cumbersome, time-consuming, or does not align with their expectations, their overall satisfaction may remain unaffected. While Perceived Usefulness positively influences Attitude (H_{16}), its lack of direct impact on satisfaction challenges the assumption that utilitarian benefits alone are sufficient to enhance the overall shopping experience. This nuanced result extends the work of Hilken et al. (2017), who demonstrated AR's ability to reduce perceived risk and uncertainty in e-commerce. Our findings suggest that while AR's practical benefits may shape attitudes, they may not directly translate to increased satisfaction, indicating a more complex relationship between usefulness and user experience.

Moreover, the positive influence of Hedonic Value on Satisfaction (H_{17}) and Attitude (H_{18}) emphasizes the role of emotional and experiential factors in shaping consumer responses to AR marketing. Poushneh and Vasquez-Parraga (2017) highlighted the importance of hedonic experiences in driving user acceptance of AR technologies. When AR experiences evoke positive emotions, consumers are more likely to be satisfied and develop favorable attitudes toward the technology and the brand. By creating holistic and compelling user experiences, brands can maximize the impact of AR on consumer behavior (Lavoye et al., 2021).

5.3. Impacts of satisfaction and attitude toward AR marketing on consumer purchase intention

The positive influence of Attitude on Satisfaction (H_{19}) suggests that consumers' favorable predispositions toward AR technology contribute significantly to their overall satisfaction with the shopping experience. This finding aligns with the finding of Rese et al. (2017), who emphasized attitude as a critical factor in determining AR adoption and usage. Moreover, satisfaction plays a crucial role in shaping purchase intention (H_{20}). When consumers are satisfied with their AR experiences, they are more likely to consider making a purchase (Voicu et al., 2023). Brands and marketers should focus on creating seamless, enjoyable, and valuable AR interactions to enhance overall satisfaction (Wang et al., 2022). Besides, attitude continues to impact consumer behavior (H_{21}). A positive attitude toward AR not only contributes to satisfaction but also influences purchase intention (Hilal & H, 2023). Therefore, by fostering favorable attitudes, brands can maximize the impact of AR on consumer behavior (Voicu et al., 2023). These findings imply that marketers should recognize that creating positive AR experiences involves not only technological sophistication but also attitudinal alignment. In Vietnam, where purchasing decisions are often influenced by social factors and collective attitudes, the impact of satisfaction and attitude on purchase intention may be amplified (Nguyen et al., 2022). Vietnamese consumers may rely heavily on peer opinions and social approval when adopting new technologies, including AR (Nguyen, Le, & Chau, 2023). Therefore, fostering positive attitudes and ensuring high satisfaction with AR experiences could significantly boost purchase intentions among Vietnamese consumers.

6. Implications

This study advances the theoretical understanding of AR applications in the e-commerce sector by elucidating the nuanced relationships between AR features, user perceptions, and consumer behaviors. Integrating theories from technology acceptance, consumer behavior, and experiential marketing, the research provides a comprehensive framework that explains how AR characteristics, including interactivity, vividness, novelty, and informativeness which affect perceived enjoyment, usefulness, and hedonic value, which in turn influence consumer attitudes, satisfaction, and purchase intentions. This comprehensive

approach not only aligns with but also extends existing literature, highlighting the mechanisms through which AR applications create more engaging and enjoyable shopping experiences, thereby influencing consumer behavior more effectively.

Furthermore, this study makes a valuable contribution to the Stimulus-Organism-Response (SOR) model in the context of AR-enhanced e-commerce. Through examining the relationships between AR characteristics (stimuli), consumer perceptions and experiences (organism), and purchase intentions (response), our research extends the application of the SOR model to emerging technologies in digital marketing. The findings underscore the importance of considering both utilitarian and hedonic aspects of AR experiences, as both significantly influence consumer behavior. This holistic approach enriches the SOR framework by demonstrating how technological features (interactivity, vividness, novelty, and informativeness) can serve as stimuli that trigger cognitive and affective responses, ultimately shaping behavioral outcomes. Moreover, our results highlight the complex interplay between these variables, suggesting that the SOR model in AR contexts should account for both direct and indirect effects of stimuli on responses. This nuanced understanding can guide future research in technology-mediated consumer behavior and inform the development of more sophisticated theoretical models in the rapidly evolving field of digital marketing.

The practical implications of these findings for e-commerce businesses and AR application developers are profound. E-commerce platforms should incorporate highly interactive and vivid AR features to create more engaging and enjoyable shopping experiences. Specifically, our findings underscore the importance of vividness in enhancing both the functional and emotional dimensions of the shopping experience. To capitalize on this, developers should prioritize high-quality visual representations through advanced 3D modeling and realistic lighting effects. Companies should integrate dynamic lighting adjustments, texture rendering, and environment mapping to create a more immersive and authentic product visualization. Additionally, real-time manipulation and realistic visualizations of products can significantly enhance perceived enjoyment and usefulness, leading to higher consumer satisfaction and purchase intentions. To stand out in the competitive e-commerce market, businesses should invest in developing novel and innovative AR features. However, given our finding that novelty's impact on hedonic value was limited, companies should focus on implementing novel AR features that enhance practical utility rather than merely creating superficial innovations. This could include AR-enabled size comparison tools, virtual try-on features with precise measurements, and contextual placement options that assist consumers in making well-informed purchase decisions. Moreover, unique AR experiences can capture consumer interest and enhance hedonic value, driving repeat usage and positive word-of-mouth. Through focusing on the elements that enhance perceived enjoyment, usefulness, and hedonic value, businesses can foster more favorable consumer attitudes towards AR applications and the brands that utilize them. Our findings emphasize the critical role of informativeness in driving consumer confidence and satisfaction. Therefore, businesses should enhance their AR interfaces by integrating comprehensive product specifications, contextual details, and comparative features. This may involve real-time product information overlays, dynamic specification displays, and interactive comparison tools that allow users to assess multiple products simultaneously within the AR environment. Through focusing on the factors that enhance both cognitive and emotional dimensions in consumer decision-making processes, businesses can drive higher satisfaction and stronger purchase intentions, contributing to overall business success. From a managerial perspective, this means that e-commerce companies should not view AR as merely an add-on feature but as an integral component of their digital marketing strategy. Given that interactivity showed strong impact on perceived enjoyment but not on usefulness, companies should design interactive features that directly support purchase decisions rather than just encouraging engagement.

This includes implementing gesture-based controls for detailed product examination, smart filtering options within the AR interface, and intuitive navigation systems that streamline the shopping journey and facilitate decision-making. Retailers should allocate resources towards AR content optimization, ensuring that it is seamlessly integrated with other digital touchpoints such as mobile apps, social media, and personalized recommendations. Furthermore, AR analytics should be leveraged to track user engagement, allowing businesses to refine AR experiences based on real-time behavioral data and continuously enhance their effectiveness.

The study extends the existing paradigms in AR marketing by integrating insights from multiple theoretical perspectives and providing empirical evidence on the multifaceted impacts of AR features. It offers a holistic view of how AR can transform online shopping experiences and influence consumer behavior, contributing to the ongoing discourse on the digital transformation of retail. Through examining the dual impacts of AR on both hedonic and functional consumer values, the research bridges the gap between these perspectives and highlights their interconnectedness in shaping consumer attitudes and behaviors. This integrated approach provides a more comprehensive understanding of the value propositions offered by AR in e-commerce, emphasizing the need for a balanced focus on cognitive engagement and emotional satisfaction in developing effective AR marketing strategies.

7. Limitations and recommendations

This study focuses on the influence of AR features on consumer behavior within a specific e-commerce context. Consequently, the findings may not be universally applicable across other industries where AR technology is employed, such as travel, education, or healthcare. The application of AR in these sectors varies significantly in terms of user interaction and content delivery. To address this limitation, future research should extend the investigation to these diverse sectors to determine if the observed relationships between AR features and consumer behavior remain consistent. This broader perspective would help identify sector-specific nuances and refine AR strategies tailored to various industries.

Additionally, the study does not account for potential variations in user demographics or prior experience with AR technology. Individual differences such as age, technological proficiency, and previous exposure to AR could significantly influence how users perceive and interact with AR applications. For example, younger users with more technological familiarity might engage with AR features differently compared to older users with limited experience. Future research should consider these demographic variables and prior experiences to provide a more nuanced understanding of how different user segments interact with AR applications. Segmenting participants based on these factors and analyzing their interactions and perceptions could yield valuable insights.

Furthermore, the study primarily examines the immediate effects of AR features on user perceptions and behavioral outcomes. While these insights are valuable, they may not fully capture the long-term impact of AR experiences on consumer behavior. Longitudinal studies could offer a deeper understanding of how users' attitudes and behaviors toward AR applications evolve over time. As AR technology becomes more prevalent and integrated into everyday consumer experiences, its impact may shift, potentially affecting user satisfaction and engagement in the long run. Investigating the long-term effects of AR features would provide insights into the sustainability of user engagement and the lasting influence of AR on consumer attitudes and behaviors.

Another important avenue for future research is the cross-cultural perspective on AR adoption and acceptance. Given the global expansion of e-commerce and digital marketing, cultural differences may influence how consumers perceive AR interactivity, usefulness, and hedonic value. Studies have shown that cultural dimensions, such as uncertainty avoidance, individualism vs. collectivism, and power

distance, can significantly impact technology acceptance. Future research should integrate cross-cultural frameworks to explore how consumers from different cultural backgrounds respond to AR marketing applications.

Additionally, methodological advancements in modeling consumer behavior in AR research should be explored. The work of [Zhu et al. \(2024\)](#) highlights the advantages of fractional-order models in capturing time-series data patterns. Similar mathematical tools could be applied to AR research to better analyze consumer behavior trends over time, improving model performance and predictive accuracy. Future studies could leverage these techniques to track user engagement with AR applications longitudinally, identifying potential shifts in perception and adoption patterns.

In conclusion, while this study provides significant contributions to the understanding of AR marketing applications, addressing these limitations and exploring additional factors can further enhance our knowledge. Through expanding research into different industries, incorporating cross-cultural perspectives, adopting advanced modeling techniques, and investigating long-term user engagement, future studies can offer more comprehensive insights for optimizing AR strategies in e-commerce and beyond.

8. Conclusion

This study explored the intricate relationship between AR marketing applications and consumer purchase intentions within the e-commerce sector. A quantitative research method was employed, collecting data through a 5-point Likert scale questionnaire from 315 participants experienced in using AR in e-commerce. The survey utilized validated scales to measure key constructs, including interactivity, vividness, novelty, informativeness, perceived enjoyment, perceived usefulness, hedonic value, attitude, and satisfaction. PLS-SEM was meticulously applied to test the research model and its associated hypotheses.

Interactivity emerged as a key factor in enhancing user engagement, though it surprisingly showed insignificant impact on perceived usefulness. This suggests that while interactive features make AR apps more engaging, they don't necessarily make them seem more practically useful for shopping decisions. Vividness significantly contributed to both functional and emotional aspects of online shopping, enhancing user engagement and increasing perceived usefulness of the AR application. This dual impact underscores the importance of high-quality visual representations in AR e-commerce applications. Novelty positively influenced perceptions of usefulness and enjoyment but did not significantly contribute to overall hedonic value, indicating that while novel AR features are seen as useful and enjoyable, they may not substantially increase the long-term pleasure derived from using the app. Informativeness significantly impacted consumer confidence and satisfaction, enhancing both functional utility and pleasurable aspects of online shopping, emphasizing the importance of providing comprehensive and relevant product information through AR interfaces. The study also revealed that perceived enjoyment, usefulness, and hedonic value of AR applications significantly influenced consumer satisfaction and attitudes towards AR-enhanced e-commerce platforms. However, the hypothesized relationship between perceived usefulness and satisfaction was not supported, suggesting that perceived usefulness alone may not directly lead to satisfaction, and other factors might mediate this relationship.

This research contributes to the growing body of knowledge on AR marketing by offering a comprehensive framework that explains how AR-specific characteristics shape consumer decision-making. Unlike previous studies that examined AR in isolated contexts, this study systematically explores the interplay between multiple AR attributes and consumer psychological responses, enhancing theoretical understanding in the field. From a practical standpoint, the findings provide actionable insights for e-commerce businesses and marketers seeking to optimize AR-driven consumer engagement. The results suggest that businesses

should focus on designing AR applications that balance interactivity, vividness, novelty, and informativeness to maximize both functional utility and emotional appeal. As AR technology continues to evolve, brands that successfully integrate these elements can enhance consumer satisfaction and strengthen purchase intentions.

However, this study has limitations, as it focuses solely on AR features in e-commerce, and its findings may not apply to other industries such as travel, education, or healthcare. Additionally, the study did not consider user demographics or previous AR experience, which can affect engagement. Moreover, while this research examines immediate effects, longitudinal studies are needed to understand how AR impacts consumer attitudes and behaviors over time, especially as AR becomes more integrated into everyday experiences.

CRediT authorship contribution statement

Thi Thuy An Ngo: Writing – review & editing, Writing – original draft, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Thanh Tu Tran:** Writing – review & editing, Writing – original draft, Visualization, Software, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Gia Khuong An:** Writing – review & editing, Writing – original draft, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Phuong Thy Nguyen:** Writing – review & editing, Writing – original draft, Resources, Methodology, Funding acquisition, Formal analysis, Data curation, Conceptualization.

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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.

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Data availability

Data will be made available on request.

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