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The influence of mobile augmented reality on consumer behavior: Insights into affective, cognitive, and behavioral responses

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ABSTRACT

Despite the growing application of Mobile Augmented Reality (MAR) in retail, research lacks empirical focus on how MAR influences the consumer decision-making process through affective, cognitive, and behavioral responses. This study investigates the effects of interactivity, system quality, perceived informativeness, and reality congruence on consumers' emotional and behavioral responses. A preliminary survey identified the product and platform for experiment, and an experimental study tested MAR's effects on 125 female participants. Results highlight that the AR-enabled condition exerts a stronger effect on consumer purchase and continuance intentions. The findings offer practical insights for retailers on leveraging MAR to optimize customer satisfaction and purchasing behavior.

1. Introduction

Augmented Reality (AR) is an innovative technology that overlays digital content onto the physical world to enhance users' perception and interaction with their environment (Aslam & Davis, 2024; Riar, Korbel, Xi, Zarnekow, & Hamari, 2021). The fusion of virtual elements with real-world surroundings creates immersive experiences that enrich consumer engagement with the product and the service providers (Vaidyanathan & Henningsson, 2023). In retail, AR creates opportunities for seamless interaction through virtual try-ons and product visualizations, augmenting the shopping experience through personalization and immersion (Liu, Balakrishnan, & Saari, 2024; Nikhashemi, Knight, Nusair, & Liat, 2021).

Mobile Augmented Reality (MAR) extends AR's capabilities using mobile devices like smartphones and tablets (Kang, Kim, Lee, & Lin, 2023) and enables users to interact with products or service providers in a virtual environment (Khashan, Elsotouhy, Alasker, & Ghonim, 2023). For example, Sephora's Virtual Artist app allows users to try on makeup products virtually and provides an interactive experience that can lead to increased purchase intentions (Raj et al., 2024). Extant literature consistently highlights MAR's potential to enhance consumer engagement, facilitate decision-making, and foster positive consumer behavior (Jessen et al., 2020; McLean & Wilson, 2019). Personalized and immersive shopping experiences through MAR contribute to increased sales and brand loyalty (Butt, Ahmad, & Muzaffar, 2024; Tan, Chandukala, & Reddy, 2022). Moreover, MAR creates value beyond functional product attributes, shifting consumer-brand interactions from purely transactional to deeply experiential (Hsu, Tsou, & Chen, 2021).

Despite the growing prominence of MAR in retail, gaps persist in the scholarly literature. Much of the research has focused on the initial phases of adoption emphasizing acceptance and customer behavior in a variety of settings (Caboni, Basile, Kumar, & Agarwal, 2024; Xue, Parker, & Hart, 2023). Most existing studies focus on short-term adoption behaviors without focusing on strategies that foster sustained engagement and continued use of MAR applications (Hilken, De Ruyter, Chylinski, Mahr, & Keeling, 2017). Research on how MAR impacts consumers' affective, cognitive, and behavioral responses throughout the shopping experience remains scarce (Qin, Peak, & Prybutok, 2021). Demographic variability also represents a significant research gap in MAR contexts. Current research often generalizes findings without sufficient attention to age, gender, or cultural differences in technology acceptance and behavior (McLean & Wilson, 2019). More specifically, there is a notable lack of research on how augmented reality (AR) applications engage specific consumer groups, particularly female shoppers (Oyman, Bal, & Ozer, 2022; Scholz & Duffy, 2018). Moreover, studies focusing exclusively on female consumer behaviors are

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particularly rare in emerging markets like India, where rapid adoption of mobile phones presents both opportunities and challenges for AR integration (Riar, Xi, Korbel, Zarnekow, & Hamari, 2022). Sharma, Ueno, Dennis, and Turan (2023), highlight the fact that despite growing research into emerging digital technologies, most marketing studies remain at best conceptual or descriptive, lacking empirical insights into consumer perceptions and behaviors. These authors call for more research on how these technologies influence stages of the consumer decision-making process. This study responds to the call for further research by investigating how MAR impacts consumer decision-making in retail. Drawing on the experiential hierarchy model (EHM) by Holbrook and Hirschman (1982) and the conceptual model by Kowalczuk, Siepmann, and Adler (2021), this research examines how key MAR attributes shape consumers' affective, cognitive, and behavioral responses. An extended framework is introduced and tested, linking MAR features (for example, interactivity, system quality etc.) to emotional and cognitive responses, such as perceived enjoyment, decision comfort, utilitarian value, and satisfaction, which ultimately influence purchase intention and continued use.

2. Theoretical framework

This study is grounded on the experiential hierarchy model (EHM) of Holbrook and Hirschman (1982), which redefines consumer behavior as something far more than a utilitarian choice. Instead, it focuses on the experiential aspects such as pleasure, fantasy, and emotion as primary motivators. This view contrasts the traditional idea that sees consumers as rational decision-makers. EHM recognizes that consumption is often about the joy of the experience, a subjective state of consciousness filled with emotional and aesthetic meaning (Holbrook & Hirschman, 1982). The experiential focus of EHM complements AR technologies in retail, which aim to amplify the immersive shopping experience by: firstly, blending digital elements with physical environments; and secondly, providing enriched sensory and interactive experiences that significantly influence the decision-making process (Kang et al., 2023; Pantano, Rese, & Baier, 2017). Applying the EHM in this study provides a layered analysis of how MAR influences the cognitive, affective, and behavioral dimensions of consumer decision-making. The study breaks down key elements to reveal how different phases of the consumer journey influence behaviors like purchase intentions and ongoing adoption of AR technologies (Hilken et al., 2017). The proposed overarching framework depicted in Fig. 1 highlights AR's role in transforming consumer interactions by influencing both affective and cognitive responses, ultimately affecting behavioral outcomes in the retail context.

3. Hypothesis development

It is well established that MAR enhances both hedonic and utilitarian shopping experiences by providing new ways for consumers to interact with products (Qin et al., 2024; Qin, Peak, & Prybutok, 2021). In terms of the AR characteristics, this study builds on the seminal work of Kowalczuk et al. (2021), and posits that attributes like interactivity, system quality, perceived informativeness, and reality congruence play a central role in driving hedonic and utilitarian experiences. Interactivity allows users to actively manipulate virtual products to create a dynamic personalized shopping experience that increases engagement and purchase intention (Park & Yoo, 2020). High system quality supports fluid interaction, which builds consumer trust, and enhance satisfaction and loyalty (Yoo, 2020). Informative AR content helps reduce uncertainty by providing relevant details, particularly for products that require physical inspection (Kang, Shin, & Ponto, 2020; Qin, Peak, & Prybutok, 2021). Reality congruence, or the alignment of AR content with real-world elements, significantly influences consumer behaviour (Kowalczuk et al., 2021; Shaheen, Aljarah, Ibrahim, Hazzam, & Ghasemi, 2024). Drawing on the work of Kowalczuk et al. (2021), this study posts that the four attributes - interactivity, system quality, perceived informativeness, and reality congruence, influence behavioral responses by seamlessly integrating immersive and practical experiences. The combination of experiential engagement with utilitarian value ultimately influences consumers' purchase and continuous use intentions. The following section discusses hypotheses that explore these relationships in more depth.

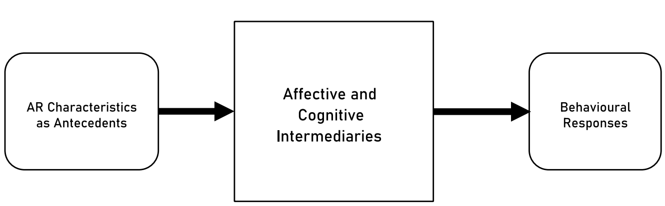

Fig. 1. Framework of the study, Source: Authors (2023).

3.1. MAR characteristics

3.1.1. Interactivity

Interactivity has been found to significantly enhance immersive shopping experiences by increasing perceived enjoyment and immersion (Kowalczuk et al., 2021). Park and Yoo (2020) have shown that interactivity dimensions such as controllability and playfulness positively impact mental imagery, which in turn positively influence consumer attitudes and behaviors. Similarly, Joo and Yang (2023) highlight that interactivity enhances consumer intentions through immersion and hedonic/utilitarian gratifications. Furthermore, Qin, Peak, and Prybutok (2021) found that interactivity foster hedonic and utilitarian value perception in MAR apps. However, conflicting evidence exists in the literature. For instance, Kim, Kim, Park, and Yoo (2021) found that interactivity does not directly influence perceived enjoyment in a VR retail context. These contradictory findings warrant further investigation, particularly in the context of MAR adoption in India. Understanding how interactivity affects consumer responses can uncover the processes that link interactive experiences to consumer actions (Jessen et al., 2020). Consequently, the following hypothesis is posited.

Hypothesis 1. Interactivity positively influences (a) Perceived Enjoyment and (b) Hedonic Value Perception.

3.2. System quality

System quality refers to the technical performance and reliability of the application, including responsiveness, ease of use, and overall usability (DeLone & McLean, 2003). High system quality ensures seamless and efficient interactions, which are essential for fostering favorable user attitudes and satisfaction (Anand, Arya, Suresh, & Sharma, 2023; Papakostas, Troussas, Krouska, & Sgouropoulou, 2023). According to the Information Systems Success Model (DeLone & McLean, 2003), system quality is a crucial determinant of both cognitive responses, such as user satisfaction, and affective responses, such as attitudes toward the system. Relevant literature further substantiates these claims. For example, Chiu, Ho, Yu, Liu, and Mo (2021) highlight that system quality of AR retail applications directly enhances user satisfaction and continuance intention, fostering positive user benefits of technology-based applications. Papakostas, Troussas, Krouska, and Sgouropoulou (2022) confirm that system quality of AR applications significantly influences user attitude and behavioural intention. In the context of MAR, while immersive and interactive features are key drivers of enjoyment (Qin, Peak, & Prybutok, 2021), technical attributes such as convenience and usability play a foundational role in shaping user satisfaction (Jung, Chung, & Leue, 2015). Without a high-quality system, users may experience frustration (Jo & Park, 2023), undermining the immersive and interactive benefits of MAR. Thus, the focus on system quality's impact on attitude and satisfaction provides valuable insights into the key factors driving MAR adoption. Testing these effects within diverse cultural contexts may reveal unique variations in user perceptions, and leads to the following hypothesis-

Hypothesis 2. System Quality positively influences (a) Attitude Towards the App and (b) User Satisfaction.

3.2.1. Perceived informativeness

Perceived informativeness refers to the extent to which AR applications provide consumers with valuable, relevant, and reliable product information (Ducoffe, 1995). Prior studies have shown that informativeness positively affects consumer attitudes and perceptions in retail contexts, such as AR shopping assistants enhancing brick-and-mortar shopping experiences (Holdack, Lurie-Stoyanov, & Fromme, 2022; Qin, Peak, & Prybutok, 2021; Zimmermann et al., 2023). When mobile app information effectively supports shopping tasks, it enhances the platform's perceived utilitarian value (Kang et al., 2020). Liu, Lu, Li, and Zhao (2022) found that mobile platform information presentation (simila r to PI) positively influences users' value perception. This reflects an understanding that in the complex decision-making context of MAR, the clarity and depth of product information can significantly influence practical outcome (Qin, Peak, & Prybutok, 2021). Based on this reasoning the following hypothesis has been proposed -

Hypothesis 3. Perceived Informativeness positively influences (a) Attitude Towards the App and (b) Utilitarian Value Perception.

3.2.2. Reality congruence

Reality congruence captures how well virtual augmentations align with the physical reality of the product it represents their physical counterparts (Kowalczuk et al., 2021). Research has shown that high levels of reality congruence can significantly impact consumers' affective and cognitive responses, such as perceived enjoyment, media richness, and choice confidence (Kowalczuk et al., 2021). A high level of reality congruence facilitates a reliable and accurate evaluation process, enhancing customer confidence and reducing the uncertainty commonly associated with online shopping (Dwivedi et al., 2021; Wong, Lee, & Lau, 2014). Consequently, AR applications can enhance customer comfort with future purchase decisions (Song, Baek, & Choo, 2020). Focusing on decision comfort rather than affective responses like enjoyment, attitude, or value perception offers a more targeted understanding of how reality congruence supports decision-making (Parker, Lehmann, & Xie, 2016). Decision comfort directly addresses consumers' confidence and satisfaction with their purchase choices, which are particularly tied to the accuracy and reliability of AR representations (Hilken et al., 2017; Parker et al., 2016). Thus, decision comfort provides a precise lens to evaluate the cognitive outcomes of reality congruence, especially in retail environments where purchase decisions hinge on the virtual representation of products (Barta, Gurrea, & Flavián, 2023; Ivanov, Head, & Biela, 2023). Moreover, reality congruence's impact on decision comfort may vary across cultural and social contexts, particularly in emerging markets where consumers may have different expectations and perceptions of AR technology (Vashisht & Chauhan, 2017). With this in mind the following hypothesis is suggested -

Hypothesis 4. Reality Congruence positively influences Decision Comfort.

3.3. Affective and cognitive intermediaries

3.3.1. Perceived enjoyment

Affective responses in the context of AR retail refer to consumers' emotional reactions during interactions with augmented reality applications, which significantly shape their attitudes and purchasing decisions (Kowalczuk et al., 2021). Perceived enjoyment refers to the intrinsic pleasure derived from interacting with AR technology (Venkatesh, 2000), while hedonic value reflects the emotional and experiential benefits of the shopping experience (Poncin & Mimoun, 2014). Unlike utilitarian value, which focuses on task completion, hedonic value is subjective, stemming from enjoyment and playfulness (Holbrook & Hirschman, 1982; Poncin & Mimoun, 2014). When users experience enjoyment in an app, they are more likely to perceive it as offering higher hedonic value. This perception is particularly significant in contexts where engagement and satisfaction depend on the quality of enjoyable experiences (Lee, Kim, & Choi, 2019). Thus, perceived enjoyment can enhance users' emotional connection with the app, leading to more favorable attitudes (Iranmanesh et al., 2024). While studies have shown how perceived enjoyment affects attitude and behavioral intentions (Huang, Ozturk, Zhang, de la Mora Velasco, & Haney, 2024; Lee et al., 2019), its role in the MAR domain is relatively underexplored. Based on this argument the hypothesis is proposed-

Hypothesis 5. Perceived Enjoyment positively influences (a) Hedonic Value Perception and (b) Attitude towards the app.

3.3.2. Attitude towards the app

Attitude towards a MAR app (ATA) represents a user's affective response and emotional and evaluative state towards the application (Ajzen & Fishbein, 2000). Recent studies have shown that positive attitudes significantly influence purchase intentions and user satisfaction in AR/MAR contexts (Iranmanesh et al., 2024; Qin, Osatuyi, & Xu, 2021). Positive attitudes further reinforce user satisfaction by creating a feedback loop where favorable evaluations lead to continued use, which strengthens confidence and fulfillment with the app's performance (Papakostas et al., 2023). However, the literature reveals conflicting evidence regarding the influence of attitude on behavioral outcomes. Shyr, Wei, and Liang (2024) found that attitudes toward using AR technology did not significantly predict intention to adopt it, suggesting contextual variability in how attitudes translate into actions. Similarly, Menidjel and Bilgihan (2022) reported that while customer satisfaction has an indirect effect on purchase intention, the direct effect was insignificant. This hypothesis seeks to address these contradictions by examining the role of attitude in driving purchase intentions and satisfaction within an emerging market context Thus, the following hypothesis is put forward-

Hypothesis 6. Attitude Towards the App positively influences (a) Purchase Intention and (b) User Satisfaction.

3.3.3. Hedonic value perception

Hedonic Value Perception reflects the enjoyment derived from using AR applications and plays a significant role in shaping consumers' attitudes towards the technology and enhancing satisfaction levels (Rauschnabel, Felix, & Hinsch, 2019). The experiential benefits of AR technologies augment the hedonic value perceived by consumers, positively influencing their emotional responses and satisfaction (Lee & Park, 2024). Qin et al. (2024) highlight that when consumers derive high hedonic value from an application, they are more likely to be satisfied and engage in sustained use of the technology. Therefore, the following hypothesis is proposed -

Hypothesis 7. Hedonic Value Perception positively influences (a) Attitude Towards the App and (b) User Satisfaction.

3.4. Cognitive responses

3.4.1. Utilitarian value perception

Utilitarian value perception focuses on the practical and functional benefits derived from using AR, such as enhanced product understanding and improved decision-making efficiency (Zhou, Zheng, & Li, 2021). When users perceive the app as useful and effective in aiding their shopping tasks, their satisfaction with the app increases. This relationship is grounded in the expectancy-confirmation theory, which posits that satisfaction arises when the app meets or exceeds the practical expectations held by the user (Bhattacherjee, 2001). Recent studies in AR/MAR contexts have shown that utilitarian value significantly affects purchase intention and satisfaction (Attri, Roy, & Choudhary, 2024; Qin et al., 2024). Additionally, Qin, Osatuyi, and Xu (2021) discovered that user satisfaction will lead to the purchase and continuance intention of MAR technology. The following hypotheses are submitted -

Hypothesis 8. Utilitarian Value Perception positively influences User Satisfaction.

3.4.2. Satisfaction

In case of MAR applications, user satisfaction plays a critical role in forming behavioral outcomes. Prior research demonstrates a strong link between satisfaction and purchase intention, where satisfied users are more likely to engage in purchasing behaviors and evaluate the application positively (Qin et al., 2024). As suggested in Expectation Confirmation theory, when satisfaction is achieved, users are more likely to develop positive behavioral intentions, such as purchasing or continuing to use the application (Bhattacherjee, 2001). Consequently, satisfaction is a key predictor of continuous use intention, driving long-term engagement with mobile applications (Sun & Yuan, 2024; Yu, Yang, & Li, 2024).

Hypothesis 9. User Satisfaction positively influences (a) Purchase Intention and (b) Continuous Use Intention.

3.4.3. Decision comfort

Decision Comfort pertains to the ease with which consumers make decisions using AR applications (Parker et al., 2016). While research has shown that MAR's immersive and interactive features augment decision comfort (Ivanov et al., 2023), which in turn influences word of mouth intention (Heller, Chylinski, de Ruyter, Mahr, & Keeling, 2019), it would be interesting to examine the specific outcome of decision comfort in terms of purchase and continuance intention. So, the following hypothesis has been propounded -

Hypothesis 10. Decision Comfort positively influences (a) Purchase Intention and (b) Continuous Use Intention.

3.5. Behavioral responses

Recent studies have consistently shown that the implementation of MAR applications positively influences consumer behavioral responses, enhancing customer experience and fostering sustained use (Aslam & Davis, 2024; Attri et al., 2024; Butt et al., 2024). However, behavioral responses in relation to AR versus non-AR conditions are largely untapped. It would be valuable to examine these responses in diverse socioeconomic contexts, for instance India, where AR adoption is still emerging and consumer behavior differs markedly from those in more developed economies (Manchanda & Deb, 2021). Thus, the following hypothesis has been posited -

Hypothesis 11. There is a significant difference between the predictive power of the model regarding the dependent variables (Purchase Intention and Continuous Use Intention) in the context of MAR and non-MAR responses.

Based on the hypotheses presented above, Fig. 2 depicts the proposed conceptual framework, illustrating the relationships between AR characteristics, affective and cognitive responses, and the subsequent behavioral outcomes in the retail context.

4. Methodology

4.1. Design

This study utilized a two-phase research design. Phase 1 involved a preliminary survey to identify the most suitable product and platform for the experimental study. Phase 2 utilized a controlled experiment to examine the effects of MAR on consumer decision-making processes in online shopping. This approach ensured the experimental setup was tailored to the target population and effectively assessed MAR's impact.

4.2. Data collection: phase 1

The preliminary survey aimed to identify the most appropriate product and shopping platform for the experiment. Female consumers familiar with online beauty product shopping were recruited through snowball sampling via personal and professional networks (Etikan, Musa, & Alkassim, 2016).

The survey included three questions addressing participants'

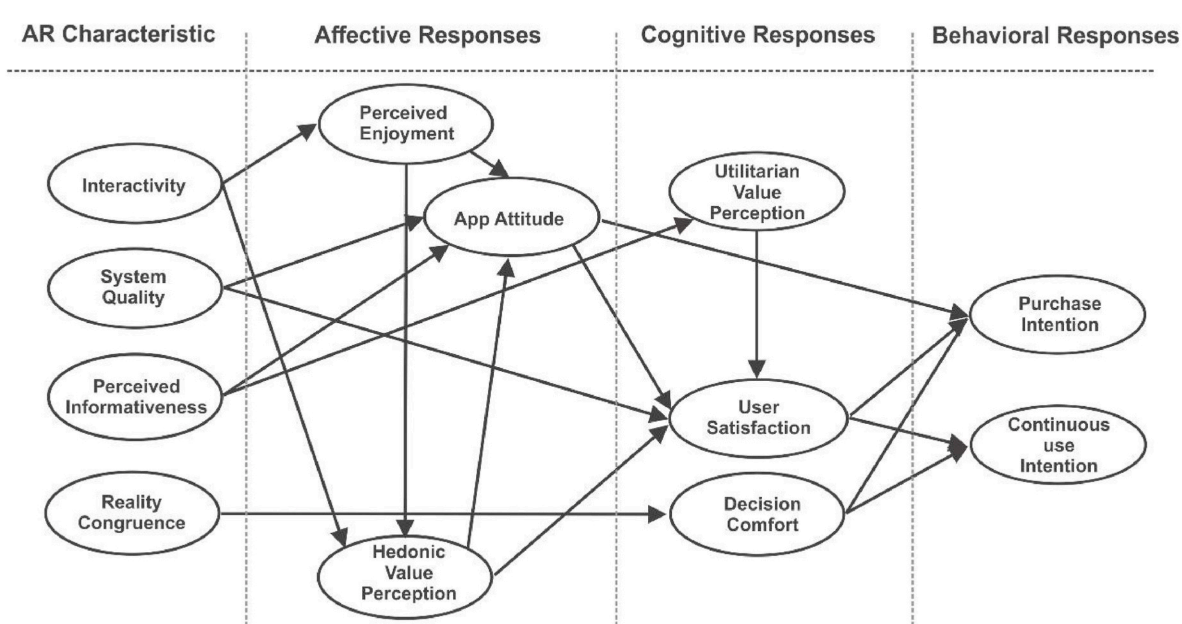

Fig. 2. Conceptual framework.

preferred beauty products, their use of AR features, and their preferred shopping platforms. Data analysis revealed that lipstick was the most frequently purchased and tried-on beauty product (55% and 60%, respectively). Among shopping platforms, Nykaa was the most preferred (51%), but the TIRA app was selected for the experiment due to its advanced MAR features and low prior usage among respondents (3%). This minimized familiarity bias and ensured objective evaluation of MAR's influence on consumer behavior (Krosnick & Alwin, 1987). Table 1 summarised the findings of the preliminary survey.

4.3. Phase 2: experimental study

In phase 2, an experimental study involved 125 female participants aged 18 to 30 who were split into two groups: MAR (experimental) and non-MAR (control). The experimental group interacted with a lipstick product using the TIRA app's MAR feature to explore its immersive impact (See Fig. 3). The control group used the app without access to this feature, serving as a baseline for assessing MAR's effect on consumer behaviour. The sample size was determined based on a power analysis using an online calculator, which indicated that a sample size of 26 participants per group would provide sufficient power. However, a larger sample size above 60 per group was chosen to enhance the generalizability of the findings (Cohen, Monion, & Morris, 2000). The experimental group consisted of 62 participants, while the control group included 63 participants. Snowball sampling was also utilized in this phase to efficiently target a niche demographic of tech-savvy female consumers likely to adopt MAR technologies. This method ensured the timely recruitment of a representative sample while maintaining the relevance to early adopters of technology in the fashion industry (Etikan et al., 2016).

The experimental group used the virtual try-on feature as their stimulus, while the control group shopped online without it. Fig. 4 depicts a genric example of the virtual try-on feature. Both groups simulated shopping within a 10–15-min timeframe and added favorable items to their carts. Afterward, participants completed a structured questionnaire measuring their emotional, cognitive, and behavioral responses to the experience. All participants were informed that their involvement was voluntary, their responses would be confidential, and the study posed no risks greater than those encountered in everyday life. Ethical guidelines were strictly adhered to, and informed consent was obtained from all participants.

4.4. Research instrument

The research instrument used in Phase 2 was a structured questionnaire adapted from established scales. The questionnaire contained 46 items related to the constructs identified in the conceptual model (Fig. 2), and it was implemented by using a seven-point Likert scale. Purchase intention was measured using a seven-point semantic differential scale. The questionnaire items and their sources are outlined in Table 2.

4.5. Reliability and validity

The reliability of the measurement instruments in this study was assessed using multiple established metrics, ensuring consistency and coherence in measuring the constructs of interest. The descriptive statistics in Table 3 suggest that the data exhibit an approximately normal distribution across most variables. The descriptive statistics in Table 3 indicate that the data are approximately normally distributed across most variables. Skewness values for both AR and non-AR conditions fall within the acceptable range of ± 2, suggesting no significant asymmetry. Moreover, AR data consistently showed higher mean scores and lower variability than non-AR data and provided a more consistent and improved user experience. These findings align with the strong reliability observed in the measurement model and support the assumption of normality required for parametric analysis.

Indicator reliability was evaluated by examining the outer loadings of each item on its respective construct. For both the AR and non-AR samples, most indicators demonstrated loadings above this threshold, suggesting strong reliability across constructs. Cronbach's alpha values ranged from 0.748 to 0.969 across the constructs, surpassing the recommended threshold of 0.7 (Nunnally, 1978). The CR values were also above 0.7 for all constructs, indicating reliable measurements across the board (Fornell & Larcker, 1981).

To ensure the validity both convergent and discriminant validity were tested. All indicator loadings were statistically significant and above 0.7, and CR values for each construct exceeded 0.7, affirming the internal consistency of the items used to measure each latent variable (Hair, Black, Babin, & Anderson, 2010). AVE values were also above 0.5 and the square root of each construct's AVE was greater than its correlations with other constructs, indicating the discriminant validity of the constructs (Fornell & Larcker, 1981). Additionally, HTMT values for both AR and non-AR samples were below the critical threshold of 0.85, except for a few construct pairs which were below the more lenient threshold of 0.90, thus confirming the distinctiveness of the constructs (Henseler, Ringle, & Sarstedt, 2015).

4.6. Common Method Bias

To minimize Common Method Bias (CMB), this study followed both procedural and statistical measures as per best practices (Podsakoff, MacKenzie, & Podsakoff, 2012). Anonymity was ensured, and unrelated questions were scattered throughout the survey to reduce response biases and avoid artificial correlations between variables. Furthermore, Harman's single-factor test showed that a single factor explained 31.57% of the variance, below the 50% threshold, indicating that CMB was not a major concern. Furthermore, variance inflation factor (VIF) values ranged from 1.50 to 3.17 which were below the 3.3 benchmark (Kock, 2015), suggesting minimal multicollinearity.

4.7. Data analysis

The data analysis employed Partial Least Squares Structural Equation Modeling (PLS-SEM) because it is effective in handling non-normal distributions and complex models. The measurement model's reliability and validity were assessed, followed by hypothesis testing through the structural model. Multi-group analysis (MGA) compared AR and non-AR samples, revealing distinct impacts of MAR features on engagement, satisfaction, and purchase intentions**.**

5. Results

5.1. Structural model

The structural model was analyzed using PLS-SEM to examine the hypothesized relationships in both AR and non-AR contexts. The AR condition provided strong empirical support for most hypotheses, affirming AR's potential to enhance consumer experiences significantly. Interactivity (INT) positively influenced perceived enjoyment (PENJ) ($\beta = 0.438$, $p = 0.002$) and hedonic value perception (HVP) ($\beta = 0.525$, $p < 0.001$), confirming the influential role of AR in creating an engaging shopping environment. System quality (SQLT) also significantly

Table 1
Preliminary survey findings.

Question	Most Common Response	Percentage (%)
Most Purchased Product	Lipstick	55%
Most Used Try-On Product	Lipstick	60%
Most Preferred Shopping Platform	Nykaa	51%
App used in the experiment	Tira	3%

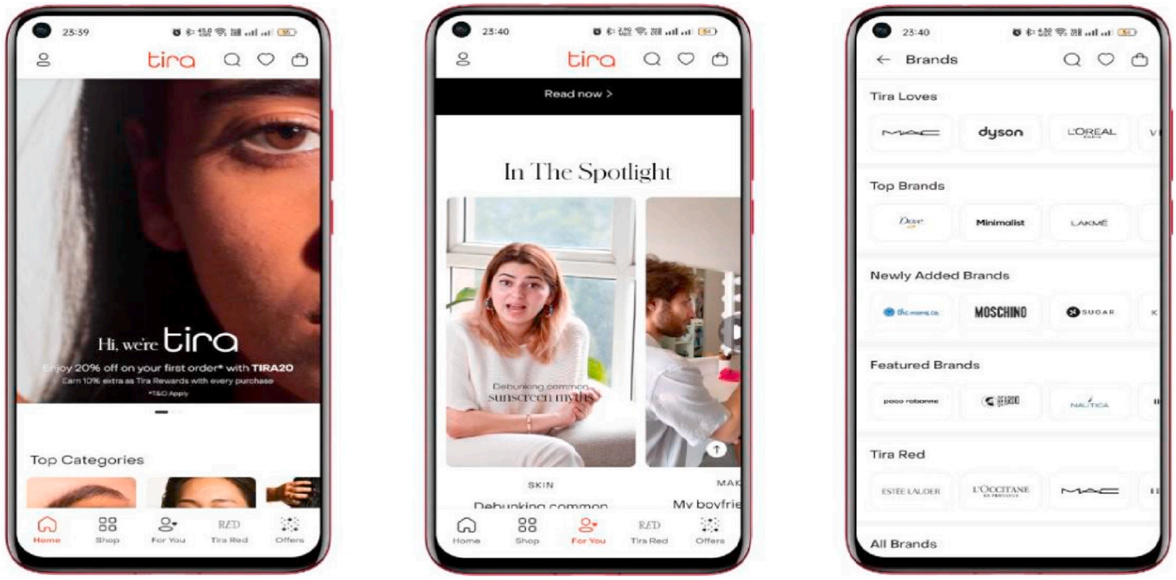

Fig. 3. TIRA mobile app, Source – (Abbas, 2023).

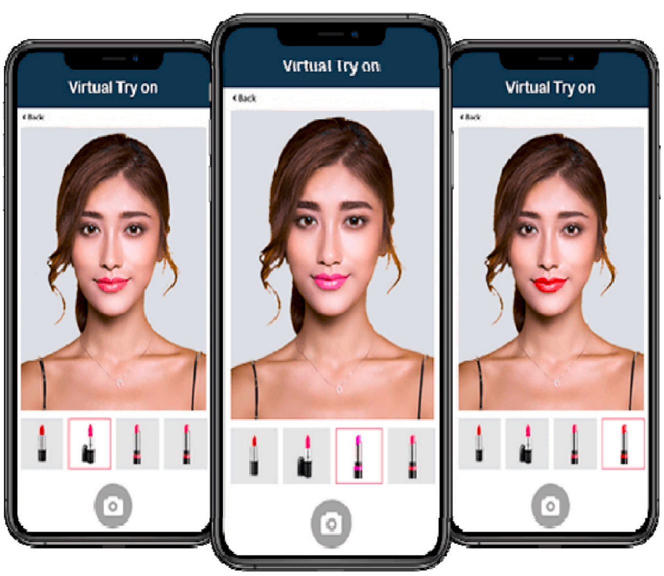

Fig. 4. Virtual try on feature example, Source - Dutta, 2022.

influenced app attitude (ATA) ($\beta = 0.352$, $p = 0.002$) and user satisfaction (USAT) ($\beta = 0.350$, $p < 0.001$), demonstrating the impact of system design on consumer perceptions.

However, mixed outcomes emerged for perceived informativeness (PIF). While it significantly enhanced utilitarian value perception (UVP) ($\beta = 0.521$, $p < 0.001$), its influence on attitude (ATA) was insignificant ($\beta = 0.208$, $p = 0.068$). Suggested here is that while information availability improved consumers' utilitarian evaluations, it did not necessarily alter their attitudes toward the app. Reality congruence (RCON) had a significant effect on decision comfort (DCFT) ($\beta = 0.493$, $p < 0.001$), showing that realistic AR visualizations enhance consumer confidence in decision-making, which, in turn positively influenced purchase intentions (PIT) ($\beta = 0.481$, $p < 0.001$) and continued usage intentions (CUI) ($\beta = 0.312$, $p = 0.002$). The impact of perceived enjoyment (PENJ) on HVP ($\beta = 0.315$, $p = 0.004$) and ATA ($\beta = 0.285$, $p = 0.001$) further supported the idea that enjoyment derived from AR features positively influences consumer attitudes and hedonic assessments.

Interestingly, hedonic value perception (HVP) did not have a significant influence on ATA ($\beta = 0.174$, $p = 0.061$) or USAT ($\beta = -0.048$, $p = 0.328$). This lack of support suggests that hedonic benefits from AR may not directly enhance attitudes or satisfaction. In contrast, utilitarian value perception (UVP) had a positive impact on user satisfaction (USAT) ($\beta = 0.421$, $p < 0.001$), indicating that utilitarian benefits play a key role in shaping satisfaction in AR contexts.

The non-AR results revealed a distinct pattern. INT significantly impacted PENJ ($\beta = 0.599$, $p < 0.001$), but it did not affect HVP ($\beta = 0.268$, $p = 0.105$), suggesting that, without AR features, interactivity alone may be insufficient for enhancing hedonic value. SQLT had positive effects on both ATA ($\beta = 0.199$, $p = 0.008$) and USAT ($\beta = 0.183$, $p = 0.043$), but these effects were weaker compared to the AR context, pointing to the additional value that AR features provide.

PIF was significantly related to ATA in the non-AR context ($\beta = 0.335$, $p = 0.023$), which was not observed in the AR condition, indicating that informativeness is more critical for forming attitudes in the absence of immersive AR features. RCON continued to significantly impact DCFT ($\beta = 0.254$, $p = 0.001$), indicating its consistent role in promoting decision comfort. However, DCFT did not significantly influence PIT ($\beta = 0.081$, $p = 0.648$), suggesting that non-AR conditions may struggle to translate decision comfort into immediate purchase behavior. It did, however, positively influence CUI ($\beta = 0.470$, $p = 0.001$), indicating that decision comfort can sustain app usage even without AR's immersive capabilities. HVP also had a significant impact on both ATA ($\beta = 0.611$, $p < 0.001$) and USAT ($\beta = 0.698$, $p < 0.001$) in the non-AR condition, contrasting the AR scenario, where these effects were not significant. This may suggest that, in the absence of immersive AR, hedonic aspects play a more substantial role in shaping attitudes and satisfaction. Lastly, USAT positively influenced both PIT ($\beta = 0.603$, $p = 0.014$) and CUI ($\beta = 0.553$, $p < 0.001$), reframing the central role of satisfaction in driving consumer behaviors. These findings suggest that AR features enhance consumer experiences by creating engagement that goes beyond what traditional interfaces offer. However, the results also highlight that the role of hedonic versus utilitarian aspects may vary significantly depending on the technological features present, suggesting that AR's immersive capacity fundamentally shifts the dynamics of consumer satisfaction and loyalty in retail environments. Table 4 presents the results of the path analysis for both MAR and non-MAR conditions.

Table 2
Questionnaire items.

Construct	Item	Statement	Source (Adapted)
Interactivity **(INT)** Reliability: [a]AR & non-AR 0.919 & 0.921 AVE: [a]AR & non-AR 0.804 & 0.801	INT1	Through the interaction with the product presentation (with 'try on' feature) in the TIRA app, I can get a profound picture of the product.	Pantano et al. (2017), Kowalczuk et al. (2021)
	INT2	The product exposition in the TIRA app has incredible interaction features.	
	INT3	I am able to interact with the product presentation (using 'try on' feature) in the TIRA app to get information tailored to my needs.	
	INT4	The degree of interaction with the product presentation in the TIRA app is outstanding.	
System Quality **(SQLT)** Reliability: [a]AR & non-AR 0.849 & 0.803 AVE: [a]AR & non-AR 0.624 & 0.553	SQLT1	The TIRA app is promptly responsive to my requests and provides good results.	Kowalczuk (2018), Park et al. (2015)
	SQLT2	The TIRA app performs its functions quickly and efficiently.	
	SQLT3	The TIRA app is reliable (it is always up and running, runs without errors, and does what it is supposed to do).	
	SQLT4	The TIRA app provides perfect and precise services in line with the purpose of the shopping app.	
Perceived Informativeness **(PIF)** Reliability: [a]AR & non-AR 0.782 & 0.955 AVE: [a]AR & non-AR 0.604 & 0.888	PIF1	The TIRA app provides detailed information about lipsticks.	Qin, Osatuyi, and Xu (2021), Rese et al. (2017)
	PIF2	The TIRA app provides complete information about lipsticks.	
	PIF3	The TIRA app provides information that helps me in my decision.	
	PIF4	The TIRA app provides information to compare products.	
Reality Congruence **(RCON)** Reliability: [a]AR & non-AR 0.822 & 0.921 AVE: 0.651 & 0.805	RCON1	The TIRA app presents (virtual) products impressively.	Kowalczuk et al. (2021), Pantano et al. (2017)
	RCON2	The TIRA app presents (virtual) products visually appealingly.	
	RCON3	The TIRA app presents the design of the (virtual) products (e.g., colors, shapes) realistically.	
	RCON4	The TIRA app presents (virtual) products as if they were real.	
Perceived Enjoyment **(PENJ)** Reliability: [a]AR & non-AR 0.834 & 0.9721; AVE: 0.75 & 0.945	PENJ1	Using the TIRA app is really fun.	Kowalczuk et al. (2021), Pantano et al. (2017)
	PENJ2	I find using the TIRA app to be enjoyable.	
	PENJ3	The actual process of using the TIRA app is pleasant.	
Attitude Towards the App **(ATA)** Reliability: [a]AR & non-AR 0.785 & 0.969 AVE: 0.61 & 0.915	ATA1	I am positive about the TIRA app.	Porter & Donthu (2006), Qin, Osatuyi, and Xu (2021)
	ATA2	The TIRA app is so interesting that you just want to learn more about it.	
	ATA3	The use of the TIRA app is a good idea.	
User Satisfaction **(USAT)** Reliability: [a]AR & non-AR 0.783 & 0.957 AVE: 0.697 & 0.922	USAT1	Overall, I am satisfied with the TIRA app.	Poushneh & V-Parraga (2017), Taylor & Baker (1994)
	USAT2	Being a user of this TIRA app has been a satisfying experience.	
	USAT3	Having experienced this TIRA app was pleasurable.	
Decision Comfort **(DCFT)** Reliability: [a]AR & non-AR 0.786 & 0.947 AVE: 0.607 & 0.864	DCFT1	I feel good about choosing this lipstick.	Heller et al. (2019), Hilken et al. (2017)
	DCFT2	Whether or not it is 'the best choice', I am okay with opting for this lipstick.	
	DCFT3	I am comfortable with choosing this lipstick.	
	DCFT4	Although I don't know if this lipstick is the best, I feel perfectly comfortable with the choice I made.	
Purchase Intention **(PIT)** Reliability: [a]AR & non-AR 0.836 & 0.956 AVE: 0.67 & 0.884	PIT1	Rate your intention to purchase.	Kowalczuk et al. (2021), Yim et al. (2017)
	PIT2	Rate your intention to purchase.	
	PIT3	Rate your intention to purchase.	
	PIT4	Rate your intention to purchase.	
Continuous Use Intention (CUI) Reliability: [a] AR & non-AR 748 & 0.956 AVE: 0.666 & 919	CUI1	If I were to buy lipstick in the future, I would download or use the TIRA app (or other apps with 'try-on features').	Qin, Osatuyi, and Xu (2021), Rese et al. (2017)
	CUI2	I would give the TIRA app (or other apps with 'try-on features') priority over other alternative means.	

[a] AR= Augmented Reality sample and non-AR= Non-Augmented Reality sample.

5.2. *Comparative analysis of AR and non-conditions*

The Mann-Whitney *U* test, R^2 comparison, and PLS-MGA analysis provide strong evidence supporting Hypothesis 11, confirming significant differences in consumer behavior between AR and non-AR groups. As noted in Table 5 below, the AR group showed higher mean scores for interactivity, system quality, and purchase intention. The R^2 values further underline AR's superior predictive power for key behavioral outcomes. In the AR model, purchase intention achieved an R^2 of 0.776, while continuous use intention recorded an R^2 of 0.584, both significantly higher than the corresponding values of 0.61 and 0.386 in the non-AR model (Table 6). This demonstrates the heightened ability of AR to explain variations in consumer behaviors compared to non-AR contexts.

As shown in Table 7, PLS-MGA revealed notable differences between the conditions. Attitude had a stronger influence on purchase intention in non-AR settings, whereas decision comfort and interactivity played more prominent roles in AR contexts. Additionally, system quality had a much stronger impact on user satisfaction in AR environments, emphasizing the importance of system reliability. These findings substantiate AR's potential as a powerful tool for shaping customer affective and cognitive perceptions.

Table 3
Descriptive statistics.

Variable	AR Data					Non-AR Data				
	Mean	Std. Error	Std. Deviation	Kurtosis	Skewness	Mean	Std. Error	Std. Deviation	Kurtosis	Skewness
Interactivity	5.7778	0.12839	1.01908	1.1899	−1.1245	4.4919	0.15796	1.24381	1.14026	−1.08775
System Quality	5.9524	0.08607	0.68318	0.7016	−0.7855	5.3839	0.09727	0.76591	−0.8506	−0.12262
Perceived Informativeness	5.8849	0.07649	0.60712	−0.141	−0.528	4.8145	0.13058	1.02822	−0.6738	−0.49474
Reality Congruence	5.9286	0.09607	0.76257	0.499	−0.850	4.8911	0.15185	1.19564	−0.5877	−0.71158
Perceived Enjoyment	5.9788	0.10502	0.8336	−0.132	−0.795	4.8226	0.15909	1.25264	−0.3574	−0.39394
Attitude towards the App	6.0198	0.08339	0.6619	2.871	−1.354	5.0927	0.14558	1.1463	−0.0876	−0.48561
Hedonic Value Perception	5.9841	0.10149	0.80557	4.3894	−1.5750	4.9032	0.16526	1.30129	−0.3435	−0.52794
Utilitarian Value Perception	6.0079	0.07797	0.61887	0.8064	−0.7755	5.0726	0.15664	1.2334	0.00756	−0.67523
User Satisfaction	5.9683	0.08423	0.66858	0.2031	−0.9180	4.8226	0.13685	1.07754	−0.4635	−0.2025
Decision Comfort	5.9603	0.09402	0.74624	−0.0703	−0.5479	5.0242	0.14922	1.17497	0.12133	−0.63756
Purchase Intention	6.0159	0.0887	0.70407	0.4916	−0.8320	5.0444	0.13204	1.03971	−0.0403	−0.28235
Continuous Use Intention	5.9894	0.08763	0.69553	−0.3000	−0.5066	4.9301	0.13758	1.0833	−0.6303	−0.09927

Table 4
Evaluation outcomes of the structural model - MAR and Non-MAR condition.

Hypothesized Paths	Linked hypothesis	MAR (β)	MAR t-value	MAR p-Value	Non -MAR (β)	Non-MAR t-value	Non-MAR p-Value
INT →PENJ	H1a	0.438	2.88	0.002	0.599	3.688	0.000
INT →'HVP	H1b	0.525	4.402	0.000	0.268	1.621	0.105
SQLT →ATA	H2a	0.352	2.851	0.002	0.199	2.514	0.008
SQLT →USAT	H2b	0.35	4.343	0.000	0.183	1.967	0.043
PIF →ATA	H3a	0.208	1.495	0.068	0.335	2.282	0.023
PIF →UVP	H3b	0.521	5.842	0.000	0.190	1.354	0.176
RCON → DCFT	H4	0.493	4.708	0.000	0.254	3.330	0.001
PENJ →HVP	H5a	0.315	2.669	0.004	0.533	11.025	0.000
PENJ → ATA	H5b	0.285	3.071	0.001	0.180	0.980	0.327
ATA → PIT	H6a	0.25	2.859	0.002	0.733	13.536	0.000
ATA → USAT	H6b	0.28	2.099	0.018	0.261	2.476	0.013
HVP →ATA	H7a	0.174	1.548	0.061	0.611	6.271	0.000
HVP →USAT	H7b	−0.048	0.446	0.328	0.698	9.030	0.000
UVP →USAT	H8	0.421	3.827	0.000	0.226	3.800	0.000
USAT →PIT	H9a	0.306	2.647	0.004	0.603	0.232	0.014
USAT →CUI	H9b	0.539	6.051	0.000	0.553	3.994	0.000
DCFT → PIT	H10a	0.481	5.772	0.000	0.081	0.456	0.648
DCFT → CUI	H10b	0.312	2.955	0.002	0.470	3.340	0.001

Table 5
Mann-Whitney *U* test.

Constructs	Non-AR group Mean	SD	AR group Mean	SD	P values
AR Characteristics Interactivity (INT)	4.492	1.244	5.778	1.019	0.000
System Quality (SQLT)	5.384	0.766	5.952	0.683	0.000
Perceived Informativeness (PIF)	4.863	1.033	5.885	0.607	0.002
Reality Congruence (RCON)	4.891	1.196	5.929	0.763	0.000
Affective Responses Perceived Enjoyment (PENJ)	4.849	1.208	5.979	0.834	0.000
App Attitude (ATA)	5.105	1.158	6.020	0.662	0.010
Hedonic Value Perception (HVP)	4.895	1.363	5.984	0.806	0.000
Cognitive Responses Utilitarian Value Perception (UVP)	5.137	1.113	6.008	0.619	0.030
User Satisfaction (USAT)	4.903	1.051	5.968	0.669	0.000
Decision Comfort (DCFT)	5.024	1.175	5.960	0.746	0.000
Behavioural Responses Purchase Intention (PIT)	5.024	1.030	6.016	0.704	0.000
Continuous Use Intention (CUI)	4.952	1.088	5.989	0.696	0.000

Table 6
R-Square Analysis for Dependent Variables in AR and Non-AR settings.

Dependent variable	R-Square	
	AR group	Non-AR group
Purchase Intention (PIT)	0.776	0.61
Continuous Use Intention (CUI)	0.584	0.386

Table 7
Result of PLS-MGA

Hypothesized Paths	Difference (AR -NON_AR)	2-tailed (AR vs NON_AR) P-value
ATA → PIT	−0.373	0.072
ATA → USAT	−0.047	0.416
DCFT → CUI	0.279	0.091
DCFT → PIT	0.312	0.020*
HVP → ATA	−0.106	0.230
HVP → USAT	−0.032	0.403
INT → HVP	0.282	0.026*
INT → PENJ	−0.119	0.236
PENJ → ATA	0.069	0.301
PENJ → HVP	−0.444	0.000*
PIF → ATA	−0.136	0.229
PIF → UVP	−0.254	0.008*
RCON → DCFT	−0.205	0.053
SQLT → ATA	0.219	0.059
SQLT → USAT	0.492	0.000*
USAT → CUI	−0.18	0.126
USAT → PIT	0.225	0.193
UVP → USAT	−0.32	0.037*

5.3. Mediation analysis

The mediation pathways in the AR context outlined in Table 8 show how interactivity, perceived informativeness, reality congruence, and system quality influence consumer outcomes. Interactivity primarily influences purchase intentions through hedonic value perception. The pathway Interactivity → Hedonic Value Perception → App Attitude →

Table 8
Mediation - AR condition.

Mediation Path	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
Interactivity - > Hedonic Value Perception - > App Attitude - > Purchase Intention	0.043	0.042	0.02	2.211	0.027
Interactivity - > Hedonic Value Perception - > App Attitude - > User Satisfaction - > Continuous Use Intention	0.026	0.025	0.016	1.597	0.111
Interactivity - > Hedonic Value Perception - > App Attitude - > User Satisfaction - > Purchase Intention	0.015	0.014	0.011	1.355	0.176
Interactivity - > Hedonic Value Perception - > User Satisfaction - > Continuous Use Intention	−0.014	−0.01	0.033	0.415	0.678
Interactivity - > Hedonic Value Perception - > User Satisfaction - > Purchase Intention	−0.008	−0.008	0.018	0.423	0.672
Interactivity - > Perceived Enjoyment - > Hedonic Value Perception - > App Attitude - > Purchase Intention	0.011	0.012	0.009	1.279	0.201
Interactivity - > Perceived Enjoyment - > Hedonic Value Perception - > App Attitude - > User Satisfaction - > Continuous Use Intention	0.007	0.007	0.006	1.089	0.277
Interactivity - > Perceived Enjoyment - > Hedonic Value Perception - > App Attitude - > User Satisfaction - > Purchase Intention	0.004	0.004	0.004	0.941	0.347
Interactivity - > Perceived Enjoyment - > Hedonic Value Perception - > User Satisfaction - > Continuous Use Intention	−0.004	−0.003	0.009	0.378	0.706
Interactivity - > Perceived Enjoyment - > Hedonic Value Perception - > User Satisfaction - > Purchase Intention	−0.002	−0.002	0.005	0.369	0.712
Interactivity - > Perceived Enjoyment - > App Attitude - > Purchase Intention	0.031	0.033	0.02	1.594	0.111
Interactivity - > Perceived Enjoyment - > App Attitude - > User Satisfaction - > Continuous Use Intention	0.019	0.018	0.013	1.477	0.140
Interactivity - > Perceived Enjoyment - > App Attitude - > User Satisfaction - > Purchase Intention	0.011	0.01	0.008	1.342	0.180
Perceived Informativeness - > App Attitude - > Purchase Intention	0.071	0.079	0.049	1.438	0.151
Perceived Informativeness - > App Attitude - > User Satisfaction - > Continuous Use Intention	0.043	0.044	0.029	1.465	0.143
Perceived Informativeness - > App Attitude - > User Satisfaction - > Purchase Intention	0.024	0.023	0.019	1.273	0.203
Perceived Informativeness - > Utilitarian Value Perceived - > User Satisfaction - > Continuous Use Intention	0.119	0.123	0.045	2.641	0.008
Perceived Informativeness - > Utilitarian Value Perceived - > User Satisfaction - > Purchase Intention	0.067	0.069	0.037	1.801	0.072
Reality Congruence - > Decision Comfort - > Continuous Use Intention	0.154	0.164	0.068	2.264	0.024
Reality Congruence - > Decision Comfort - > Purchase Intention	0.237	0.248	0.073	3.268	0.001
System Quality - > App Attitude - >	0.075	0.078	0.047	1.571	0.117

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Table 8 (*continued*)

Mediation Path	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
Purchase Intention					
System Quality - > App Attitude - > User Satisfaction - > Continuous Use Intention	0.045	0.043	0.029	1.542	0.124
System Quality - > App Attitude - > User Satisfaction - > Purchase Intention	0.026	0.023	0.019	1.327	0.185
System Quality - > User Satisfaction - > Continuous Use Intention	0.189	0.182	0.054	3.527	0.000
System Quality - > User Satisfaction - > Purchase Intention	0.107	0.102	0.05	2.148	0.032

Purchase Intention (β = 0.043, p = 0.027) demonstrates the ability of AR features to foster hedonic value, which translates into favorable app attitudes and purchase decisions. The non-significant pathway Interactivity → Perceived Enjoyment → Hedonic Value Perception → App Attitude → Purchase Intention (β = 0.011, p = 0.201) suggests that interactivity's direct influence on hedonic value outweighs its indirect effects through enjoyment, possibly highlighting the immersive capabilities of AR. Moreover, perceived informativeness significantly influences utilitarian value perception, influencing satisfaction and continued use. The pathway Perceived Informativeness → Utilitarian Value Perception → User Satisfaction → Continuous Use Intention (β = 0.119, p = 0.008) points towards the practical benefits of AR in meeting functional consumer needs, contributing to satisfaction and long-term use. The pathways Reality Congruence → Decision Comfort → Purchase Intention (β = 0.237, p = 0.001) and Reality Congruence → Decision Comfort → Continuous Use Intention (β = 0.154, p = 0.024) possibly indicates how realistic AR features reduce uncertainty and enhance decision comfort, facilitating purchase decisions and sustained interactions. Furthermore, system quality plays a crucial role in facilitating user satisfaction and behavioral outcomes. The pathway System Quality → User Satisfaction → Continuous Use Intention (β = 0.189, p < 0.001) underscores the importance of seamless technical performance in driving continued use, while System Quality → User Satisfaction → Purchase Intention (β = 0.107, p = 0.032) highlights its indirect influence on purchasing intention.

In the non-AR setting (See Table 9) , the mediation pathways highlight specific dynamics influencing consumer behavior. For example, Interactivity → Perceived Enjoyment → Hedonic Value Perception → App Attitude → Purchase Intention (β = 0.111, p = 0.003) shows the role of enjoyment in shaping hedonic evaluations and driving purchasing decisions in the absence of immersive features. Similarly, Interactivity → Hedonic Value Perception → App Attitude → Purchase Intention (β = 0.072, p = 0.018) highlights the direct influence of hedonic constructs in fostering positive app attitudes and subsequent purchase intentions. Perceived informativeness emerges as an important variable in utilitarian pathways. Perceived Informativeness → Utilitarian Value Perception → User Satisfaction → Continuous Use Intention (β = 0.159, p = 0.011) reveals the importance of information-rich features in addressing satisfaction and sustained use. Additionally, Perceived Informativeness → App Attitude → Purchase Intention (β = 0.153, p = 0.034) indicates that informativeness strongly influences attitudes and purchasing behavior, more so in non-immersive environments where

Table 9
Mediation analysis: Non-AR condition.

Mediation Path	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
Interactivity - > Hedonic Value Perception - > App Attitude - > Purchase Intention	0.072	0.067	0.03	2.367	0.018
Interactivity - > Hedonic Value Perception - > App Attitude - > User Satisfaction - > Continuous Use Intention	0.018	0.018	0.013	1.325	0.185
Interactivity - > Hedonic Value Perception - > App Attitude - > User Satisfaction - > Purchase Intention	0.003	0.005	0.008	0.31	0.756
Interactivity - > Hedonic Value Perception - > User Satisfaction - > Continuous Use Intention	0.027	0.026	0.023	1.142	0.254
Interactivity - > Hedonic Value Perception - > User Satisfaction - > Purchase Intention	0.004	0.002	0.009	0.42	0.674
Interactivity - > Perceived Enjoyment - > Hedonic Value Perception - > App Attitude - > Purchase Intention	0.111	0.109	0.038	2.966	0.003
Interactivity - > Perceived Enjoyment - > Hedonic Value Perception - > App Attitude - > User Satisfaction - > Continuous Use Intention	0.028	0.029	0.02	1.352	0.177
Interactivity - > Perceived Enjoyment - > Hedonic Value Perception - > App Attitude - > User Satisfaction - > Purchase Intention	0.004	0.008	0.014	0.281	0.779
Interactivity - > Perceived Enjoyment - > Hedonic Value Perception - > User Satisfaction - > Continuous Use Intention	0.041	0.043	0.034	1.224	0.221
Interactivity - > Perceived Enjoyment - > Hedonic Value Perception - >	0.006	0.004	0.016	0.381	0.704

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Table 9 (*continued*)

Mediation Path	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/ STDEV|)	P Values
User Satisfaction - > Purchase Intention					
Interactivity - > Perceived Enjoyment - > App Attitude - > Purchase Intention	0.058	0.048	0.058	0.997	0.319
Interactivity - > Perceived Enjoyment - > App Attitude - > User Satisfaction - > Purchase Intention	0.002	0.004	0.01	0.214	0.830
Interactivity - > Perceived Enjoyment - > App Attitude - > User Satisfaction - > Continuous Use Intention	0.014	0.015	0.019	0.742	0.458
Perceived Informativeness - > App Attitude - > Purchase Intention	0.153	0.142	0.072	2.122	0.034
Perceived Informativeness - > App Attitude - > User Satisfaction - > Continuous Use Intention	0.038	0.041	0.033	1.156	0.248
Perceived Informativeness - > App Attitude - > User Satisfaction - > Purchase Intention	0.006	0.011	0.022	0.252	0.801
Perceived Informativeness - > Utilitarian Value Perceived - > User Satisfaction - > Continuous Use Intention	0.159	0.155	0.062	2.54	0.011
Perceived Informativeness - > Utilitarian Value Perceived - > User Satisfaction - > Purchase Intention	0.023	0.035	0.052	0.448	0.655
Reality Congruence - > Decision Comfort - > Continuous Use Intention	0.069	0.07	0.137	0.503	0.615
Reality Congruence - > Decision Comfort - > Purchase Intention	0.128	0.125	0.086	1.485	0.138
System Quality - > App Attitude - > Purchase Intention	0.159	0.151	0.056	2.863	0.004
System Quality - > App Attitude - > User Satisfaction - > Continuous Use Intention	0.039	0.041	0.029	1.343	0.180
System Quality - > App Attitude - > User Satisfaction - > Purchase Intention	0.006	0.011	0.02	0.286	0.775
System Quality - > User Satisfaction - > Continuous Use Intention	0.002	−0.002	0.05	0.032	0.974
System Quality - > User Satisfaction - > Purchase Intention	0.001	−0.008	0.02	0.012	0.991

practical evaluations dominate customer decision making process. System quality remains significant in shaping attitudes and purchase intentions, as evidenced by System Quality → App Attitude → Purchase Intention ($\beta = 0.159$, $p = 0.004$). However, its non-significant effect on continuous use intentions (System Quality → User Satisfaction → Continuous Use Intention, $\beta = 0.002$, $p = 0.974$) suggests that system quality alone may not drive sustained use without hedonic or immersive features.

6. Discussion

The above findings invite a critical reassessment of how MAR shapes consumer behavior in retail environments and offer confirmation and nuance to existing literature while also challenging certain assumptions. The positive impact of interactivity on perceived enjoyment and hedonic value perception is largely consistent with previous literature that emphasizes the role of user engagement in enriching consumer experiences. For example, Park and Yoo (2020) demonstrated that the controllability and playfulness of perceived interactivity shape mental imagery which subsequently influences their attitudes and behavioral intentions. The findings of this study align well with these conclusions, showing that interactivity in MAR can significantly elevate consumer satisfaction by enabling a more engaging environment (Kim et al., 2021; Kowalczuk et al., 2021). However, the strength of these relationships seems context-dependent, as evidenced by weaker effects in non-AR settings, suggesting that while interactivity itself is influential, its full impact is only realized within immersive AR experiences.

The mediation results further confirm that hedonic value perception play a significant role in linking interactivity to behavioral outcomes in both AR and non-AR contexts. In both settings, interactivity influenced purchase intentions indirectly through hedonic value perception and app attitudes. However, while these pathways were present in both conditions, the reliance on specific intermediary constructs differed. In AR settings, interactivity primarily operated through hedonic value perception and app attitudes. Thus, AR's immersive features inherently provided an enriched experience without requiring additional emotional reinforcement. In non-AR settings, perceived enjoyment became a more prominent intermediary construct, reflecting the need for emotional engagement to compensate for the lack of immersive features. This distinction suggests that while hedonic valued are critical across both contexts, the mechanisms through which interactivity influences outcomes vary based on the presence or absence of immersive technology.

In terms of system quality, the results reaffirm its significance in driving both affective and cognitive responses. Consistent with DeLone and McLean's (2003) model, the findings suggest that seamless system performance positively influences app attitudes and user satisfaction (David, Senn, Peak, Prybutok, & Blankson, 2021). The relationship was particularly pronounced in AR contexts, where consumers likely hold higher expectations for fluidity and responsiveness to maintain immersion (Yoo, 2020). Mediation pathways revealed that in AR settings, system quality's influence on continuous use intention and purchase intention is primarily mediated by user satisfaction, reaffirming its foundational role in shaping consumer behavior (Liao, Palvia, & Chen, 2009). However, in non-AR settings, system quality had minimal impact on these outcomes, suggesting that its importance diminishes in the absence of AR's immersive features.

The mixed results for perceived informativeness provide an interesting divergence from existing studies that have highlighted its significant influence on consumer attitudes in traditional retail settings (Holdack et al., 2022; Oyman et al., 2022). In the AR context, informativeness significantly enhanced utilitarian value perception but failed to directly influence app attitude, contrary to what was observed in non-AR settings. This finding may imply that the role of informativeness in shaping attitudes may be diminished by the stronger experiential elements of AR.

Building on this, the mediation results revealed that in both AR and non-AR settings, informativeness influences continuous use intention indirectly through utilitarian value perception. However, in non-AR settings, informativeness also plays a significant role in shaping attitudes and purchase intentions, demonstrating its dual functional and attitudinal influence. This finding contrasts with the AR context, where informativeness had a limited effect on attitudes, partially contradicting the findings of Qin, Osatuyi, and Xu (2021), who assert that informativeness directly shapes attitudes in AR settings. These results point to the context-dependent nature of informativeness, with its influence on attitudes being stronger in non-AR settings where the absence of immersive features shifts greater weight onto informational elements.

Moreover, reality congruence significantly influenced decision comfort, in line with the arguments of Kowalczuk et al. (2021). The consistency of this finding across AR and non-AR contexts reaffirms the importance of reality congruence in fostering decision comfort. However, the stronger effect observed in AR contexts suggests that realistic alignment is required when consumers lack physical touchpoints (Qin, Osatuyi, & Xu, 2021). The mediation analysis highlights the key role of decision comfort in connecting reality congruence with purchase intention and continuous use intention. This suggests that AR effectively recreates the assurance and trust often associated with in-store shopping, supporting better decision-making and sustained engagement.

The influence of affective responses, such as perceived enjoyment, on hedonic value perception and attitude towards the app was generally consistent with extant literature (Lee & Wu, 2017), but revealed context-specific variations. In non-AR settings, perceived enjoyment played a more significant role in influencing hedonic value compared to AR settings. The hedonic value perception findings were mixed, with significant effects on attitudes and satisfaction in non-AR environments but not in AR contexts. This contradiction with prior findings (Rauschnabel et al., 2019) implies that while hedonic value holds a significant influence in non-immersive environments, MAR's inherent capacity to engage consumers emotionally may reduce the additional impact of hedonic perceptions. Instead, AR environments seem to blend both hedonic and utilitarian benefits into a single immersive experience that might not require separate reinforcement from hedonic value.

The role of attitude towards the app in driving purchase intention and user satisfaction was supported in both AR and non-AR contexts, reaffirming the established link between positive user attitudes and behavioral outcomes (Iranmanesh et al., 2024). However, the difference in the strength of these relationships between AR and non-AR groups suggests that while positive attitudes are universally important, the mechanisms by which these attitudes translate into behavior may vary depending on the context.

Lastly, the study's examination of behavioral responses demonstrated significant differences between AR and non-AR contexts, highlighting AR's superior capacity to drive purchase intention and continuous use. This finding supports assertions made by Aslam and Davis (2024) and Butt et al. (2024), who noted that AR features significantly influence consumer behavior. The heightened predictive power of AR models indicates that the immersive and interactive features of MAR provide a distinct advantage in influencing both immediate and sustained consumer engagement, particularly in diverse socioeconomic contexts like India, where the adoption of such technology is still emerging (Manchanda & Deb, 2021).

7. Implications and limitations

7.1. Theoretical implications

This study offers notable theoretical contributions. First, it extends Holbrook and Hirschman's (1982) experiential hierarchy model by showing how MAR adds layers to consumer experiences. While the original model emphasizes emotional engagement through sensory input, this study shows AR enhances experiences without replacing affective responses like perceived enjoyment. For example, while AR interactivity increased perceived enjoyment (H1a), hedonic value did not significantly affect attitudes or satisfaction (H7). This suggests AR creates a complex mix of emotional and cognitive responses, where both remain essential. The immersive nature of AR may reduce the impact of traditional emotional factors, but they still influence satisfaction and purchase intention. This builds on the experiential hierarchy model by highlighting AR's need for a balance between emotional enjoyment and practical value, as reflected in the significant role of utilitarian value perception.

Second, this study extends the consumer response model devised by Kowalczuk et al. (2021), which established AR's superiority over web-based presentations in fostering immersion and enjoyment. While Kowalczuk et al. (2021), emphasized media usefulness, this research shows the reduced influence of perceived informativeness in AR contexts. AR's immersive sensory engagement tends to overshadow the role of practical information in shaping consumer attitudes, which suggest that traditional cognitive drivers like informativeness play a smaller role in highly immersive AR experiences.

Finally, this research advances generic technology adoption theories by highlighting the interaction between cognitive and affective responses in MAR contexts. While traditional models like the technology acceptance model (Venkatesh and Davis, 2000) prioritize utilitarian factors such as perceived usefulness, this study demonstrates the influence of affective responses, for example perceived enjoyment and hedonic value, in shaping behavioral responses. The study compares AR and non-AR contexts to show how AR uniquely enhances satisfaction, purchase intention, and continuance intention, contributing to a deeper understanding of how emerging technologies reshape consumer experiences.

7.2. Note to practitioners

This study highlights MAR's immense potential in retail. However, implementing its insights requires careful consideration. While AR enhances consumer satisfaction and purchase intention, leveraging these benefits comes with challenges. AR's interactivity enhances perceived enjoyment, but it is important to balance complexity and accessibility (Olsson, Lagerstam, Kärkkäinen, & Väänänen-Vainio-Mattila, 2013). Retailers must design AR experiences that engage users without overwhelming less tech-savvy consumers. Complex interfaces may alienate users, while overly simple designs could undermine AR's immersive potential (Cao et al., 2023).

The mediation results further emphasize the critical role of system quality in driving satisfaction and sustained usage in AR environments. High-performance AR systems meet heightened consumer expectations for seamless operation and responsiveness, but achieving this requires considerable investment in technological infrastructure (Parekh, Patel, Patel, & Shah, 2020). Lessons can be drawn from industries like fashion, where virtual fitting rooms succeed only when backed by personalized, reliable and efficient platforms that support consistent, high-quality user experiences (Batool & Mou, 2023).

The study also shows how AR shifts the balance between hedonic and utilitarian values. Unlike traditional retail where emotional appeal often drives engagement, AR blurs the line between enjoyment and practicality. Retailers should adopt a more balanced approach, customizing strategies to their product categories and consumer segments. Luxury brands may continue to emphasize AR's emotional aspects, while more utilitarian brands could focus on highlighting practical features like product customization.

The role of reality congruence adds another layer of complexity to managerial decision-making. Realistic AR simulations were shown to significantly enhance decision comfort, but inaccuracies can undermine satisfaction and trust. Retailers must invest in ensuring their AR features align with real-world expectations to maintain credibility (Tan et al., 2022). Moreover, the distinct roles of informativeness in AR versus non-AR environments suggest that marketing strategies need to be tailored. AR platforms should prioritize immersive and engaging experiences, while non-AR platforms should highlight practical, information-rich features to meet consumer needs. A uniform approach risks underutilizing AR's unique strengths and may fail to address varying consumer expectations across different platforms.

Finally, the findings also demonstrate the importance of reducing cognitive overload in AR implementations. While AR enhances confidence and purchase intentions, poorly executed systems can overwhelm users. Retailers must provide clear, user-friendly guidance on AR functionalities to simplify decision-making and ensure the technology serves as an enabler rather than a barrier to purchasing (Xue et al., 2023). Mediation results demonstrate that while immersive experiences drive satisfaction and behavioral outcomes in AR, practical elements like perceived informativeness remain crucial in non-AR settings, necessitating a dual-focus strategy to optimize consumer engagement.

7.3. Limitations and directions for future research

This study has several limitations that warrant consideration. First, the sample was limited to female consumers aged 18 to 30, which restricts the generalizability of the findings. Future research could extend the investigation to more diverse demographic groups, including older consumers or those less familiar with AR technology.

Second, this study focused on beauty products and a specific app (TIRA). This approach allowed for controlled experimentation. Future research could explore the impact of MAR on a wider range of product categories. It could also examine items with stronger utilitarian value such as electronics or furniture. This would help uncover how the balance between hedonic and utilitarian value shifts across product types.

Third, the study relied on self-reported measures of consumer behavior. This approach may introduce bias. Future research could include objective data such as purchase behavior or app usage metrics. This would complement self-reported data and provide a broader view of consumer responses to AR. The experimental design focused only on short-term interactions with MAR. Future studies could investigate the long-term effects of AR on consumer behavior. Moreover, longitudinal studies would provide greater insight into how MAR influences consumer behavior over time and whether initial engagement leads to sustained interactions.

Lastly, this study did not account for potential moderating variables such as consumer technology readiness or individual differences in cognitive styles. Future research could investigate how these factors influence the effectiveness of AR features and provide a more nuanced understanding of how different consumers engage with MAR.

CRediT authorship contribution statement

Lingam Naveen: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Md Irfanuzzaman Khan:** Writing – review & editing, Writing – original draft, Validation, Resources, Methodology, Formal analysis, Conceptualization. **Md Abu Saleh:** Writing – review & editing, Writing – original draft, Validation, Methodology, Investigation, Formal analysis, Data curation. **Rabi Narayan Subudhi:** Writing – review & editing, Writing – original draft, Validation, Supervision, Methodology, Conceptualization.

Declaration of competing interest

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

Data availability

Data will be made available on request.

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