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Shopping in Another Dimension: What Keeps Customers Coming Back to Mobile AR?

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ABSTRACT

Adopting Taylor and Todd's "decomposed theory of planned behavior" as a theoretical framework, this study examines the key factors influencing users' intention to use Mobile Augmented Reality applications for shopping activities. A structural equation modeling approach, utilizing the SmartPLS software version 4.0.9.4, was employed to empirically test the research hypotheses. 261 responses were collected through the survey questionnaire. The results of the study indicate that users' attitudes, social norms, and perceived behavioral control are significant determinants of user intention to continue using mobile augmented reality applications. Furthermore, interactivity, perceived mobility, and trust positively influenced users' attitudes toward mobile augmented reality applications. The study provides insights into the essential factors affecting users' intentions to continue using MAR applications for shopping. Drawing from the study's findings, developers of mobile augmented reality applications should prioritize offering quick and stable interactive platforms for virtual product try-ons. The current research adds to the body of knowledge regarding both the DTPB and MAR. Firstly, the study applies the DTPB framework to understand user continuance intention in the context of mobile augmented reality shopping applications. It extends the application of DTPB to a relatively new technological domain.

Keywords: Mobile Augmented Reality, Technology Adoption, Decomposed Theory of Planned Behaviour, Perceived Mobility, Facilitating Conditions

JEL Classifications: M31, O33

1. INTRODUCTION

The retailing industry is currently anticipating nothing less than a revolutionary shift in the online shopping landscape due to the upcoming technical developments. Marketers now persuade customers with immersive and inspiring virtual try-ons (Try before you buy), known as augmented reality marketing (Xu et al., 2024). These MAR applications are designed to enhance customer experiences in the online consumer journey by real-time integration of virtual products with camera inputs (Jung et al., 2021) and foster a sense of immersion experience across diverse touchpoints in the customer journey (Towers and Towers, 2022). Moreover, prominent technology conglomerates have integrated MAR services into their business activities (Kowalczuk et al., 2021). Examples of such applications include virtual mirrors used by Swarovski and LaCoste, which are screens that enable users to see themselves adorned in virtual attire (Beck and Crié, 2018), furniture planners by IKEA (applications that facilitate the visualization of furniture within one's living space), Wholesale Giants such as amazon and Flipkart use augmented reverse image search and virtual make-up trials by L'Oréal and Sephora (Berman and Pollack, 2021).

Augmented reality technology was previously limited to specific augmented reality devices and desktops. However, technological advancements have enabled smartphones, with their increased computational capabilities, to support augmented reality applications effortlessly (Kalia et al., 2022). 5G technology has

further enhanced the potential of smartphones, with reduced latency and increased bandwidth (Taylor, 2024). As a result, smartphones have become an essential tool for brands to engage with consumers through MAR applications (Rauschnabel et al., 2022).

A growing body of practitioner-focused publications (India Augmented Reality and Virtual Reality Market, Demand and Growth, BlueWeave, 2022; Alsop, 2024), as well as recent scholarly work, already demonstrate the effectiveness of augmented reality in marketing (Hilken et al., 2017). Prior studies mainly focused on augmented reality technological attributes, including interactivity, vividness, novelty, and environmental embedding in creating hedonic and utilitarian experiences resulting in consumer behavioral decision-making (Saleem et al., 2022; Pantano et al., 2017; Alcañíz et al., 2019; Agustini et al., 2023; Jin-Feng and Dong, 2022). However, consumers have used AR applications for more hedonic purposes than utilitarian ones (Chen et al., 2022; Panhale et al., 2023). Consequently, there is a noticeable gap in the literature examining individual psychological characteristics that influence adoption behavior (Kumar, 2022). Trust in the E-vendor is a prerequisite for utilizing the application and promoting its adoption (Kalia et al., 2022). Despite the advantages of such cutting-edge technologies, they can induce anxiety in individuals due to various data security concerns (Arghashi, 2022). The level of trust and technological concerns are the primary factors of MAR application adoption that necessitate additional research (Yim and Park, 2019; Bhattacherjee, 2001). For augmented reality to have a subsequent effect on consumer purchase intent, the customer's continued adoption intent is required (Yim and Park, 2019; Chen et al., 2022). Identifying the factors leading to the continued adoption of such technologies has acquired importance in both the practical and academic realms. However, a dearth of comprehensive research on the continued use of MAR exists.

This study contributes to both academic and practical domains. From a theoretical perspective, it examines the impact of augmented reality features and individual psychological attributes, identified as crucial determinants for adopting mobile augmented reality applications, thereby expanding the augmented reality literature. The study employs the decomposed theory of planned behavior to investigate MAR application adoption, validating the utility of this framework in the augmented reality context. Furthermore, while prior studies on augmented reality have primarily focused on developed economies (Alam et al., 2021; Yavuz et al., 2021; Saprikis et al., 2020), this research provides insights into a developing economy like India, where sociocultural variables may differ in their importance for adoption. For system developers, this study offers an understanding of the attributes of augmented reality applications, which is crucial given the significant budgets involved in designing and developing MAR applications. The findings will assist MAR application developers and marketers in formulating strategies that leverage the appropriate MAR features and psychological variables to enhance the adoption of these applications. The study addressed two research questions:

RQ 1: Do attitude, subjective norms, and perceived behavioral control affect the continuance intention of MAR applications for shopping purposes?

RQ 2: Do technological features and psychological traits influence attitude, subjective norms, and perceived behavioral control as antecedents?

The study is structured in three sections. The first section proposes the research model and outlines the research hypotheses. The proposed model is tested using structural equation modeling in the second section. The third section discusses the study's findings and its practical and theoretical implications.

2. DEVELOPMENT OF THE RESEARCH MODEL AND HYPOTHESES

2.1. Decomposed Theory of Planned Behaviour (DTPB)

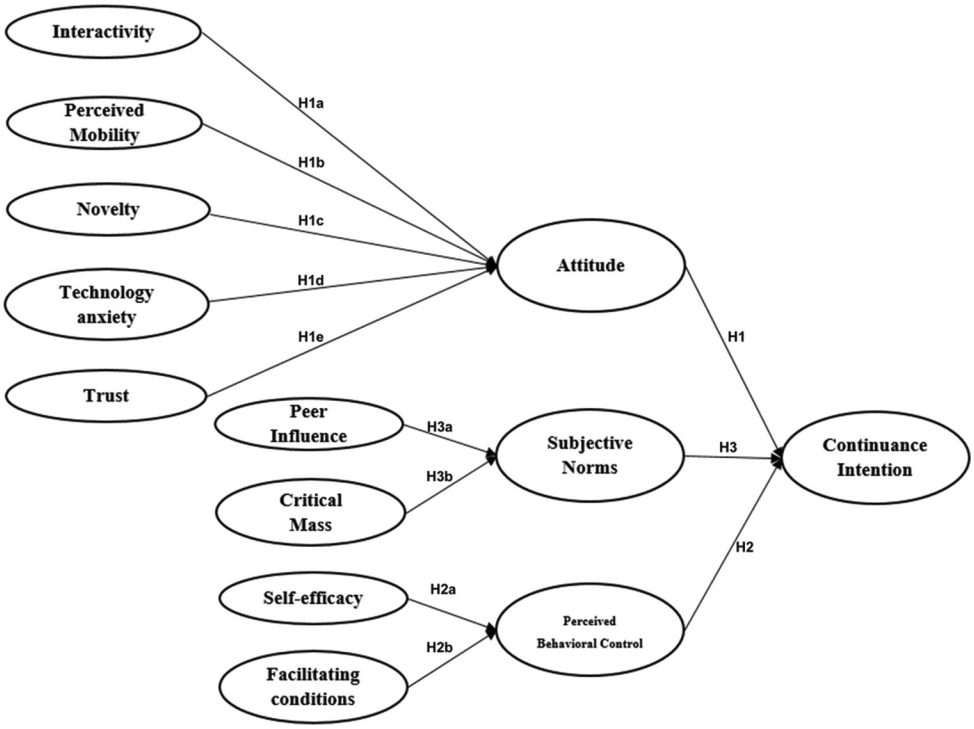
The success of a new technology in the market depends on consumer acceptability (Holdack et al., 2022; Rese et al., 2017). Most relevant studies have used TAM and the Theory of Planned Behavior (TPB) as underpinning theories to identify factors affecting AR adoption behavior (Alzahrani et al., 2017; Hung et al., 2021). A key advantage of the Theory of Planned Behavior as a conceptual framework is that its three antecedent variables of behavioral intention can explain a significant portion of the variance in actual behavior.

However, Rise et al. (2010) concluded in a systematic review that variables only account for 40% of behavior explained. The explanatory power can be increased by adding extra variables; two strategies are typically used. The first method calls for adding variables to the model's original three variables. The explanatory strength of the model is increased with the addition of variables, but the model's generality is compromised (Ajzen, 1991). As a result, a second approach to TPB adaptation is to explore the antecedent elements that drive TPB's three predictor variables. The Decomposed Theory of Planned Behaviour method, which examines people's attitudes toward an innovation (Taylor and Todd, 1995), illustrates this approach used in our study. In the literature, Decomposed theory of planned behavior has been mainly used to examine the consumers' behavioral intention in different contexts like purchase intention, satisfaction, and adoption behavior (Moons and De Pelsmacker, 2015; Nyasulu and Dominic Chawinga, 2019; Al-Ghaith, 2016). DTPB was used to analyze users' intentions for continued use of novel information services such as online banking (Nasri and Charfeddine, 2012), online shopping (Lin, 2007), and user intention to play online games (Sharma et al., 2020) and continue using virtual worlds (Mantymaki et al., 2014). In addition, it demonstrated that continuation intention is positively and significantly associated with the TPB model's fundamental constructs (ATT, SN, and PBC) (Kuo and Hsu, 2022; Zhu et al., 2014; Qin, et al., 2021). In line with the research mentioned above, this study is based on the decomposed theory of planned behavior, which measured the association between DTPB Predictors (ATT, SN, and PBC) and user adoption behavior, as well as technological features and psychological traits affect ATT, SN, and PBC as antecedents. Table 1 conceptualizes all the prior research conducted in the AR area. Based on the discussed literature, the following hypotheses were proposed (Figure 1):

Table 1: Comparative review of existing studies

Authors and year	Independent variable	Mediators	Moderators	Outcome variables
(McLean and Wilson, 2019a)	AR attributes, TAM variables			Consumer satisfaction, Usage intention
(Rauschnabel et al., 2019)	Augmentation Quality, Utilitarian and Hedonic experience	inspiration		Attitude towards the brand
(Hsu et al., 2021b)	Informative, intrusiveness, personalization, and interactivity	Utilitarian and hedonic value		Usage intention
(Nikhashemi et al., 2021)	AR attributes,			Continues intention, Premium pricing
Arghashi (2022)	Novelty, wow-effect, inspiration		hedonic shopping motivation	purchase intention
(Chen et al., 2022)	Sense, fell, act and relate experience	AR marketing activities		Continuance intention, purchase intention, customer engagement
(Vo et al., 2022)	Immersive experience, attitude towards AR apps		Technology anxiety	Adoption intention
(Oyman et al., 2022)	Consumer novelty seeking, technology anxiety			Behavioural intention to use
Current study	Attitude beliefs, perceived behavioral control, subjective norms			Continuance intention

Figure 1: Conceptual model



H_1: Attitude positively influences user's continuance intention towards MAR apps.

H_2: Subjective norms positively influence the user's continuance intention towards MAR apps.

H_3: Perceived behavioral control positively influences the user's continuance intention towards MAR apps.

The next part provides an in-depth explanation of the MAR constructs within the context of the user's continuance intention.

2.2. Deconstruction of Attitude Beliefs

Under the TPB, attitude is the primary factor influencing behavioral intention (Ajzen, 1991). Attitude can be considered a significant predictor and descriptor of human behavior (Ajzen, 1991). Prior research has examined the relationship between the technological features of augmented reality applications and user attitudes (Feng and Xie, 2019; Kumar, 2022; Rese et al., 2017). Psychological attributes important for technology adoption have not been studied in the context of AR adoption (Kumar, 2022). Therefore, this study disintegrated users' attitudes into AR features (Interactivity, Novelty, Perceived mobility) and psychological factors (technology anxiety and Trust).

In terms of augmented reality applications, interactivity refers to the ability of applications to engage consumers with a wide range of content and actively participate in real-time with the interface (Bigne et al., 2024). Interactivity as a feature of AR devices leads to sustainable relationship behaviour (Yim and Park, 2019; Park and

Yoo, 2020). Higher interactivity further leads to user immersion experience due to their enhanced control of virtual experience (Jongmans et al., 2022; Yim et al., 2017). In contrast to conventional two-dimensional visual representations, mobile augmented reality devices offer users a virtual 360° rotational capability, which provides enhanced realism in product or environmental depiction, more detailed and vivid imagery, and faster information transmission (Barhorst et al., 2021). Interactivity is an antecedent to hedonic and utilitarian customer experience and positively influences consumer engagement and continuance intention (Chen et al., 2022; Carrozzi et al., 2019). Prior research posits that interactivity significantly affects user attitude (Kumar, 2022). Providing users with a more interactive experience in augmented reality applications facilitates the acquisition of information about products or services through virtual displays, object placement, and immersive features (Nikhashemi et al., 2021). It subsequently leads to diverse and memorable consumer experiences. Therefore, we propose the following hypothesis:

H_{1a}: Interactivity with MAR applications positively influences user attitude.

Novel or unusual stimuli that users perceive as unique or new are considered the novelty of a mobile augmented reality application (Rise et al., 2010). This novelty attribute has been found to have a significant positive effect on the perceived enjoyment and pleasure experienced by users of the MAR application (Nikhashemi et al., 2021). Initial AR virtual trials stimulate novelty, positively influencing continued usage intention. Researchers have established a strong relationship between novelty, consumer product evaluation, and purchase decisions (Javornik et al., 2021; Rese et al., 2017). Consequently, the media novelty effect of an augmented reality application diminishes over time as the user interacts with it (Manis and Choi, 2019). Based on the discussed literature, the following hypothesis have been proposed:

H_{1b}: Novelty of MAR applications positively influences user attitude.

The perceived mobility of services reflects their accessibility and availability across different times and locations (Groeppel-Klein and Koenigstorfer, 2007; Seppälä and Alamäki, 2003). Mobile technology enables ubiquitous access to information and services, enriching user experience (Noguti and Waller, 2020). The mobility of devices fosters a sense of connectivity and influences user experience Park et al. (2014). Mobility is a key feature of mobile augmented reality applications that enables users to access a wide range of information and services at different places and times (Phon et al., 2013). Previous studies have found that perceptions of mobility positively impact user attitudes and adoption of mobile technologies (Mokbel et al., 2023; Gao et al., 2009; Brewer and Dourish, 2008). The mobility of MAR devices is an essential feature that influences the user experience, owing to its available trial, irrespective of place. Thus, we suggest the following hypothesis:

H_{1c}: Perceived Mobility of MAR applications positively influences user attitude.

Technology anxiety refers to the emotional state experienced by individuals characterized by restlessness, worry, or fear when engaging with modern technological devices (Oyman et al., 2022). Contact with technology can impact various aspects of users' lives, including their social interactions, learning abilities, and emotional well-being (Ibili et al., 2019). Adoption and utilization of new technologies are low among individuals with high technology anxiety (Li and Xu, 2020). The experience of anxiety is heightened in those who initially engage with emerging technologies (George Saadé and Kira, 2009). Technological anxiety leads to negative emotional responses, including unfavorable user perception, limited interaction, and slower adoption of augmented reality (AR) technology (Dogra et al., 2023). Based on the discussed literature, the following hypothesis have been proposed:

H_{1d}: Technology anxiety of MAR applications negatively influences user attitude.

Trust refers to a customer's level of assurance and conviction in a seller (Wilson et al., 2016; Harrison McKnight et al., 2002). Consumers' level of trust in a seller's website shapes their relationship with the seller, subsequently impacting their purchase decisions (Kim and Ahn, 2007; Nelson and Kim, 2021). In the context of mobile augmented reality applications, users' perception of trust in the technology is a crucial determinant of their attitude and usage behavior (Al-Dwairi and Kamala, 2009). If individuals perceive the MAR technology as unreliable or untrustworthy, they are less likely to use it regularly. Online shoppers often experience feelings of insecurity and uncertainty when using e-commerce websites (Hao Suan Samuel et al., 2015; Fu et al., 2023). Trust in the vendor is a prerequisite condition for any technology adoption (Tam et al., 2019; Kim and Peterson, 2017). Prior research has demonstrated that trust is vital in online and traditional purchasing contexts, influencing consumer satisfaction (Soleimani, 2021). Based on the following discussion, we propose the following hypothesis:

H_{1e}: Trust in MAR applications positively influences user attitude.

2.3. Deconstruction of Perceived Behavioural Control

PBC refers to the consumer's belief about their ability to perform a desired activity (Ajzen, 1991) successfully. Perceived behavioral control comprises two constituent elements.

The first element of perceived behavioral control is facilitating conditions, which refer to the availability of essential resources, such as financial, temporal, and other necessary resources, required to engage in a desired behavior (Jensen et al., 2002). The second element is self-efficacy, which represents an individual's belief in their ability to successfully perform a particular behavior (Bandura, 1977). Consumers with high levels of PBC are more likely to exhibit a strong intention to engage in the target behavior and are more likely to act on that intention (Indawati et al., 2022; Sussman and Gifford, 2018). In the context of MAR applications, PBC would reflect consumers' confidence in their ability to use the technology and the availability of facilitating conditions required. Several studies have supported the idea that self-efficacy and facilitating situations influence individuals' perceived behavioral control (George, 2004; Huang et al., 2007; Nasri and Charfeddine, 2012). Consumers who believe they have the necessary skills, resources, and opportunities to use MAR applications will be more likely to form a positive intention to use them. Based on the discussed literature, the following hypothesis have been proposed:

H_{2a}: Self-efficacy in using MAR applications positively influences perceived behavioral control.

H_{2b}: Facilitating conditions for using MAR applications positively influence perceived behavioral control.

2.4. Deconstruction of Subjective Norms

Subjective norm is the outcome of one's feelings towards the perceptions of others (family, friends, co-workers, and other agents) regarding one's behavior and the significance placed on it personally (Ajzen, 2020). Subjective norms have been deconstructed into peer influence as normative views and perceived critical mass as descriptive views. The concept of "critical mass" was proposed by Oliver and Marwell (1988), which is one of the fundamental causes that contribute to collective behaviors. In this regard, it was discovered that when people believe there is a critical mass of users, they start to recognize the usefulness of interactive media systems and use them (Geber et al., 2019; Lou et al., 2000). In online shopping, majority acceptance determines the social acceptance of emerging technologies (Hsu and Lu, 2007). Peers influence individuals as a reference group due to their shared interests and values (Hu et al., 2019). Additionally, previous studies have demonstrated that peer influence and critical mass strongly relate to subjective norms (Hartshorne and Ajjan, 2009; Fan et al., 2022). Based on the discussed literature, the following hypothesis have been proposed and the conceptual Diagram is shown in Figure 1:

H_{3a}: Peer influence of MAR applications positively influences subjective norms.

H_{3a}: Perceived critical mass of MAR applications positively influences subjective norms.

3. METHODS

3.1. Sample Statistics and Survey

The study was conducted in North India, specifically in the Delhi NCR region and urban areas of Punjab and Haryana states, due to the significant potential of the growing market in the country (Dogra et al., 2023). A multi-stage sampling approach was employed, where cities were purposefully selected based on their level of urbanization, and then convenience sampling was used to gather data from respondents. A qualifying question ensured that only individuals with prior experience with augmented reality-based virtual try-on applications for apparel and cosmetics on mobile devices were included in the further survey. Initially developed in English, the questionnaire was translated into Hindi and Punjabi using a back-translation technique to accommodate the diverse linguistic landscape. Data collection took place between October and December 2024, and a five-point Likert scale was utilized to record the responses, ranging from "highly disagree" to "highly agree." The survey items were derived from previous scales with minor modifications. 341 replies were obtained from the online survey, with 80 considered invalid due to missing essential information. Hence, 261 responses that exhibited comprehensiveness were chosen for further examination and interpretation. The appropriate sample size was found using G*Power software, with a power of 0.80 (Faul et al., 2009). The minimal sample size required at a significance level of 5% was 160. Hence, our sample of 261 was considered appropriate. A pilot study was undertaken to evaluate the survey instrument's dependability employed in the research, with the participation of 30 consumers of the MAR application in the validation process. Non-response bias was checked by employing Kolmogorov-Smirnov (K-S) on two groups of collected data, namely early and late respondents. The distributions of both groups were compared, and no significant difference was observed (Ryans, 1974). Thus, the outcome signifies the absence of non-response bias in the collected data. The detailed demographics are given in Table 2.

4. DATA ANALYSIS

Partial least square (PLS) structural equational modeling (SEM) Structural equation modeling was used in the current study to study the impact of MAR attributes, technology anxiety, and trust resulting in positive or negative consumer attitudes as well as subjective norms and perceived behavioral control on "users" continued intention to utilize MAR applications. PLS-SEM was preferred in the study because of its exploratory nature. Additionally, the data thus collected from the respondents was found to be non-normal. Due to increasing the sample size constraints, PLS-SEM was used to obtain a sufficient power of 0.80 (Goodhue et al., 2012). The data sample was at par with the requirements for applying partial least squares in the study. To analyse the collected data, SmartPLS software version 4.0 was used.

4.1. Multi Collinearity

The presence of CMB was checked by analyzing the variance inflated factor (VIF). As per the recommended values, the VIF values of the inner model should be <5. The values of VIF, as shown in Table 3, are below 5, representing the absence of common method bias in the data.

4.2. Measurement Model

The measurement model was employed to evaluate the reliability and validity of the constructs. To ensure reliability, Cronbach's alpha and composite reliability were assessed, and the values for these metrics surpassed the recommended threshold of 0.7, corroborating the instrument's reliability (Mohamad et al., 2015).

Table 2: Demographic profile of respondents

Distribution (n=393)	Frequency	Percentage
Gender		
Male	109	41.7
Female	152	58.3
Age		
22 or younger	105	40.2
22-29	97	37.1
30 or older	59	22.6
Education		
Up to 12th	34	13
Up to bachelors	185	70.1
Above bachelors	42	16.9
Income per annum (in hundred thousand rupees)		
<1	28	10.7
1-3	65	24.9
3-5	102	39
More than 5	66	25.2

To establish convergent validity, the average variance extracted for each construct was calculated, and all values exceeded the recommended threshold of 0.5, indicating that the items converged well on their respective constructs (Yavuz et al., 2021). Additionally, the factor loadings of all items were above the recommended value of 0.7, further supporting convergent validity.

Cross loadings and Fornell and Lacker criteria were used to examine discriminant validity. Cross-loading of each statement should be <0.4 as compared to the respective loading of the construct, and all the diagonal values (square root of AVE) should be greater than the values in the lower matrix (Hair et al., 2014; Henseler et al., 2009). Both conditions were fulfilled, ensuring validity and reliability (Tables 3 and 4).

Table 3: Variance inflation factor

Items	Loadings	Cronbach's alpha	CR	AVE	VIF
ATT1	0.991	0.989	0.992	0.978	2.6
ATT2	0.994				
ATT3	0.981				
CM1	0.828	0.743	0.85	0.892	1.001
CM2	0.922				
CM3	0.899				
CUI1	0.95	0.939	0.952	0.833	-
CUI2	0.881				
CUI3	0.923				
CUI4	0.895				
FC1	0.827	0.716	0.879	0.978	1.01
FC2	0.901				
FC3	0.781				
I1	0.751	0.751	0.844	0.945	1.05
I2	0.784				
I3	0.869				
N1	0.961	0.964	0.973	0.9	1.04
N2	0.954				
N3	0.937				
N4	0.942				
PBC1	0.978	0.975	0.982	0.931	3.7
PBC2	0.966				
PBC3	0.986				
PBC4	0.929				
PI1	0.864	0.594	0.769	0.899	1
PI2	0.824				
PI3	0.876				
PM1	0.744	0.972	0.876	0.978	1
PM2	0.897				
PM3	0.79				
PM4	0.823				
SE1	0.789	0.646	0.73	0.812	1.01
SE2	0.984				
SE3	0.934				
SE4	0.764				
SE5	0.776				
SE6	0.799				
SN1	0.928	0.941	0.962	0.894	1.1
SN2	0.964				
SN3	0.945				
TE1	0.793	0.739	0.788	0.854	1.1
TE2	0.812				
TE3	0.965				
TE4	0.803				
trst1	0.985	0.971	0.976	0.912	1.02
trst2	0.975				
trst3	0.903				
trst4	0.955				

Table 4: Reliability and validity

	Attitude	Critical mass	CUI	Facilitating conditions	Interactivity	Novelty	Perceived behaviour control	Peer influence	Perceived mobility	Self-efficacy	Subjective norms	Technology anxiety	Trust
Attitude	0.989												
Critical mass	0.1	0.944											
CUI	0.057	0.098	0.913										
Facilitating conditions	0.233	0.153	0.125	0.989									
Interactivity	0.103	0.092	0.051	0.291	0.972								
Novelty	0.175	0.193	0.09	0.048	0.002	0.949							
Perceived behaviour control	0.987	0.083	0.055	0.235	0.123	0.208	0.965						
Peer influence	0.114	0.032	0.213	0.102	0.113	0.149	0.101	0.948					
Perceived mobility	0.141	0.068	0.093	0.119	0.039	0.021	0.161	0.156	0.989				
Self-efficacy	0.207	0.13	0.085	0.115	0.315	0.076	0.231	0.186	0.013	0.901			
Subjective norms	0.142	0.183	0.093	0.082	0.058	0.91	0.18	0.166	0.029	0.099	0.946		
Technology anxiety	0.31	0.043	0.039	0.192	0.216	0.189	0.297	0.022	0.011	0.263	0.173	0.924	
Trust	0.103	0.143	0.392	0.034	0.032	0.024	0.103	–0.05	0.04	0.054	0.061	0.105	0.955

4.3. Structural Model

After ensuring validity and reliability, hypothesis testing was done by assessing the structural model with 5,000 iterations (Hair et al., 2017).

The results presented in Table 5 corroborate the empirical support for the hypothesized relationships. All hypotheses were accepted, except for four which were not supported. The data analysis indicates that users' attitudes, subjective norms, and perceived behavioral control are significant determinants of their intention to continue using mobile augmented reality applications, thereby substantiating hypotheses H_1, H_2, and H_3. Among these factors, user attitude emerges as the strongest predictor of continued intention to utilize mobile augmented reality applications, followed by the influences of subjective norms and perceived behavioral control.

Table 5: Path coefficients

Path	Beta	T statistics (|O/STDEV|)	Support
ATT->CUI	0.596	9.675	Accept
CM->SN	0.327	10.567	Accept
FC->PBC	0.108	0.894	Reject
I->ATT	0.453	5.456	Accept
N->ATT	0.112	1.146	Reject
PBC->CUI	0.293	5.789	Accept
PI->SN	0.021	1.248	Reject
PM->ATT	0.431	10.344	Accept
SE->PBC	0.206	9.768	Accept
SN->CUI	0.202	8.678	Accept
TE->ATT	0.054	1.450	Reject
TRST->ATT	0.433	4.565	Accept

Furthermore, the constructs "interactivity," "perceived mobility," and "trust" demonstrate significant positive effects on users' attitudes toward MAR applications. This validates hypotheses H_{1a}, H_{1b}, and H_{1e}. In contrast, the hypotheses H_{1c} and H_{1d} were not supported, as the constructs of "Technology Anxiety" and "Novelty" were found to have an insignificant relationship with users' attitudes toward mobile augmented reality applications.

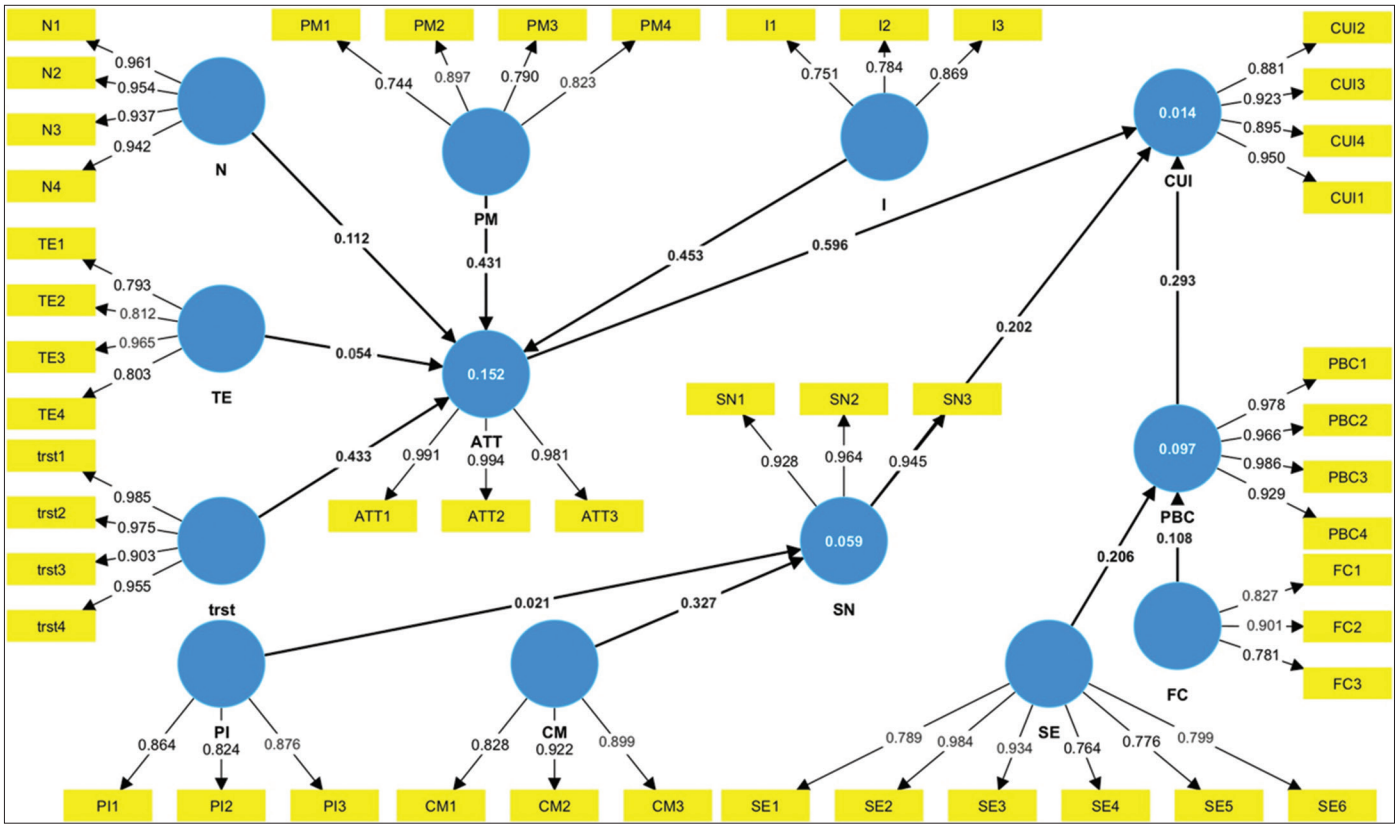
The findings shown in Figure 2 (Structural Model) indicate that the perceived critical mass of users significantly and positively influences users' subjective norms regarding mobile augmented reality applications, supporting hypothesis H_{2b}. In contrast, the construct of peer influence was found to have an insignificant impact on subjective norms, leading to the rejection of hypothesis H_{2a}. Additionally, the data analysis demonstrates that the construct of self-efficacy has a significant positive effect on users' perceived behavioral control of MAR applications, thereby corroborating hypothesis H_{3a}.

However, the construct "facilitating conditions" relationship with users' perceived behavioral control of MAR applications was found to be extremely weak and statistically insignificant.

5. DISCUSSION

The study aimed to determine the key drivers of mobile augmented reality application usage and intention to continue. The proposed conceptual framework includes the technological and psychological attributes of MAR applications. It examines its relation with user' attitude and their subsequent influence

Figure 2: Structural model



on individuals' continued intention to utilize mobile augmented reality applications.

In line with the findings of previous studies (Jing et al., 2019), the current research validates that users' attitudes, subjective norms, and perceived behavioral control are significant determinants of their intention to continue using mobile augmented reality applications for shopping. Specifically, user attitude emerged as the strongest predictor of continued intention to utilize mobile augmented reality applications, followed by the influences of subjective norms and perceived behavioral control.

Attributes like interactivity, perceived mobility, and trust positively influence user's attitudes toward MAR apps, and these findings align with previous studies of AR devices (Chen et al., 2022; Hilken et al., 2017; Yim and Park, 2019a; Plotkina and Saurel, 2019). This implies that app developers and service providers should focus on enhancing the interactive experience of their AR apps, improving the ubiquity and accessibility of the AR services, and building robust trust mechanisms to foster a positive user attitude, leading to sustained usage intentions. Technology anxiety has no significant negative effect on user attitudes, contrary to the findings of previous studies conducted by (Dogra et al., 2023; Ibili et al., 2019). The novelty did not have a significant effect on user attitude. The user initially uses MAR applications for hedonic purposes because it is a new technology, and novelty is a significant factor initially. Still, as its effect diminishes over time, novelty no longer exerts a significant influence.

The study also highlights the importance of subjective norms, with the perceived critical mass of users emerging as a key driver. However, peer influence does not significantly impact subjective norms; peer influence (H_{2a}) did not significantly impact subjective norms in this study, which contradicts the findings by Hung et al. (2021). It's possible that because MAR applications are used individually, users are not influenced by their peers because there is no social platform for AR try-ons. This suggests that service providers should emphasize creating a critical mass of AR app users, as the perception of widespread adoption can positively influence the social acceptability and continued usage of these apps. The role of perceived behavioral control is also noteworthy, with self-efficacy playing a significant part. It indicates that users' belief in their ability to use AR apps effectively is a key determinant of their continued usage intentions.

The findings of this study offer valuable insights for AR app developers and service providers to devise effective strategies for promoting long-term user engagement with mobile augmented reality applications. Service providers can nurture a positive ecosystem and drive sustained usage of mobile augmented reality applications by addressing the key determinants identified in this research, such as enhancing interactive experience, improving mobility, building trust, and fostering a critical mass of AR users.

5.1. Theoretical Contribution

The current research adds to the body of knowledge regarding both the DTPB and MAR. Firstly, the study applies the DTPB framework to understand user continuance intention in the context of mobile augmented reality shopping applications. It extends the application of DTPB to a relatively new technological domain.

The findings show that all three TPB variables significantly impact user continuation adoption of MAR applications. However, "all the fingers are not equal" as attitude is more influential, followed by subjective norms and perceived behavioral control (Table 3). The second significant contribution of this study is establishing a positive relation between trust, interactivity, perceived mobility, and user attitude. Also, technology anxiety does not negatively influence user attitude. Thirdly, the study confirms that critical mass substantially impacts MAR applications, whereas peer influence does not. This conclusion contrasts with that of (Hu et al., 2019), who demonstrated that peer influence is more significant than critical mass when considering the continuation intention of online shopping. The impact of critical mass surpasses peer pressure, potentially attributed to the user's exclusive use of augmented reality applications. Yet, they are not integrated with social networking sites to share their experience. Self-efficacy has a significant positive influence on perceived behavioral control.

5.2. Practical Implications

The study offers several managerial insights for AR app developers and service providers to enhance the long-term engagement of users with mobile augmented reality applications.

First, the study highlights the critical role of user experience in driving continued usage intentions. Service providers should focus on improving AR apps' interactive and engaging features, enhancing the perceived mobility and ubiquity of the services, and building robust trust mechanisms to foster positive user attitudes.

Second, the findings underscore the significance of social influence in the context of mobile AR applications. Service providers should emphasize creating a critical mass of AR app users, as the perception of widespread adoption can positively influence the social acceptability and continued usage of these apps.

Third, the study reveals the importance of users' self-efficacy in determining their continued usage intentions. AR app developers should design intuitive and user-friendly interfaces to enhance users' confidence in effectively utilizing the AR features, thereby promoting sustained usage.

Overall, this study provides a comprehensive understanding of the key drivers of mobile AR usage continuance. This can guide AR service providers in developing effective strategies to promote long-term user engagement and successful deployment of mobile augmented reality applications.

5.3. Limitations of the Study and Directions for Future Research

First, the study's focus on MAR applications limits the generalizability of findings to other technologies. Future research could explore the applicability of these findings to other emerging technologies like virtual reality or mixed reality applications. Also, exploring the impact of integrating MAR applications with social networking sites on user adoption and continuance intention could provide valuable insights.

Additionally, the study's geographic scope may constrain the generalizability of its findings. Future research would benefit from a more diverse geographic sample to strengthen the external validity of the results. Addressing these limitations and exploring new research avenues can provide a more comprehensive understanding of user behavior in the context of mobile augmented reality applications.

6. CONCLUSION

This study examined the determinants of users' continuance intention toward mobile augmented reality (MAR) applications in retail shopping using the decomposed theory of planned behavior. The findings confirm that attitude, subjective norms, and perceived behavioral control significantly influence continuance intention, with attitude emerging as the strongest predictor. Interactivity, perceived mobility, and trust were found to be critical in shaping favorable user attitudes, while novelty and technology anxiety did not exert a significant long-term influence. Moreover, perceived critical mass strengthened subjective norms, whereas peer influence remained insignificant, reflecting the individualized nature of MAR usage. Self-efficacy significantly enhanced perceived behavioral control. Overall, the study extends the application of DTPB to mobile augmented reality and highlights that sustained MAR adoption depends less on novelty and more on interactive, trustworthy, and user-empowering experiences.

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