



Influence of Augmented Reality on Shopping Behavior

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ABSTRACT:

Digital technologies emerged as innovative avenues for launching new products, advertising brands, increasing customer awareness, and thus leaving a remarkable impact on the online marketplace. The present study analyzed the effects of crucial antecedents of AR interactive technology on customers’ behavior toward AR-based e-commerce websites.

Convenience sampling was used to collect primary data from 357 iGen respondents aged 16-22 years; residing in New Delhi and the NCR region of India and examined using the structural equation modeling technique.

Results revealed that technology anxiety and virtuality significantly influence customers’ attitudes and behavioral intentions toward AR-based e-commerce websites. However, interactivity and innovativeness remain non-significant. Additionally, non-significant moderating effects were identified for the moderators, i.e., trust and need for touch. At the same time, gender has a significant moderating effect only for the association between technology anxiety and attitude toward AR-based e-commerce websites.

The study summarizes numerous theoretical and managerial implications for AR-based website designers and policymakers, followed by the crucial limitations and directions for future research.

CUST_PRACTICAL_IMPLICATIONS__(LIMIT_100_WORDS) :No data available.

CUST_SOCIAL_IMPLICATIONS__(LIMIT_100_WORDS) :No data available.

The present research provides a significant understanding of the e-commerce industry by providing valuable insights about young iGen consumers’ perceptions of AR-based e-commerce websites.

Table 1: Description of research instrument

Constructs	Definition	Sources
Technology Anxiety	The fear or uneasiness felt by individuals when they use technology-related applications	Venkatesh et al. (2003), Meuter et al. (2003); Richter and Raška (2017), Ibili et al. (2019)
Innovativeness	Individual willingness to try new technologies	Agarwal & Prasad (1998); Goldsmith & Hofacker (1991); Roehrich (2004); Kim et al. (2015)
Interactivity	Interactivity refers to the amount of freedom the user is given to control the learning experience, often through handheld controllers and a virtual body	Lee et al. (2010); Zhao and Lu, (2012); Yim et al (2017); Makransky & Petersen (2021)
Virtuality	Virtuality is the technological ability to promote immersive perceptions by engagingly depicting virtual characteristics and virtual worlds.	Choi and Taylor (2014); Van Kerrebroeck et al. (2017)
Attitude toward technology	The degree to which an individual has a favorable or unfavorable response towards technology.	Li et al. (2002); Porter and Donthu (2006); Rese et al. (2017).
Behavioral intention toward technology	The influence of the motivational factor that directs the behavior, the stronger the intention, the more likely the behavior will be performed.	Ahn et al. (2004); Van Noort et al. (2012)
Trust	Trust is consumers believe that all the parties in the exchange transaction would fulfill their promised obligations	Miao et al. (2022); Dhingra et al., (2020)
Need for touch	The consumer preference for extracting and utilizing information obtained through the haptic system.	San-Martín et al. (2017); Kühn et al. (2020)

Table 2: Demographic Details

Demographics		Frequency	Percentage
Gender	Male	204	57
	Female	153	43
Age (Years)	16-17	85	24
	18-19	115	32
	20-22	157	44
Qualification	Diploma or vocational	122	34

	course		
	Graduate	235	66
Dependency Level	Dependent on parents	214	60
	Self-dependent	143	40
Type of operating system in mobile phone	Android operating system	225	63
	IOS operating system.	132	37

Table 3: Reliability and Convergent Validity

Variables	Loadings	Cronbach's Alpha	Composite Reliability	Average Variance Extracted
TA1	0.793	0.747	0.84	0.569
TA2	0.78			
TA3	0.704			
TA4	0.736			
IN1	0.799	0.774	0.854	0.594
IN2	0.808			
IN3	0.718			
IN4	0.754			
INT1	0.806	0.738	0.851	0.656
INT2	0.819			
INT4	0.805			
VR1	0.768	0.71	0.82	0.533
VR2	0.643			
VR3	0.746			
VR4	0.757			
ATT1	0.704	0.736	0.833	0.555
ATT2	0.741			
ATT3	0.757			
ATT4	0.777			
BITAR1	0.703	0.742	0.837	0.563
BITAR2	0.732			
BITAR3	0.755			

BITAR4	0.807			
ND1	0.867	0.753	0.849	0.654
ND2	0.851			
ND3	0.697			
TR1	0.598	0.715	0.812	0.597
TR2	0.776			
TR3	0.911			

Table 4: Discriminant Validity

Variables	ATT	BITAR	IN	INT	ND	TA	TR	VR
ATT	0.745							
BITAR	0.34	0.750						
IN	0.325	0.222	0.771					
INT	0.315	0.233	0.757	0.811				
ND	-0.078	-0.016	-0.088	-0.099	0.809			
TA	0.333	0.424	0.211	0.219	0.027	0.754		
TR	-0.015	-0.108	-0.069	-0.031	0.504	-0.02	0.773	
VR	0.546	0.300	0.285	0.274	-0.138	0.357	-0.131	0.730

Table 5: Path coefficients and Hypothesis testing

Hyp.	Path	Path coefficient	Std. dev	t-value	p-value	Result
H1	TA → ATT	0.134	0.046	2.906	0.004**	S
H2	IN → ATT	0.109	0.065	1.688	0.091	NS
H3	INT → ATT	0.081	0.069	1.173	0.241	NS
H4	VR → ATT	0.445	0.046	9.669	0**	S
H5	ATT → BITAR	0.343	0.052	6.577	0**	S

NS: Not significant; S: Significant

Table 6: Interaction - Moderation Results

Hyp.	Path	Path coefficient	Std. dev	t-value	p-value	Result
	TR x TA → ATT	-0.005	0.06	0.084	0.933	NS
	TR x IN → ATT	0.093	0.087	1.065	0.287	NS
	TR x INT → ATT	-0.064	0.085	0.757	0.449	NS
	TR x VR → ATT	-0.027	0.062	0.443	0.658	NS

H7	ND x TA → ATT	0.064	0.059	1.090	0.276	NS
	ND x IN → ATT	0.170	0.104	1.635	0.102	NS
	ND x INT → ATT	-0.089	0.103	0.869	0.385	NS
	ND x VR → ATT	-0.030	0.060	0.506	0.613	NS
NS: Not significant						

Table 7: Multigroup analysis (Gender)

Hyp.	Path	t-value		p-value		Results
		FEMALE	MALE	FEMALE	MALE	
	IN → ATT	1.819	1.242	.069	.214	NS
	INT → ATT	1.486	1.751	.137	.080	NS
	TA → ATT	2.104	1.577	.035*	.115	S
	VR → ATT	4.988	7.827	.000**	.000**	NS
NS: Not significant; S: Significant						

Table 8: Control variable analysis

	Std. dev	t-statistics	p-values
Age			
Age -----> ATT	0.053	0.808	0.419
Age -----> BITAR	0.062	1.032	0.302
GENDER			
Gender -----> ATT	0.087	0.843	0.399
Gender -----> BITAR	0.101	0.488	0.625
Education			
Education-----> ATT	0.084	1.926	0.054
Education-----> BITAR	0.101	0.659	0.51

Appendix

Q1: Tick on the level of agreement or disagreement:

Construct	Statements	SA	A	NAND	D	SD
Technology Anxiety						
TA1	I am concerned when I am using the AR-based shopping websites					
TA2	I feel that I can make mistakes when shopping from AR-based shopping websites					
TA3	I am afraid that mistakes cannot be rectified while using the AR-based shopping websites					
TA4	I have difficulty understanding the technology used in AR-based shopping websites.					
Innovativeness						
IN1	I like to try out the latest technology embedded in e-commerce websites					
IN2	When I hear about the latest technology, I love to experiment with it.					
IN3	Among my peers and family members, I usually try out the latest technology applications					
IN4	I feel excited when I try the latest technology applications, such as AR and VR, during me shopping on e-commerce platforms					
IN5	It gives me a WOW feeling whenever I use AR-based shopping websites					
Interactivity						
INT1	I can easily control the content displayed by AR-based e-commerce websites.					
INT2	I controlled the products that could be viewed on the website.					
INT3	AR-based e-commerce website provides information thrust and clears my doubts.					
INT4	AR-based e-commerce websites quickly and efficiently respond to my particular needs.					
INT5	I think using the AR features for my shopping was interesting.					
Virtuality						
VR1	I don't like buying products on virtual platforms, even if they are using VR or AR technology.					
VR2	Buying the products on virtual platforms lacks the description of the information					
VR3	3D images and 360 rotations of products help me to visualize the product and affect my purchase decisions.					
VR4	Zooming on the products helps me better understand their features of the product.					
Attitude towards AR						
ATT1	I feel that AR-based shopping websites are appealing.					
ATT2	In my opinion, AR-based shopping websites are likable.					
ATT3	The use of AR-based shopping websites is a good idea					
ATT4	AR-based shopping websites are very interesting and make you learn a lot about them					
ATT5	AR-based shopping websites appeal to people.					
Behavioral Intention toward AR						
BITAR1	I will recommend AR-based shopping websites or apps to my friends, family, or colleagues.					
BITAR2	I will share the AR-based shopping websites or apps via social media					
BITAR3	I give more priority to AR-based shopping websites or apps over traditional websites.					
BITAR4	I will use AR-based shopping websites or apps in the future.					
BITAR5	When I need to purchase products online, I will download AR-based shopping apps and do shopping.					

Trust	
TR1	I trust the AR technology used in the e-commerce sites
TR2	I don't trust the technology used by e-commerce vendors
TR3	Advanced technology applications attained my trust
Need for touch	
NT1	I want to personally touch the products before purchasing them.
NT2	I feel that personally touching the products gives me more confidence.
NT3	I like to purchase the products after physically touching them
SA: Strongly agree, A: Agree; NAND: Neither agree nor disagree; D: Disagree; SD: Strongly disagree	

Demographic profile:

Age

- a)16-18 years b) 18-20 years c) 20-22 years

Gender

- a) Male B) Female

Qualification

- a) Diploma or vocational course degree b) Graduation degree c) Post-graduation

Dependency Level

- A) Self-dependent B) Dependent on parents

Type of operating system in mobile phone

- A) Android operating system B) iOS operating system

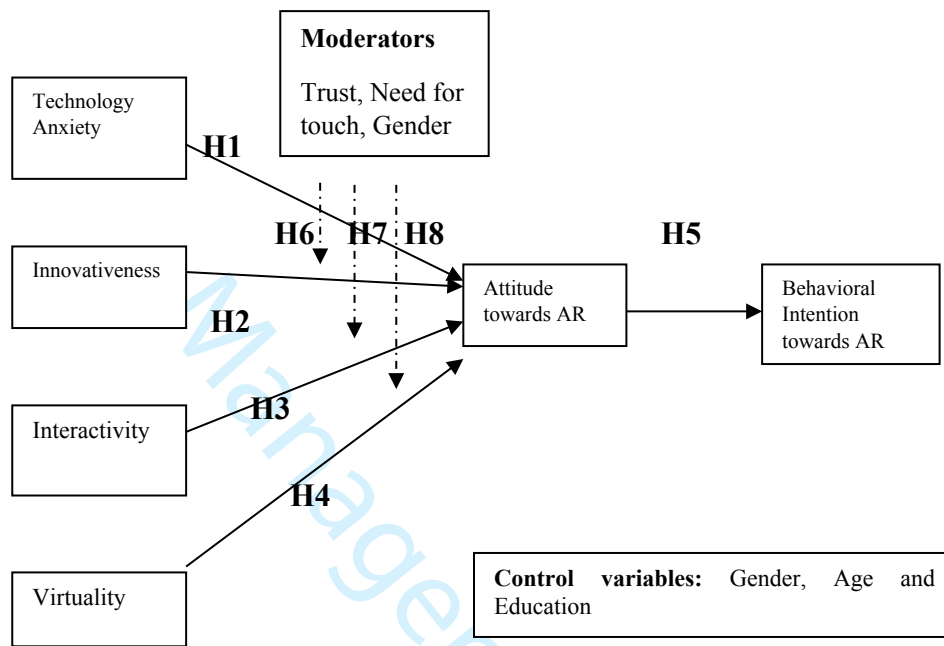


Figure 1: Proposed conceptual model

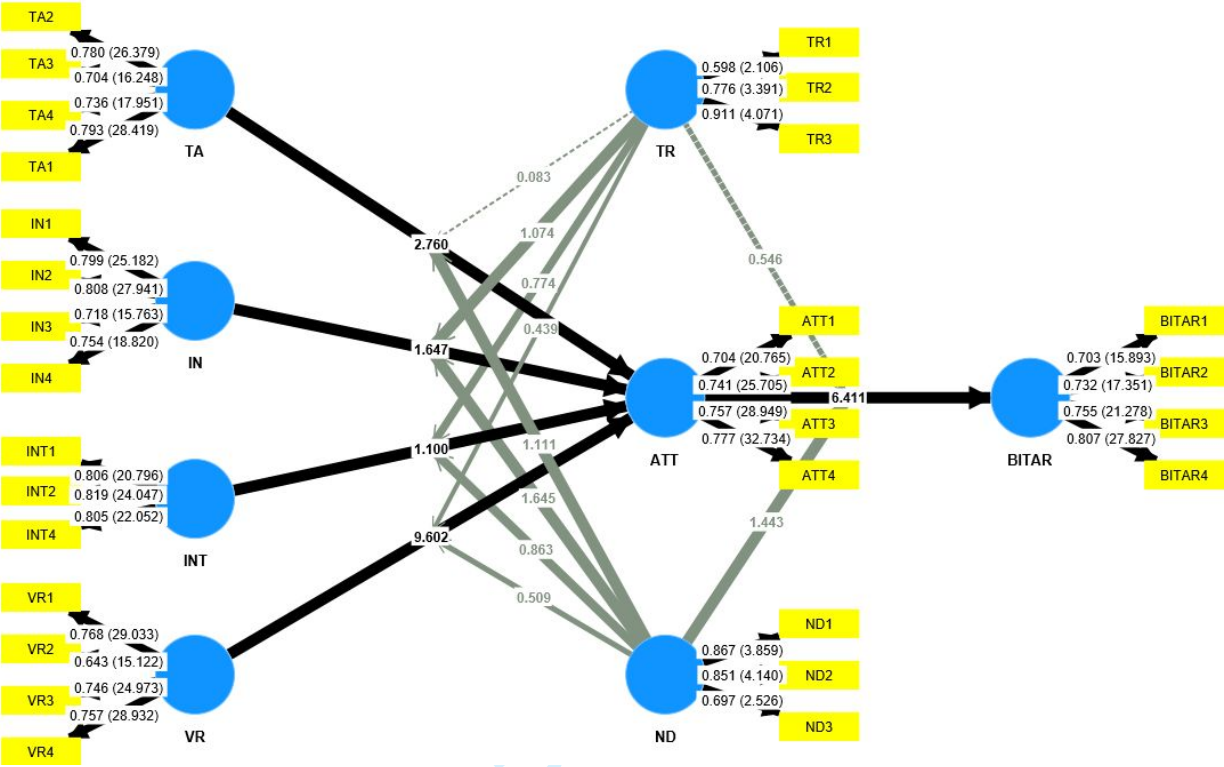


Figure 2. Path diagram

Influence of Augmented Reality on Shopping Behavior

Abstract

Purpose: Digital technologies emerged as innovative avenues for launching new products, advertising brands, increasing customer awareness, and thus leaving a remarkable impact on the online marketplace. The present study analyzed the effects of crucial antecedents of AR interactive technology on customers' behavior toward AR-based e-commerce websites.

Methodology: Convenience sampling was used to collect primary data from 357 iGen respondents aged 16-22 years; residing in New Delhi and the NCR region of India and examined using the structural equation modeling technique.

Findings: Results revealed that technology anxiety and virtuality significantly influence customers' attitudes and behavioral intentions toward AR-based e-commerce websites. However, interactivity and innovativeness remain non-significant. Additionally, non-significant moderating effects were identified for the moderators, i.e., trust and need for touch. At the same time, gender has a significant moderating effect only for the association between technology anxiety and attitude toward AR-based e-commerce websites.

Research limitations/implications: The study summarizes numerous theoretical and managerial implications for AR-based website designers and policymakers, followed by the crucial limitations and directions for future research.

Originality: The present research provides a significant understanding of the e-commerce industry by providing valuable insights about young iGen consumers' perceptions of AR-based e-commerce websites.

Keywords: Augmented reality, Innovativeness, Interactivity, Technology anxiety, Virtuality

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3 **1. Introduction**
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5 Technological development and innovative digital initiatives have leveraged the business from
6 traditional to digitized platforms and boosted the competition in the contemporary business world
7 (Dogra and Kaushal, 2021; Ganesan and Gopalsamy, 2019). Global companies like Google,
8 Amazon, and Alibaba have realized the competence and necessity of advanced digital
9 technologies. Google has invested £400 million in acquiring the DeepMind Company (2014) and
10 has successfully solved its operational business problems by applying artificial intelligence
11 (Kolakowski, 2019). Furthermore, global online shopping giants like Amazon and Alibaba initially
12 adopted augmented reality (AR) technology in data mining, managing big data, chatbot creation,
13 customers’ recently viewed products, and product recommendations. The e-commerce players are
14 continuously striving to adopt AR and virtual reality (VR-based) innovative practices for speedy
15 processes, economic viability, faster information processing, customer convenience (Patel, H. and
16 Cardinali, R. 1994; Song et al., 2019), and effective customer relationship management (Demirkan
17 et al., 2008). Nowadays, providing 2D product images and descriptions on online platforms does
18 not satisfy the information thrust for many product categories, such as apparel, shoes, jewelry, and
19 furniture, for online shoppers, resulting in a decline in direct online sales (Lu and Smith, 2007).
20 Online shoppers are more curious about the product’s dimensions and functionality. These
21 increased expectations of online shoppers are alarming signals for the e-commerce industry and
22 online market (Cho et al., 2002.).
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36 These emerging challenges forced the online marketplace, especially e-commerce players, to
37 shift from 2D to 3D technology (Hilken et al., 2017). Applications of 3D technology provide a
38 unique experience to online shoppers. For instance, AR-enabled apps and websites, in the case of
39 cosmetics products, show customers how the makeup or a dress looks on them (Hilken et al.,
40 2017). Similarly, it shows how the furniture fits and looks when kept at home (Verhagen et al.,
41 2014). AR apps provide a “try-before-you-buy” experience to online buyers. Additionally, these
42 advanced features are expected to reduce the experience gap between online and offline platforms
43 (Scholz and Smith, 2016; Baek et al., 2018). Extant studies stated that many online retail marketers
44 added AR-featured apps to their marketing programs to increase customer awareness, brand
45 engagement, and brand loyalty (BCG, 2018; Loureiro et al., 2020).
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53 Effective use of AR-based apps in the online market develops curiosity among academic
54 researchers. Subsequently, researchers have initiated to examine the customers’ adoption and
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satisfaction with AR-based e-commerce platforms (Trivedi et al., 2022; Gatter et al., 2021; Rauschnabel et al., 2019). Previous literature on the effectiveness of AR shopping websites suffers from various drawbacks; for example, Trivedi et al. (2022) examined the impulse purchase in AR-based mobile apps; virtual reality for improved online retailing (Hilken et al., 2022); customer engagement with augmented reality mobile applications (McLean and Wilson, 2019). But no study has examined crucial antecedents of AR-enabled technology, especially for e-commerce websites. Thus, an additional investigation is needed to recognize how AR-based e-commerce websites affect online shoppers' behavior when they buy, especially from these websites. From the practitioner's perspective, this research examines the succeeding two research problems:

“The effect of augmented reality in mobile applications on consumers' online impulse purchase intention: The mediating role of perceived value

- How do the proposed antecedents of AR interactive technology influence customers' attitudes and intentions toward AR-based e-commerce websites?
- How do trust, need for touch, and gender moderate the influence of antecedents on consumers' attitudes toward AR-based e-commerce websites?

This research adds significantly to previous literature in the following three ways. *First*, past studies emphasized the underlying effects of AR-based websites and ignored their negative consequences on shoppers' psychology (Rauschnabel et al., 2019; Baek et al., 2018; Javornik, 2016; Verhagen et al., 2014). The present study uses technology anxiety as an essential factor that hinders the use of AR-enabled online shopping platforms. AR-based e-commerce websites help to view the product from different angles, virtual distances, and simulations of functionality that can increase the perceived image and intrusiveness. However, technology anxiety can be an obstacle that can hamper its effectiveness. (Park and Yoo, 2020). *Second*, an investigation of the direct effect of the virtuality and interactivity of AR-based e-commerce websites on the shopper's attitude, which leads to favorable purchase intention, has been done. Previous studies have investigated numerous technologies, such as AR, VR, and new wearable technologies called AR-based smart glasses (e.g., Rauschnabel, 2018; Chuah et al., 2016; Scholz and Smith, 2016). However, the direct influence of virtuality and interactivity remains an under-explored but fruitful research domain.

In addition, existing literature emphasized app-and brand-related responses and reported combined results. For instance, Zeph van Berlo et al. (2021) investigated how emotional responses

influenced brand responses and concluded that VR improves brand attitude, particularly when online customers find the exhibited products appealing. Additionally, Rauschnabel and Ro (2016) reported that German consumers had no discernible effect on the self-expressive symbolic benefits of Google Glass. However, based on two research studies conducted in the United States, Rauschnabel et al. (2016) highlighted a connection between usage intention and the impact of wearing AR-based smart glasses on a customer's outward look. Self-augmentation apps were the main focus of these studies, but it has been looked into whether AR could negatively influence users' behavior. Therefore, more investigation is needed to determine whether and how AR-based websites can benefit online shoppers.

Third, the present research has been conducted in India, an emerging economy. The AR and VR market statistics are predicted to increase by 38.29% to reach a CAGR of US\$ 14.07 billion by 2027 (IBEF, 2022). Indians have shown more curiosity in implementing such modern technology for numerous product categories such as apparel (67%) and home appliances (56%) (Indian Retailer Bureau, 2021). Ample of the existing research has been conducted in a developed economy, including the United States of America (Rauschnabel et al., 2016; Rauschnabel and Krey, 2018), the United Kingdom (Anderson et al., 2013), and the majority of Western and Northern Europe, such as Germany (Rauschnabel et al., 2022; Rauschnabel and Ro, 2016). Thus, the present study extends the existing marketing literature established primarily in a developed economy and examines its applicability in India. The remaining paper is framed as the next section provides the literature reviewed to develop and propose the conceptual model, followed by hypotheses development.

2. Theoretical background

2.1. Augmented reality

AR combines the physical and virtual worlds that are compatible, supportive, and interactive for online users (Moriuchi, 2020). AR facilitates the user with audio and video components that lead to a rich experience (Ohta and Tamura, 2014). AR creates a hybrid reality in which the environment is real, but the objects depicted in it are virtual; as a result, it has a better perspective than VR. (Yim et al., 2017; Cho and Schwarz, 2012). Craig (2013) discussed how AR-based interactive technology affects the user's overall experience and concluded that there is a strong association between technology and user experience. Additionally, AR includes distinct features projecting the physical world on the virtual content, interactivity of the virtual object shown, and

a 3D view of the virtual products (Smink et al., 2020). It lets users virtually try, verify and check the products from various angles and dimensions. These features directly influence the product purchase, as images and videos deliver a more indirect product experience (Kowalczyk et al., 2021). These different benefits resulted in AR's gradual adoption and usage on various e-commerce apps, which induced different persuasive responses. While AR is still comparatively novel in marketing technology, this technology is estimated to rise with more opportunities in the future.

2.2. Augmented reality in e-commerce

The shortcomings of VR felt by e-commerce industry players were overcome by AR, which provides more realistic product displays and enhanced user interaction, leading to a lifelong customer experience (Billewar et al., 2021). AR technology focuses on interactivity and converts physical reality by assimilating virtual objects into the real world. Zhang et al. (2000) found that 3D images of the actual product and video demonstrations influence the buyer's mindset better than ever in a new online marketing system. Fritz et al. (2020) demonstrated how AR technology could virtually take customers to a real-time environment, affect their mentality, and ease in imagination, thus affecting their purchase intentions. Recently, visualization-enriched technologies in e-commerce shopping apps like IKEA allow shoppers to visualize virtually how specific furniture might look in their houses (Ozturkcan, 2021). Moreover, the media richness, visualization, and interactivity proved to speed up customer involvement and, in turn, enhance product learning and satisfaction (Suh and Chang, 2006). Further, the automated service technology offers interactivity and fosters a new level of customer engagement that is more intense (Rejeb et al., 2021).

2.3. Augmented reality and Consumer purchase decisions

Emerging technologies are designed to supplement and automate human decisions previously reserved for experts. Over 20 billion users depend on Amazon Echo devices, chatbots, and sensors. These technology-based intelligent devices are entering human life by transforming their thinking processes, interaction, and decision level (Melumad et al., 2020). New technologies such as smartphones, wearable devices, chatbots, and voice-based assistants can alter human buying decisions and their emotional and cognitive bases (Melumad et al., 2020). These modern devices involve the features of voice and AR that can provide Vibrio-tactical feedback affecting the consumer's reactions according to the environment (Hadi and Venezuela, 2019). For instance,

Amazon’s recommendation system intelligently allows the user to choose based on algorithms prediction (Lee et al., 2020). Consequently, the latest technologies can serve as an essential parameter in the consumer’s policymaking and preferences by consistently analyzing their search behavior and, based on algorithmic, suggesting better choices.

3. Conceptual Framework and Hypothesis Formulation

3.1. Technology Anxiety

Technology anxiety is a feeling that makes the individual restless, anxious, or frightened while using the latest technology (Igbaria and Parasuraman 1989). Technology interaction can affect users’ social relationships, learning, and emotional states (Ibili et al., 2019). Individuals with high technology anxiety and consciousness are expected to deny using and adopting information systems. Saadé and Kira (2009) stated that anxiety is enhanced when the user first uses the latest technology. Technology anxiety induces adverse emotional reactions (Chang et al., 2017), such as unfavorable user perception, minimal interaction, and slow AR technology adoption (Kang, 2014). It directly affects the consumer intent to adopt future AR applications (Kim and Forsythe, 2008). Virtual technologies are assumed to affect purchase willingness and the results in positive intention (Fiore et al., 2005; Li et al., 2002). As AR-based apps in an e-commerce website are newly added features, they can provoke anxiety (Li and Xu, 2020). Previous studies explained how technology anxiety influences new technology adoption, like Virtual Try-on technology and self-service technology (Kim and Forsythe, 2008; Meuter et al., 2003). However, the degree of technology anxiety varies across the product categories. For example, apparels, furniture, and cosmetics are highly involved products, and individuals fear uncorrectable mistakes that affect cognitive processing (Appelbaum, 2015), resulting in anxiety (Lee et al., 2021). Against this theoretical background, we hypothesize:

H1: Technology anxiety will have a negative effect on the attitude toward AR-based e-commerce websites.

3.2. Innovativeness

Innovativeness is the intensity by which consumers are willing to try new services and goods. (Agarwal and Prasad, 1998). Innovativeness originated from the diffusion of innovation theory. Prior literature stated that innovativeness is one of the significant constructs for technology adaptation studies (Baytar et al.2020). Mazman and Usluel (2009) identified personal

innovativeness as essential to admit or discarding innovative technology such as AR. Acceptance of AR interactive technology is affected by the consumer's level of innovativeness (Kim and Forsythe 2008).

Furthermore, Tzou and Lu (2009) demonstrated that early adopters have a different adoption level than late adopters. Liu et al. (2010) explained that a higher level of consumer innovativeness makes them more acceptable and encourages them to experience novel technology, which helps them to develop positive beliefs about innovations. Daineko et al. (2016) identified the essential factors that affect the growth and popularity of AR. These factors are interactivity, accessibility, realism, and innovativeness. Zarpou et al. (2012) further confirmed that personal innovativeness is essential in AR acceptance. Therefore, we hypothesize:

H2: Innovativeness will have a positive effect on the attitude toward AR-based e-commerce websites.

3.3. *Interactivity*

Downes and McMillan (2000) and Steuer (1992) defined interactivity as the property of the technology employed or the user's ability to interact and get involved with information (Hoffman and Novak, 1996). Scholars focused on the methods to increase the interactivity speed (Steuer, 1992). Downes and McMillan (2000) emphasized the individual's traits that affect the sense of interactivity. Yim et al. (2017) focused on the role of interactivity in online shopping, as consumers can more effectively collect information by visually examining realistically displayed virtual products. VR technologies guide consumers to virtually displayed products, increasing their direct experience and improving product knowledge (Yim et al. 2012). Heller et al. (2019) found that interactive VR technology increases product experiences and expertise. Jin et al. (2007) explained that 3-D visualization increases virtual imagery compared to traditional advertising.

Similarly, AR interactivity helps customers understand the virtual environment in real-time (Zhao et al., 2020). Thus, interactive AR is emerging as an effective tool that enhances product experiences by educating the consumer and is effective in the shopping experience (. Henceforth, we hypothesize:

H3: Interactivity will have a positive effect on the attitude toward AR-based e-commerce websites.

3.4. *Virtuality*

Virtuality promotes immersive perceptions by engaging users with virtual characteristics of the latest technology. Virtuality affects the consumer’s cognitive and affective states (Suh and Prophet, 2018) and the product’s physical and virtual elements with the help of a computer-generated environment (Qin et al., 2020). The consumer’s experience with interactions, such as virtual views, is highlighted and improved by interactive AR by adding images and videos, value-added propositions, and improving information processing during the various stages of purchase decision-making (Javornik, 2016; Flavian et al., 2019). For example, by using virtual apps, consumers can see themselves sporting new clothing or eyewear and even enjoying a ride on a roller coaster, creating a sense of involvement (Yim et al., 2017). Real-time user contact with a large population is ensured by computer-generated AR components (Arbelaez and Osorio-Gomez, 2018; Javornik, 2016). When physical and virtual facilities are combined into a single setting, interactive AR technologies shrink the gap between reality and virtuality. These technologies are applied to tech-savvy millennials, for whom VR and AR satisfy hedonic consumer desires (Hinsch et al., 2020; Rauschnabel et al., 2018). Therefore, we hypothesize:

H4: Virtuality will have a positive effect on the attitude toward AR-based e-commerce websites.

3.5. Attitude and Behavioral Intention

AR technology experience will influence the user’s attitudes, persuasion, and motivation level due to the user’s utilitarian and hedonic values (Fogg, 2003). AR delivers the information and affects the multi-sensory simulation experience known as “visual and haptic features,” which will supplement the shopping journey with entertainment as an added feature (Huang, 2015). AR facilitates purchases and encourages online interaction, improving their attitude toward purchases (Huang and Tseng, 2015; Van Krevelen and Poelman, 2010). Various researchers such as Mukherjee et al. (2023), Venkatesh et al. (2003), and Walker et al. (2002) explored various factors of technology adoption, their effect on customers’ attitudes, and further how the attitude is linked to their behavioral intentions. Users’ attitude toward AR was essential to customers’ behavioral preferences, which referred to customers’ likelihood to visit particular e-commerce websites. Therefore, we hypothesize:

H5: Customers’ attitudes will have a positive effect on their behavioral intentions toward AR-based e-commerce websites.

3.6. Moderating Effects

3.6.1. Trust

Trust is the degree of certainty and confidence a buyer has in a service provider (Wilson et al., 2016). Trust affects acceptance of shopping on an e-commerce portal, which the brand portal's reliability and credibility can shape. Confidence in the seller's website influences the nature of the relationship and purchase decisions (Castellano et al., 2018). On e-commerce websites, online shoppers usually feel insecure and uncertain about whether the website administrators can misuse their personal information, affecting their trust (Hao et al., 2015). Similarly, different sources of trust, i.e., customer characteristics, firm characteristics, and consumer interactions, influence trust dimensions, affecting purchase intention. Loureiro and Oliveira (2020) opined that more trust results in better consumer satisfaction and perceived website performance. Kim and Peterson (2017) demonstrated that trust remains essential for online and traditional shopping. However, it seems more necessarily needed in an online context. Therefore, it is interesting to see the moderation effects of trust on the proposed relationships among antecedents and consumers' attitudes toward AR-based e-commerce websites. Hence, we can hypothesize,

H6: Trust moderates the relationship between the proposed antecedents, i.e., technology anxiety (H_{6a}), innovativeness (H_{6b}), interactivity (H_{6c}), virtuality (H_{6d}), and consumers' attitude toward AR-based e-commerce websites.

3.6.2. Need for Touch

Yazdanparast and Spears (2012) found that customers need to personally feel the products to determine product features experimentally and analytically. They enjoy it. However, online shopping reduces such enjoyment, as physical touch is absent (Burke 2002). The inability to touch increases uncertainty and frustration, thus reducing familiarity and resulting in an unpleasant online shopping experience (Peck and Childers 2003). Shoppers with a low need for touch are least affected by the inability to touch and have less effect on their overall shopping experiences (Luna-Nevarez and McGovern, 2021). However, if products require critical decision-making and profound knowledge, consumers with a greater need for touch reduce their online product purchase intention (Citrin et al. 2003). Specifically, in the case of apparel, purchase intentions get higher if an element of feel, touch, and try is there. Providing such an authentic experience might not be possible in online shopping. However, the VR market enables customers to engage with the

sensory inputs that influence their consciousness and product imagination, improving their abilities during product evaluation (Cowan et al., 2019). Hence, we hypothesize:

H7: The need for touch moderates the relationship between the proposed antecedents, i.e., technology anxiety (H_{7a}), innovativeness (H_{7b}), interactivity (H_{7c}), and virtuality (H_{7d}), and consumers' attitude toward AR-based e-commerce websites.

3.6.3. *Gender*

Previous studies identified gender variations in the adoption of internet-based technologies. For instance, males are more excited about using computers than females (Qureshi and Hoppel, 1995). Men spend additional time and gain confidence using internet technologies (Hou and Elliott, 2016; Lin and Lu, 2011). However, female consumers are more anxious while using a computer due to less confidence and hence have unfavorable attitudes towards using the computer (Jackson et al., 2001). Gender differences were identified for shopping stereotypes (Bae and Lee, 2011), product information searches, purchase intentions, and shopping attitudes (Dholakia and Chiang, 2003).

Furthermore, gender differences in e-commerce shopping are mainly due to differences in online shopping preferences (Yang and Lester, 2005). Van Slyke et al. (2002) discovered substantial discrepancies between male and female respondents. On the contrary, Awad and Ragowsky (2008) concluded that women have higher levels of trust and more plans to shop online than men. Thus, previous studies have shown mixed findings. Thus, it is expected that gender differences might exist on AR-enabled e-commerce shopping websites. Hence, we hypothesize:

H8: Gender moderates the relationship between the proposed antecedents, i.e., technology anxiety (H_{8a}), innovativeness (H_{8b}), interactivity (H_{8c}), virtuality (H_{8d}), and consumers' attitude toward AR-based e-commerce websites.

Following Vanaelst et al. (2006), control variables measure characteristics of businesses and entrepreneurs, which tend to influence business strategy-making practices; the present study included gender, age, and education as control variables. These demographic variables might influence the empirical findings of the present study and, therefore, should be examined independently (Chen and Mitomo, 2017). Subsequently, the discussion mentioned above facilitates to development of a proposed conceptual model, as shown in Figure 1.

Insert Figure 1

4. Research Methodology

4.1. Measurement Instrument

The items for all eight latent constructs were adopted from the existing literature. Table 1 presents the constructs' details and their corresponding scale items. The research questionnaire was separated into two parts. The first part consists of statements related to the dependent and independent variables, measured with the help of a five-point Likert scale. The next part includes questions about respondents' characteristics such as age, gender, qualification, dependency level, place of belonging, and mobile phone operating system.

Insert Table 1

4.2. Data Collection

The study uses convenience sampling to collect primary data from 357 respondents aged 16-22 residing in New Delhi and India's North capital region (NCR) (Berkup, 2014). Young college students were contacted and requested to participate in the survey. For this, the researchers personally visited various educational institutes nearby, and those ready to contribute to the research were asked to assemble in the conference room. The researcher demonstrated the study's aim and promised that the collected data would only be used for academic research. The present research investigated the attitude of the iGen category of the population aged 16-22, as they serve the best sample. For instance, according to the Blagojević (2021) study, 34% of VR users are between 16 and 24 years old. Also, the new generation spends more time on innovative and creative technology (Smith et al., 2022). They are heavy smartphone users and use online shopping portals and AI-based apps, including Alexa, Chatbots, etc. (Flippin 2017; Priporas et al. 2017).

All the respondents were asked to open various e-commerce websites on their mobile phones. Participants who didn't have a smartphone or faced any trouble with internet connectivity were asked to use two spare smartphones in the conference room, especially for this purpose. Participants were asked to proceed with the trial purchase of products primarily focusing on virtual "try before you buy" features like jewelry, furniture, glasses, cosmetics, etc. An appointed observer spots the respondents and briefs all the qualitative data (i.e., observations) on a paper. If any respondent gets confused regarding the use of the e-commerce platform using AR, proper assistance is given by the researchers. After the respondents gained enough experience regarding the AR-based product purchase, they were asked to answer a research questionnaire designed using Google Forms.

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4.3. Sample Characteristics

5 The majority of respondents were aged 20-22 years (n = 157; 44%), followed by 32% aged 18-19
6 years (n = 115), and 24% were 16-17 years old (n = 85). 57% (n = 204) of respondents were males;
7 the rest, 43% (n = 153), were females. Most respondents pursue a graduation college degree (n =
8 235; 66%), while 34% have a diploma or vocational course degree (n = 122). The data was
9 collected from the Capital, i.e., New Delhi, and the country’s National Capital Region (NCR). 40%
10 (n=143) of respondents are self-dependent as they (n = 132) were doing some part-time jobs. Some
11 of them (n = 11) also mentioned their scholarships. However, a majority of 60% (n=214) were
12 financially dependent upon their parents for their livelihood. Most respondents spend their pocket
13 money on online purchases using such e-commerce websites and apps, mainly due to various
14 promotional schemes, such as price discounts, gifts, etc. The majority of respondents, i.e., 63%,
15 use the Android operating system-based mobile phone, whereas 37% use the iOS operating
16 system-based mobile phone.
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Insert Table 2

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5. Results

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5.1. Measurement model analysis

32 The assessment of the reliability and validity (mainly convergent and discriminant validity) for the
33 first-order variables that determine the robustness of the proposed conceptual model (Hair et al.,
34 2011) has been investigated. The present study considers attitudes, behavioral intentions, and
35 antecedents of AR-based e-commerce websites as first-order constructs. The convergent validity
36 and reliability were tested with the help of Cronbach’s alpha, Composite reliability (CR), Factor
37 loadings, and Average variance extracted (AVE). While examining, the INT3 item was deleted as
38 the factor loading value was lower than the threshold value of 0.5 (Hair et al., 2019). As reported
39 in Table 3, all other values of Cronbach’s alpha (>0.70), CR (>0.70), and AVE (>0.50) and factor
40 loadings fall in the threshold, confirming the reliability and convergent validity of the scale.
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47 Discriminant validity was evaluated based on the two conditions. In the first condition, all item
48 loadings on the corresponding latent construct were higher than its cross-loadings, i.e., the item’s
49 loadings on other latent constructs (Hair et al., 2011; Dey et al., 2020). Also, the cross-loadings
50 were not significantly high (<0.4). In the second condition, the square root values of AVE exceed
51 the correlations of each latent construct with other corresponding latent constructs (Fornell and
52 Larcker, 1981), thus confirming the discriminant validity in the proposed model (see Table 4). As
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the data were collected from the millennials as AR-based technology users using the same research instrument, there might be problems of common method bias. Harman's single-factor test provides the solution for the same. The results revealed that the one factor, extracted using Harman's single factor test with unrotated factor analysis, is responsible for 18.1% of the total variance, below the threshold limit of 50%, as given by Podsakoff and Organ (1986). Thus, the data is free from the common method bias.

Insert Table 3

Insert Table 4

5.2. Structural model: Hypothesis testing

A structural equation modeling using SMART PLS 4.0.2 tests the proposed hypothetical relationships among latent constructs. For this, the bootstrapping technique with 5000 re-samples was used to estimate various path coefficients of the structural model. The results, as reported in Table 5 (and Figure 2), revealed that technology anxiety ($\beta = 0.134$, $p < 0.01$) and virtuality ($\beta = 0.445$, $p < 0.01$) significantly influence the attitude toward AR, thus confirming H_1 and H_4 . However, innovativeness ($\beta = 0.109$, $p > 0.01$) and interactivity ($\beta = 0.081$, $p > 0.01$) do not show any significant influences on the attitude toward AR, thus rejecting H_2 and H_3 . Furthermore, attitude toward AR significantly influences the behavioral intention toward AR ($\beta = 0.343$, $p < 0.01$). The R^2 value of 0.342 indicates that the four proposed antecedents explained 34.2% of the variance of the attitude construct. In contrast, the attitude toward AR explains 11.5 % of the variance for behavioral intention.

Insert Table 5

Insert Figure 2

5.3. Moderating effects

The present study investigated the moderation effect of two continuous variables (i.e., trust and need for touch) and another categorical variable (gender) on the relationships between proposed antecedents and consumers' attitudes toward AR-based e-commerce websites (see Tables 6 and 7). The results revealed that trust did not moderate the relationship between technology anxiety and attitude toward AR (H_{6a} : $\beta = -0.005$, $p > 0.001$), therefore, rejecting H_{6a} . Similarly, trust showed insignificant moderating effects on the relationships between the other three antecedents and attitude toward AR, thus H_{6b} , H_{6c} , and H_{6d} . The need for touch had also not shown significant moderating effects on the relationship between technology anxiety and attitude toward AR (H_{7a} :

$\beta = 0.064, p > 0.001$), and with the other three antecedents, thus rejecting H_{7a} , H_{7b} , H_{7c} , and H_{7d} (See Table 6).

Insert Table 6

5.4. Multigroup Analysis

The gender did not moderate the relationship between innovativeness and attitude toward AR technology (female: $\beta = 1.819, p > 0.01$ vs. male: $\beta = 1.242, p > 0.01$), rejecting H_{8b} . Similarly, gender showed insignificant moderating effects on the other relationships, i.e., interactivity and attitude (female: $\beta = 1.486, p > 0.01$ vs. male: $\beta = 1.751, p > 0.01$) and virtuality and attitude (female: $\beta = 4.988, p < 0.01$ vs. male: $\beta = 7.827, p < 0.01$), thus rejecting hypotheses H_{8c} and H_{8d} . However, a significant difference can be seen between males and females in the case of technology anxiety (female: $\beta = 2.104, p > 0.05$ vs. male: $\beta = 1.577, p > 0.01$) (female: $\beta = 2.104, p > 0.05$ vs. male: $\beta = 1.577, p > 0.01$), therefore, supporting H_{8a} . Thus, technology anxiety shows a significantly different influence on females than on males.

Insert Table 7

For the control variables, the study found that not a single demographic variable significantly influenced the respondents' attitudes and intentions toward AR-based e-commerce websites. As reported in Table 8, age does not significantly influence users' attitudes toward AR-based e-commerce websites ($\beta = 0.053, t = 0.808, p > 0.01$) and behavioral intention towards AR ($\beta = 0.062, t = 1.032, p > 0.01$). Similarly, gender and education do not significantly influence users' attitudes toward AR-based e-commerce websites (Gender: $\beta = 0.087, t = 0.843, p > 0.01$ and Education: $\beta = 0.084, t = 1.926, p > 0.01$) and behavioral intention towards AR (Gender $\beta = 0.101, t = 0.488, p > 0.01$ and Education: $\beta = 0.101, t = 0.659, p > 0.01$).

Insert Table 8

6. Discussion

Recent technological developments such as VR and AR have stimulated many applications in diverse areas that ease human and machine interaction, leading to new experiences. Like other industries, e-commerce has also grown exponentially by adopting modern technology applications such as live chats, chatbots, augmented interactive reality technology, 360-degree view, 3D images of products, etc. These interactive augmented realities enhance customer involvement, create efficiency, and bring a competitive edge by adding a differentiation angle among online retailers. The absence of face-to-face interaction, as a primary disadvantage against offline retailers, has

been rectified by adopting such AR-based interactive technologies to some extent, if not entirely. Although the e-commerce industry experts have initiated to adopt the AR-based technology, it is still essential to know the influence of various antecedents of AR interactive technology on the attitude and behavioral intention of the customers. To this end, the present study has explored the crucial antecedents of AR interactive technology and studied their influence on consumer attitude and behavioral intention, especially for AR-based e-commerce websites. The study profoundly presents the understanding of the behavioral mechanism by concentrating on the moderating effects of trust, need for touch, and gender on the association between proposed antecedents and consumers' attitudes toward AR-based e-commerce websites.

To this end, results found that technology anxiety significantly influences the attitude toward AR-based e-commerce websites. The result of this study is consistent with prior behavioral studies, as Ibili et al. (2019) found that technology anxiety affects users' perceived ease of use and satisfaction. The present result suggests that AR-based e-commerce websites should use new features to reduce individuals' anxiety, boosts confidence, enhance easiness, and help positively evaluate the products (Oyman et al. 2022). AR-based e-commerce websites offer utilitarian and hedonic benefits, enhancing the immersive experience and the values of interactive technology (Lee et al., 2021). Kim (2017); Kwak et al. (2022) found AI, AR, and VR technology-based applications provide benefits and improve customer choice and acceptance of the latest technology.

Further, results indicate that users' innovativeness non-significantly affects their attitude toward AR-based e-commerce websites. Innovativeness has a substantial role among predictors for innovation adoption across other disciplines (Karjaluoto et al., 2019; Slade et al., 2014; Cowart et al., 2008). For instance, for mobile technology adoption behavior, personal innovativeness significantly affects mobile users' attitudes and behavioral intentions (Tan et al., 2014; Zampou et al., 2012). Rohm et al. (2012) found that consumers' innovativeness positively affected the attitudes toward mobile advertising. Additionally, users' innovativeness positively influenced the beliefs about ease of use and new technology usefulness (Lewis et al. 2003). Domain-specific consumer innovativeness increased the impact of internet usage on online commerce (Citrin et al., 2000). Contrary to this, an indirect effect of innovativeness on attitude was reported by Junsawang et al. (2022). After that, it can be proposed that mixed results have been investigated regarding the impact of users' innovativeness on attitude

The results support the non-significant relationship between interactivity and the attitude toward AR-based e-commerce websites. Interactivity in AR allows consumers to collect information about virtual products by viewing their images and interacting with them (Ariely, 2000). Messages projected via AR enhance information processing and make the customers proactive in product purchases (Yim et al., 2017). In a technological era, the high interactivity level hinders the individual's motivation to experience it (Yim et al. 2017). Newhagen et al. (1995) insisted that without individual motivation to participate in interactive media, they can't experience them. Thus, AR-based interfaces require the individuals' self-interest in the technology so they will not feel irritated. The irritation negatively affects the user's interaction willingness with virtual products, thus resulting in a refusal to accept AR-based e-commerce interfaces (Sundar, 2007; Yim et al., 2012).

The results are similar to prior studies, as Virtuality has a significant positive relationship with the attitude toward AR interactive technology. Previous studies confirmed that virtuality could improve customer experiences and facilitate information processing (Flavian et al., 2019), thus affecting the cognitive or affective component of consumer's attitudes (Suh and Prophet, 2018) and their purchase decision-making (Hinsch et al., 2020; Rauschnabel et al., 2018). Kang and Haile (2020) also reported that virtuality significantly influences consumer perception and helps them decide. Lastly, results found that attitude toward AR-based e-commerce websites has a significant positive relationship with behavioral intention toward such AR-based technology. This result is similar and in line with the previous studies conducted by Um (2019), Luna-Nevarez and McGovern (2021), Keyzer et al. (2000), Maslowska et al. (2016), and Tam and Ho (2006). Customers are expected to respond positively to the brands due to AR-based interactive images, which further enhance the behavioral intention to purchase a product from such e-commerce portals (Luna-Nevarez and McGovern, 2021). Moriuchi et al. (2020) concluded that AR interactive technology affects customers' attitude and result in better behavioral intentions.

The moderation results showed that trust and need for touch do not significantly moderate the relationship between the proposed antecedents and attitude toward AR-based e-commerce websites. However, it doesn't mean that trust and the need for touch are not crucial variables. Many previous studies have included these variables as direct antecedents and confirmed their significant influences on attitudes toward technology adoption (Kaushik and Rahman 2015). Additionally, gender moderates the relationship between technology anxiety and attitude toward

AR-based e-commerce websites. Inconsistent with previous studies, males and females showed such differences due to changes in their online shopping preferences (Yang and Lester, 2005; Bae and Lee, 2011; Awad and Ragowsky, 2008). Finally, the direct influence of demographic variables as control variables has been examined. Findings revealed that gender, age, and education did not significantly influence users' attitudes and intentions toward AR-based technology.

6.1. Theoretical implications

The current research contributed to the existing literature body in various aspects. *First*, the study proposed and validated a conceptual model that presents the relationships among the crucial antecedents, attitudes, and behavioral intentions towards AR-based e-commerce websites; and, thus, elaborates the extant literature on adoption behavior theory. The study used the antecedents to predict the individual's attitude and behavior towards AR-based shopping websites that have not been investigated before, at least in the given context. These constructs have been examined individually or as parts of different dimensions in different contexts. However, a framework developed in the study provides a complete approach to deeply understanding the individual's attitude and behavioral intention toward AR interactive technologies. *Second*, the present study helps to understand the comprehensive process of psychological behavior of young e-commerce consumers, i.e., the iGen category of the population aged 16-22 years. The young iGen is a heavy user generation and comparatively spends more time on innovative and creative technology (Smith et al., 2021). Targeting these users and understanding factors affecting their attitudes and intentions toward innovative and creative technological options will always be appropriate.

Third, the study investigated the moderating effects of different moderators in the context of AR-based shopping websites, which had not been studied before. Moderation analysis results will help other researchers and academicians who want to explore AR-based technology adoption, at least in similar contexts. Besides, the paper presents insights into AR attitudes and intentions by conducting survey-based research in a country with limited technology awareness and utility. Therefore, an academic community that wants further investigation into other emerging economies can use the proposed model. It will also help them understand common patterns and changes in user adoption behavior. The study presents a new model that can be utilized in other areas of interest where AR interactive technologies are used, such as mobile apps, the entertainment industry, shopping stores, and others using AR and VR technologies.

6.2. Managerial implications

The study provides a practical understanding to online retailers, marketers, and other practitioners. AR-enabled websites make the shopping experience more prosperous and realistic by adding a 360-degree view of products to try and buy, thus improving imagination and making shopping easier. Moreover, AR can improve the brand image and attitude and thus becomes a powerful tool if adequately utilized. People are usually resistant to change. Technology anxiety is one key barrier to technology adoption. Therefore, online retailers could focus on the interactivity aspect that reduces anxiety among potential users. Also, practitioners should communicate the innovative features of their technology (website) that can assist customers in solving their troubles when they shop for specific products such as furniture, clothes, etc. Thus, it reduced the gap between offline and online shopping. By standardizing an immersive AR experience, the available online products might communicate better appearance, fit, and color options utilizing AR technology to improve buyers' perceived value.

With an Investigation of users' psychological processes, retailers could use this technology to communicate unintended qualities that can shorten psychological gaps by giving clear, informative cues about product attributes. The results specify that AR-enabled e-commerce helps customers to reduce perceived technology anxiety and boosts their purchase trust by evaluating the product more realistically. Thus, AR becomes the potential medium for virtual product shopping that entail interactivity. The study provides insights into developing economies like India, where nascent technology sometimes creates confusion and makes users anxious. Thus, the proper utilization of AR technology is essential. The study helps to understand the respondent's behavior when encountering machines and during machine-human interaction in general.

6.3. Limitations and future research

Despite providing valuable contributions, the present study has some limitations. Firstly, India is culturally diverse and the second most populated country globally. The study considered a homogenous sample with respondents from New Delhi aged 16-22 years; it limits the generalizability of the study's findings. Therefore, a heterogeneous sample should be collected from other parts of the country. It will bring more clarity and broader generalizability to the results. Secondly, multiple countries can be considered for research to examine the role of cultural factors on customers' attitudes and behavioral intentions when encountering any latest technology. Furthermore, it helps in the cross-cultural comparative analysis as well. AR technology adoption

depends on the users' background, which can be essential in creating a favorable attitude and acceptance of such technology applications.

Thirdly, the present study considered four antecedents of AR interactive websites affecting customer adoption behavior. In contrast, the impact of other determinants such as information and visual quality (Yoo, 2020); perceived immersion (Vishwakarma et al., 2020); ease of use, and responsiveness (Mishra et al., 2020) can be added to the current model to explore the consumer behavior further in other, similar research contexts. Lastly, the study primarily considered the effect of AR-based shopping websites on users' behavior, whereas mobile-based apps can also be considered in further examinations. Besides, a comparative analysis can also be conducted to examine respondents' usage intention toward AR-based shopping websites and mobile apps.

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