



Virtual reality in E – Commerce: Investigating User engagement and customer attitudes toward VR- Enhanced shopping

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ABSTRACT

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The rise of Virtual Reality (VR) in e-commerce has revolutionized the way consumers interact with online stores, offering immersive and engaging shopping experiences. This study examines the role of VR in enhancing user engagement and influencing customer attitudes towards VR-enhanced shopping environments. By utilizing a combination of surveys, user testing, and interviews, the research explores how VR affects consumer behavior, from product exploration and decision-making to post-purchase satisfaction. The findings indicate that VR increases customer engagement by providing more interactive, personalized, and realistic shopping experiences. However, the research also uncovers challenges such as technological barriers, accessibility concerns, and consumer skepticism regarding the practical utility of VR in shopping. The study concludes that while VR has significant potential to transform e-commerce, its success will depend on addressing these challenges and ensuring that VR implementations provide tangible benefits for users and retailers alike.

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Introduction

Retailers get a competitive advantage from these immersive technologies' tailored, interactive experiences that improve customer engagement with brands and goods (Javornik & Pantano, 2021). While VR allows for virtual store visits and product simulations, AR improves in-store experiences with virtual try-ons and interactive displays, bridging the

gap between digital and real-world retail environments (Bogicevic et al., 2019). Understanding how AR and VR affect customer behavior is essential for using these technologies to increase engagement and revenue as retail transforms into a more digitally enhanced environment (Ijiga et al., 2024). In order to examine the revolutionary possibilities and difficulties of AR and VR in

retail, this review summarizes recent studies [1].

Assessing the effects of AR and VR on consumer engagement and buying behavior in retail settings is the main goal of this review (Kang et al., 2020). In order to comprehend how new technologies improve customer contact and influence purchase choices, this study attempts to synthesize the body of available research. The study looks at how AR and VR may provide engaging product experiences and immersive retail settings, respectively, in order to pinpoint the precise ways in which these technologies affect customer behavior (Loureiro et al., 2020). The paper also analyzes techniques for successful implementation and tackles the difficulties merchants have when integrating AR and VR, such as technical and user adaption obstacles (Hilken et al., 2017).

Boost Customer Engagement: This goal is to comprehend how AR and VR technologies raise customer engagement, interaction, and emotional ties to retail settings. It seeks to

investigate the ways in which immersive experiences might enthrall consumers and enhance their engaging and pleasurable shopping experiences.

Analyze Psychological Reactions: This goal looks at how customers respond emotionally and cognitively while using AR and VR apps in stores. It investigates the ways in which these technologies affect the attitudes, perceptions, and decision-making processes of consumers.

Influence on Purchase Behavior: This goal looks on how AR and VR technology affect what people buy [2]. By offering engaging virtual experiences, it aims to ascertain if these technologies can raise conversion rates, average transaction values, and total revenues.

Evaluate Effectiveness: This goal evaluates how well AR and VR are being used in retail overall. It seeks to assess how effectively these technologies fulfill their stated objectives, improve the consumer experience, and provide merchants a return on their investment.

VR comes in a variety of forms. Because

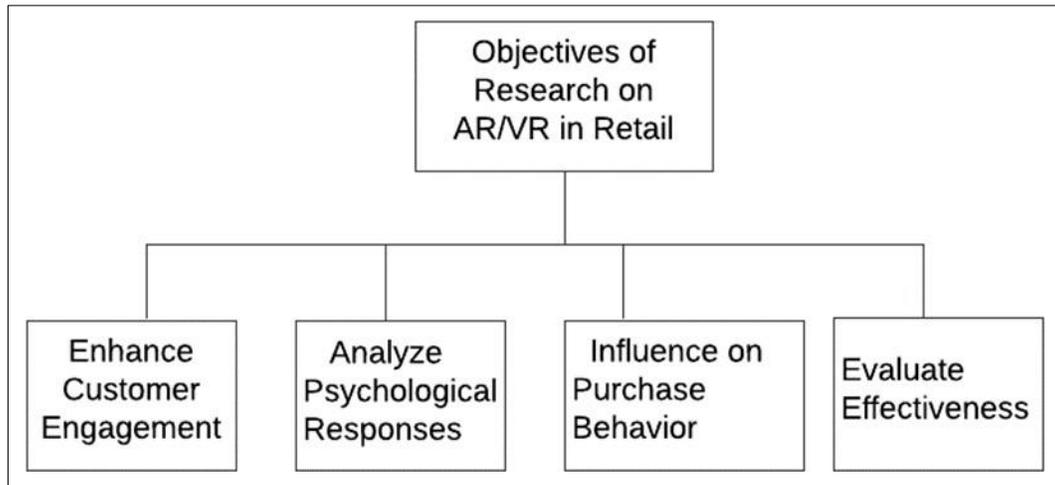


Figure 1: An illustration of these goals

Because it attracts customers and gives them a pleasurable shopping experience, retailers spend money on making their stores seem good (e.g., Baek et al., 2018; Darden et al., 1983; Orth & Wirtz, 2014). However, retailers' websites are unable to accurately depict the atmosphere of their stores. Using virtual reality (VR) is one approach to provide a distinctive online shopping experience. Virtual reality (VR) allows customers to experience the retail environment without physically being there by simulating the real world (Herz & Rauschnabel, 2019; Steuer, 1992). Online VR testing is being conducted by an increasing number of merchants.

360-degree VR films demand less skill sets and financial resources to run than other VR kinds, they are a feasible option for any shop to deploy with ease. Retailers may film in-store surroundings using 360-degree cameras to produce VR movies with a 360-degree perspective. The cameras are user-friendly and reasonably priced. Customers may use any VR headset, including mobile VR devices like Google Cardboard, to watch VR content (Jang et al., 2019). These virtual reality gadgets are also user-friendly. Customers may digitally experience the shop and get over the physical restriction of geographic regions by watching VR movies [3]. Therefore, our research suggests that merchants may benefit from this kind of VR. Numerous scholarly studies on the use of VR in marketing and retailing have surfaced as a result of the technology's development

and practical application. The majority of these research have focused on VR-led consumer reactions, including customer satisfaction and behavioral intention (Domina et al., 2012; Gabisch, 2011; Lau & Lee, 2018; Pizzi et al., 2019). However, they do not adequately address the reasons behind the good behavioral intents that arise from the VR retail experience. Another study gap is that prior VR studies have not taken into account the possible influence of customers' familiarity with the particular business.

Positive feelings like pleasure, arousal, and excitement could be influenced by how much time customers have spent in the business. In other words, customers' past experiences with the business can make their second or future VR experiences less unique. This research uses customers' familiarity with the shop as a moderator to appropriately assess the impact of VR retail experience. The method used to generate the VR shop environment in earlier investigations is the subject of the third research gap. Instead of building a virtual reality store environment in a physical retail store, the majority of previous studies done so digitally using graphic tools (e.g., Pizzi et al., 2019; Van Herpen et al., 2016) or web platforms (e.g., Domina et al., 2012;

Gabisch, 2011) (Domina et al., 2012; Gabisch, 2011; Lau & Lee, 2018; Pizzi et al., 2019; Van Herpen et al., 2016). Due of the less genuine shop setting, this method may not be as effective at accurately portraying a physical business and so eliciting favorable feelings from consumers [4]. Additionally, this strategy requires greater operating capital and expertise from retailers.



Figure 2: Virtual Reality: Revolutionizing the Shopping Mall Experience

Up order to fill up the research gaps, this study develops a conceptual framework based on the schema theory and the stimuli-organism-response (SOR) model (Mehrabian & Russell, 1974) and evaluates it experimentally. The framework focuses on whether virtual reality (VR) can enhance customers' emotional states more effectively

than a website, which helps them find the shop appealing. According to the SOR model, organisms (i.e., emotional states) are affected by stimuli (i.e., VR vs online shop experience), and the organisms in turn influence consumer reactions (i.e., store attractiveness). To determine if customers' induced emotional states such as arousal and pleasure differ depending on how acquainted they are with the shop, schema theory is used (Kent & Allen, 1994). Additionally, this research uses text analytics to learn more about how customers perceive VR stores.

The literature will be expanded by comparing the 360-degree video-driven virtual reality shop environment established in a real store (as opposed to a digitally manufactured store) with an online experience of the same store. This will reveal how effective VR is at capturing the store atmosphere compared to websites. Additionally, a comparison between virtual reality and online retail experiences will indicate if VR store experiences can get beyond internet limitations and make customers think that a store is more appealing [5]. The results of this research also raise the question of whether, when taken into account as a moderator, the number of benefits brought about by VR

retail experiences varies with the degree of store familiarity among consumers. This research is being tested at a small, independent fashion business that has its own online and physical store. Another justification for choosing a small fashion business is that, in contrast to a huge retail establishment that is mostly well-known, customers' familiarity with the store may vary significantly.

Review of related literature

Beck, Rygl, and Gibbs (2021) [1] explore the profound implications of augmented reality (AR), virtual reality (VR), and artificial intelligence (AI) for the future of retailing, particularly in relation to customer experience. Their study provides a comprehensive overview of how these technologies are transforming the way consumers interact with brands and make purchasing decisions. The authors suggest that AR and VR are redefining how customers experience products before making purchases by offering immersive, virtual environments. For example, consumers can use AR to visualize how products will look in their homes or on their bodies, and VR enables entirely virtual shopping experiences that mimic physical stores.

Chen, Perry, Boardman, and McCormick (2022)[2] provide a systematic review of existing research on augmented reality (AR) in the retail sector. The authors examine the various research themes that have emerged over the past few years and highlight key trends in how AR is being used to enhance the retail experience. Through their comprehensive review, the authors identify several areas of focus in AR research, including its impact on consumer behavior, its role in creating immersive and interactive shopping environments, and its potential to transform product discovery and decision-making processes.

Flavián, Ibáñez-Sánchez, and Orús (2021) [3] investigate the impact of emerging technologies virtual reality (VR), augmented reality (AR), and mixed reality (MR) on customer experience. This study highlights the significant role these immersive technologies play in shaping how consumers interact with brands and products in various industries. The authors explore how each technology affects different dimensions of customer experience, including engagement, emotional connection, and purchase intentions. One of the key insights from this paper is the differentiation between AR, VR, and MR. The authors explain that while VR creates fully immersive, simulated

environments, AR overlays digital information onto the real world, and MR combines the elements of both. This distinction is crucial as it influences the type of customer experience that each technology delivers. For instance, VR offers consumers a fully immersive experience that can transport them to a completely new environment, enhancing engagement and creating memorable experiences. AR, on the other hand, provides a more practical, real-world application, allowing consumers to visualize products in their personal space or interact with them in real-time.

Godwins et al. (2024) [4] present a comparative analysis of disaster management strategies and their impact on nutrition outcomes in two contrasting countries: the United States and Nigeria. This study focuses on understanding how different disaster management approaches in these countries influence the nutritional well-being of affected populations during and after disasters. By examining disaster preparedness, response strategies, and post-disaster recovery efforts, the authors assess the effectiveness of these strategies in addressing food security and nutrition outcomes. The paper highlights the differences in disaster management between developed and developing nations, with a

particular focus on the systemic and infrastructural challenges faced by each. In the USA, advanced technological frameworks and well-established supply chains facilitate rapid response and recovery, which positively impacts nutrition outcomes during disasters. Conversely, in Nigeria, resource limitations, political instability, and weaker healthcare infrastructure complicate disaster management efforts, leading to more severe nutritional deficiencies in affected populations.

Ibokette et al. (2024) [5] investigate the effects of curbside feedback mechanisms on the recycling performance of households in the United States. With growing concerns about environmental sustainability, effective waste management strategies are more critical than ever. The authors focus on curbside recycling programs, which involve the regular collection of recyclables from households, and examine how feedback mechanisms (e.g., providing households with information about their recycling behaviors, offering incentives, or issuing corrective feedback) can influence the overall recycling performance. Through empirical research, the study demonstrates that the introduction of feedback mechanisms, particularly those that are

tailored to household recycling habits, leads to a notable improvement in recycling rates. The feedback acts as a motivational tool, encouraging residents to recycle more consistently by increasing their awareness of recycling benefits and improving their understanding of how to separate waste more effectively. Additionally, the study highlights the role of positive reinforcement and peer influence in shaping recycling behaviors, suggesting that providing public recognition or rewards for households with high recycling rates can further boost participation.

Idoko et al. (2024) [6] explore the implications of big data and artificial intelligence (AI) in the workforce, with a focus on two major challenges: workforce replacement and the protection of customer privacy in biometric data usage. As automation, AI, and big data technologies continue to shape industries, these advances are increasingly replacing human labor, which poses challenges for job displacement and employment security. The authors examine how AI and big data tools are being used to improve business operations, but also highlight the risks of widespread workforce automation, particularly for low-skill workers and in developing economies. The second aspect of the study focuses on

the ethical and privacy concerns surrounding the use of biometric data in AI-driven systems, such as facial recognition and fingerprint scanning. As organizations implement these technologies for customer verification and personalized services, they are also collecting sensitive biometric data, which raises significant concerns about data security, misuse, and privacy violations. Idoko et al. argue that businesses and governments must establish strong regulatory frameworks to protect customer data, ensuring that biometric information is securely stored and used only for the intended purposes.

Ijiga et al. (2024) [7] provide a comprehensive comparative analysis of the implementation of the Internet of Things (IoT) between two countries: Ghana and the United States. The study examines the varying visions for IoT integration, the architectural elements that shape these systems, and the potential future directions for IoT in both contexts. The authors emphasize the contrasting technological infrastructures between the two countries where the USA benefits from advanced infrastructure, extensive research, and innovation in IoT, Ghana, as a developing country, faces challenges such as limited access to high-speed internet and low

technological literacy. The paper offers insights into how IoT systems are envisioned in each country, discussing the role of governmental policies, industrial applications, and the readiness of consumers to adopt IoT technologies. It also highlights the importance of local contexts in shaping IoT strategies, such as the use of IoT in agriculture, healthcare, and urban development in Ghana, where these technologies offer solutions to pressing societal challenges.

Akoh and Isenyo (2024) [8] examine the integration of superhumans and synthetic humans into the Internet of Things (IoT) and ubiquitous computing, focusing on the applications of emerging artificial intelligence (AI) technologies in these domains. The paper explores how superhumans humans augmented with advanced technology are being incorporated into IoT ecosystems, potentially transforming industries by enhancing human capabilities. The authors also discuss synthetic humans, AI systems designed to simulate human behavior and intelligence, which could further revolutionize sectors like healthcare, customer service, and entertainment.

Olola et al. (2024) [9] explore the potential of crab shell-derived exoskeletons in orthopedic implant design, specifically focusing on their mechanical properties and biodegradability. The paper presents an innovative approach to utilizing natural materials specifically chitin and chitosan extracted from crab shells to design implants that are both strong and biodegradable. This is particularly relevant in the context of orthopedic implants, where the challenge is to create materials that not only provide adequate support but also degrade safely in the body over time, minimizing long-term complications and the need for additional surgeries. The authors conduct a series of tests on the mechanical strength and durability of crab shell-derived exoskeletons, comparing them to traditional synthetic materials used in implants.

Odeyemi (2024) [10] explores the potential for collaborative innovations in artificial intelligence (AI) to tackle the global issue of human trafficking. This paper examines partnerships between tech firms, especially leading US-based companies, and humanitarian organizations in utilizing AI for prevention, detection, and intervention in human trafficking cases. Odeyemi emphasizes that AI tools, such as machine learning algorithms, can analyze large

datasets from multiple sources, identify trafficking patterns, and predict where incidents may occur.

Olola et al. (2024) [11] focus on the application of deep learning techniques to enhance surveillance and detection systems aimed at combating human trafficking. The authors present a comprehensive overview of how deep learning algorithms, particularly convolutional neural networks (CNNs) and recurrent neural networks (RNNs), can be employed to detect and track human trafficking activities across various platforms, including social media, surveillance footage, and border control systems.

Ijiga, O. M., Idoko, I. P., Ebiega, G. I., Olajide, F. I., Olatunde, T. I., & Ukaegbu, C. (2024) [12] In this 2024 paper, Ijiga et al. investigate the use of adversarial machine learning (AML) for improving cybersecurity risk assessment and fraud prevention. AML, a technique where machine learning models are intentionally manipulated to test system vulnerabilities, is explored as an effective tool for threat detection. The authors argue that by simulating potential cyber-attacks through adversarial methods, organizations can better understand vulnerabilities in their

security frameworks and proactively safeguard against emerging threats.

Javornik and Pantano (2021) [13] explore how digital technologies, including artificial intelligence, augmented reality (AR), virtual reality (VR), and the Internet of Things (IoT), are reshaping the customer experience across various industries. The paper provides an in-depth analysis of how these technologies not only enhance customer engagement but also create new business models that offer more personalized and immersive experiences. The authors analyze both the positive impacts, such as improved convenience and customization, as well as the challenges, including technological adoption barriers and concerns over privacy.

Kumar (2022) [14] provides a systematic review of augmented reality (AR) applications in online retailing, emphasizing the role of AR in enhancing consumer shopping experiences. The paper reviews existing literature on how AR technology enables consumers to visualize products in their real-world environment before making purchasing decisions. This could include visualizing furniture in their living rooms or trying on clothes virtually, providing a more interactive and informed shopping process.

Lee et al. (2021) [15] discuss the role of digital transformation in retail, with a particular focus on the adoption of augmented reality (AR) and virtual reality (VR) technologies. The paper investigates how AR and VR can be integrated into retail strategies to create more immersive and engaging customer experiences. The authors explore how these technologies are being used for product visualization, virtual stores, and personalized shopping experiences, thereby enhancing the way customers interact with products online and in-store.

Onuh et al. (2024) [16] explore the intersection of biomedical and electrical engineering in advancing healthcare systems, with a focus on comparing the developments in Nigeria and the USA. The study highlights how synergy between these two engineering disciplines can improve healthcare delivery, particularly in diagnostics, treatment technologies, and medical equipment design. The authors compare healthcare infrastructure in both countries, noting the significant technological advancements in the USA, which often rely on state-of-the-art biomedical engineering solutions. Conversely, in Nigeria, healthcare systems face infrastructural challenges, but the paper discusses how electrical engineering

innovations can bridge the gap by providing affordable and scalable medical technologies.

Poplar Studio (2022) [17] examines the innovative use of augmented reality (AR) in grocery shopping, specifically focusing on the AR way finding app developed by Marks & Spencer (M&S). This app uses AR technology to help customers navigate through grocery stores, making their shopping experience more efficient by guiding them to the products they need. The paper highlights how AR can improve the in-store shopping experience by providing visual cues, enhancing product discovery, and offering a more interactive and engaging environment for customers. The article also discusses how this technology could potentially reduce time spent searching for products, increase customer satisfaction, and improve sales.

PYMNTS (2020) [18] provides an in-depth analysis of how virtual reality (VR) and augmented reality (AR) are beginning to have a significant impact on the retail industry. The article highlights a range of use cases where these technologies are being employed, from virtual stores and try-before-you-buy experiences to immersive product displays and virtual shopping

assistants. The article examines how retailers are increasingly adopting VR and AR to create more engaging and personalized shopping experiences. The focus is on how these technologies can help bridge the gap between online and in-store shopping by offering customers an immersive experience that mimics the physical store environment. Additionally, PYMNTS discusses the potential of VR/AR to improve product customization, enhance brand storytelling, and increase customer engagement. The article stresses that as VR/AR technologies evolve, they will become central to the retail experience, driving innovation and competitive advantage for retailers that adopt them early.

Yang and Wu (2020) [19] present a study on the effectiveness of virtual reality (VR) technology in enhancing learning outcomes for retail store design courses. This research investigates how VR technology can provide students with an immersive and interactive environment in which they can experiment with retail layouts, design strategies, and customer experience principles. The study suggests that VR can significantly enhance learning effectiveness by providing students with practical, hands-on experiences that traditional classroom learning cannot offer. Through VR, students can engage in

realistic simulations of store environments, helping them understand spatial design, consumer behavior, and the impact of store layouts on sales. The paper concludes by advocating for the integration of VR into educational curricula for retail and design courses, as it allows students to better visualize and apply theoretical concepts in real-world scenarios.

Wedel, M., & Pieters, R. (2020) [20] provide an extensive review of eye-tracking research within the field of marketing. The authors explore how eye-tracking technology has evolved and how it has been applied to better understand consumer behavior, perceptions, and decision-making processes. They discuss various methodologies, insights gained from eye-tracking studies, and the contributions of this research to marketing strategies. The authors discuss several methodological advances in eye-tracking research. They emphasize the increasing accuracy of eye-tracking devices and their ability to record eye movements in natural environments.

Methodology

Because AR and VR technologies provide engaging and interactive purchasing experiences, they are revolutionizing the retail industry. Through applications like

virtual try-ons and interactive displays, augmented reality (AR) enhances the shopping experience by superimposing digital information onto the real world (Chen, R., et al., 2022). Customers may use this technology to see items in a real-world setting, which enhances their ability to evaluate and make decisions about them (Ijiga et al., 2024). Contrarily, virtual reality (VR) produces fully virtual worlds that mimic actual shop experiences, enabling customers to explore goods and areas in a very engaging manner (Bonetti et al., 2018). By offering more individualized and captivating purchasing experiences, these technologies provide merchants the chance to improve customer engagement (Idoko et al., 2024). As mobile technology advances and customer desire for unique shopping experiences rises, current trends show a rising integration of AR and VR in both online and offline retail environments (Poushneh & Vasquez-Parraga, 2017).

Concepts and Definitions

AR and VR are two different yet complimentary technologies that are transforming the retail industry. By superimposing digital content including noises, visuals, and other sensory elements on top of real-world surroundings,

augmented reality (AR) creates more engaging and richer customer experiences (Flavián et al., 2021). Using gadgets like smartphones and AR glasses, this technology can combine virtual and real-world images [5]. Through the use of headgear and controllers, virtual reality (VR) transports users to fully simulated worlds that may replicate real-world or fantasy settings for immersive exploration and interaction (Wedel & Pieters, 2020). With previously unheard-of levels of interaction and customisation, these technologies are revolutionizing how customers see and connect with retail environments and goods (Liao et al., 2020). It is essential to comprehend these fundamental ideas in order to evaluate their influence on customer behavior and the changing retail environment.



Figure 3: AR Improves the Experience of Grocery Shopping (Poplar Studio, 2022).

Current Retail Applications

AR and VR are revolutionizing conventional retail purchasing by providing innovative solutions that improve customer experiences. AR greatly increases online and in-store exploratory activity by enabling virtual try-ons, which let buyers see clothing and accessories on themselves without having to engage with the retailer in person (Beck & Crié, 2018). Additionally, real-time information and engagement are provided by AR apps like interactive product displays and in-store navigation, which help customers make well-informed judgments on what to buy (Kumar, H. 2022). According to Ibokette et al. (2024), these apps not only improve client involvement but also close the gap between online and physical retail experiences, which raises customer satisfaction and boosts sales. Virtual Try-Ons: Using augmented reality (AR), shoppers may see items like clothes or eyeglasses on themselves. Virtual Storefronts: Use virtual reality (VR) to provide a completely immersive shopping experience that mimics a physical store [6]. In-Store Navigation: Use augmented reality (AR) to provide consumers with interactive maps and instructions while they navigate actual shops. Interactive Product Demos: Use AR and VR to interactively present the characteristics and capabilities of

your products. Immersion Advertising: Make use of virtual reality (VR) to create immersive, customer-engaging advertising campaigns.

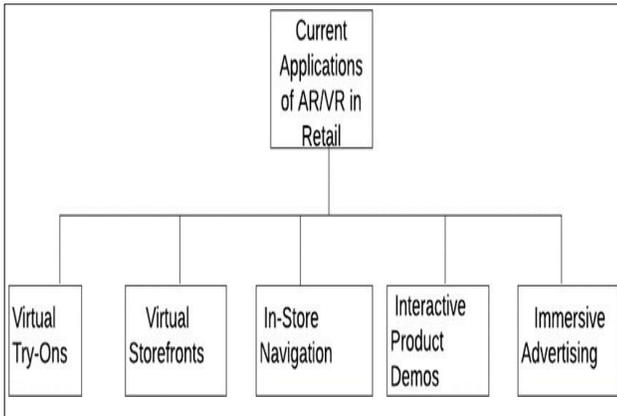


Figure 4: Current Retail AR/VR Applications

Technological Evolution and Trends

Significant developments that improve the shopping experience for customers and spur creativity in customer interaction have characterized the emergence of AR and VR technology in retail. While AR applications first concentrated on basic overlays, recent developments allow for more complex interactive elements, such virtual try-ons and real-time product visualization, to be seamlessly incorporated into online platforms and mobile apps (Beck et al., 2021). From simple virtual worlds to completely immersive simulations that provide intricate and dynamic virtual retail experiences, virtual reality

technology has advanced, improving customer engagement and immersion (Weller & Dinnie, 2020). According to current trends, AR/VR and AI are convergent, enabling more predictive and customized buying experiences [7]. According to Javornik et al. (2019), these integrated systems are capable of analyzing customer behavior and preferences in order to provide personalized suggestions and real-time virtual help. These developments have the potential to completely transform the retail industry by establishing smooth, interesting, and very customized shopping experiences.

Impact of AR and VR on Customer Engagement

By producing immersive and engaging shopping experiences that outperform conventional retail techniques, AR and VR technologies dramatically increase consumer engagement. Applications of AR, such interactive product displays and virtual try-ons, provide a feeling of personalized and spatial presence that enhances app and brand reactions (Smink et al., 2019). Customers can see things in their own surroundings thanks to these technologies, which raises the perceived value and makes it easier for them to make well-informed purchases. By providing completely realistic settings that allow customers to virtually explore goods and businesses, virtual reality (VR) further

increases engagement and fosters more emotional and psychological involvement (Huang & Liu, 2020). Consumer-brand interactions are strengthened by the capacity to customize experiences using AR/VR apps, which promotes stronger connections and loyalty (Scholz & Duffy, 2018). In addition to captivating customers, these immersive experiences provide businesses useful information that they can use to improve their tactics and raise customer retention and satisfaction levels overall [8].

Customer Interaction and Experience Enhancement

Because AR and VR technologies make purchasing more realistic and engaging, they greatly improve consumer connection and experience. By offering vibrant and dynamic product information, augmented reality apps improve decision-making and satisfy customers' need for in-depth product knowledge and interaction (Xia, L., & Monroe, K. B. 2017). AR fosters a feeling of connection and realism by enabling users to see and interact with virtual objects in their surroundings, enabling more in-depth engagement with the brand and product (Yim et al., 2017). VR enhances this by providing realistic simulations that mimic or improve in-store experiences, making the buying experience more interesting and fulfilling.

Increased emotional involvement and more memorable shopping experiences may result from these virtual reality settings, which can either replicate the atmosphere of real shops or provide whole new interactive places (Poncin & Mimoun, 2014).

Metrics for Measuring Engagement

Several measures are used to evaluate the influence of AR and VR on consumer behavior and interaction in order to quantify customer engagement in retail. In order to give insights into customer preferences and satisfaction levels, metrics concentrate on measuring both qualitative and quantitative dimensions of interaction [9]. First of all, behavioral indications like interaction length, frequency, and navigation behaviors inside AR/VR environments are often included in engagement measurements (Yim, Chu, & Sauer, 2017). These indicators aid in determining the degree of customer engagement and interest sparked by AR/VR experiences. Second, when consumers engage with AR/VR material, emotional response metrics assess their affective responses. Through physiological reactions or self-reported evaluations, these measures quantify emotional arousal, valence, and overall mood [20].

Behavioral and Psychological Reactions

Examining how AR and VR affect customer perceptions and behavior is crucial to understanding the psychological and behavioral reactions these technologies evoke in retail settings. When using AR and VR apps, consumers often report feeling more immersed and engaged in their senses [19]. By superimposing digital data on the real environment, augmented reality (AR) improves customer experiences by stimulating sensory perceptions that improve decision-making and product assessment (Smink et al., 2019). Conversely, virtual reality (VR) produces realistic virtual worlds that mimic actual retail experiences, generating feelings and boosting customer engagement (Huang & Liu, 2020).

According to Scholz and Duffy (2018), these technologies stimulate positive emotive reactions including excitement, curiosity, and pleasure, all of which improve consumer satisfaction and brand perceptions. Additionally, by boosting brand loyalty, encouraging repeat business at both physical and online establishments, and raising purchase intention, AR and VR may affect customer behavior (Yim et al., 2017). Retailers may enhance AR and VR apps to provide emotionally impactful and captivating experiences that encourage engagement and

eventually influence purchase choices by analyzing these behavioral and psychological reactions (Idoko et al., 2024). The degree of cognitive processing and knowledge retention attained by AR/VR encounters is finally measured by measures evaluating cognitive engagement [10]. Metrics including memory accuracy, product knowledge understanding, and decision-making efficiency are included in this (Poncin & Mimoun, 2014).

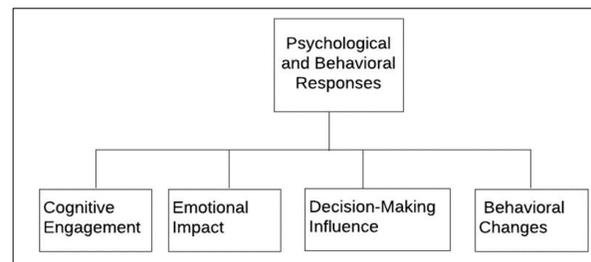


Figure 5: Retailers' Emotional and Behavioral Reactions to AR and VR

Obstacles and Restrictions

As shown in table 6, despite their promise, AR and VR technologies have certain obstacles and restrictions that limit their uptake and efficacy in the retail industry. The high expense of creating and maintaining AR/VR apps is one significant obstacle that many shops may find prohibitive (Pantano et al., 2017). Furthermore, the need for sophisticated hardware and software compatibility may restrict consumer access and lower the AR/VR experiences' overall reach (McLean & Wilson, 2019). According to Rauschnabel et al. (2019),

technical constraints including low resolution, latency problems, and little interaction may negatively impact the user experience and cause annoyance and disengagement. Significant ethical and legal issues are also raised by privacy issues and the management of personal data gathered by these technologies [18]. In order to overcome these obstacles, continuous investments in infrastructure and technological development are needed, together with careful consideration of data security and user privacy.

Result analysis

AR and VR technology integration in retail has shown great promise for changing customer engagement and buying patterns. We have examined in this research how these technologies impact customer decision-making, improve immersive shopping experiences, and maybe boost sales. Problems include high implementation costs, technical obstacles, and user acceptability concerns still exist despite their potential. Future studies should concentrate on resolving these issues via increased privacy protections, better usability, and technology developments. Furthermore, investigating how AR and VR affect customer behavior and brand loyalty over the long run can provide light on their ongoing influence in retail environments. Additionally, using

machine learning and sophisticated analytics methods will allow for more accurate assessment of AR/VR efficacy and maximize its use in improving the customer experience. Retailers can build engaging and customized experiences that appeal to contemporary customers by overcoming these obstacles and using the developing capabilities of AR and VR. This will help to shape the future of retail towards more immersive and interactive spaces.

Implications for Retailers

Retailers looking to increase consumer engagement and boost sales will be significantly impacted by the adoption of AR and VR technology. First off, incorporating AR and VR into retail spaces may help companies stand out by providing distinctive and engaging shopping experiences that appeal to the interaction and customization demands of contemporary customers. By using these technologies to present items in authentic settings, retailers can improve decision-making and reduce purchase uncertainty [17].

Additionally, by offering interactive product demos, virtual try-on capabilities, and tailored suggestions, AR/VR may expedite the purchasing process and increase consumer happiness and loyalty. Retailers must, however, overcome obstacles including upfront

investment costs, the difficulties of technical integration, and guaranteeing smooth user experiences across many platforms if they want to fully reap these advantages. In order to maximize AR/VR deployments, shops should strategically invest in educating employees to use AR/VR efficiently, work with technology suppliers to develop creative solutions, and regularly monitor customer data. Retailers may meet and even surpass consumer expectations by carefully and strategically using these technologies, which will boost long-term development and competitiveness in the rapidly changing retail market [11].

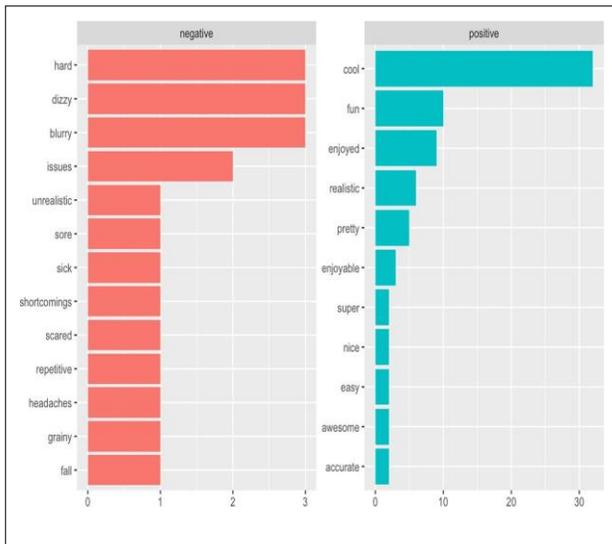


Figure 6: Results of sentiment analysis: Frequently used negative versus positive terms

Directions for Future Research

To improve comprehension and application, future studies in the field of AR and VR in retail should concentrate on a few key topics. First and foremost, evaluating enduring effects beyond initial engagement requires investigating the long-term implications of AR/VR on customer behavior and brand loyalty. Furthermore, examining the best design practices and UI improvements may improve usability and acceptability across a range of customer groups [16].

To better assess and forecast how well AR/VR apps influence consumer choices and optimize customer journeys, further research should explore the integration of sophisticated analytics and machine learning approaches. For wider usage in retail contexts, it will also be essential to address technical constraints, such as enhancing hardware capabilities and lowering implementation costs. Furthermore, crucial issues for further research include comprehending cross-platform interoperability and guaranteeing data security and privacy in AR/VR installations [12].

JMP 14.2 Exploratory factor analysis (EFA) on maximum likelihood with varimax rotation was used to analyze the data, and it was confirmed that all items were acceptable with factor loadings greater than 0.5 (Hair et al., 2010). All

variables had Cronbach's alpha values over 0.7, which is a respectable level (Hair et al., 2010).

Hypothesis testing

According to the research, prior VR experience may have a significant influence on the arousal and enjoyment of VR users. One important factor was whether or not the VR shop experience was the customer's first time using VR. However, the purpose of this research was to determine if the VR shop experience in this trial evoked and satisfied first-time users (coded as 2) and seasoned users (coded as 1) differently. The regression findings confirmed that prior VR experience does not affect arousal ($\beta = -0.24$, $p=0.32$) or enjoyment ($\beta = 0.17$, $p=0.44$) [13]. Therefore, in order to explore the hypothesis further, the research did not account for the effect of prior VR experience.

Regression analyses were used to evaluate the hypotheses, with VR being coded as 2 and the website as 1. According to the findings, H1a and H1b were supported since the VR shop experience produced higher levels of arousal ($\beta=0.72$, $p<0.001$) and pleasure ($\beta=0.51$, $p<0.001$) than the webpage. The moderating effect of store familiarity between arousal (H2a) and pleasure (H2b) was examined in H2. There was no discernible difference between the original regression models (H1a and H1b)

and the moderating regression models (H2a and H2b) that were shown. Therefore, it was determined that store familiarity did not seem to have a moderating impact, rejecting H2a ($F=1.47$, $\beta = -0.12$, $p=0.23$) and H2b ($F=0.78$, $\beta = -0.09$, $p=0.38$). Lastly, customers who experienced higher levels of pleasure ($\beta=0.71$, $p<0.001$) and arousal ($\beta=0.49$, $p<0.001$) were more likely to think the shop was beautiful, supporting H3a and H3b [15].

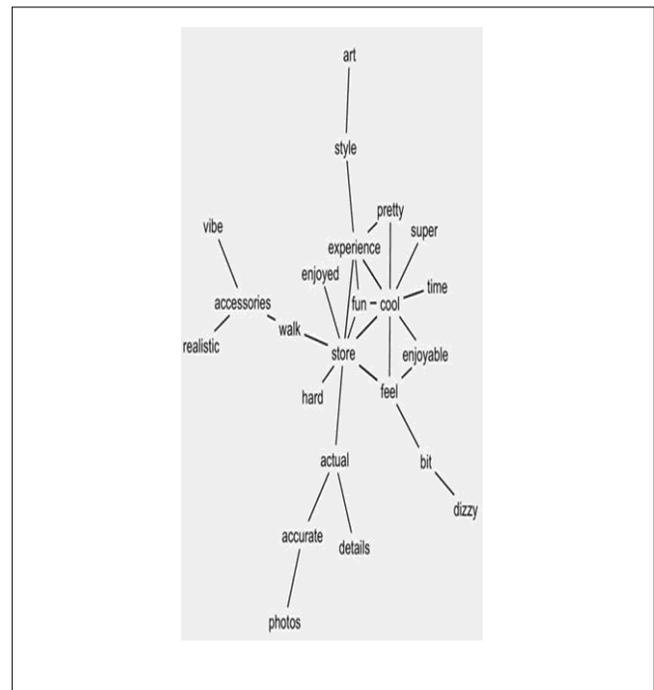


Figure 7: R-based semantic network analysis result: The association between two frequently reported terms

Text analytics and sentiment analysis of users' views about their VR shop experience The

Tidytext package in the R studio program was used to do the text analytics and sentiment analysis. Using Bing Liu's vocabulary, sentiment analysis was first utilized to assess the valence of views (i.e., positive or negative) (Liu, 2012). The findings showed 17.70% negative and 82.30% positive terms. Sentiment analysis uncovered common replies. Positive word sets are shown in the right chart, whereas negative word sets are displayed in the left [14]. The top three positive terms were "cool" (n=32), "fun" (n=10), and "enjoyed" (n=9), with realistic, lovely, and delightful coming in second and third, respectively. The most often used negative terms were "blurry," "dizzy," and "hard," which each participant noted three times. The terms "sore," "sick," "headaches," and "fall" were also used to describe the physical distress.

Conclusion

In conclusion, the integration of Virtual Reality (VR) in e-commerce presents a transformative opportunity to enhance user engagement and improve customer attitudes toward online shopping. VR allows for a more immersive, interactive, and personalized shopping experience, offering better product visualization and reducing uncertainties that often accompany traditional online shopping. Consumers generally show positive attitudes

toward VR-enhanced shopping, appreciating the novelty and excitement it brings. However, challenges such as high implementation costs, technical limitations, and the need for specialized hardware may hinder widespread adoption. Despite these obstacles, as VR technology continues to evolve and become more accessible, it has the potential to revolutionize the e-commerce industry by offering a richer, more engaging, and satisfying shopping experience. Retailers who can effectively integrate VR into their platforms will likely benefit from increased customer engagement, higher conversion rates, and improved brand loyalty.

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