Summer 7-26-2022

VR/AR Application in E-commerce: a Literature Review

Hong Chen
Faculty of Management and Business, Tampere University, Finland

Hongxiu Li
Faculty of Management and Business, Tampere University, Finland

Full Research Paper

VR/AR Application in E-commerce: a Literature Review

Hong Chen[1], Hongxiu Li[2]

[1,2]Faculty of Management and Business, Tampere University, Finland

Abstract: Virtual Reality (VR) or Augmented Reality (AR) offers practitioners unprecedented opportunities to boom their businesses, such as in the e-commerce context. However, there is a lack of holistic understanding of the application of VR/AR in e-commerce based on the literature. To address the above research gap, the current study conducts a literature review on VR/AR research in the e-commerce field from the methods, theories, and devices perspectives. Based on the 77 journal articles reviewed in this study, we found that the experimental approach has been the dominant research method to investigate the application of various VR/AR technology in different e-commerce contexts from different theoretical views. Finally, future research agendas and the research limitations are presented.

Keywords: VR, AR, literature review, e-commerce

1. INTRODUCTION

E-commerce companies have applied innovative immersive technologies in their business, such as Virtual Reality (VR) or Augmented Reality (AR), which both offer practitioners unprecedented opportunities to boom their businesses, such as in the e-commerce context. In 2017, the furniture giant IKEA has launched its first version of IKEA PLACE (AR App) with over 2,000 3D virtual furniture and interior design, providing consumers with a vivid pre-try experience. The COVID-19 pandemic has led to the scaling of e-commerce, and many companies have attempted to use VR/AR to enhance consumers' online shopping experiences.

Mixed reality technologies, including VR and AR, are cutting-edge human interface technologies that fuse the virtual and real worlds seamlessly in real-time [1]. VR refers to a simulated 3D environment by mediating technologies, where users can interact with virtual goods [2]. VR technology can be divided into three patterns: i) computer-based VR; ii) projection system-based VR; and iii) VR with 3D glasses, voice monitors, and headsets [2]. AR refers to another 3D virtual technology that incorporates virtual components into a real-world context to incur alternate perceptions of reality [3]. AR technology can be divided into computer-based AR [4], headset-based AR [5] and mobile-based AR [2]. VR has been argued to enhance consumers' involvement in online shopping and help consumers get more information about products to support their purchasing decisions [6]. Reference [7] investigated AR try-on systems in online stores and found that AR improves consumers' perceived re-processability and the sense of ownership, which in turn positively affect consumers' rapport experience in online shopping. A body of previous VR/AR literature also argued that VR/AR has advantages of interactivity, novelty, and vividness, which help enhance consumers' perceived usefulness and informativeness of technologies and reduce their perceived risk and uncertainty of products in online shopping [8],[9].

VR/AR has also attracted the attention of scholars and has been witnessing a continuous increase in research but lacks a holistic understanding of the application of VR/AR in e-commerce based on literature. It is necessary to make a review of literature on VR/AR in e-commerce to provide an understanding of the research on VR/AR in e-commerce, which might provide some new insights to the VR/AR research and practitioners.

To address the above research gap, this study made a literature review of VR/AR in the e-commerce field based on the previous literature. This study analyzed the selected 77 articles based on the researched devices, the research methods, and the applied theories. Based on the findings from the literature review, future research agendas were proposed.

2. LITERATURE REVIEW PROCEDURE

The literature review was conducted based on the articles published in three databases: Scopus, ABI, and EBSCO within the time range from 2000 to 2021. The search for literature in Scopus was conducted with the query “TITLE-ABS-KEY (VR OR "virtual reality" OR AR OR "Augmented Reality") AND TITLE-ABS-KEY (e-commerce OR "online shopping" OR "online store" OR "online retail" OR "online sale" OR "online purchase") AND SRCTYPE(j) AND DOCTYPE (ar) AND PUBYEAR AFT 1999”. The search was limited to peer-reviewed journal articles. The other search term is “E-commerce, online retail, online shopping, online purchase, or online sale”, which are synonyms in the online shopping context.

In the ABI database, the query of search is “ab((VR OR "virtual reality" OR AR OR "Augmented Reality") AND (e-commerce OR "online shopping" OR "online store" OR "online retail" OR "online sale" OR "online purchase")) OR ti((VR OR "virtual reality" OR AR OR "Augmented Reality") AND (e-commerce OR "online shopping" OR "online store" OR "online retail" OR "online sale" OR "online purchase")) from 2000 to 2021 (only peer-reviewed)”, and limited in articles in academic journals. In EBSCO, the query is “(VR OR virtual reality" OR AR OR "Augmented Reality") in (AB OR TI) AND (e-commerce OR online shopping OR online store OR online retail OR online sale OR online purchase) in (AB OR TI).

The literature search was conducted in November 2021. A total of 264 academic journal articles were collected from ABI (N=31), EBSCO (N=4), and SCOPUS (N=229). All references were collected and stored in the reference management software Mendeley for further reading and analysis.

Among the 264 articles, 59 articles were excluded as full access to these articles are not available, or these articles are not published in English. We then read the full articles of the 205 left articles to check whether these studies research on VR/AR in the e-commerce context. Consequently, 113 articles were excluded in the review as these studies do not examine VR/AR in e-commerce yet, and 92 articles were left. We also excluded 8 literature review articles as these studies do not provide empirical findings, and 84 journal articles were left. In the final selected 84 articles from the three different databases, there are 7 duplicated papers. Thus, 77 journal articles were finally included in the literature review for analysis. Figure 1 provides more details of the article searching process.

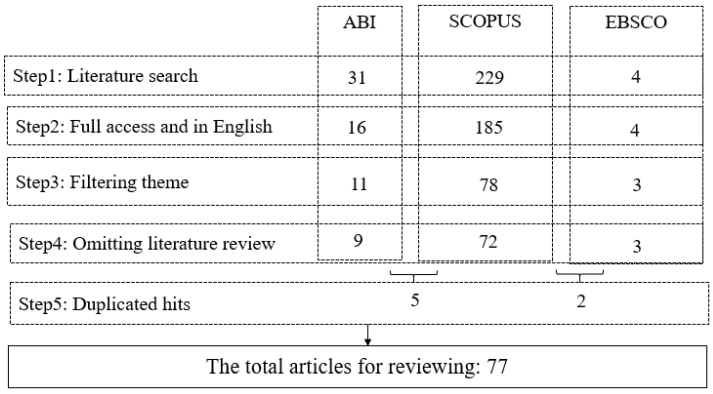

Figure 1. The flow of literature searching

3. FINDINGS

In the current literature review, a total of 77 academic journal articles were selected from ABI (N=4, 5.2%), EBSCO (N=1, 1.3%), and SCOPUS (N=72, 93.5%) for review from 2000 to 2021. The distribution of these articles from the year 2000 to 2021 is presented in Figure 2. Obviously, there are more studies on VR/AR in e-commerce from 2018 when compared with research on the topic before 2018. There has been a continuous increase in research on these topics in the e-commerce field since that year. The articles (total number=54)

published from 2018 to 2021 account for more than 70 percent of the articles published in the studied years from 2000 to 2021, indicating the increasing research interest in VR/AR application in the e-commerce context.

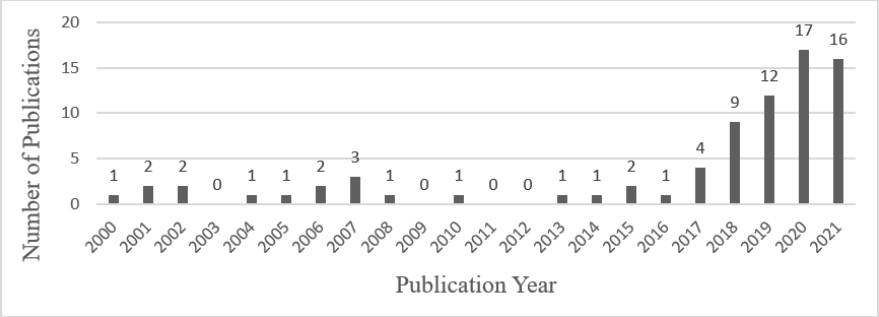

Figure 2. The distribution of publications from 2000 to 2021

In the following, we discuss the main studied VR/AR devices, the applied research methods, and the applied theories based on the analysis of the 77 selected articles.

3.1 Research methods

Among the 77 papers, experiments have been the dominant research method (N=40, 51.9%). The experimental approach is a suitable method to explain and reveal psychological processes and human reactions that are normally hard to observe. These studies applied experiments method to examine consumers' perceptions and reactions to different VR/AR devices applied in different e-commerce contexts to understand how VR/AR influence consumers' perceptions and behaviors from the consumer perspective. Specifically, among these 40 empirical studies, different experimental approaches have been applied, such as field and quasi-experiment (N=6, 15.0%), lab-experiment (N=25, 62.5%), web-experiment (N=7, 17.5%), and mix lab and web-experiment (N=2, 5.0%).

A couple of studies have applied survey (N=3, 3.9%) method. Case study (N=4, 5.2%), design research (N=17, 22.1%), and interview (N=3, 3.9%) have also been applied in these reviewed articles to explore the effect of technological features and application environment of VR/AR on online purchase or foster the development and innovation of VR/AR in e-commerce field. One article has applied mixed research methods, including focus group interviews and questionnaires. In the selected 77 articles, 9 (11.7%) of them are conceptual papers developed to explain the application of VR/AR in the e-commerce field. More details about the research methods applied in these studied articles are presented in Figure 3.

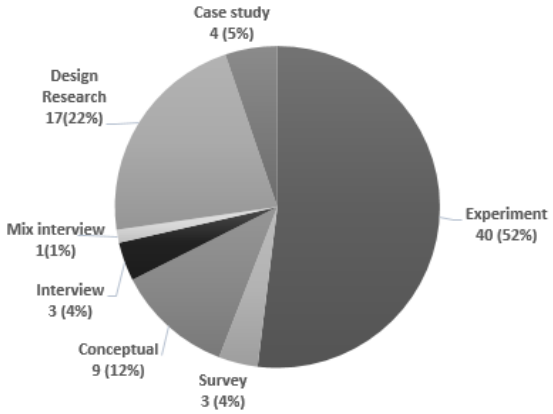

Figure 3. The description of methods

3.2 Research theories

Theories across disciplines, such as information system, psychology, and marketing, have been applied to

explore the effect of VR/AR in e-commerce. For instance, telepresence theory has been applied to explain how technical features of VR/AR, such as vividness, richness, usefulness, and interactivity enhance consumer experience [2]; construal level theory has been used to explore how the technical characteristics of interactive VR/AR technology affect consumers' perceived ease of use and usefulness of the technology in the online shopping context [10]. Some theoretical frameworks have also been employed to explain how VR/AR affect consumers' cognition, affects, and related behaviors, such as technology-organization-environment (TOE) [11], technology acceptance model (TAM) [6], stimulus-organism-response (SOR model) [12], and the value-based adoption model (VAM) [5]. More details of the theories applied in the reviewed articles are presented in Table 1.

Table 1. List of theories applied in the reviewed articles

Theories	Explanation	Articles
Telepresence theory	The psychological state of "being there" in a virtual world together with the vividness and interactivity generates a positive persuasion effect from VR, AR and augments consumers' product knowledge and purchase intentions.	[2, 4,13]
Media richness theory	The communication media that can clarify vague affairs and tackle different perspectives of information timely are considered high richness. VR has the advantage of such richness which can influence consumers' ease of use and perceived usefulness of VR.	[14]
Flow theory	People would have a high level of flow experience in AR use, which enhances purchase intention.	[15]
Partially observed Markov decision process	It explains the nature of VR/AR-human interaction partially observed due to uncertainty and lack of understanding of the dynamic system. After consistent interaction with the VR/AR application, consumers would alter their behavior to prime a different consequence from those technologies.	[16]
Product fit uncertainty	The uncertainty occurs when consumers cannot determine whether a product meets their needs. AR use reduces fit uncertainty and thereby boosts sales.	[3]
Task-technology fit Theory	VR-based product presentation can improve consumers' knowledge of the product due to its technology fit for product presentation tasks.	[17, 18]
Equity theory	The perceived augmented quality and privacy information control as high equity induce users' satisfaction towards AR when they evaluate the value of output overweigh that of the input.	[19]
Affective and cognition model	User perceptions of the informativeness and playfulness of VR shape the purchase intention.	[8]
Feelings as information theory	The enjoyment and interactivity in AR app use ensure consumers' confidence about the chosen products and induce their reuse intention of AR technology due to the cognitive appraisal.	[20]
Construal level theory	AR applications have a perception of proximity to virtual products and enhance purchase intention.	[21]
Memory theory	VR environment enhances consumers' recall product locations, no matter whether products were targets or were incidental to the consumers' goals.	[22]
Transfer theory	Consumers will transfer their excitement from AR usage to the evaluation of products and the intention to recommend them.	[23]
Reactance theory	In a make-up AR App, perceived persuasive impedes users' purchase intention because they do not feel freedom or control.	[4]
Big five personalities	In VR-based shopping malls, shopper personalities including agreeableness, openness to experience, neuroticism, conscientiousness and extraversion, do not affect their purchase behaviors.	[24]
Cue-utilization theory	The more familiar are for products, the lower attention is in AR-based online shopping as stable cognitive flow could be interrupted by special or unexpected sensory stimuli, such as visual and audial stimuli in AR.	[25, 26]
Audition marketing	AR augmented sounds of products, which helps consumers infer about the power of the products and influences consumers' perception about the products.	[27]
Cue diagnosticity and power	AR can augment sounds of products, which helps consumers infer about their power, improving the paying willingness of consumers for those louder products.	[27]
Sensory marketing	A VR-based retail environment is more suitable for instrumental touch products such as tools since consumers can gather touch information to support their decision about the	[28]

Theories	Explanation	Articles
	product.	
Theory of reasoned action	Attitude with VR mode in medical beauty can positively predict consumers' purchase intention.	[17]
Self-evaluation theory	AR try-on systems in online stores improves consumers' perceived re-processability and the sense of ownership, which in turn positively affect consumers' rapport experience in online shopping.	[7]
Socially situated cognition theory	Embedding a point-of-view share recommendation system in AR would enhance the likelihood for consumers to adopt the advice in their decision-making as consumers usually rely on others' support to make decisions.	[29, 30]
Technology-organization-environment theory	Technological factors, organizational factors, and environmental factors affect AR adoption intention in firms.	[11]
Technology acceptance model	Perceived usefulness and ease of use affect users' attitude and behavior towards VR and AR technology.	[6, 31, 32]
Stimuli-organism - response theory	VR & AR presentation stimulates patronage intention and revisit via psychological responses, such as immersion, enjoyment, perceived product risk and confidence in choice.	[12, 33]
The value-based adoption model	Users evaluate the value of AR value in terms of social, technical, experiential, and the economic dimension to support their decision on AR use.	[5]

3.3 Researched devices

Initial VR/AR devices has been mainly used to present 3D visual images and drag users into an artificial real-time environment, which has been commonly shown by computers and mice. The development of input and output devices equipped with VR glasses and headsets make a more vivid and higher pixel panoramic view possible. The recent advanced VR/AR devices prime multiple sensory within visual, audio, and touch, which provides users with funnier and immersive experiences. Among the 77 articles, 47 of them have examined the visual-based (N=36, 76.7%), audio-based (N=8, 17.0%) and haptic-based (N=3, 6.3%) VR/AR devices with various sensory as well as input and output devices. The investigation of different VR/AR devices in the e-commerce context indicate the diversity of VR/AR devices applied in business as well as the improvement and development of VR/AR devices over the past years.

Table 2. VR/AR devices used in e-commerce context

Senses	Input & tracking devices	Presentation devices	Output styles	Articles
Visual (N=36, 76.7%)	PC	HTML pages	Panoramic image/text	[22]
	Multiple agent system	Virtual reality modeling language (VRML) or Java 3D-based browser	Video	[34]
	3DIGM's virtual reality engine, NOVA	HTML/ ASP/ JavaScript/Flash	Image/text	[13]
	Active Worlds SDK	HTML and asp pages	Image	[35]
	Vuzix ST AR 1200XLD headset	/	Image	[36]
	3D Einscan Pro+	/	360 panoramic widespread view	[37]
	Web camera/a Kinect for Windows SDK device	/	Image	[23, 38]
	HTC VIVE Headset	/	Image	[39]
	VR headsets embed website/mobile system	Unity (present 2D or 3D) + Gamification (CoSpaces Edu)	Image	[14]
	Akzo Nobel's Visualizer application	Data glove	Data	[29]
	3D AR-based VTO (3DLook software)	Google Pixel 3	Posture, animation clips	[9]

Visual (N=36, 76.7%)	Marker-based AR: laptop and smartphones/physical card/QR on packages	Unity 3D engine, Vuforia SDK	Image	[30]
	Markerless augmented reality headwear/mouse	Autodesk Maya 2012	Image	[40]
	3D/HD JVC projector	Stereoscopic projection	Life-size and photorealistic 3D model	[6]
	Visual & spatial: virtual city 3D models	UML and Visio	Geographic image	[41]
	Viola-Jones` face detection/Camshift	/	Data	[42]
	Smartphones ´camera/active LCD shutter glasses or TFT-LCD/monocular camera/ iOS glasses try-on App	Superimposed the shade of chosen products	Image/video	[3, 43, 44]
	Camera with IBMR technology/camera and smartphone	Garment CAD 3D technology: AR via website & App	Graphics, text, & image	[19, 45, 46]
	AR smart glasses (ARSG) Virtual mirror/camera	App & website	Colorful figures/ image	[5, 31]
	AR laptop or computer with a webcam	App & website	Image	[4]
Audio (N=8, 17.0%)	Microsoft Speech Engine SAPI	Native DLL & Java Native Interface (JNI)	Voice & image	[34]
	Headset (Vive Pro MV)	/	Voice & image	[27]
	Smartcard (scanning booth) /MR headset/palmtop computer	Personal Avatar performed by software	Graphic callouts with color and size	[1]
	iPad 2 equipped with GPS, cellular data/gravity sensors	Snapshot software & AR App	Audio	[47]
	Mobile Webcam	Markbased/markerless AR APP	Video/audio/images	[32]
	3DIGM's virtual-reality engine, NOVA, extending VRML 97	HTML, Active Server Page, JavaScript, & Flash	Audio & images	[18]
Haptic (N=3, 6.3%)	The-weight device/head-mounted display Arduino Uno device/HX711 amplifier-cellular module	Decrypt SMS to sense the weight	The sense of weight	[48]
	Oculus Rift headset	Unity	Text & image	[28]
	Head-mounted (HTC Vive) display & hand-held controllers	Unity game engine V5.5.3f1	Image	[49]

4. FUTURE AGENDAS

The literature review provides a comprehensive understanding of the VR/AR research in the e-commerce context based on the analysis of the research theories, research methods and the VR/AR devices in the selected 77 articles. Though prior research has applied different research methods to examine the application of various VR/AR devices in e-commerce field from different theoretical lens, future research needs to consider about extend the theories to provide deep understanding of the influence of VR/AR in e-commerce in different contexts with different or mixed research methods. We propose the future agenda from the perspectives of research theories, research method, and researched device. Prior research has mainly applied theories to explain VR/AR application in e-commerce from the individual consumer level with a focus on the technological features of VR/AR, future research should consider about the cognition and diversity of emotion reactions of consumers in VR/AR use in different e-commerce contexts as well as the positive and negative sides of VR/AR in different e-commerce context. In addition, future research should consider about investigating the impact of VR/AR on e-commerce from the organizational level and applying organizational theories to explore the

application of VR/AR in e-commerce contexts and provide insights into VR/AR application in online business for companies' organizations.

Although experiment approach has been a dominant research method to investigate individual consumers' perceptions and reactions to different VR/AR devices in the e-commerce context, future research should consider about applying different research methods, such as panel data, longitudinal study, design science research, action research, as well as mixed methods, such as mixed qualitative and quantitative study, mixed panel data and survey/experiment data in research to understand the phenomena, which might provide deep understanding of VR/AR use in business.

Prior research has examined various VR/AR devices in the e-commerce context. Future research could consider researching on multi-sense VR/AR devices and comparing user differences in VR/AR use in different online shopping settings.

5. LIMITATIONS

This study has its limitations which should be acknowledged. First, this study provides a comprehensive picture of the prior research on VR/AR application in e-commerce based on the research theories, research methods, and researched devices in these reviewed article, future research should consider about providing deep understanding of the prior research findings on the antecedents and consequences of VR/AR use in e-commerce in details based on prior literature. Second, the current study searched articles in the database of ABI, SCOPUS and EBSCO. Future research can consider about including articles from other academic database in literature review work. Third, this study only analyzed the theories, the devices and the research methods applied in the reviewed literature, future research could consider conducting meta-analysis of prior literature in the e-commerce context to provide comprehensive understanding of the findings on VR/AR use in e-commerce.

ACKNOWLEDGEMENT

This research was supported by the Finnish Foundation for Economic Education under Grant 7955-72358.

REFERENCES

[1] Koontz, M. L., & Gibson, I. E. (2002). Mixed reality merchandising: bricks, clicks and mix. Journal of Fashion Marketing and Management, 6(4): 381-395.

[2] Wang, Y., Yeh, C., Tseng, T. H., Lin, H., & Lin, S. (2019). Investigating online consumers' responses to product presentation modes: does product type really matter? Internet research, 29(6): 1233-1255.

[3] Tan, Y. C., Chandukala, S. R., & Reddy, S. K. (2021). Augmented reality in retail and its impact on sales. Journal of Marketing, 86(1): 48-66.

[4] Smink, A. R., van Reijmersdal, E. A., van Noort, G., & Neijens, P. C. (2020). Shopping in augmented reality: the effects of spatial presence, personalization and intrusiveness on app and brand responses. Journal of Business Research, 118(08): 474-485.

[5] Erdmann, A., Mas, J. M., & Arilla, R. (2021). Value-based adoption of augmented reality: a study on the influence on online purchase intention in retail. Journal of Consumer Behavior, 9: 1-21.

[6] Altarteer, S., & Charissis, V. (2019). Technology acceptance model for 3D virtual reality system in luxury brands online stores. IEEE Access, 7: 64053-64062.

[7] Huang, T. L., Mathews, S., & Chou, C. Y. (2019). Enhancing online rapport experience via augmented reality. Journal of Services Marketing, 31(7): 851-865.

[8] Kang, H. J., Shin, J. H., & Ponto, K. (2020). How 3D virtual reality stores can shape consumer purchase decisions: the roles of informativeness and playfulness. Journal of Interactive Marketing, 49: 70-85.

[9] Liu, Y., Liu, Y., Xu, S., Cheng, K., Masuko, S., & Tanaka, J. (2020). Comparing VR-and AR-based try-on systems using personalized avatars. Electronics (Switzerland), 9(11): 1-25.

[10] Chiang, L. L. (Luke), Huang, T. L., & Chung, H. F. L. (2021). Augmented reality interactive technology and interfaces: a construal-level theory perspective. Journal of Research in Interactive Marketing, online access. DOI 10.1108/JRIM-06-2021-0156.

[11] Chandra, S., Road, H., Kumar, K. N., & Road, H. (2018). Exploring factors influencing organizational adoption of augmented reality in e-commerce: empirical analysis using technology–organization–environment model. Journal of Electronic Commerce Research, 19(3): 237-266.

[12] Han, X., Wang, F., Lv, S., & Han, W. (2021). Mechanism linking AR-based presentation mode and consumers' responses: a moderated serial mediation model. Journal of Theoretical and Applied Electronic Commerce Research, 16(7): 2694-2707.

[13] Suh, K., & Chang, S. (2006). User interfaces and consumer perceptions of online stores: the role of telepresence. Behavior & Information Technology, 25(2): 99-113.

[14] Jang, Y. T., & Hsieh, P. S. (2021). Understanding consumer behavior in the multimedia context: incorporating gamification in VR-enhanced web system for tourism e-commerce. Multimedia Tools and Applications, 80(19): 29339-29365.

[15] Wang, Y, Ko, E., & Wang, H. (2021). Augmented reality (AR) app use in the beauty product industry and consumer purchase intention. Asia Pacific Journal of Marketing and Logistics.

[16] Moriuchi, E., Landers, V. M., Colton, D., & Hair, N. (2021). Engagement with chatbots versus augmented reality interactive technology in e-commerce. Journal of Strategic Marketing, 29(5): 375-389.

[17] Wang, M., Wang, W., & Lin, C. (2020). Implementation of AI e-commerce model for medical beauty industry: a case study in Penghu. Journal of Accounting, Finance & Management Strategy, 15(1): 103–128.

[18] Suh, K. S., & Lee, Y. E. (2005). The effects of virtual reality on consumer learning: an empirical investigation. MIS Quarterly, 29(4): 673-697.

[19] Poushneh, A. (2018). Augmented reality in retail: a trade-off between user's control of access to personal information and augmentation quality. Journal of Retailing and Consumer Services, 41(3): 169-176.

[20] Kowalczuk, P., Siepmann C., & Adler, J. (2021). Cognitive, affective, and behavioral consumer responses to augmented reality in e-commerce: a comparative study. Journal of Business Research, 124(3): 357-373.

[21] Poushneh, A. (2021). How close do we feel to virtual product to make a purchase decision? Impact of perceived proximity to virtual product and temporal purchase intention. Journal of Retailing and Consumer Services, 63(3): 1-9.

[22] Howes, A., Miles, G. E., Payne, S. J., Mitchell, C. D., & Davies, A. J. (2001). Incidental memory and navigation in panoramic virtual reality for electronic commerce. Human Factors, 43(2): 239-254.

[23] Brito, P. Q., Stoyanova, J., & Coelho, A. (2018). Augmented reality versus conventional interface: is there any difference in effectiveness? Multimedia Tools and Applications, 77(6): 7487-7516.

[24] Schnack, A., Wright, M. J., & Elms, J. (2021). Investigating the impact of shopper personality on behavior in immersive virtual reality store environments. Journal of Retailing and Consumer Services, 61(3): 1-11.

[25] Yim, M. Y. C., Chu, S. C., & Sauer, P. L. (2017). Is augmented reality technology an effective tool for e-commerce? An interactivity and vividness perspective. Journal of Interactive Marketing, 39(3): 89-103.

[26] Song, H. K., Baek, E., & Choo, H. J. (2020). Try-on experience with augmented reality comforts your decision: focusing on the roles of immersion and psychological ownership. Information Technology and People, 33(4): 1214-1234.

[27] Ringler, C., Sirianni, N. J., & Christenson, B. (2021). The power of consequential product sounds. Journal of Retailing, 97(2): 288-300.

[28] Alzayat, A., & Lee, S. H. (Mark). (2021). Virtual products as an extension of my body: exploring hedonic and utilitarian

shopping value in a virtual reality retail environment. Journal of Business Research, 130(3): 348-363.

[29] Hilken, T., Keeling, D. I., de Ruyter, K., Mahr, D., & Chylinski, M. (2020). Seeing eye to eye: social augmented reality and shared decision making in the marketplace. Journal of the Academy of Marketing Science, 48(2): 143-164.

[30] Liu, B., & Tanaka, J. (2020). Integrating gamification and social interaction into an AR-based gamified point system. Multimodal Technologies and Interaction, 4(3): 1-19.

[31] Pantano, E., Rese, A., & Baier, D. (2017). Enhancing the online decision-making process by using augmented reality: a two-country comparison of youth markets. Journal of Retailing and Consumer Services, 38(3): 81-95.

[32] Rese, A., Baier, D., Geyer-Schulz, A., & Schreiber, S. (2017). How augmented reality apps are accepted by consumers: a comparative analysis using scales and opinions. Technological Forecasting and Social Change, 124(3): 306-319.

[33] Hwangbo, H., Kim, E. H., Lee, S. H., & Jang, Y. J. (2020). Effects of 3D virtual "try-on" on online sales and customers' purchasing experiences. IEEE Access, 8: 189479-189489.

[34] Shen, X., Radakrishnan, T., & Georganas, N. D. (2002). vCOM: electronic commerce in a collaborative virtual world. Electronic Commerce Research and Applications, 1(4): 281-300.

[35] Papadopoulou, P. (2007). Applying virtual reality for trust-building e-commerce environments. Virtual Reality, 11(2): 107-127.

[36] Schaeffer, S. E., Garza, S. E., Espinosa, J. C., Urbina, S. C., Nurmi, P., & Cruz-Reyes, L. (2018). A framework for informing consumers on the ecological impact of products at point of sale. Behavior and Information Technology, 37(6): 607-621.

[37] Wook, T. S. M. T., Nor, S. F. M., Mohamed, H., Ashaari, N. S., & Zin, N. A. M. (2020). Multi-dimensional interface design of e-commerce for virtual museum system. International Journal on Advanced Science, Engineering and Information Technology, 10(2): 668-675.

[38] Moroz, M. (2019). Tendency to use the virtual fitting room in generation Y-results of qualitative study. Foundations of Management, 11(1): 239-254.

[39] Su, K. W., Chen, S. C., Lin, P. H., & Hsieh, C. I. (2020). Evaluating the user interface and experience of VR in the electronic commerce environment: a hybrid approach. Virtual Reality, 24(2): 241-254.

[40] Wang, C. H., Chiang, Y. C., & Wang, M. J. (2015). Evaluation of an augmented reality embedded online shopping system. Procedia Manufacturing, 3: 5624-5630.

[41] Wang, H., & Fang, F. (2020). Research on e-commerce supply chain design based on MVC model and virtual image technology. IEEE Access, 8: 98295-98304.

[42] Jun, L. X., Bo, X., & Feng, Y. (2013). Research and application of online product display technology based on augmented reality. Information Technology Journal, 12(6): 1134-1142.

[43] Liu, C. L., & Uang, S. T. (2016). Effects of depth perception cues and display types on presence and cybersickness in the elderly within a 3D virtual store. Journal of Ambient Intelligence and Humanized Computing, 7(6): 763-775.

[44] Zhang, B. (2018). Augmented reality virtual glasses try-on technology based on iOS platform. Eurasip Journal on Image and Video Processing, 2018(1): 1-19.

[45] Zhang, X. (2021). New retail marketing strategy combining virtual reality and 5G mobile communication. Mathematical Problems in Engineering, 2021: 1-14.

[46] Li, C., & Cohen, F. (2021). In-home application (App) for 3D virtual garment fitting dressing room. Multimedia Tools and Applications, 80(4): 5203-5224.

[47] Zhao, X., Shi, C., You, X., & Zong, C. (2017). Analysis of mental workload in online shopping: are augmented and virtual reality consistent? Frontiers in Psychology, 8: 1-8.

[48] Farooq, A., Seyedmahmoudian, M., Horan, B., Mekhilef, S., & Stojcevski, A. (2021). Overview and exploitation of haptic tele-weight device in virtual shopping stores. Sustainability (Switzerland), 13(13): 1-13.

[49] Meißner, M., Pfeiffer, J., Peukert, C., Dietrich, H., & Pfeiffer, T. (2020). How virtual reality affects consumer choice. Journal of Business Research, 117(3): 219-231.