EXTENDED REALITY IN CULTURE AND CREATIVE INDUSTRIES

EDITED BY

ALMIR PEŠTEK, SELMA RIZVIĆ AND SANDA SOUCIE

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EDITED BY

ALMIR PEŠTEK

University of Sarajevo, Bosnia and Herzegovina

SELMA RIZVIĆ

University of Sarajevo, Bosnia and Herzegovina

AND

SANDA SOUCIE

University of Zagreb, Croatia

United Kingdom – North America – Japan – India – Malaysia – China

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About the Editors

Almir Peštek is a Professor at the Department of Marketing of the School of Economics and Business, University of Sarajevo. He is a Fulbright Postdoctoral Fellow and served at Loyola University Chicago – Quinlan School of Business in the academic year 2014/15. He has been as a Visiting Lecturer at universities in the United States, Austria, Italy, Croatia, Poland, Spain and Slovenia. He has 25 years of teaching, consulting and research experience. His research interests focus on marketing, digital marketing and tourism. He has published more than 100 scientific and professional papers and is the author and co-author of several research monographs, books and book chapters.

Selma Rizvić is a Professor of Computer Graphics at the Faculty of Electrical Engineering, University of Sarajevo. She has been teaching there Bachelor, Master and PhD study programs. From 2005 to 2010, she has been engaged as well at the Sarajevo School of Science and Technology, where she established computer graphics courses and a Digital Media Centre laboratory. From 2021 to 2022, she was again engaged there at the Game Design and Development Programme. At the University of Sarajevo, she founded in 2004 the Laboratory for Computer Graphics – Sarajevo Graphics Group (SGG). It is a research group that specialises in using IT technologies to present cultural heritage. The SGG research group is multidisciplinary; it includes computer graphics experts and works with archaeologists, historians, visual artists, writers and film professionals, to design and implement virtual cultural heritage applications that have educational values and are engaging, entertaining and attractive at the same time. In 2010, they founded the Association for Cultural Heritage Digitisation DIGI.BA.

Sanda Soucie is a Tenured Professor at the Department of Trade and International Business at the Faculty of Economics and Business, University of Zagreb, Croatia. She has almost 20 years of experience in teaching and organising classes, and she is a the co-ordinator of many different courses (e.g. *Wholesale and retail business, Fashion Retailing, Business Logistics, Trade Services, Risk and Security Management in Global Logistics, etc.*). She was the editor of the following books: *Counterfeiting and Fraud in Supply Chains* (2022), *Gastronomy for Tourism Development: Potential of the Western Balkans* (2020), *Green Economy in the Western Balkans: Towards a Sustainable Future* (2017) and *Challenges for the*

Trade in Central and Southeast Europe (2013) published by *Emerald Group,* and *Supply Chain Management – New Perspectives* (2011) published by *InTech*. Also, she has been the guest editor in high-rated scientific journals, presented papers at many international scientific conferences and has been actively involved in international research projects of the University of Zagreb, and the European Commission.

About the Contributors

Amra Banda, PhD, is employed at the University of Sarajevo – Faculty of Science as an Assistant Professor in Tourism and Geoecology within the Department of Geography. She has participated in several projects in the fields of tourism and environmental protection. Her primary research areas are nature-based tourism and sustainable tourism development, and she is the author of numerous scientific and professional articles. Currently, she is a member of the project team analysing the significance and role of VR in tourism in BiH.

Danko Ćosić is the Danube Competence Centre Director of Programmes, born, educated and living in Belgrade, Serbia. Married, two children. Work experience ranging from community organising and organisation development to working as a consultant on policy evaluation and strategy development. Experienced in a complex political and work environment. Currently working in tourism development, closely collaborating with members from private, public and NGO sectors in creating and supporting initiatives aiming at creation and promotion of the Danube region as a single tourism destination. Over the last 10 years, Principle Manager of the Roman Emperors and Danube Wine Route, a certified CoE European Cultural Route. As a Principle Route Manager, engaged from the beginning on mapping, selecting and recreating archaeological sites and respective management organisations to join the Route. Later, responsible for coordinating the Route Scientific Committee and planning and managing development and marketing projects and activities. More about the Route at https://roma-nemperorsroute.org/.

Martin G. Debattista, from Malta (EU), is a scholar in the digital humanities with expertise in education, media and heritage. He is a senior academic at the Institute of Tourism Studies (Malta) and a Visiting Senior Lecturer at the Faculty of Media and Knowledge Sciences at the University of Malta. He is qualified in communication studies, educational pedagogy and digital media and is currently conducting doctoral research in digital technologies for heritage interpretation at the University of Salford (Manchester, UK). He has presented his research on virtual reality for heritage interpretation at three annual sessions of Digital Research in the Humanities and the Arts (http://www.drha.tech) conferences. Pioneering journalist in online media have over 25 years of experience in education and research. His hobbies are also related to history and heritage, as he is a historical scale modeller, a Napoleonic re-enactor and an avid military history reader.

Jasmina Dlačić, PhD, Faculty of Economics and Business, University of Rijeka, Rijeka, Croatia: She is an Associate Professor of Marketing, Department Chair of the Academic Unit for Marketing and a head of university specialist study Marketing management – MBA at the Faculty of Economics and Business, University of Rijeka. She is the co-editor of the scientific journal *Proceedings of Rijeka Faculty of Economics: Journal of Economics and Business*. Her research interest includes value co-creation in services, relationship marketing, sustainable consumer behaviour and quality in higher education. Her research was published in several journals such as *Journal of Business Research*, *Journal of Cleaner Production*, *Economic Research*, *British Food Journal* and *Total Quality Management & Business Excellence*. Associate Prof. Jasmina Dlačić is a member of CROMAR (Croatian marketing association).

Sanja Dolenec, with a PhD in tourism from the University of Primorska (Slovenia), is a Postdoctoral Assistant at the Juraj Dobrila University of Pula (Croatia). With 10 years of university teaching and research experience, she has authored or co-authored approximately 15 scientific papers. Her scientific interest lies in the impacts of dark tourism development on local communities and visitors, particularly in the context of sites with a tragic war past.

Belma Durmišević, MA, is a Teaching Assistant in the Department of Geography at the University of Sarajevo – Faculty of Science. Her areas of interest include educational geography, with a special focus on innovations in teaching, and regional geography. She is currently working on her PhD thesis in the field of VR technology applications in education and is participating in a scientific project on the significance and role of VR in tourism in BiH.

Emir Durmišević is an illustrator and concept-character designer who works as an assistant at the Faculty of Educational Sciences at the University of Sarajevo and currently holds a position of creative lead and consultant at Cavalier Game Studios in London. After completing his studies at the Secondary School of Applied Arts, he earned his degree from the Academy of Fine Arts in Sarajevo. Emir is the author of a book titled *Kings and Queens of Bosnia* and has co-authored illustrations for publications like *Bosnian Kingdom*, *Stećkopedia*, *Magical World of Illyrians* and *Hasanaginica*. He has contributed as a Guest Lecturer at International Burch University, Sarajevo School of Science and Technology, the Faculty of Electrical Engineering at the University of Sarajevo, and the American University in Sharjah, UAE. He has also participated in VR/AR projects like 'Crafts,' 'SheLeaders,' and 'StećakLand'. The artist specialises in visualising cultural and historical heritage, receiving the 'Golden Pen' award for his exceptional illustration work.

Martina Ferenčić, PhD, marketing expert with 20 years of professional experience, both in FMCG and B2B companies. Throughout her career, she has had the opportunity to develop some of the leading Croatian FMCG brands, most recently focusing on B2B marketing. She is also an External Senior Lecturer at the Medjimurje University of Applied Sciences in Cakovec, Croatia. Her expertise is primarily focused on strategic marketing and brand development but also extends

to digital marketing and corporate communications. She holds a PhD in Marketing and is the author of several professional and scientific papers.

Brooke Hansen is the Associate Director in the School of Hospitality and Tourism Management, Muma College of Business, University of South Florida. She serves on the Board of Directors for Keep Florida Beautiful and the WellFed Community. She is an Expert for Hospitality Net's World Panel and an Academic Affiliate at the Center for Responsible Travel (CREST) in Washington, D.C. Her current research projects include using virtualisation technologies for cultural heritage tourism, implementing sustainability certifications in tourism, fostering regenerative agriculture and tourism and promoting the UN Sustainable Development Goals. She works as a consultant with the US Green Building Council and internationally on sustainable development projects in Serbia through a Fulbright award and with UNDP and other organisations.

Kishokanth Jeganathan is a PhD student at the Department of Commerce and Marketing at Poznan University of Economics and Business (Poland). His research focus is on how AR drives cognitive, affective and behavioural consumer responses across industries such as retail, hospitality and organisations. Alongside his academic pursuits, he is a Full-Stack Engineer, leveraging his interdisciplinary background to bridge technology and consumer psychology with an emphasis on innovative AR applications in marketing and user experience. His work has been published in the *Journal of Consumer Behaviour*, *Technology in Society*, *British Journal of Educational Technology* and *Food Quality and Preference*.

Tanja Komarac, PhD, is an Assistant Professor in the Marketing Department of the Faculty of Economics and Business at the University of Zagreb, Croatia. Her research interests include arts marketing and management, experiential marketing and mobile marketing in arts and culture. She has published papers in *Current Issues in Tourism*, *International Journal of Arts Management*, *Museum Management and Curatorship* and other journals. Also, she has collaborated with museum professionals on successful museum projects such as the exhibition 'The Sixties in Croatia: Myth and Reality' with the Museum of Arts and Crafts in Zagreb, 'Museum shop student experience' with the Museum of Contemporary Art Zagreb, and other museums.

Andrijana Kos Kavran, PhD, expert in marketing, PR and higher education with 17 years of experience. She has built an academic career as a Professor of professional studies at the Međimurje University of Applied Sciences in Čakovec, Croatia, where she teaches courses in marketing. Alongside her academic work, Andrijana has significant experience in the private sector, specialising in digital marketing, public relations and marketing management. She continually enhances her professional skills through additional trainings and certifications and scientific expertise in publishing numerous scientific publications.

Darko Kovačević, University of Montenegro, Institute of Interdisciplinary and Multidisciplinary Studies, Centre of Archaeology, Montenegro.

Darko Kovačević, a maritime archaeologist, specialises in digital documentation, remote sensing, and geomatics. He holds Bachelor's and Master's degrees in History from the University of Novi Sad, Serbia, as well as a Master's in Maritime Archaeology from the University of Alexandria, Egypt. A grant from the Honor Frost Foundation supported his studies on early mediaeval shipbuilding in the Eastern Mediterranean. Darko has participated in various underwater archaeology projects in Egypt, Greece, Lebanon and Croatia. In Malta, he worked as a Maritime Archaeologist in Heritage Malta's Underwater Cultural Heritage Unit. At the University of Montenegro, he established the research unit for Underwater Cultural Heritage.

Milena Kužnin, RIT Croatia, Croatia, is a Senior Lecturer at RIT Croatia. She has an MS from Rochester Institute of Technology, NY. Her research interests include service quality, leadership in service industry, customer satisfaction, responsible entrepreneurship, intercultural communication and organisational behaviour. Her work has been presented at conferences and published in journals. Milena has also won the Excellence in Teaching Award in 2023 and the Faculty Excellence Award in 2019. Since 2016, she serves as the advisor to the Eta Sigma Delta international hospitality honorary society at RIT Croatia, Dubrovnik. She served as the member of the Board of Governors of ESD from 2020 to 2022 representing the European Federation.

Mijana Matošević Radić, University of Split, University Department of Professional Studies, Croatia, is a College Professor at the University of Split, University Department of Professional Studies. She earned her PhD from the Faculty of Economics, Business and Tourism at the University of Split, and her doctoral dissertation received the 'Highly Commended 2018 Emerald/EFMD Outstanding Doctoral Research Award'. She is the author and co-author of numerous scientific and professional publications. As a consultant, she has participated in international projects in the field of destination management. Her research interests include tourism product development, destination management and sustainable tourism development.

Milivoj Marković, RIT Croatia, Croatia, is a Senior Lecturer at RIT Croatia, with over a decade of experience in academic research, management education and leadership. Holding a PhD in Business Administration from the University of Zagreb, he authored numerous peer-reviewed journal publications and book chapters. His scholarly work was presented at several conferences. Milivoj has served as an instructor, Degree Programs Chair and Area Head for International Business, excelling in business strategy and planning. An active member of AmCham Croatia's Trade and Investment Committee, he has earned awards for faculty excellence, research and professional service. With a strong focus on continuous improvement and innovative teaching, he contributes to global education initiatives and champions advanced methodologies in management education.

Dušan Mladenović has a PhD degree in Marketing Communication from Masaryk University (Czechia) in 2020. He acts as an Assistant Professor at the

Faculty of Economics and Administration, at Masaryk University. Since 2015, he has been involved with teaching and research activities in areas of consumer behaviour in the digital environment, digital marketing, word-of-mouth communication, etc. His research interests include digital consumer behaviour, online marketing strategies, electronic Word of Mouth, metaverse, etc.

Jovana Musić is the co-founder and director of the Sarajevo VRX Immersive Museum, as well as the director of HUB387/ACADEMY387. She has extensive experience working with start-ups in the IT and educational sectors. Although a psychologist by profession, she has spent most of her career in business-oriented companies, holding positions as a Human Resources Manager and Operations Manager. During her time in the United States as a Fulbright Scholar at Boston University, she served as a mentor to start-ups operating within the University's Incubator.

Muniba Osmanović, MA is a Teaching Assistant and PhD student in the Department of Geography at the University of Sarajevo – Faculty of Science. Her research interests include the development of protected natural areas and tourism. Her PhD thesis focuses on assessing geodiversity and biodiversity in the protected areas of BiH. She is also involved in a Horizon project studying the impact of climate change on cultural heritage.

Đurđana Ozretić Došen, PhD, is a Full Professor in the Marketing Department of the Faculty of Economics and Business at the University of Zagreb, Croatia. Her research interests include services marketing, brand management and international marketing. She has published books, contributions to books, journal articles (e.g., in *Current Issues in Tourism*, *Journal of Business Research*, *European Management Journal*, *International Journal of Contemporary Hospitality Management*, *International Journal of Arts Management*, etc.) and conference proceedings. She frequently collaborates in projects to popularise science with different public and private institutions, including museums (Museum of Arts and Crafts in Zagreb, Museum of Contemporary Art Zagreb).

Goran Petković is a Full Professor at the Department of Business Economics and Management of the Faculty of Economics, University of Belgrade. He teaches and conducts research in the field of marketing channels, retail and tourism. He participated in a joint programme organised by the University of Belgrade and La Sapienza University, Rome. Professor Petković was a Guest Lecturer at the Wirtschaftsuniversität, Vienna, DHBW Heilbronn and Poznan University of Economics and Business. He participated in the book *Counterfeiting and Fraud in Supply Chains*, published by Emerald and The Roman Emperors and Danube Wine Route for You. He served as State Secretary in the Government of the Republic of Serbia. Professor Petković is a member of the Presidency of the Serbian Association of Economists, member of the Scientific Committee for the EU-certified Roman Emperors Route with the Danube Competence Centre and Chairman of the Alumni Club of the University of Belgrade.

Neetu Singh, Symbiosis International (Deemed University), Pune, India, is a Professor of Fashion Business at Symbiosis Institute of Design. Her areas of interest are marketing and branding supply chain, circular economy, retail and sustainability studies in Fashion. Her recent works include chapters on building sustainability in Textile and Apparel supply chains, Consumers' choice behaviour towards sustainable Fashion based on social media influence and Circular Economy in Textile and Apparel Supply Chains.

Andrzej Szymkowiak (PhD) is an Associate Professor at the Department of Commerce and Marketing at Poznan University of Economics and Business (Poland) and the head of ConsumerLab.pl. His research focuses on consumer behaviour, sustainable consumption and food marketing with a particular emphasis on new technologies and media. His work has been published among others in *Sustainable Production and Consumption*, *Trends in Food Science & Technology*, *Food Quality and Preference and Technology in Society*.

Kevin Walker, RIT Croatia, Croatia, is a Senior Lecturer at RIT Croatia, specialising in business and entrepreneurship courses such as Entrepreneurship in the Hospitality Industry, Principles of Marketing and Financial Management. He has been recognised with the Faculty Excellence Award multiple times and the Experiential Learning Ambassador award. He currently serves as an HTM Area Head, coordinating curriculum and faculty activities. He modernised a family-run restaurant and co-managed an equity options trading firm. He holds an MBA from UC Berkeley and a BSc in Electrical Engineering from Stanford University. Currently, he is pursuing a PhD in Entrepreneurship and Innovativeness. He has published extensively on topics related to entrepreneurship and tourism in scholarly journals, and his work was presented at several academic conferences.

Michael Werner is an Emeritus Professor of Roman Art and Archaeology. His doctorate is from Stanford University with a dissertation on the architecture of Diocletian's Palace in Split. He has also completed specialised programmes in historic preservation from the International Center for the Study of the Preservation and Restoration of Cultural Property (ICCROM), Rome, Italy and the Advisory Council on Historic Preservation, Washington, D.C. His research focused on the Balkan provinces of the Roman Empire for the last 50 years; his current research involves historic preservation and heritage tourism for Roman archaeological sites in the Western Balkans. This includes acting as scientific advisor for the Sirmium Imperial Palace Project in Sremska Mitrovica, Serbia and the multinational Roman Emperors Route. In addition to his academic and research pursuits, he has also served for 8 years as City Archaeologist for the City of Albany, one of the oldest cities in North America.

Preface

With the progress of technology, the content communicated to culture consummates changes its form. Attention span of people is shortening. They are not keen to read text nor watch long videos any more. Information is bombarding us from all sides, making it difficult to filter what we are really interested in. Creative industries follow modern trends offering content on-demand and using the most recent technological advancements, including extended reality (XR).

Although there is some ambiguity and confusion of terms and concepts in the academic literature, XR is most commonly defined as a reference for virtual reality (VR), augmented reality (AR) and mixed reality (MR). All three technologies present computer-generated content used to either transfer the users in a completely new reality (VR) or enhance the physical reality with computer-generated content (AR and MR), superimposed over the image of physical reality recorded by cameras. To view the content presented by these technologies, the users need a VR headset or a mobile device such as a tablet or smartphone.

In this book, we will show the diversity of XR applications in culture and creative industries through case study project descriptions. The readers will be able to grasp the enormous potential of XR applications in various digital presentations of cultural heritage monuments and sites in museums or online. For the modern museum visitors, it is not enough to see physical exhibits with small labels as explanations; they want to learn the stories behind and to experience cultural heritage. Our book will show that XR technologies are the right solution for gathering such experiences.

Eleven different implementations of XR are presented in the chapters of this book. They range from explanations of workflows for digital heritage projects production to the experiences and lessons learnt by the members of production teams, such as archaeologists, museum curators, visual artists or software developers. The topics include Roman heritage, underwater heritage, mediaeval tombstones symbolism, female rulers of Balkan countries, fashion industry reshaping, dark tourism and immersive storytelling about intangible cultural heritage.

We believe that this book will open a new window into the magical world of XR and inspire the readers to think of the future ideas for using these technologies in experiencing cultural heritage. As one of the main characteristics of XR production is interdisciplinary approach, we encourage the people from various professions to seek their spots in production teams and create together XR

applications with educational and amusing content, encouraging all generations of users to enjoy cultural heritage.

We would like to thank all our contributors from different countries for their individual and collaborative work in sharing information about their projects accurately and on time. We also thank the reviewers for their contributions in enhancing the quality of the manuscript.

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Kristina Petljak, University of Zagreb, Faculty of Economics and Business, Croatia.

Amila Pilav-Velić, University of Sarajevo, School of Economics and Business, Bosnia and Herzegovina.

Belma Ramić-Brkić, Sarajevo School of Science and Technology, Bosnia and Herzegovina.

Lejla Turulja, University of Sarajevo, School of Economics and Business, Bosnia and Herzegovina.

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Chapter 1

Beyond the Runway: A Comprehensive Review of XR Opportunities, Applications and Challenges in the Fashion Industry

Neetu Singh

Symbiosis International (Deemed University), India

Abstract

With the growth of e-commerce, the fashion retail industry is exploring new technologies like virtual reality (VR), augmented reality (AR) and mixed reality (MR), together known as extended reality (XR). According to the extended-self theory, the symbolic high-involvement fashion products become a part of their extended self, enhancing consumers' self-concept and resulting in cognitive and affective outcomes due to self-exploratory engagement. Therefore, due to high body surveillance experience and strong fashion consciousness, consumers seek means and technologies to alter their appearance or body image. XR technologies are disrupting how fashion brands interact with customers by re-orienting their business models, going digital and using immersive technologies blending the physical and virtual worlds, enabling a more interactive personalised experience. Through virtual try-ons, AR apps and shopping on the Metaverse, the brands engage in multi-sensory stimulation, high interactivity and vividness, resulting in high utilitarian and hedonic value to the consumers. Consumers' initial stimulation by an aesthetic experience develops into a combination of relational, emotional and interactive experiences through these technologies. Brands can now tell their story in XR, moving beyond the 2D user phase and resulting in brand differentiation. This work addresses the recent advances in fashion industries where XR technologies allow brands to create compelling stories and build the right brand experiences for consumers, resulting in customer engagement and brand loyalty.

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Introduction

Fashion retail is changing rapidly due to advances in e-commerce, making traditional shopping formats redundant for consumers after the COVID-19 outbreak (Silvestri, 2022; Xue et al., 2023). Consumers' experience with digital shopping platforms makes them seek instant information, entertainment and gratification from their shopping experience (Siregar et al., 2023). They seek more involvement, surprise and building memorable experiences that enhance their sensory, affective, intellectual and behavioural perceptions (Baek et al., 2020). The shutting down of physical store scape during the COVID pandemic brought digital technologies to the forefront, with consumers experiencing reality through high-speed internet, artificial intelligence (AI), increased computing efficiency and high-resolution displays (Dwivedi et al., 2021; Hoyer et al., 2020). XR (often used as an abbreviation for extended technology) has been assigned as an umbrella term for a variety of concepts such as virtual reality (VR), augmented reality (AR) and mixed reality (MR) with virtual and real elements combining and creating ambiguity and confusion regarding their actual meaning (Rauschnabel et al., 2022). However, AR, VR and MR are distinct terms categorising specific technologies (Wedel et al., 2020).

VR simulates reality in a computer-generated virtual environment, incorporating the user who perceives it using the senses of vision, hearing and touch. Brands can deliver VR experiences through hardware such as head-mounted displays (HMDs), cubic immersive spaces, large screens, mobile devices, smartphones, tablets, laptops and desktop computers (Wedel et al., 2020). Research conceptualises VR experiences on a Telepresence continuum ranging from atomistic to holistic (Kim et al., 2021; Rauschnabel et al., 2022). A distinct form of VR technology is AR, which supplements sensory information through the digital overlaying of 3D objects into consumers' natural environment and is finding increasing usage in fashion, accessories, tourism, entertainment and other such areas (Parekh et al., 2020). This technology enables consumers to try products on a mirror image of themselves projected digitally using the camera on their digital devices. AR lies in the continuum between VR and real-life scenarios described as a Local presence continuum ranging from assisted reality to MR (Dwivedi et al., 2021; Milgram et al., 1995). With mature technologies emerging, it needs to be noted that the segregation between AR and VR technologies is diminishing, with more head-mounted displays, starting from mobile phones to more advanced applications such as Varjo 2021, which are customised towards implementing immersive MR experience blending VR and AR naturally (Varjo.com, 2024). With advancements in VR and AR technologies, a new concept known as is emerging, merging the virtual and real worlds. MR represents the controlled amalgamation of VR/AR and IoT trends, shifting

engagement patterns and allowing the users to immerse themselves in the virtual world while working on data generated by sensors and connected assets (Nelson, 2017). Meanwhile, Internet of Things (IoT) is also gaining prominence, moving away from connected devices and sensors to more real-world scenarios powered by IoT technology, pioneering health wellness, gaming, supply chain, tourism and education infrastructure, among others (Kumari & Polke, 2019; Nelson, 2017; Parekh et al., 2020). Hence, digital assistants and smartwatches are becoming more sophisticated and user-friendly, incorporating themselves into fashion and apparel (Hoyer et al., 2020).

The terminology XR, therefore, as an umbrella term for 'extended reality' should instead be the placeholder for all reality formats, with VR, AR, MR, IoT, virtual assistants, Chabots and robots powered by AI (Seiger et al., 2021). Retailers focus on meeting the consumers' functional and service requirements and providing them with an ultimate shopping experience using XR technologies (Cornelia & Paul, 2020). The usage of XR technologies in fashion retail enhances the brand's marketing strategies while providing superior consumer engagement and improving brand recall and recognition (Cappasity, 2022).

Literature Review

Fashion is an essential contributor to the world economy, valued at 1.3 trillion globally and employing more than 300 million people along its value chain. Clothing dominates about 60% of the textile chain, which has doubled in the last 15 years due to easy accessibility of affordable fashion, new styles, quick turnover of styles and increased collection, thanks to the fast fashion phenomenon (Foundation, 2024; Wojciechowska, 2021). Fashion is a universal phenomenon that satisfies an individual's need for social recognition and equalisation, which are simultaneously satisfied with imitation and desire for differentiation and change (Simmel, 1957). It is a dualistic tool that enables the construction and communication of one's self-identity, creating a desire and longing to consume fashion products (Lipovetsky, 2017). A vast majority of studies related to technology emerge from the Technology Acceptance Model (TAM), not considering consumers' psychological motivations behind the acceptance of technology (Rese et al., 2017). As suggested in the TAM, customers adopt new technology through its perceived usefulness and ease of use, indicating utilitarian usefulness and perceived enjoyment (Davis et al., 1992; Hsu et al., 2017). Hence, technology and providing functional ease are also a source of enjoyment for consumers through experiential and hedonic benefits.

With the development of the internet and mobile technologies, apparel e-commerce is expanding, with consumers increasingly buying their clothing online (Khare et al., 2022; McNeill, 2018). However, an ICSC consumer return survey on a demographically representative US sample suggests that the consumer return rate of online transactions at 15.2% is three times higher than in-store purchase returns at 5%, with typical reasons for returning items were damaged items (52%), fit issues (50%), items not meeting expectations (42%) and

wrong items (37%) (ICSC, 2024). Fashion apparel is a high-involvement product characterised by technological advancement and digital presence. However, it requires consumers to physically connect with products and people with brands building identity through their brick-and-mortar physical stores (Kim et al., 2018). Consumer concerns with garment colour, fit and appearance in digital shopping environments where they cannot physically try on clothes result in discrepancies that negatively impact their shopping experience and purchase intention (Wu & Lee, 2020). Apart from the apparel trying-on experience, the interaction between customers and store staff, shopping assistants and store shopping experience of brick-and-mortar stores is challenging to recreate, primarily through digital channels. The ongoing development of extended technologies (XR) is therefore augmenting retail performance along with cost reduction, attracting consumers and creating new avenues for an XR-based commerce ecosystem (Morotti et al., 2022).

Rationale for the Study

This research seeks to understand XR technologies' current role in fashion, their application and benefits, using fashion brands as examples. Currently, numerous uses of XR technologies in fashion retail, both online and offline, are enhancing consumer brand experience. Brand experience is an emotional, cognitive and behavioural response to brand-related stimuli formulating brand identity (Brakus et al., 2009). Brand experience using XR technologies can be categorised as entertainment, aesthetic, real escape and educational, affecting consumer brand relationships and influencing purchase motivation (Zeng et al., 2023).The methodology of study is a 'review of the literature', analysing data from sources like Google Scholar, Scopus, Web of Science, Ebsco and other databases, to ascertain the application and outcome of XR technologies in fashion retail. Table 1.1 details various clothing requirements and various XR technologies used to address consumer requirements.

Virtual Reality

VR creates a virtual environment simulating real-world settings, immersing users into a three-dimensional environment projected through computer hardware and software. It gives consumers an immersive experience, letting them experience multiple sensations and realistic sensory engagement approximating reality. VR experiences are (i) Non-immersive-3D stimulated environment accessed through a computer screen that does not directly interact with the user but in which the user has some control using a keyboard, mouse and other devices. (ii) Semi-immersive technology offers a partial VR experience accessible through a computer screen and external devices such as glasses or headsets. These experiences focus on a visual 3D experience, not incorporating physical movements such as flight simulators used in gaming or training purposes. (iii) Fully immersive VR immerses the users fully in the 3D world incorporating sensory, affective and haptics in the

Table 1.1. XR Technology Application in the Fashion Industry.

Clothing Requirement	Activity	Technology	Advantages
Trying on clothing for fit, size, appearance	Virtual try on animation	3D model generation, 3D rendering, AI fashion models	Replacing a traditional fitting room Detailing garment fit with movements
Personalising the tried on garments	Virtual try on personal avatar	3D avatar/animation	Replacing a traditional fitting room. Personalised 3D visual of the collection
Visualising garment and garment texture on website	3D garment visualisation	AR (augmented reality)	Enabling assessment of garment texture, actual colour appearance. Comfortable product visualisation
Brand story telling	Virtual environment	VR/AR powered campaigns; metaverse	Creation of brand experience, sensory, affective, intellectual behavioural
Store environment	Creation of retail brand experience	VR environment/AR environment	Creation of brand experience, sensory, affective, intellectual behavioural
Brand marketing	Brand marketing and branding	Metaverse channels	Creation of immersive experiences, entertainment, aesthetic, real escape, educational
Personalisation, customisation	AI and machine learning algorithms	Artificial intelligence, machine learning, computer vision, optical character recognition	Data aggregation, predictive analysis, multi data processing

experience (Zeng et al., 2023), even incorporating olfactory senses using technology such as Olorama (Company, 2024; Olorama, 2024) which incorporates olfactory devices such as digital scent synthesisers creating a fully immersive setting in movies, events and escape rooms (Jha et al., 2020; Lefebvre & Biswas, 2019).

Virtual Fashion Shows

Virtual fashion shows using AR and VR devices such as head-mounted displays provide consumers with higher utilitarian and hedonic values and greater immersion than the sense of presence in the physical world (Ricci et al., 2023). This technology allows consumers to experience runaway fashion from any place or city globally, supported by communication infrastructure such as IoT and 5G technology along with the Metaverse, which is accessible from anywhere (Kim, 2023).

Brand Topshop pioneered going virtual with the world's first telepresence for London Fashion Week in 2014, inviting five competition winners to view their fashion show using an Oculus Rift HMD from their Oxford Circus flagship store (Natalie, 2014). Tommy Hilfiger adopted VR technologies on a large scale by filming its fashion show held in 2015 New York using a 3D camera, capturing 360 videos horizontally and vertically and later projecting them using Samsung gear VR headsets in selected stores (Anyanwu, 2015; Donatiello et al., 2018). VR enables cognitive presence, sensible immersion and aesthetic interaction through virtual fashion experience. Cognitive presence refers to consumers' psychological experience of being in a virtual place, perceiving the objects, location and experiences as rea, generating a sense of vividness and interactivity (Parsons et al., 2020). Sensible immersion refers to users' perceptual, psychological awareness of using VR applications. It takes over their sensory organs and transports them to a stimulated domain, triggering a positive effect with audio-visual exposure and reducing stress and emotional arousal (Li et al., 2023). The hyper-realistic facial expressions of digital humans in VR induce interest and pleasure, and this satisfaction results in emotional immersion (Pavic et al., 2023). Fig. 1.1 shows a virtual fashion show using digital models to showcase a fashion collection.

Gamification in Fashion

Gamification or game design elements are progressively being used in the fashion industry using VR, AR and 3D visualisation, encouraging value-creating behaviours such as increased consumption, engagement, product advocacy and brand loyalty of young Generation Z consumers (Cedrola & Giovannetti, 2024). Customer's acceptance of gamification in fashion is a result of technological innovativeness (propensity to try new technology) and fashion innovativeness (propensity to make various fashion choices) (Hur et al., 2017). Self-determination theory, or SDT by Deci and Ryan, is a theory of human motivation that examines the human tendency to engage in certain behaviours resulting in their psychological well-being

Fig. 1.1. Virtual Fashion Show Using Digital Models. *Source:* Image courtesy (Riddhi & Siddhi, 2024).

(Deci & Ryan, 2008; Miller et al., 1988). Competence, autonomy and relatedness are three basic needs that motivate a person to initiate behaviour (Miller et al., 1988). For example, a VR fashion app game like Taobao Life or Roblox can daily challenge its users to win points and engage in clothing or accessory purchase behaviour, or the tie-up between Balenciaga and Fortnite creating outfits for Fortnite players enables consumers to engage in all three behaviours (Jill, 2021; Lau & Ki, 2021). Game dynamics engage consumers' sense of competitiveness by satisfying their intrinsic need to challenge, which is the feeling of engaging in a complex yet achievable task (Moller et al., 2024; Saxena et al., 2023). Gaming app customisation creates value by helping consumers fulfil their need for autonomy. Gaming fashion apps like the one created by The Gap offer a mobile app called 'Dressing Room' and a virtual fashion game, 'Animal Crossing', which allow consumers to customise their avatars and try on clothes virtually, giving them autonomy to personalise their gaming features (Kakade et al., 2024; Zagel, 2023). Social presence and relatedness have a significant relationship with each other, with 'Presence signalling' (social presence in a virtual world) enabling people to develop meaningful relationships with each other through fashion apps gratify consumers' need for relatedness by harbouring a sense of belonging, feeling connected and supported by others (Bilali & Papahristou, 2024; Koma, 2023).

Augmented Reality

AR enhances consumers' real-time shopping experience by overlaying digital objects and information on the physical world. The advancement of AR interactive technology presents consumers' bodies in real-time, addressing website limitations for full representation of body types (Jiang et al., 2022; Loureiro et al.,

2020). Consumers' shopping behaviour for high-involvement products like apparel, cosmetics and accessories where the consumer's self-concept is involved is justified using the self-congruence theory (Ericksen & Sirgy, 1992). Hence, consumers seek to enhance self-esteem by choosing products that meet their ideal self-image and are dependant highly on the actual representation of products as per body size, fit and final appearance (Aleem et al., 2024; Huang & Chung, 2024). Consumers' adoption of AR technologies is a result of The SOR (Stimulus organism response) mechanism, resulting in utilitarian and hedonism as user benefits resulting in telepresence or consumers' sensory arousal, control and immersion influencing purchase outcomes (Li et al., 2023; Mehrabian & Russell, 1976). The impact of AR extends beyond visual interaction, incorporating features like personalisation and customisation of products varying from the 'one size fits all' associated with everyday brick-and-mortar store shopping. The consumer's initial adoption of AR websites and smart apps uses the SOR (stimulus organism response) mechanism (Mehrabian & Russell, 1976), stipulating that AR features trigger users' benefit evaluation (utilitarian and hedonic benefits), ultimately facilitating telepresence (Nikhashemi et al., 2021). Telepresence is the consumers' psychological state of mind after interacting with the AR environment, resulting in cognitive and sensory arousal, control and immersion, resulting in positive purchase outcomes (Kim et al., 2021; Zhao et al., 2021).

Virtual catalogues are another example of AR in fashion, allowing shoppers to view catalogues from stores without entering a brick-and-mortar store (Simbott.com, 2024). When trying for a Gucci ring, customers try on various styles, and Gucci's AR ring try-on makes them find the perfect fitting and enables decision-making (Caroline, 2023). Gap has introduced an AR app that allows consumers to pick their clothing, select their preferred size and view how an article of clothing looks on them. FX Mirror is an AR fitting room solution that offers convenience to shoppers and customer data to retailers. Shoppers can try on clothes virtually without getting in and out of clothes. Retailers can gather crucial data about customers' preferences and shopping behaviour (FXGear, 2024). The new authentication system created by Ordre along with Louis Vuitton lets customers verify genuine products from fake by using just an AR app and a phone camera (Marc, 2023; Ordre, 2024). Fig. 1.2 shows innovative try-on technology enabling 3D try-on of optical glasses on the consumer using advanced AR technology.

Virtual Try-on in Fashion

The growing customer needs to procure mass-customised garments that meet their fit, size and body type standards, building the requirement for apparel customisation in retail. Virtual try-on (VTO) enables consumers to superimpose digital representations of products in natural, real-life environments using smartphones, tablets and AR-enabled devices. Virtual trying rooms, therefore, fulfil a functional requirement, enabling an emotional decision for the consumer to assess how the