The appliance of augmented reality (AR) and virtual reality (VR) in cultural tourism: a critical overview

Garbin Praničević, Daniela; Peterlin, Judita; Matas, Marina

Varazdin Development and Entrepreneurship Agency and **University North**
in cooperation with
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Economic and Social Development

105th International Scientific Conference on Economic and Social Development – "Building Resilient Society"

Book of Proceedings

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ISSN 1849-7535
9 771849 753006 >

Zagreb, 15-16 December, 2023

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Title ■ Economic and Social Development (Book of Proceedings), 105th International Scientific Conference on Economic and Social Development - "Building Resilient Society"

Editors ■ Ivana Kovac, Petar Misevic, Andrey Zahariev

Publishing Editor ■ Spomenko Kesina, Domagoj Cingula

Publisher ■ **Design** ■ **Print** ■ Varazdin Development and Entrepreneurship Agency, Varazdin, Croatia / University North, Koprivnica, Croatia / Faculty of Management University of Warsaw, Warsaw, Poland / Faculty of Law, Economics and Social Sciences Sale - Mohammed V University in Rabat, Morocco / ENCGT - Ecole Nationale de Commerce et de Gestion de Tanger - Abdelmalek Essaadi University, Tangier, Morocco / Polytechnic of Medimurje in Cakovec, Cakovec, Croatia / University of Applied Science "Nikola Tesla" in Gospic, Gospic, Croatia

Printing ■ Online Edition

ISSN 1849-7535
The Book is open access and double-blind peer reviewed.
Our past Books are indexed and abstracted by ProQuest, EconBIZ, CPCI (Web of Science) and EconLit databases and available for download in a PDF format from the Economic and Social Development Conference website: http://www.esd-conference.com

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THE APPLIANCE OF AUGMENTED REALITY (AR) AND VIRTUAL REALITY (VR) IN CULTURAL TOURISM: A CRITICAL OVERVIEW

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ABSTRACT

As one of the fastest growing economic sectors in the world and a key driver of socio-economic development, tourism is an extremely dynamic industry whose changes need to be constantly adapted to. Advances in technology are visible in many areas where it was unimaginable in the past. One of these areas is cultural tourism, in which cultural attractions have experienced a renaissance by applying virtual and augmented (VR & AR) reality. Recently, such application in the field of cultural tourism has become increasingly known, where some cultural entities have recognized their special potential in reviving the historical cultural heritage. However, the VR and AR technology application in cultural tourism brings certain limiting factors. For example, physical museums and galleries are becoming increasingly isolated and less functioning without the participation of visitors. In such context, the paper aims to provide a SWOT analysis, i.e., to investigate the strengths, weaknesses, opportunities, and threats that appear when applying VR and AR technology in cultural tourism. For this study, the relevant literature has been analyzed in detail, and in-depth interviews with cultural tourism responsible staff have been conducted. Based on related findings, the authors claim certain strengths and opportunities, weaknesses, and threats induced by the VR and AR applications in cultural tourism.

Keywords: *augmented reality (AR), virtual reality (VR), cultural tourism, critical overview*

1. INTRODUCTION

Tourism is a dynamic industry; therefore, attraction promoters must constantly react to environmental changes to remain competitive (Lei, Suntikul, & Chen, 2023). In such a context, technology plays an important role. Consequently, promoters of cultural heritage attractions have begun to explore the possibilities of applying the latest technologies to enhance tourism experiences (tom Dieck, Jung, & Michopoulou, 2019). Recent studies have found wearable augmented reality, primarily via mobile phones, contributes to enhancing the learning experience at cultural heritage attractions (Dieck & Jung, 2017). By using such technologies, tourist visitors experience improved interaction with the attraction, which is considered much more significant after such a lived experience (Buhalis, & Amaranggana, 2015; Han et al., 2019). Evidently, in last more than 20 years, virtual reality technologies such as virtual reality (VR) and augmented reality (AR) have enabled tourism managers to significantly increase the satisfaction of tourists by providing them with unforgettable experiences (Loureiro, Guerreiro,

& Ali, 2020). It seems to be the commercialization of smartphones and online virtual environments have also encouraged service providers to engage tourists as active participants through virtual reality applications, allowing them to experience products and different destinations from the comfort of their homes (Bogičević et al., 2019). Additionally, the advances in sensor technologies have also led to increased availability and use in the tourism sector (tom Dieck, & Jung, 2017.) Such virtual environments based on new and upcoming technologies are changing how travel operators stimulate their customers' experiences before, during, and after their stay in the destination (Loureiro et al., 2020; Neuhofer, Buhalis, & Ladkin, 2012). More specifically, VR/AR technologies are used to promote a destination or place, to enhance the experience of reality at the destination, or to "immerse" consumers in a new and completely challenging tourist experience (Han et al., 2019). On the other side, over time, the use of AR and VR in cultural tourism, besides opportunities like enhanced engagement, accessibility, storytelling, accessibility, cost-effective replication, etc., also highlighted challenges like inclusivity, content quality, cultural and ethical concerns, dependency on technology, privacy and data concerns etc. In light of the stated research problem, this study aims to answer the following research questions, going into different aspects of the application of virtual and augmented reality technology in cultural tourism:

1) What are the advantages of using VR/AR technologies in cultural tourism?
2) What disadvantages or limitations arise from implementing VR/AR reality technology in cultural tourism?
3) What potential opportunities exist for using VR/AR technology to enhance cultural tourism experiences?
4) What are the challenges or risks of applying VR/AR technology in cultural tourism?

These questions will serve as the guiding framework for exploration and analysis in this research endeavor. The paper finished with a conclusion and related implications for future research on forthcoming challenges of VR/AR technology usage in culural tourism.

2. EMERGING TECHNOLOGIES: VR AND AR REALITY

Virtual reality (VR) is a multifaceted concept with varying definitions, encompassing the creation of computer-generated 3D environments, referred to as virtual environments, that users can actively control and interact with, thereby simulating real-time sensory experiences (Guttentag, 2010; Mandal, 2023). The managerial aspect of VR involves the user's ability to navigate and explore this virtual space, while the communicative dimension focuses on selecting and manipulating objects within it (Guttentag, 2010; Beck at., al. 2019). The devices facilitating the VR experience are central to it, enabling users to seamlessly become part of the virtual environment. These VR devices dynamically adjust in response to user reactions and movements, fostering a profound sense of interaction and immersion (Tussyadiah et al., 2017). This immersive quality is a key feature of the VR encounter (Doumanoglou et al., 2018), characterized by both physical and psychological elements. The physical aspect relates to the user's isolation from the real world, encapsulating the user within the digitally generated environment (Guttentag, 2010). Simultaneously, psychological presence is cultivated, transcending the visual and auditory components to create a holistic perception of being present within the virtual realm. VR encapsulates a transformative blend of cutting-edge technology and human experience. By allowing users to actively shape and engage with computer-generated environments, VR redefines the boundaries of traditional interaction and beckons the exploration of novel dimensions where the virtual and the real seamlessly coalesce. The evolving definitions of VR underscore its dynamic nature and the ongoing quest to push the boundaries of what is possible in creating immersive and interactive digital experiences.

Virtual Reality (VR) redefines user engagement by transcending physical boundaries, with key elements being immersion, interaction, and imagination, which form the basis of VR's defining characteristics. Advancements in technology promise increasingly immersive and authentic digital worlds, blurring the line between reality and the virtual realm (Sheriran, 2000). The term "augmented reality" (AR) denotes the integration of technologies that seamlessly blend real-time computer-generated content with live video displays (Mekni & Lemieux, 2014). Derived from virtual reality techniques, AR interacts with the virtual world and exhibits a degree of interdependence with the real world. In essence, AR offers a direct or indirect representation of the physical environment in real-time, enhanced by the addition of virtual computer-generated data. By bringing digital information and virtual objects into physical space, AR animates the captured image on devices like phones or tablets. The primary AR objective is to enhance the user's life by introducing virtual information into their immediate environment and any indirect view of the real environment, such as live video (Carmigniani et al., 2010). While some definitions of AR stipulate the use of head-mounted display (HMD) screens (Mekni & Lemieux, 2014), a more inclusive definition involves a system with the following characteristics: (i) a combination of real and virtual elements, (ii) real-time interactivity, and (iii) content registered in 3D format (Attila & Edit, 2012). This broader definition accommodates various technologies, including mobile devices, while preserving the essential components of AR. Moreover, AR enables users to perceive the real world with virtual objects seamlessly integrated or superimposed onto their surroundings. Consequently, AR complements reality rather than a replacement (Edwards-Stewart, Hoyt, & Reger, 2016, Bouzis, & Poulaki, 2022). In summary, while AR/VR shares similarities, they represent distinct technologies with unique capabilities, contributing varied user experiences.

Similarities	Differences
Fundamentally, AR and VR share a common goal: enhancing user experiences.	Augmented reality overlays digital information onto real-life images and contexts. In contrast, virtual reality immerses users in an entirely new computer-generated world, allowing experiences like virtual city flyovers without physically leaving the ground.
Once deemed futuristic, both AR and VR have become tangible technologies, finding widespread application across various fields, with a particular emphasis on entertainment.	Virtual reality replaces the real world with a simulated environment, providing an immersive experience, whereas augmented reality enhances the existing environment without replacing it.
Both technologies play integral roles in education, business logistics, and healthcare, offering transformative possibilities, such as enabling remote surgery in the medical field.	Virtual reality typically constructs an entirely computer-generated world, while augmented reality integrates virtual components into the real world, creating a new interaction layer.
	Augmented reality is versatile, and compatible with various digital devices like laptops, tablets, and smartphones, requiring only a camera. In contrast, virtual reality demands specialized systems designed explicitly for its use.

Table 1: AR/VR main similarities/differences
(Source: Author(s) research)

3. AR AND VR APPLIANCE IN CULTURAL TOURISM: SWOT APPROACH

From a general standpoint, SWOT analysis comprehensively examines the internal and external factors shaping an organizational environment. This strategic evaluation method involves meticulously reviewing key characteristics within and outside an entity to pinpoint critical elements influencing the company's future trajectory (Helms and Nixon, 2012).

The outcomes of this analysis, which encompasses both the environmental and strategic factors, serve as invaluable decision-support tools during formulating a chosen strategy. In essence, SWOT analysis as a foundational approach to environmental analysis, providing a structured framework for organizations to assess their competitive landscape. The acronym SWOT encapsulates the four critical dimensions under scrutiny: Strengths (S), Weaknesses (W), Opportunities (O), and Threats (T). Each element corresponds to a distinct aspect of the internal and external business environment, offering a comprehensive perspective that facilitates informed decision-making and strategic planning. By delineating a company's strengths and weaknesses, SWOT analysis enables a precise understanding of its internal landscape, aiding in identifying areas for improvement and optimization. Simultaneously, exploring external opportunities and threats equips decision-makers with insights into potential avenues for growth and the challenges that may impede progress. To sum up, SWOT analysis emerges as a fundamental tool for organizations seeking a systematic and holistic assessment of their environment. By elucidating the interplay between internal and external factors, SWOT analysis not only enhances strategic decision-making but also serves as a foundational step toward ensuring the sustained success and adaptability of a business in a dynamic and ever-evolving landscape. Based on relevant literature (Kulakoğlu-Dilek, Kizilirmak, & Dilek, 2018; Han et, al., 2019; Garbin Praničević, 2021; Siddiqui, et.al, 2022), the SWOT analyses in the context of AR/VR appliance in cultural tourism results with quite challengeable items. According a/m literature the main *AR/VR strength* in cultural tourism are derived due to AR/VR: (i) enhance and expand cultural tourism offerings, fostering industry growth, (ii) its related tools simplify the promotion of cultural tourism, reaching a broader audience and increasing the visibility of cultural destinations, (iii) rejuvenate travel agencies and tour operators, countering the trend of tourists organizing their own trips, (iv) empower tourists to explore attractions remotely, evaluate preferences, and make informed travel decisions, (v) transport users to the past, providing sensory experiences in historical settings that were previously inaccessible, (vi) offer a comprehensive tourist experience while minimizing the negative effects of mass tourism on cultural heritage, (vii) serve as supplementary attractions, enhancing existing tourist offerings, and (viii) AR and VR serve as powerful tools for educating and entertaining tourists while minimizing negative impacts on attractions and the environment. According to a/m literature, the main *AR/VR weaknesses* in cultural tourism are derived due to AR/VR: (i) are still evolving, with issues like high costs, large software sizes, heavy devices, and graphic limitations, (ii) some individuals, especially the older generation, may have reservations about information technologies, making it challenging to introduce advanced tech solutions to them, (iii) can't fully replace physical authenticity, as tourists do not physically exist within the historical context, (iv) reduce personal contact and human connection, (v) is expensive due to limited technology accessibility and thus unaffordable for many potential users, (vi) produce discomforts such as nausea and dizziness due to the immersive effects, and (vii) prioritize the overall experience over souvenir shopping. According to a/m literature the main *AR/VR opportunities* in cultural tourism are derived due to AR/VR: (i) help minimize the impact on cultural heritage sites, ensuring their long-term preservation, (ii) contribute to the better preservation of natural attractions and environmental sustainability, (iii) enhance accessibility for individuals with disabilities and older visitors, even in remote locations, (iv) provide a visual glimpse of the past, making historical and cultural sites more engaging, (v) make it possible to present historical events in a realistic and real-time manner, (vi) rapidly growing trend in tourism, catering to increasing demand, (vii) allow limitless creative possibilities, and (viii) eliminate bureaucratic, security, and language barriers, making them accessible to a wide range of visitors. Finally, according to a/m literature, the main *AR/VR threats* in cultural tourism derived from AR/VR may: (i) limit interactions between tourists and local communities, affecting the effective communication of cultural specifics, (ii)lead to a

decrease in the appeal of in-person visits to museums, (iii) push developing countries potentially falling behind more developed nations, (iv) had undefined tax framework, (v) lead to social isolation and reduced face-to-face interactions, (vi) not stimulate other sectors in the destination, lacking the multiplier effect seen in traditional tourism, (vii) result in job losses, changing the employment landscape in the tourism sector, (viii) lead to monopolies, reducing the variety and quality of offerings by other providers. A more concise overview of a/m explained SWOT items is enclosed in Table 2:

Strengths	Weakness	Opportunities	Threats
i. Advancement of cultural tourism	i. Technological limitations	i. preservation of cultural heritage sites	i. reduced cultural interaction
ii. promoting cultural heritage	ii. negative initial impressions	ii. sustainable tourism and environmental protection	ii. impact on physical tourism
iii. marketing aid for agencies	iii. distancing from real experiences	iii. accessibility for diverse visitors	iii. economic challenges for developing nations
iv. pre-visit cultural assessment	iv. lack of tourist interaction with locals	iv. time travel	iv. unclear taxation policies
v. sensory immersion	v. high costs for users	v. achieving the impossible	v. contribution to antisocial behavior
vi. minimizing tourism impact	vi. physical and psychological discomfort	vi. development potential	vi. effects on other tourism sectors
vii. creating additional destination attractions	vii. inability to purchase souvenirs	vii. limitless design	vii. employment impact
viii. enhancing user knowledge		viii. elimination of barriers	viii. monopolization and competition

Table 2: SWOT items (in order of appearance as in text above)
(Source: Author(s) research)

AR and VR have the potential to greatly enrich the cultural tourism experience by making it more interactive and accessible. However, they also come with various challenges, including accessibility, cost, content quality, and ethical considerations. Integrating these technologies into cultural tourism requires careful planning, investment, and consideration of tourists' and cultural institutions' unique needs and expectations.

4. DESIGN/METHODOLOGY APPROACH

Effective research lies in its flexibility and disciplined approach (Tiu Wright, 1996). The use of in-depth interviews is considered a solution in investigating "Why?" especially when the need to generalize the results is unnecessary. In-depth interviews (Hollway, & Jefferson, 1997) are preferable when the investigation is oriented to determine motivation, perceptions, or beliefs (Milena et al., 2008). An in-depth interview is a medium for researching the interaction between a person and a field of research, as it means an internal view or an internal exchange of opinions between people, where the generativity of the interview method rests on the researcher's interpersonal skills (Kvale & Brinkman in Marshall & Rossman, 2011, p. 145). In qualitative research, there is never a perfect match between the questions, answers, and final findings, so citations make it possible to assess the relationship between the original data and the researcher's interpretation (Schostak, 2006, p. 161). Citations: (1) provide evidence that the researcher's interpretation is appropriate; (2) they show language and behavior since the use of language is a means of conveying meaning and action; (3) show the experience of the text, as the participants adequately express how they make sense of their development and enter into the presentation and interpretation of the findings (Boeije, 2010, p. 201). In general, open-ended or qualitative interviews are divided into (1) unstructured, (2) in-depth, and (3) semi-structured interviews; in terms of content, they are divided into (1) thematic, which include only one subject of interest; (2) the life story interview, which focuses on the life narrative of the interviewee (e.g., key informant interviews); (3) elite interview, which is an interview with a high-ranking or well-known individual, while (4) an expert interview term for an interview with informants who have professional-practical expertise on a certain topic (Boeije, 2010, pp. 62-63). Through in-depth interviews, open-ended questions such as: "What do you think about …?" allow for unexpected and potentially valuable information (Ancona, 2012, p. 9). Qualitative researchers are looking for a better understanding of what is happening, so in-depth interviews are usually not fully structured in content, formulation, sequence, and answers, nor are they fully open as the researcher prepares topics (e.g., a semi-structured interview). We mutually complemented the research process of qualitative interviews (Silverman, 2006): (1) the positivist approach to interviewing was based on tested qualitative interviews with the aim of mutual comparison; (2) the emotional approach to interviewing dealt with the more emotionally sensitive topic of personal experience; (3) we implemented a constructivist approach to interviewing to understand and co-create the phenomenon. The comparative method is meaningful and feasible (also) within smaller qualitative data collections (Silverman, 2006, p. 8). Researchers working within a narrative paradigm frequently engage in in-depth conversations (Voutsina, 2018) with participants. Analysis and interpretation of these conversations often involve reducing long stretches of text to codes and recombining the codes into themes that move across stories, people, and contexts (McCormack, 2004). This study employed qualitative research methods, specifically utilizing an expert interview with informants who have professional-practical expertise on AR/VR appliances in cultural tourism. Operating as a semi-structured interview, the in-depth interview was chosen to capture comprehensive and detailed answers to the questions posed, offering a high degree of flexibility to the interviewees. All interviews are realized in Croatia at the end of May 2020. The first interview was conducted with the head (Respondent 1) of the Museum of Krapina Neanderthals in Krapina[1], Croatia. The Museum offers its users a virtual walk through the museum exhibit using a multimedia DVD in which users can explore each exhibit room independently or with the help of an audio guide, music sounds from the museum and special ambient music accompany more than 100 virtual panoramas. The audio guide educates users with stories about the discovery in Krapina, the world's origin, and its evolution to the present day, with an automatic Museum virtual tour.

[1] https://mkn.mhz.hr/#

The second interview was conducted with the director (Respondent 2) of the Magic Croatia tourist agency[2] in Zadar. The Agency offers a Visitors City tour with a virtual reality experience, where visitors are guided through the city by a licensed guide to 8 of the most attractive locations where, with the help of VR glasses, they discover what Zadar looked like in different historical periods. In addition to the virtual displays, an audio guide provides the most important information about Zadar and historical events in 7 languages. The third interview was conducted with the Diocletian's Dream project[3] leader (Respondent 3) in Split. The Project has been a newly opened virtual reality experience attraction in Split. It is an animated film of the history of Diocletian's Palace that visitors can experience using VR glasses upon entering their space. Users go back to the ancient year 305 during the time of Emperor Diocletian and, through an appealing scenario, way entertainingly learn about Split history. A set of questions regarding SWOT framework was thoughtfully crafted, each directly related to the respondents' experiences with AR/VR technology usage in cultural tourism. All three respondents, who serve as managers of cultural institutions actively employing AR/VR technology, were presented with the same questions. These open-ended questions allowed participants to provide responses relevant to the given inquiries. Additionally, an eighth supplementary question was included to allow participants to offer further insights on the subject, make suggestions they considered significant for the overall interview, or provide any additional information they believed would be valuable for the examiner's final analysis of this topic.

5. RESULTS OUTPUT AND INTERPRETATION

Table 3 contains quotations/respondent's answers to the question:
What would be the strengths/weakness/opportunities/threats according to your up-to-date experience with AR/VR use in cultural tourism?

Table following on the next page

[2] https://magic-croatia.hr/izleti/virtualna-setnja-kroz-povijest-zadra1/
[3] https://diocletiansdream.com/#about

	Respondent 1	***Respondent 2***	***Respondent 3***
Strengths	*Given that the Museum has several thousand pieces of fossil remains, when creating multimedia and virtual content, it was easier to choose attractive objects for presentation to visitors within the museum's display. When using objects in a virtual sense, you get an attractive "product".*	*The use of VR glasses in tourism allows users to see what, until now, they could only hear and imagine based on the story told. The user is in a 3D world, content is displayed around him, and he feels as if he is part of the story, as if he is participating.*	*The main strength in our case is that it is a new and unique product on the market (USP - unique selling point). This form of technology represents a new medium and is still not sufficiently developed, but certainly, the demand is still greater than the supply, which ensures the further development of this product.*
Weakness	*Multimedia (installations) is extremely expensive, maintenance is very expensive and delicate. Often, experts for individual installations are not located in Croatia, so it is very difficult to work remotely. Also, it would be best to have an expert employed at the Museum who would always be your first aid. When such virtual installations are installed, it is important to keep in mind their maintenance. After a few years, it is difficult to find a replacement or spare parts or they no longer exist.*	*People who are not familiar with the technology of VR glasses, who have not used VR glasses and do not know how they work, have a harder time deciding to use VR glasses and conclude that they are not interested in using them until they are persuaded to try them - then everyone is delighted with the content and the result they see.*	*The weaknesses are that our project is still in its infancy, the whole VR technology is in development, and there is much room for improvement. VR technology is like computer games ten years ago, which were not yet developed enough. Although the technology has developed a lot, it is still nowhere near its peak, and it will take a lot of investment and effort to realize that potential.*
Opportunities	*Innovation in the presentation of the museum theme. Something that is not common in other museums, and multimedia is something that visitors do not expect in museums. Unfortunately, even today, the common opinion is that museums are dusty and boring places... So, something new, attractive, and unusual, a prehistoric theme told in a modern way, is a winning combination.*	*By displaying content through VR glasses, you can show a past event, buildings that no longer exist, people, clothing styles... there are a lot of possibilities, you just have to be creative. Also, VR glasses have speakers, so you can hear stories, interesting facts, and facts about everything you see through the glasses. A complete experience can be provided to the user.*	*The opportunities of VR technologies are great, and as the most important, I would point out the combination of modern technologies with significant cultural heritage and history. I think it is the most effective thing that can be done, and people love it when some things from history that would otherwise be forgotten or insufficiently understood come to life.*
Threats	*Threats in such a way of presenting museum materials are hacker attacks and viruses (Internet).*	*Technology is advancing rapidly, and new models of VR glasses are coming to the market. Also, programs that create animations and 3D content are constantly updated. Creators and authors must constantly follow trends, invest in improvements, and improve content and devices, and this costs.*	*Technology is constantly advancing, and each upgrade requires large financial costs. Also, one of the threats is the possibility of product copying by competitors.*

Table 3: Respondent quotations by SWOT items
(Source: Author(s) research)

Regarding AR/VR strengths, the findings indicate as follows: Respondent 1 values the ease of selecting engaging objects from the museum's fossil collection for multimedia, enhancing virtual presentations. Respondent 2 highlights the transformative power of VR glasses in tourism, offering users a vivid 3D experience beyond imagination. Respondent 3 emphasizes their technology's unique selling point (USP), noting its market novelty, recognizing its current development stage, and expressing confidence in sustained demand for ongoing evolution. Regarding AR/VR weakness weaknesses, the empirical findings briefly indicate that Respondent 1 stresses the challenges of costly and delicate maintenance for multimedia installations, underscoring difficulties in finding external experts and the importance of on-site expertise. Respondent 2 observes initial skepticism toward VR glasses but notes a positive perception shift after firsthand experience.

Respondent 3 acknowledges their VR project's early stage, drawing parallels to the past development of computer games, highlighting the necessity of substantial investment for its full potential. As far as *AR/VR opportunities* are considered, the empirical findings briefly indicate as follows:

- Respondent 1 advocates for innovative museum presentations, emphasizing the appeal of multimedia to break the stereotype of museums as dull places.
- Respondent 2 underscores the creative possibilities of VR glasses in showcasing historical events and providing a comprehensive user experience with visual and auditory elements.
- Respondent 3 sees significant opportunities in combining VR technologies with cultural heritage and history, bringing forgotten or misunderstood aspects to life and resonating well with people.

Regarding AR/VR threats, the empirical findings indicate as follows: Respondent 1 identifies threats in presenting museum materials, citing concerns about hacker attacks and viruses online. Respondent 2 points out the rapid advancements in technology, necessitating continuous investment by creators to stay current with VR glasses and content creation tools. Respondent 3 highlights ongoing financial challenges due to technological advancements and expresses concerns about competitors' potential for product copying.

6. DISCUSSION AND CONCLUSION

Drawing from examining professional, scientific literature and stakeholder interviews, our findings reveal distinct strengths, weaknesses, opportunities, and threats in integrating virtual and augmented reality technology within cultural tourism. As far as the empirical part is considered, it can be concluded that significant efforts must be dedicated to the better integration of VR/AR technology in cultural product development, thereby enhancing authenticity and broadening the cultural offerings at destinations. Cultural entities in Croatia ought to stay abreast of the latest technological advancements, channeling their creative energies toward leveraging Croatia's rich cultural heritage. This strategic focus is core to delivering unique and extraordinary experiences to visitors, effectively showcasing the cultural wealth of Croatia engagingly and innovatively. However, some potential challenges and considerations regarding AR/VR in cultural tourism have to be additionally pointed out. The same can also set the direction for future related research. Following above, (i) the challenge is to ensure that the content presented through AR/VR applications accurately reflects the historical and cultural context. Low-quality content can negatively affect a cultural site's user experience and perception. Also (ii) some users may be hesitant to adopt AR/VR technologies due to unfamiliarity or concerns about comfort and health issues (such as motion sickness). (iii) AR/VR experiences often require a robust technological infrastructure. In some cultural tourism sites, especially in remote or less developed areas, the lack of high-speed Internet or adequate hardware may prevent the implementation of AR/VR applications. Furthermore, (iv) developing high-quality AR/VR experiences can be expensive for some destinations. Cultural tourism sites, especially smaller ones or those in developing regions, may face challenges in financing the development and maintenance of AR/VR applications. (v) Ensuring compliance with local regulations and addressing privacy issues is also one of the challenges the AR/VR industry is increasingly facing. The next challenge (vi) is to create AR/VR experiences that entertain and educate visitors about the site's cultural significance. Achieving the right balance between entertainment and education is crucial to the success of these cultural tourism applications. The field of AR/VR is developing rapidly, so keeping up with technological progress can be also a challenge (vii). Cultural tourism stakeholders must keep abreast of new developments to ensure their applications remain relevant and competitive.

And, in the end, (viii) the cooperation between cultural institutions, technology developers, and other stakeholders is the last but not the least respectful challenge in the context of the analyzed topic. In conclusion, as the field of AR/VR in cultural tourism continues to evolve, addressing these challenges while preserving the cultural and historical integrity of sites become of crucial importance for maintaining future desirable visitor experiences.

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