

A Meta-Synthesis on the Role of Metaverse Technology in the Sustainable Development of Tourism

(A Case Study of Technology Integration in Tourism Sustainability)

Sousan Esmi^{a*}, Seyed Saeed Hashemi^b

^aPhD Student of Tourism, University of Science and Culture, Tehran, Iran; esmi.suzan@gmail.com

^bAssociate Professor, Department of Tourism Planning, Faculty of Tourism Sciences, University of Science and Culture, Tehran, Iran; hashemi@usc.ac.ir

ABSTRACT

This study explores the potential of metaverse technology in advancing sustainable tourism development in alignment with the United Nations' Sustainable Development Goals. Through a meta-synthesis analysis following a seven-step approach, 17 articles were selected from an initial pool of 149 and analyzed, identifying six key categories that illustrate how the metaverse contributes to tourism sustainability. The findings emphasize the metaverse's significant role in sustainable tourism by offering economic, educational, technological, and environmental benefits. The metaverse supports long-term sustainability in the sector by enhancing tourism experiences while reducing environmental impact, promoting responsible travel behaviors, and leveraging digital innovations. This study provides valuable insights for policymakers and stakeholders seeking to harness metaverse technology to drive innovation, foster sustainability, and develop models that balance economic growth with environmental stewardship.

Keywords—Sustainable tourism development, Metaverse, Virtual tourism, Virtual reality, Meta-synthesis

1. Introduction

Tourism has a vast capacity to accelerate progress towards Sustainable Development Goals (SDGs). When effectively managed, it fosters quality employment, supports sustainable growth, alleviates poverty, and incentivizes environmental conservation, contributing to a more inclusive and resilient economy. However, without protective measures and adequate investments, the development of the tourism market risks undermining biodiversity and ecosystems, which are vital to the livelihoods of many individuals and communities.

The United Nations' 2030 Agenda for Sustainable Development outlines 17 SDGs to end poverty, protect the environment, and promote well-being for all. In this agenda, tourism is recognized as an activity with significant positive impacts on the economy, society, and the environment. Specifically, it is linked to Goals 8, 12, and 14, which focus on sustainable

economic growth, sustainable consumption and production, and sustainable use of marine and ocean resources [1].

Sustainable tourism development has been the focus of tourism policymakers, destination marketing organizations, and researchers for years. Recognizing its significance, the United Nations designated 2017 as the International Year of Sustainable Tourism for development. The topic continues to attract widespread interest, with numerous researchers exploring various aspects of sustainable tourism and a growing number of publications dedicated to the field. However, despite this increasing attention, tourism remains less sustainable than ever [2] and many aspects of this field still require further study and exploration [3].

On the other hand, with the exponential growth of mass tourism in certain destinations, negative consequences have emerged, including the



<http://dx.doi.org/10.22133/ijwr.2025.500642.1263>

Citation S. Esmi, S.S. Hashemib, "A Meta-Synthesis on the Role of Metaverse Technology in the Sustainable Development of Tourism ", *International Journal of Web Research*, vol.8, no.1, pp.79-95, 2025, doi: <http://dx.doi.org/10.22133/ijwr.2025.500642.1263>.

*Corresponding Author

Article History: Received: 18 September 2024; Revised: 21 November 2024; Accepted: 9 December 2024.

Copyright © 2025 University of Science and Culture. Published by University of Science and Culture. This work is licensed under a Creative Commons Attribution-Noncommercial 4.0 International license(<https://creativecommons.org/licenses/by-nc/4.0/>). Noncommercial uses of the work are permitted, provided the original work is properly cited.

deterioration of local cultures, increased pressure on natural resources, and environmental destruction [2]. These adverse effects have led to the focus on sustainable tourism, primarily aimed at regulating tourist activity to minimize environmental harm. The COVID-19 pandemic created a unique opportunity for affected destinations to recover. However, limiting the number of visitors or tourism products poses economic challenges for destinations that depend on tourism income. Therefore, new approaches are needed to improve the sustainability of tourism destinations [4].

Veii ce's aanals re.. vered ss tourism halted during the pandemic, and older generations embraced virtual spaces. Los Angeles hosted a virtual film festival, while a metaverse concert sold 1.33 million tickets, earning \$71M. Amazon launched virtual tours, and Facebook rebranded it Meta, expanding metaverse experiences. These trends highlight research opportunities for sustainable tourism and evolving Gen Z and Alpha demands [4]. However, metaverse developments in tourism are still in their early stages [5]. However, The metaverse is expected to become a major factor in transforming consumer experiences in the tourism industry, much like the internet [6].

The tourism industry must embrace the metaverse, developing strategies for engagement to gain a competitive edge. While it can't replace real experiences, it will transform consumer interactions with tourism and hospitality services [5]. Metaverse products and experiences can expand natural tourism resources and support sustainability by offering profitable alternatives. Developing licensed, revenue-generating metaverse products can boost tourism destinations' profitability while aligning with UNWTO's SDGs [4]. Metaverse and sustainability are related in several ways. Sustainability is a crucial issue, as studies suggest that the metaverse significantly impacts environmental, economic, and social domains, influencing global sustainability.

As tourism can contribute to the advancement of the UN 2030 SDGs Agenda, metaverse can provide immersive and educational experiences that may foster sustainable tourism practices. Therefore, this study seeks to investigate and explore the role of the metaverse in sustainable tourism development, through a meta-synthesis analysis. By exploring the intersection of the metaverse and sustainable tourism, this study aims to highlight the metaverse's transformative role in promoting sustainability, offering insights for stakeholders on leveraging the metaverse for more sustainable tourism development.

2. Theoretical Foundations

The word "EE TVVER" ss a oombintt oon of ooo earms, "mtt" and "vrrs.." "ee t" maans bbyyond," and "vers" ss a shortnned form of uuniverse." Thss "beyond oorld" refers oo a computer-generated realm that allows access to metaphysical or metaphysical realms distinct from the physical world [7].

Historically, the metaverse is derived from the science fiction novel SnowCrash [8]. Although the metaverse was coined in 1992, no comprehensive definition exists [9]. " It is defined as an immersive three-dimensional virtual world in which people interact with each other as avatars and with software agents using metaphors from the real world but without its physical limitations" [10]. In another definttton, MMaaavrrs" ss an inspiring or hypothetical concept that envisions a futuristic digital realm. In the minds of its creators and enthusiasts, the metaverse holds a captivating allure and is closely intertwined with familiar objects, experiences, and the human body [11].

The metaverse involves the integration and interaction of the digital and physical worlds, encompassing the integration of digital and real economies, digital and social life, digital and real identities, and digital and physical assets. It includes high-speed communication networks, IoT, AR, VR, cloud computing, blockchain, artificial intelligence and other technologies. Technology is the driving force promoting the transition from the current Internet to the metaverse The eight essential technologies in the metaverse include augmented reality, user interaction (human-computer interaction), artificial intelligence, blockchain, computer vision, the Internet of Things and robotics, cloud computing, and future mobile networks [12]. Despite its potential, the metaverse faces many challenges, such as interaction and device limitations, computing and network requirements, ethical governance, privacy concerns, cyber syndrome and issues with standards, and compatibility [13]. The technology behind the metaverse is rapidly evolving using VR headsets, haptic gloves, AR, and augmented reality (XR), enabling users to have immersive experiences [12]. Interactive virtual environments and immersive games are considered predecessors of the metaverse. They can potentially expand physical boundaries through advanced technologies [13]. For example, virtual reality completely immerses people in a digital environment. These environments can be created entirely from computer content, real-world content (in actual 360-degree video), or a combination of both [13].

2.1. Metaverse and Tourism

The metaverse is a parallel virtual universe that uses environmental intelligence to enhance physical

products and services. It emerges as a shared virtual space for collaborative value creation. In tourism, the metaverse integrates physical reality with augmented and virtual reality to synchronize needs and entities within a standard 3D virtual space. By transforming physical spaces into mixed-reality environments, it turns the internet into a parallel virtual world [14]. Metaverse tourism refers to transdimensional environments that provide spatial experiences (or tours). Interaction with these environments increases tourists' experiences of a destination or product. Metaverse environments can intersect physical and virtual spaces, enabled by infrastructure, multi-sensory information, and metaverse technologies. Therefore, metaverse tourism offers products or experiences using collective spatial environments, enhancing tourist experiences by integrating physical and virtual worlds with multi-sensory data processing [4]. Tourism is one of the key sectors that can benefit from the metaverse [15]. The metaverse enhances authentic tourism experiences by allowing them to access virtual resources and environments away from their destinations. This is expected to improve their physical travel experience by providing better preparation. The metaverse allows tourists to engage virtually with destinations and organizations before arrival. Metaverse tours build on existing virtual tours using 360-degree mediated reality technology, offering avatar visualization and deep psychological and physiological immersion by encouraging real-time interactions with objects and environments in a virtual destination [16].

The metaverse brings exciting opportunities to the hospitality and tourism industry and presents significant challenges. Hospitality and tourism organizations should use the metaverse as a strategic tool to customize mixed virtual and physical experiences, enabling consumers to interact with other customers before, during, and after their trips [4]. In tourism, the metaverse uses a combination of physical reality with mixed reality (MR), augmented reality (AR), and virtual reality (VR) to unify all needs in a shared three-dimensional virtual space and transform physical spaces into mixed reality spaces. This turns the Internet into a virtual parallel world. MR offers a very realistic representation of the real world, blurring the line between virtual and physical objects for an immersive, seamless experience MR requires special hardware, such as smart glasses with transparent display lenses and multiple sensors to track the user's environment. These devices integrate 3D content naturally into the physical world, enhancing the realism of digital interactions[17].

2.2. Augmented Reality (AR)

AR overlays digital information onto real-world environments. For example, using a smartphone camera to translate signs and menus from one language to another, is an application of AR. Unlike

VR, AR keeps the real world as the focal point while enhancing it with digital elements that complement the environment [14].

2.3. Mixed Reality

MR enables real-time interaction with computer-generated images in the real world. Using a headset, users remain immersed in their physical surroundings while interacting with virtual elements through hand movements. For example, they can explore a 3D model of a new school building or an electric vehicle design. MR is primarily used in education, industrial design, military training, and medical applications[18].

Enhancing mixed reality experiences in cultural heritage destinations personalizes content and interactions based on user preferences, improving overall engagement. MR allows users to interact with historical objects in the real world using storytelling methods to engage visitors. This technology integrates digital information into real environments, enabling the display of artifacts without requiring physical presence[14]. However, in some studies, these two concepts are used interchangeably.

2.4. Sustainable Development of Tourism

Sustainable tourism integrates economic, environmental, and socio-cultural aspects into planning and management. Its goal is to mitigate tourism's negative impacts by applying sustainable development principles [19]. Guidelines and management practices for sustainable tourism apply to all forms of tourism in various destinations, including mass tourism and niche sectors. The sustainability principles emphasize environmental, economic, and socio-cultural factors, requiring a balanced approach to ensure long-term sustainability.

SDGs are global goals and objectives for sustainable development by 2030. They form the backbone of the 2030 Agenda, consisting of 169 goals and 17 interconnected goals designed to ensure peace, prosperity, and security for all people. These goals cover many areas, including poverty eradication, access to clean water and sanitation, reducing inequalities, and providing affordable and clean energy. They balance economic, social, and environmental sustainability [19]. Tourism can contribute directly or indirectly to all Sustainable Development Goals (SDGs). Notably, it plays a key role in Goal 8 (inclusive and sustainable economic growth), Goal 12 (sustainable consumption and production – SCP), and Goal 14 (sustainable use of oceans and marine resources) [19] (see Figure 1).

Tourism plays a significant role in achieving SDGs, and the World Tourism Organization is committed to providing a platform for the global tourism community to come together and advance the 2030 Agenda. Sustainable tourism is a key

component of this agenda, but achieving it requires a clear implementation framework, sufficient funding, and investments in technology, infrastructure, and human resources[19].

3. Research Background

Gu Hanyong et al. [4] suggested a four-layer architecture for metaverse tourism that includes tourists' experiences in metaverse environments. These environments emerge from the intersection of physical and virtual environments. The physical environment includes various infrastructures, such as tourist attractions, equipment, and supporting technological devices. The virtual environment is shaped by user-generated content, economic factors, and artificial intelligence, forming a dynamic metaverse ecosystem.

In another study [18], the "metaverse tourism ecosystem" was defined as an engaging 3D virtual world that supports social interactions between tourists and service providers. This ecosystem, supported by stakeholders, introduces new approaches to experiential tourism and creative economy inspiration through virtual and physical connectivity while enhancing connectivity with the real world. Tourists can detach from their physical identity and adopt multiple identities (such as avatars and personas), within the metaverse. They actively engage in tourism before, during, and after their trips through immersive experiences using tools like Google Earth, digital twin technology, and AR. Mobile applications and VR head-mounted displays (HMDs) enable users to create digital profiles and avatars, immersing them in virtual environments. However, the metaverse tourism ecosystem has not yet been fully realized, facing challenges like limited sensory experiences (such as smell, touch, and taste) and immersion constraints due to inadequate HMD technology. A rich sensory environment requires advanced 3D visualization technologies and sufficient bandwidth to control avatars and simulate travel behaviors. Ultimately, various tourism providers (hotels, destinations, amenities, and transport services) contribute to diverse immersive experiences, offering options for tourists to reconnect with the real world while benefiting from virtual engagement [18].

Jauhiainen et al. [20] conducted a systematic study on the metaverse and sustainability, analyzing research published between 1990 and 2022, finding that despite the metaverse's potential economic and social impact, sustainability had received limited attention in related research. They recommended integrating sustainability principles into the metaverse's development, design, and research to ensure a more comprehensive and responsible approach.



Figure. 1. Goals related to tourism according to the World Tourism Organization [19]

Hanyoung Go [4] analyzed the potential metaverse for sustainable tourism development. Drawing from UNWTO reports and Google Trends data, the research investigated how metaverse products and experiences can augment tourism resources and contribute to sustainability by providing alternative and lucrative options. The study suggested that developing licensed and high-yield metaverse tourism products can boost the profitability of tourism destinations, provided they align with UNWTO Sustainable Development Goals. However, the study underscored the necessity for further empirical research and case studies to assess the efficacy of this approach.

While various strategies have been proposed for sustainable tourism development, tourists generally prioritize their short-term benefits. The fact is that relying solely on mass tourism is insufficient and trusting tourists as a solution to achieving sustainability is not a guaranteed approach.

During COVID-19, the decline in tourism provided a unique opportunity to observe the impact of reduced visitation on polluted tourism areas and reassess sustainability issues. This situation showed that a limited number of visitors could help improve the conditions of overburdened tourist cities. In contrast, previous sustainable tourism approaches in these areas could not reduce environmental damage.

Protecting the environment may require radical measures, such as limiting the number of visitors or not promoting tourism products. However, implementing these strategies is challenging, as many tourist cities need income from tourism. Limiting tourism development in underdeveloped countries and regions may lead to economic burdens and inequalities regarding responsibility for environmental protection and sustainable development. Therefore, further studies are needed to evaluate the efficiency of these new approaches to sustainable tourism development [4].

Go and Kang [4] states that the metaverse enables remote collaboration and communication, allowing individuals worldwide to work together toward common goals, contributing to SDG 17 (Partnerships for Goals). Virtual education programs within the metaverse can provide access to quality education (SDG 4) for those lacking traditional educational resources. In addition, simulations and gaming

experiences in the metaverse can increase people's awareness about sustainability issues, such as climate change and environmental conservation, supporting SDG 13 (Climate Action) and SDG14 (Life Underwater) [4].

Metaverse tourism can strengthen the resilience of tourism destinations. By developing metaverse-based tourism products and experiences, additional sources of income can be created while reducing physical visits and preserving natural tourism resources. This approach is suitable for attracting the next generation of tourists. Researchers and tourism stakeholders should rethink the use and development of metaverse tourism to contribute to sustainable tourism development goals by 2030 [4].

Similarly, another study [21] examined the role of the metaverse in sustainability and how it can help accelerate progress towards United Nations SDGs. Using a multidimensional framework, the study systematically examined all 17 SDGs, showing that the metaverse can impact various sustainability factors, including water (SDG 6), energy (SDG 7), urbanization (SDG 11), economy (SDG 8), health (SDG 3), education (SDG 4), and forests (SDG 15). Additionally, the same study addressed the legal and social challenges of metaverse adoption and recommended a sandbox model for developing countries and policymakers, allowing developing countries to experiment with metaverse applications in a controlled environment. While the metaverse can positively impact various sustainability factors, it also brings significant and challenges that must be addressed [21].

Narin [22] stated that the metaverse has the potential to contribute to achieving several SDGs, including Goals 4, 8, 9, 11, and 16. Another study [23] on the use of VR technology in ecotourism found that the VR has the potential to reduce the negative impact of tourism on the environment. By allowing tourists to explore natural and cultural sights without physically traveling to the destination, VR can help lower carbon emissions and minimize the environmental footprint associated with travel.

In another study [24] a virtual world model was proposed to improve accessibility to tourism destinations, suggesting that the proposed model can contribute to sustainable development of tourism in emerging regions by increasing the use of potential destinations and improving access to tourism products to different users.

De Giovanni [25] presented frameworks for analysing the metaverse through the lens of the three main factors: environmental, social, and governance and the SDGs. These tools can help companies identify more effective strategies and take measures to mitigate potential negative impacts associated with metaverse adoption.

Lorrieu and Nascimento [26] explored the relationship between technology and sustainable tourism, highlighting conflicting views on the benefits and risks of technology adoption, identifying five work streams that lead to a broader view of technology that can contribute to the future of sustainable tourism. Additionally, the same study presented theoretical and managerial implications and proposed a research agenda for future studies on the impact of digital disruption in sustainable tourism [26].

Moreover, Hui et al. [27] suggested that metaverse-based promotional content can serve as an effective communication strategy to enhance environmental literacy and encourage positive ecological behaviors among tourists. Finally, it can facilitate the adoption of regenerative tourism practices during travel experiences, as metaverse technology has potential to promote sustainable tourism. Bouhalis et al. [16] discussed the potential of metaverse technology to revolutionize tourism management and marketing. While this study does not explicitly address sustainable tourism, it emphasizes that the metaverse can empower destination awareness, positioning, branding and management through digital supply chains. These Advancement can lead to more efficient and sustainable tourism experiences [16].

On the other hand, digital technologies such as social media, artificial intelligence, and machine learning promote sustainable tourism practices. These technologies helped tourism companies withstand the social restrictions created following the spread of the COVID-19, while respecting the social aspect of sustainable development. Additionally, digital technologies can help maintain the health and safety of tourists and local communities. In addition, they can help sustain business model innovations, such as services that assist people with disabilities and the elderly in overcoming physical and spatial constraints at home or employing local guides to provide interactive, real-time, and personalized tours. [28].

The present study aims to analyse and synthesize previous studies on the metaverse and sustainable tourism development to comprehensively understand existing literature.

4. Research Methodology

This study is grounded in meta-synthesis, which refers to integrating and analyzing qualitative results of different previous studies to develop a comprehensive view and deeper understanding of a specific subject. This method is commonly used in qualitative research, where qualitative data is analyzed to synthesize information, allowing for a deeper conceptualization of the topic and more complex interactions between concepts. Meta-

synthesis involves combining qualitative results of different studies, identifying patterns, differences, and analysing similar themes, focusing on empirically related phenomena [29].

The seven-step meta-synthesis approach proposed by Shandelowski and Barroso[30] is used in this study. A summary of these steps is presented in the Figure 2.

4.1. Step 1

The first step in meta-synthesis process is formulating the research question. To do so, the researcher must first determine the focus of the study. In this study, the following questions were addressed (see Table 1).

4.2. Step 2

Second step is the systematic review of the literature. To identify and collect relevant studies, this study searched international databases such as Web of Science, ScienceDirect, IEEE Xplore, Google Scholar and Scopus. These databases were selected for their extensive coverage of high-quality academic research on the subject matter

4.3. Step 3

Step three involves searching and selecting relevant text for analysis. The timeframe for selected studies was 2013 to July 2023. The search process began with broad keywords such as "metaverse tourism", "sustainable tourism development", and "virtual reality" across different databases. However, these general terms often

yielded irrelevant results, making it necessary to refine the search strategy. To improve accuracy, studies were specifically search using combined keywords, including "metaverse and sustainable development", "metaverse tourism and sustainable tourism development" or "virtual reality and sustainable tourism development".

Additionally, some studies used "virtual reality" and "augmented reality" as synonyms for hle metaverse, the terms "augmented reality" and "sustainable tourism" were also incorporated into the search. The keyword "metaverse tourism" proved to be the most effective in identifying relevant studies, whereas "sustainable tourism development" resulted in an overwhelming number of unrelated studies, making it challenging to find focused studies.

Database filters were applied to ensure the selection of the most relevant studies, allowing for a more targeted approach to narrowing down the results. This leads to identifying high quality studies that align with our topic.

To refine the sampling process, the study focused on articles in which "metaverse tourism" and "sustainable development" appeared at least once in the title, abstract, or main text. Based on the inclusion criteria, 149 studies were initially selected. However, after a thorough review considering exclusion such as content relevance, accessibility issues and lack of key terms in the title or abstract, 17 studies were finally analyzed. The inclusion and exclusion criteria used for identifying relevant studies are detailed in Figure 3 to ensure relevant selection.



Figure. 2. Shandelowski and Barroso's meta-synthesis steps[30]

Table 1. Parameters

Details	Parameter
How can the metaverse be used for sustainable tourism development?	What (Research questions)
In meta-synthesis, the text of previous studies serves as research data. Therefore, the study population includes existing research on tourism metaverse and sustainable tourism development.	Who (Study population)
The articles reviewed in this study were published between 2013 and July 2023.	When (Timeframe limitations)
Since the number of studies in this area is limited due to its novelty, articles with the highest relevance to the research scope were selected.	How (Method for collecting studies)

Algorithm for selecting the final articles of this research

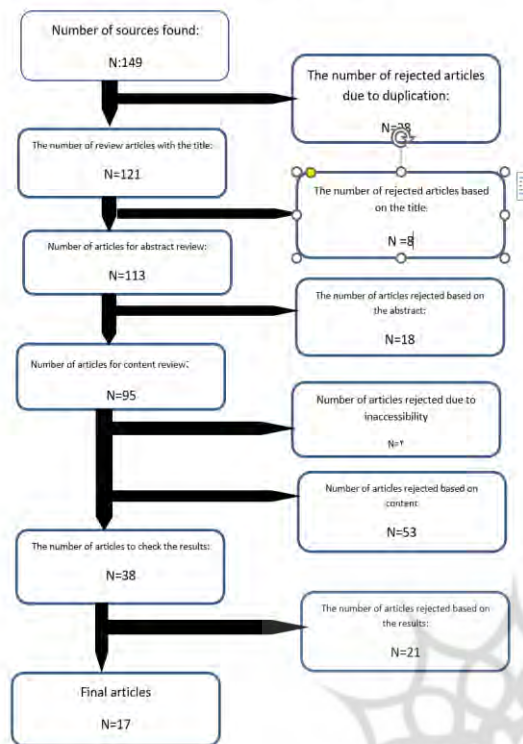


Figure. 3. Steps to select the final articles in this study

4.4. Step 4

Step four is extracting concepts from article. In this regard, the selected article were categorized chronologically based on their publication date. Each entry included the authors' name, summary, year of publication and other relevant details to ensure systematic organization.

4.5. Step 5

Step five is analyzing and combining qualitative findings. In this study, all factors identified from previous studies, based on their relevance to the study questions and objectives, were coded using MAXQDA. The extracted codes for each of the 17 selected sources, are presented in the Table 2.

4.6. Step 6

Step six is quality control. At this stage, researchers use various methods to ensure reliability in their findings. One of the key quality control tools in meta-synthesis is the Kappa Coefficient measures the agreement and consistency between interpretations made by two or more researchers. In other words, the Kappa helps determine whether the analysis results from multiple researchers align on a given subject.

In this study, an independent tourism expert, unaware of how codes were initially integrated,

conducted a separate coding process. The resulting codes were compared with the categories provided by primary the researcher. Using SPSS, the Kappa coefficient was calculated at 0.705 with a significance level of 0.000, indicating a high level reliability in the extracted codes.

4.7. Step 7

Last step is presenting the findings. At this stage, through multiple rounds of review and re-examination, back- and-forth process was conducting between concepts and categories. The key findings of fundamental studies were placed side by side by considering the studies related to each category. The role of metaverse in sustainable tourism development was then analyzed, allowing for the identification and interpretation of relationships between different categories and concepts.

To illustrate this synthesis process, the key characteristics of each category were first presented in a table under its title. Then, using the corresponding codes for each study, the main findings were integrated to reflect the metaverse's role in sustainable tourism development. This structured approach ensures that the findings directly address the core research question, comprehensively analyzing how metaverse technologies contribute to sustainability in tourism.

After coding, the resulting concepts were grouped into categories with shared themes. The Table 3 presents the categorization of extracted codes within the framework of key concepts and main categories. A total 221 codes were classified into six main categories, highlighting how the metaverse contributes to sustainability in tourism: advancing education, cultural preservation and immersive experiences; enhancing economic impacts and opportunities; advancing SDGs and overcoming challenges; driving sustainable tourism through technological advancements and responsible digitalization; improving sustainability and environmental conservation; benefiting from VR, AR, and Metaverse for virtual-based tourism

5. Findings and Discussion

Each category highlights a specific way in which metaverse technology can drive sustainable tourism development.

5.1. Advancing education, Cultural Preservation and Immersive Experiences

Studies indicate that the application of VR and the metaverse technology in education and empowerment of local communities is highly significant. The enhancement of educational and learning quality can be highlighted among their positive impacts. Through VR, individuals can engage

Table 2. Identified codes

<i>Codes</i>	<i>Article title</i>	<i>Author's name and year of publication</i>
Impact of technology on sustainable tourism development, SDGs, local community empowerment, economic benefits, sustainable tourism development, communication technologies and information technologies	Technology in Tourism and Hospitality to Achieve Sustainable Development Goals (SDGs)(Editorial)	Ali, Rasoolimanesh, & Cobanoglu, 2020 [32]
Budget optimization for heritage conservation, universalization of heritage accessibility, equal opportunities for cultural experiences, cultural exchange and understanding, enhanced educational experiences, Increased accessibility to educational resources, Streamlined project management, heritage dissemination and popularization	Architectural Survey, Diagnostic, and Constructive Analysis Strategies for Monumental Preservation of Cultural Heritage and Sustainable Management of Tourism	Rueda Márquez De La Plata, Cruz Franco, & Ramos Sánchez, 2022 [33]
Improving access to diving, increasing the experience of divers, VR, expanding tourism experiences, improving access to diving	Digital Technologies for the Sustainable Development of the Accessible Underwater Cultural Heritage Sites	Bruno et al., 2020 [35]
Sustainable development policies, technology impacts on sustainable tourism development, implementation of sustainable innovations, adoption of digital technologies, SDGs, executive recommendations	Driving hospitality and tourism to foster sustainable innovation: A systematic review of COVID-19-related studies and practical implications in the digital era	Elkhwesky, El Manzani, & Elbayoumi Salem, 2024 [28]
Adoption of digital technologies, social influence, sustainable behaviour, eco-friendly performance, virtual reality, sense of pleasure in place, virtual reality in teaching and learning, potential significant impact on the global economy, pro-environmental response, virtual reality technology for conservation and education, VR and learning	Eco-friendly performance as a determining factor of the Adoption of Virtual Reality Applications in National Parks	Sánchez, Palos-Sánchez, & Velicia-Martin, 2021 [36]
Communication technology and awareness, metaverse and awareness, VR and learning, metaverse and sustainable tourism, local community empowerment, pro-environmental behaviours, challenges, implementation suggestions, regenerative tourism, local community, metaverse and regenerative tourism, environmentally friendly performance, technology impacts on sustainable tourism development, local community participation	Exploring Regenerative Tourism Using Media Richness Theory: Emerging Role of Immersive Journalism, Metaverse-Based Promotion, Eco-Literacy, and Pro-Environmental Behavior	Hui, Raza, Khan, Zaman, & Ogadimma, 2023 [27]
VR and influential stimuli, VR and tourism, VR and tourism marketing, adoption of virtual reality, VR and learning, VR and sustainability, VR and users	How VR Technological Features Prompt Tourist's Visiting Intention: An Integrated Approach	Nguyen, Le, & Chau, 2023 [37]
Potential significant impact on the global economy, reforming people's social relations, education and learning, global and local sustainability, SDGs, environmental impact, importance of social sustainability in the metaverse, access to the metaverse for all individuals regardless of location, social status, or economic position, economic sustainability, social relations, addressing digital divides to ensure broader social sustainability	Metaverse and Sustainability: Systematic Review of Scientific Publications until 2022 and beyond	Jauhiainen, Krohn, & Junnila, 2022 [20]

<i>Codes</i>	<i>Article title</i>	<i>Author's name and year of publication</i>
Metaverse and excitement /innovation, metaverse support for transformative tourism experiences, defining metaverse tourism, social interactions, expanding tourism experiences, facilitating interaction with residents, evaluating travel options through the metaverse, impact on tourism management and marketing, research agenda	Metaverse as a disruptive technology revolutionizing tourism management and marketing	Buhalis, Leung, & Lin, 2023 [16]
Metaverse in cultural Heritages and conservation, practical recommendations	Metaverse for Cultural Heritages	Zhang et al., 2022 [39]
SDGs, education and learning, negative impacts on residents' quality of life, negative effects on sustainability of tourism resources, short-term benefits prioritized by tourists over long-term sustainability concerns, positive impact of reduced visits on polluted tourism destinations, re-evaluating sustainable tourism approaches, considering radical measures for environmental protection, significant economic potential, defining metaverse tourism, global and local sustainability, resilience and sustainability in tourism, expanding tourism experiences, transformative tourism support, impact of mass tourism, metaverse and social interaction changes	Metaverse tourism for sustainable tourism development: Tourism Agenda 2030	Go & Kang, 2023 [4]
Impacts of Technology on sustainable tourism development, environmental sustainability, metaverse and carbon reduction	Shaping a View on the Influence of Technologies on Sustainable Tourism	Loureiro & Nascimento, 2021 [26]
SDGs, industry 5.0, acceptance of digital technologies, blockchain, artificial intelligence, suggestions	Sustainability of the Metaverse: A Transition to Industry 5.0	De Giovanni, 2023 [25]
VR in tourism, VR in heritage preservation, VR in education, virtual tourism marketing, metaverse in tourist decision-making, AR, VR	The Use of Virtual Reality to Promote Sustainable Tourism: A Case Study of Wooden Churches Historical Monuments from Romania	Caciora et al., 2021 [40]
Tourism metaverse, VR and AR, Metaverse avatars, cost reduction, metaverse and sustainable tourism, metaverse and carbon reduction, metaverse and the reduction of mass tourism, metaverse and limitations, VR and tourism,	Travelling the Metaverse: Potential Benefits and Main Challenges for Tourism Sectors and Research Applications	Monaco & Sacchi, 2023 [41]
Drivers and barriers of sustainable behavior, green behavior, virtual tourism as a sustainable alternative, reducing environmental impact, feeling satisfaction from pro-environmental behavior	Virtual reality tourism to satisfy wanderlust without wandering: An unconventional innovation to promote sustainability	Talwar, Kaur, Escobar, & Lan, 2022 [42]
VR and sustainability, pro-environmental response, VR investment, economic benefits, practical recommendations, VR experiences, equal opportunities for cultural experiences	Digitalization and sustainability: virtual reality tourism in a post pandemic world	Talwar, Kaur, Nunkoo, & Dhir, 2023 [31]

Table 3. Findings of meta-synthesis analysis

<i>Codes</i>	<i>Concepts</i>	<i>Category</i>
Increasing access to educational resources, teaching and learning, advanced educational experiences, improving access to diving, enhancing the experience of divers	Impact on teaching and learning	Advancing education, cultural preservation and immersive experiences
	Virtual reality and education	
	Empowering the local community	
	Increasing access to educational resources	
	Metaverse and education	
Reducing the negative effects of tourism, impact of the pandemic on hotels and travel, optimizing budgets for heritage protection, and economic benefits	Economic management opportunities	Enhancing economic impacts and opportunities
	Impacts on tourism management and marketing	
Managing digital divides to ensure broader societal sustainability, importance of social sustainability in the metaverse	Social sustainability and digital divide	Advancing SDGs and overcoming challenges
Facilitating interaction with residents, local community participation in regenerative tourism	Local community	
Cultural exchange and understanding, globalization of access to heritage, equal opportunities for cultural experiences	Social benefits	
SDGs	Sustainable development and SDGs	
Facilitating access to metaverse for everyone, regardless of geographic location, social relationships	Social and cultural opportunities	
Radical measures for environmental protection, environmental sustainability, and reduction of environmental impacts	Environmental resources management	Improving sustainability and environmental conservation
Development of sustainable tourism, contributing to the resilience and sustainability of tourism	Sustainable Tourism	
Sustainability and development, sustainability impacts, impact of sustainability on the global economy and social relations, economic sustainability, significant potential for the global economy, metaverse and modification of social relations, environmental impacts of sustainability, global and local sustainability, sustainable development policies, sustainable behaviour	Sustainability and development	
Pro-environmental behaviours, reasons and challenges of sustainable behaviour, satisfaction from pro-environmental behaviour, driving forces of pro-environmental behaviours, dedication to environmental protection, sense of pleasure in place, environmentally friendly performance, pro-environment reaction, daily green behaviours, role of children in pro-environment behaviours	Environmentally sustainable behaviours	
Observations during the COVID-19 pandemic, reconsideration of existing approaches to sustainable tourism, positive effects of reduced visits on polluted tourism destinations	Observations during the COVID-19	
Tourists' behaviour, tourists' tendency to prioritize their short-term interests, lack of emphasis on long-term sustainability concerns, negative impacts on residents' quality of life, and negative effects on sustainability of tourism resources	Impact of mass tourism	

<i>Codes</i>	<i>Concepts</i>	<i>Category</i>
Social influence, adoption of digital technologies	Society and technology acceptance	Driving sustainable tourism through technological advancements and responsible digitalization
Dissemination and generalization of heritage, technology impacts, efficiency in management, efficient project management, communication technology, and awareness	Technology and sustainability	
Establishment of sustainable innovations, impacts of technology on sustainable tourism development	Innovation and sustainable development	
Artificial intelligence, blockchain, industry 5.0	Information and communications technology	
Metaverse and AR, Metaverse and limitations, Metaverse and decision making for tourists, metaverse and reducing mass tourism, metaverse and carbon reduction, metaverse and cost reduction, metaverse and avatars, metaverse and heritage conservation, metaverse and regenerative tourism, metaverse, and sustainable tourism, evaluation of travel options through metaverse, metaverse and excitement and innovation, metaverse and supporting transformative tourism experiences, defining metaverse tourism	Metaverse tourism	Benefiting from VR, AR, Metaverse for virtual-based tourism
VR and users, adaptability with VR, VR and tourism, expanding tourism experiences, VR in national park, VR and tourism marketing, VR and influence drivers, VR for protection and education, investment in VR, VR and sustainability, effects of virtual reality on sustainability	VR	
AR and VR, expanding tourism experiences, VR experiences	AR	

in more interactive and immersive educational experiences, facilitating a more profound understanding and learning. This engaging experience, by increasing awareness of local cultures, languages and artworks, inspirss young peopee's interest in cultural heritage. Additionally, this technology can increase access to educational resources and provide greater learning opportunities for individuals with limited access.

The importance of VR and AR systems in improving access to archaeological sites and underwater environments is also a significant topic. These technologies provide divers and non-divers with engaging experiences, allowing them to explore historical and natural sites while promoting pro-environmental behaviors. Based to these findings, the COVID-19 pandemic has been identified as an opportunity to influence behavioral changes through VR technology for environmental education and entertainment, particularly for individuals deprived of travel.

Talwar et al. [31] discussed using VR and AR systems to promote sustainable tourism in coastal Mediterranean destinations, focusing on underwater archaeological sites. These technologies aim to increase divers and non-diving tourists' access to the submerged cultural. The same study highlighted that VR and AR systems serve as access points for tourists

interested in exploring valuable cultural heritage sites beneath the Mediterranean Sea. These technologies can give visitors a unique and immersive experience, allowing them to visit multiple archaeological sites virtually. Additionally, tablet-based AR systems are valuable tools for divers, enabling them to navigate underwater archaeological sites using a 3D map, while receiving real-time information about key points of interest during visits.

Integrating VR and AR into such experiences aims to expand the appeal of virtual diving and digital exhibitions to a broader and more diverse audience, thereby promoting sustainable tourism in lesser-known coastal areas in the Mediterranean region. These technologies can create engaging and educational tourist experiences while preserving and showcasing underwater sites' historical and cultural significance [31].

In their study, Ali et al [32]. highlighted the role of technology, especially the metaverse and VR, in preserving and sharing local culture, languages, and artifacts in communities, stating that these technological advancements help protect cultural heritage and facilitate the transfer of this rich heritage to future generations.

Hui et al.[28] underscored the increasing attention of researchers on creating fundamental and practical

changes in the management of sustainable tourism development, focusing on the critical role of technology in motivating individuals to cultivate environmental objectives and attain pertinent knowledge regarding regenerative tourism. Consequently, this strengthens actions that benefit both ecological systems and local communities. In addition, interactive and experiential media content can encourage tourists to actively participate in improving the destination and local communities. This demonstrates how modern technologies can enhance the participation of both local communities and tourists in sustainable tourism practices [28].

5.2. Enhancing Economic Impacts and Opportunities

The role of small enterprises within the tourism sector is vital, particularly in rural areas where they are often family-owned and deeply connected to local communities. Fostering opportunities for these businesses contribute to sustainable development by poverty reduction, job creation, and economic growth. A study by Ali et al. [32] on the sharing economy in tourism, small business entrepreneurship, shows how the sharing economy can contribute to sustainable development and entrepreneurship in the tourism industry. Their results indicated that the sharing economy can strengthen cooperation and innovation among entrepreneurs and local communities, emphasizing that if sharing economy platforms cooperate with these micro-businesses, tourism experiences can be customized to fit each local community. In this way, tourism experience can be specifically designed to positively impact sustainable development and the environment. This study also supports investment in local sharing economy platforms to promote community-based tourism development rather than relying on current dominant platforms.

From another perspective, the role of metaverse technology and VR is the economic impact of their use on the costs of maintaining heritage. Access to accessible databases to everyone (from managers to technicians) ensures better preservation of heritage through broader control over the needs of these assets, and the ability to manage administrative tasks and financial resources with precise criteria. This approach enables the preservation of heritage with more limited budget allocation.

In another study, Rueda Márquez De La Plata et al. [33] stated that from an economic perspective, ensuring database access for all, including administration and technicians, is necessary to effectively preserve ancient sites. These technologies provide greater control over the management of archaeological site assets and the associated administrative and financial resources, leading to more efficient resource allocation. This approach

enables the preservation of cultural heritage even with limited budget allocation [33].

5.3. Benefiting from VR, AR, Metaverse for Virtual-based Tourism

Integrating VR and the metaverse in sustainable tourism development offers promising opportunities for innovation and transformation. These technologies provide tools to bridge the gap between the real and virtual worlds, offering tourists a unique interactive experience. The metaverse is emerging as a popular trend with the potential to reshape tourism places and experiences.

The potential of the metaverse and VR in preserving and enhancing cultural heritage is significant. Specialized virtual spaces can protect fragile historical and religious sites, allowing users to explore them without compromising their integrity. Furthermore, these technologies have the potential to foster a stronger connection with cultural assets and encourage public involvement in conservation initiatives. [39]

The concept of virtual tourism reality (VTR) has also gained attention, providing an alternative for experiencing destinations without the need for physical travel. VTR can also act as a powerful marketing tool. This shift towards VTR, particularly during and after the COVID-19 pandemic, has gained momentum, highlighting its potential as an environmentally friendly and sustainable alternative to traditional tourism.

However, while the metaverse and VR offer significant potential, challenges remain. Technical constraints in reproducing real-world experiences across all human senses and concerns about energy consumption are areas that require attention. Issues related to privacy, security, and accessibility are also important, as the adoption of the metaverse may create disparities in access and technical skills. Despite these challenges, the potential of the metaverse for engagement, education, and sustainably transforming tourism experiences is substantial. As a result, incorporating VR and Metaverse into sustainable tourism has the potential to revolutionize how travelers interact with destinations, cultural assets, and the environment. To ensure a sustainable and secure future for tourism, it's crucial to prioritize ethical, environmental, and technical considerations while offering diverse immersive experiences and innovative marketing avenues.

Virtual Reality

Talwar et al. [31] stated that the promotion of virtual reality experience should be designed so that virtual tourists gain such satisfaction that their loyalty, intentions, and behaviors persist for a long time. In this regard, VR application developers should focus on creating valuable, unique, diverse, authentic, and immersive experiences with the

support of gamification and enjoyment. The enjoyment derived from a seamless VR experience demonstrates the potential of VRT as an environmentally sustainable and cost-effective solution and presents a favorable opportunity for proactive anticipation and exploration, leading to increased interest in visiting the destination [31].

Rueda Márquez De La Plata et al. [33] stated that the globalization of our heritage is ensured thanks to new technologies. The initial step in this globalization is to ensure that the opportunity to visit a work of art, a bell tower, or a church is not hindered by physical limitations or geographical distance. Thus, people with reduced mobility due to age or other conditions can see what was previously possible without limitations. On the other hand, we can travel farther each time because there will be no limitations preventing people from visiting the old building due to sustainability considerations [33].

Augmented Reality

Oncioiu and Priescu [34] highlighted the evolving landscape of AR technology, stating that AR can bridge the gap between the physical and digital worlds by simulating human senses such as touch, smell, and proprioception in a virtual environment. It is often seen as a promising solution for achieving this sensory transition, although currently, its practical application appears primarily in the conceptual stage [34].

Bruno et al. [35] also discussed the practical application of AR in the context of a tablet-based system. In this scenario, the focus is on increasing the experience of exploring submerged cultural objects. AR brings these underwater artifacts to life by providing informative subtitles, visual content, and additional context. The application of AR effectively overcomes the spatial limitations posed by the underwater environment and increases accessibility and interaction around these cultural treasures [35].

Metaverse

The metaverse concept has emerged as a key driver of social changes and technological advancements in recent years. This digital world, often defined as the meeting point of the real and virtual worlds, has generated much debate about its potential to reshape various aspects of our lives. Tourism is one area where the metaverse is making significant waves, which promises to introduce a new way of exploring, learning, and engaging with the world around us.

One of the primary goals of destination marketing is to enhance tourists' decision-making process by providing them with informational support before their trip. To achieve this goal, advanced technologies must create immersive and informative experiences. Additionally, the metaverse offers a substitute when unanticipated circumstances, such as natural disasters

and epidemics, make typical tourist experiences difficult. For instance, targeted metaverse marketing can be used to conserve and promote historical landmarks, such as wooden churches, to boost local economies.[40]

The rapid proliferation of the metaverse has made participation in research more accessible and inclusive. The metaverse goes beyond physical limitations, allowing individuals with mobility impairments to engage in various research activities. The rapid proliferation of the metaverse has made participation in research more accessible and inclusive. The metaverse goes beyond physical limitations, allowing individuals with mobility impairments to engage in various research activities.

One of the appealing aspects of the metaverse is its potential to contribute to environmental sustainability. By making air travel, train rides, and personal transportation unnecessary for activities previously done in person, the metaverse can significantly help reduce carbon emissions. It offers a strategy to reduce the density of crowded tourist areas and prevent over-tourism during peak seasons.

The metaverse is poised to transform the tourism industry by seamlessly integrating the physical and virtual worlds. Tourists can experience both these areas, creating exciting opportunities and challenges. It may also be an alternative to physical travel when individuals cannot embark on physical journeys due to personal circumstances or environmental factors.

Efforts to apply the metaverse to preserve cultural heritage present a universal approach that can be useful for all forms of heritage. Further research is needed to explore the metaverse development among tangible and intangible heritage and to incorporate gamification and new games into cultural heritage metaverse experiences.

However, some discussions warrant some caution, as the growth of the metaverse may increase energy consumption, mainly through non-renewable sources, and demand more computational power and bandwidth. Researchers should address these challenges and identify their potential limitations.

Despite its potential, the metaverse faces regulatory challenges. Cybersecurity measures and privacy laws are struggling to keep pace with innovations of the metaverse. For example, the borderless nature of the metaverse raises questions about data transfer and processing. Furthermore, disparities in access to metaverse infrastructure and necessary technical knowledge may exclude certain populations from its benefits. Therefore, the metaverse is more than a purely digital phenomenon. It is a revolutionary force changing sustainability, research, and tourism. While it offers

vast opportunities, it also raises significant issues with regulation, equal access, and environmental damage. Embracing the metaverse will undoubtedly transform way of exploring and interacting with the environment and present fascinating opportunities for the future.

5.4. Advancing SDGs and Overcoming Challenges

The Integration of VR and the metaverse technologies has the potential to significantly impact sustainable tourism and align with various SDGs. These technologies provide creative means of altering consumer habits and improving environmental preservation.

One notable application of the Metaverse and VR in sustainable tourism is their role in SDG 12, which focuses on sustainable consumption and production patterns. The metaverse can virtualize production and consumption activities by utilizing digital technologies such as digital twins, VR, augmented reality, and blockchain. This can improve efficiency, cost-effectiveness, reduce waste, and preserve working conditions. This integration, while ensuring the integrity of the production process, enables environmentally-friendly practices.

Additionally, SDG14 emphasizes the sustainable conservation and use of marine resources. The metaverse can extend beyond virtualizing physical objects and be used for monitoring and protecting underwater ecosystems. Continuous monitoring of oceans, seas, and marine life can prompt remedial measures and regulations that help preserve coastal and marine environments.

The metaverse also potential to address sustainable development's economic and social facets. It can create job and entrepreneurship opportunities in various communities, especially micro-businesses in rural areas. This supports SDGs such as industrial innovation (SDG 9) and poverty reduction (SDG 1).

The metaverse enhances access to cultural heritage and tourism experiences. It enables individuals with limited mobility or financial constraints to virtually visit historical sites and landmarks, promoting the globalization of cultural knowledge. This aligns with the SDGs related to Sustainable Cities (SDG11) and high-quality education (SDG4).

However, the integration of the metaverse into sustainable tourism also presents challenges. The digital divide and access hurdles need to be addressed to guarantee social inclusion. Ethical considerations, such as privacy and data security, as well as the potential environmental impacts due to increased digital consumption, are critical factors that need careful attention.

On the other hand, Go and Kang [4] highlighted a unique phenomenon observed during the COVID-19 quarantine period, showing that in the absence of mass tourism during the pandemic, well-known destinations, such as Venice and Los Angeles, experienced a rapid improvement in the quality of natural resources, including cleaner air. This remarkable case exemplifies how significantly reducing visitor numbers can help restore tourism destinations facing environmental challenges. This raises questions about the effectiveness of previous sustainability efforts in these areas that have failed to reduce negative environmental impacts [4]. Despite its challenges, the COVID-19 pandemic provided a rare opportunity to observe the direct consequences of fewer people visiting previously affected tourism destinations. These results raise concerns about the current sustainable development methods and emphasize the need for more potent strategies to address environmental concerns in tourism industry.

Integrating metaverse with virtual reality technologies presents a revolutionary approach to sustainable tourism. By aligning with various SDGs, it enables the virtualization of production and consumption, supports conservation efforts, enhances economic opportunities, and strengthens cultural inclusivity. Careful attention to ethical and environmental concerns is essential to ensuring the long-term positive impact of the metaverse on sustainable tourism and global development.

5.5. Driving Sustainable Tourism through Technological Advancements and Responsible Digitalization

The role of technology in achieving sustainability includes enhancing continuous skills development and aligning with industry advancements. Resilience in the post-pandemic period relies on business models supported by digital technologies. However, adopting technology also requires careful consideration of its social impacts. The media and social networks significantly impact shaping technology acceptability and encouraging sustainable behavior. Effective communication strategies can use technology to enhance environmental knowledge and awareness.

Several technologies have been identified as having both positive and negative impacts on sustainability. Blockchain, for instance, combat counterfeiting and protect authenticity, but its energy-intensive nature raises environmental concerns. Similarly, while robotics, 3D printing, artificial intelligence, and the Internet of Things promote proactive decision-making and increase efficiency, they can result in job loss and privacy issues. While technology can open new market opportunities and improve job security, data security and privacy preservation concerns must be addressed.

Technological advancements in sustainability focus on integrating advanced technologies to enhance sustainability across various sectors, emphasizing the role of the metaverse in Industry 5.0. This approach highlights human-centered procedures, the creation of fair working environments, respect for human rights, and responsible digitalization. The goal of comprehensive analysis is to guide individuals, companies, policymakers, and stakeholders toward the adoption and management of the metaverse, with a focus on sustainability and the transition to Industry 5.0. Attention to digital transformation with care and responsibility can prevent unintended consequences of technology adoption.

5.6. Improving Sustainability and Environmental Conservation

The discussions in this category cover various aspects related to sustainable tourism development, the impact of virtual reality technologies, and environmental conservation. These concepts address the influence of tourists' consumption behaviors on sustainable tourism development, the potential of gamified experiences to promote responsible production and consumption, and the shift in the use of VTR, even after the pandemic.

VR can help address challenges such as mass tourism, as observed during the COVID-19 quarantine, where destinations regained their environmental quality due to reduced visitors. Studies emphasizing the importance of eco-friendly performance and its impact on acceptance goals highlight VR's potential for educating tourists about eco-friendly activities and improving their environmental literacy.[36]

In addition, eco-friendly performance, motivation for enjoyment, and personal norms influence the intention to use VR. Social influence and empathy are essential factors shaping pro-environmental behavior. Promoting VR experiences aligned with SDGs can contribute to sustainable tourism.

Metaverse, as a potential economic force, carries both positive and negative impacts, and significant attention is needed to consider its implications for sustainability and address environmental concerns [37]

This study shows that metaverse research, development, and careful integration can provide new ways to increase sustainability in various sectors, including tourism. As a result, key topics such as the role of VR and Metaverse in strengthening sustainable practices in the tourism industry, influencing tourist behavior towards responsible consumption, reducing the negative impacts of mass tourism, and improving environmental literacy, are emphasized. Emphasizing the link between

sustainable tourism, digital innovation, and environmental protection, these sections shed light on the complexities and opportunities of achieving a more sustainable and responsible future for the tourism sector.

The meta-synthesis analysis identified six key categories that highlight how the metaverse can be utilized for sustainable tourism development. The findings demonstrate that this technology is multifaceted, offering benefits across education, economics, environmental conservation, and cultural preservation while addressing critical challenges and promoting responsible digitalization.

6. Conclusions

By creating virtual reality experiences and interactive spaces, the metaverse can help increase tourists' awareness of the environmental, cultural, and social issues of the locations visited. This heightened awareness can promote sustainable tourism development and encourage tourists' participation in the development processes of tourism destinations. Furthermore, the metaverse can also be a significant marketing tool in tourism development. By showcasing virtual realities of tourist destinations and offering unique experiences to tourists, individuals can access more realistic and beautiful experiences without the need for physical presence at tourism sites. These beautiful experiences can attract travelers and increase demand for tourist destinations. As a result, the increased tourism activities following the greater embrace of metaverse experiences can lead to job creation and income generation in tourist areas. On the other hand, by creating platforms for improving the management of historical sites, the metaverse plays a role in reducing the maintenance costs of historical attractions. Thus, it can be said that it greatly contributes to achieving the economic goals of sustainable development in the tourism industry.

Another important result of this study is the emphasis on understanding sustainability concepts among tourists. The metaverse can assist in promoting tourists' responsibility regarding sustainability issues by enhancing their awareness of environmental and social topics. In conclusion, the metaverse influences sustainable development's social, economic, and environmental dimensions.

In the social dimension, it supports SDG 4 (Quality Education) by creating engaging educational and recreational experiences related to tourism, offering quality learning opportunities, and aligns with SDG 11 (Sustainable Cities and Communities) by enhancing access to cultural heritage and enabling virtual visits to historical sites for individuals with mobility or financial constraints, promoting global cultural awareness. Economically, the metaverse fosters SDG 8 (Decent Work and Economic Growth) by promoting tourism, creating engaging

experiences, supporting the sharing economy, and reducing maintenance costs for historical sites, contributing to job creation. It also aligns with SDG 12 (Responsible Consumption and Production) by offering educational experiences on sustainable consumption, encouraging responsible behavior. Environmentally, the metaverse aids in SDG 13 (Climate Action) by raising awareness about climate change and its impacts through informative experiences, fostering environmental action. Moreover, it supports SDG 14 (Life Below Water) by providing virtual experiences like diving to increase public awareness on preserving underwater resources, driving efforts to protect marine environments, and creating economic opportunities in underwater activities.

The implications discussed above must be addressed simultaneously, considering their ethical implications, to minimize risks and maximize the potential of the metaverse. To overcome these challenges, policymakers, academics, and tourism industry practitioners must collaborate. In the travel context, the metaverse serves as a transformative tool and catalyst for change, providing innovative solutions to achieve new equilibrium in a situation where tourism growth is essential while upholding sustainability goals and supporting local communities.

Declarations

Funding

This research received no funding from public, commercial, or non-profit sectors.

Authors' contributions

SE: Study design, data acquisition, results interpretation, and manuscript draft.

SSH: Study design, manuscript revision, and final approval.

Conflict of interest

The authors declare no conflicts of interest.

Reference

- [1] UN Tourism, "2017 International Year of Sustainable Tourism for Development" Accessed: Feb. 25, 2025. [Online]. Available: <https://www.unwto.org/tourism4development2017>
- [2] R. Dodds, and R. Butler, "Barriers to implementing sustainable tourism policy in mass tourism destinations," *Tourism: An International Multidisciplinary Journal of Tourism*, vol. 5, no. 1, pp. 35-53, 2010. https://mpra.ub.uni-muenchen.de/25162/1/MPRA_paper_25162.pdf
- [3] I. Tyan, M. I. Yagüe, and A. Guevara-Plaza. "Blockchain technology's potential for sustainable tourism" in *Information and Communication Technologies in Tourism 2021: Proceedings of the ENTER 2021 eTourism Conference, January 19–22, 2021*. Springer. https://doi.org/10.1007/978-3-030-65785-7_2
- [4] H. Go and M. Kang, "Metaverse tourism for sustainable tourism development: tourism agenda 2030," *Tourism Review*, vol. 78, no. 2, pp. 381-394, 2023. <https://doi.org/10.1108/TR-02-2022-0102>
- [5] D. Gursay, S. Malodia, and A. Dhir, "The metaverse in the hospitality and tourism industry: An overview of current trends and future research directions," *Journal of Hospitality Marketing & Management*, vol. 31, no. 5, pp. 527-534, 2022. <https://doi.org/10.1080/19368623.2022.2072504>
- [6] T. Vo-Thanh, M. Zaman, R. Hasan, S. Akter, and T. Dang-Van, "The rise of digitalization in fine-dining restaurants: a cost-benefit perspective," *ICCHM*, vol. 34, no. 9, pp. 3502–3524, Aug. 2022. <https://doi.org/10.1108/IJCHM-09-2021-1130>
- [7] D. N. Dionisio, W. G. B. Iii, and R. Gilbert, "3D Virtual worlds and the metaverse: Current status and future possibilities," *ACM Comput. Surv.*, vol. 45, no. 3, pp. 1–38, Jun. 2013. <https://doi.org/10.1145/2480741.2480751>
- [8] N. Stephenson, Snow Crash. Bragelonne, 2014.
- [9] D. Buhalis, D. Leung, and M. Lin, "Metaverse as a disruptive technology revolutionising tourism management and marketing," *Tourism Management*, vol. 97, pp. 104724, 2023. <https://doi.org/10.1016/j.tourman.2023.104724>
- [10] A. Davis, J. Murphy, D. Owens, D. Khazanchi, and I. Zigurs, "Avatar, People, and Virtual Worlds: Foundations for Research in Metaverses," *Journal of the Association for Information Systems*, vol. 10, no. 2, Feb. 2009, <https://doi.org/10.17705/1jais.00183>
- [11] L. H. Lee *et al.*, "All one needs to know about metaverse: A complete survey on technological singularity, virtual ecosystem, and research agenda," *Foundations and trends in human-computer interaction*, vol. 18, no. 2–3, pp.100-337, 2021. <http://dx.doi.org/10.1561/11000000095>
- [12] K. Bhugaonkar, R. Bhugaonkar, and N. Masne, "The rise of Metaverse and Augmented & Virtual Reality Extending to the Healthcare System," *Cureus*, vol. 14, no. 9, 2022. <https://doi.org/10.7759/cureus.29071>
- [13] Y. K. Dwivedi *et al.*, "Metaverse beyond the hype: Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy," *International Journal of Information Management*, vol. 66, p. 102542, Oct. 2022. <https://doi.org/10.1016/j.ijinfomgt.2022.102542>
- [14] D. Buhalis and N. Karatay, "Mixed reality (MR) for generation Z in cultural heritage tourism towards metaverse," in *Information and Communication Technologies in Tourism 2022: Proceedings of the ENTER 2022 eTourism Conference, January 11–14, 2022*. Springer. https://doi.org/10.1007/978-3-030-94751-4_2
- [15] World Economic Forum, "How the metaverse can be a force for good in an uncertain world," World Economic Forum. Accessed: Feb. 25, 2025. [Online]. Available: <https://www.weforum.org/stories/2022/05/how-metaverse-can-be-a-force-for-good-in-an-uncertain-world/>
- [16] D. Buhali, D. Leung, and M. Lin, "Metaverse as a disruptive technology revolutionising tourism management and marketing," *Tourism Management*, vol. 97, p. 104724, Aug. 2023. <https://doi.org/10.1016/j.tourman.2023.104724>
- [17] "The Role of Metaverse Tourism and Hospitality Online in Egypt" *مجلة المعهد العالي للدراسات النوعية*, vol. 3, no. 2, pp. 587-612, 2023. <https://doi.org/10.21608/hiss.2023.281598>
- [18] C. Koo, N. Kwon, N. Chung, and N. Kim, "Metaverse tourism: conceptual framework and research proposition," *Current Issues in Tourism*, vol. 26, no. 20, pp. 3268–3274, Oct. 2023. <https://doi.org/10.1080/13683500.2022.2122781>

- [19] UNWTO, "Tourism 2030 Agenda." Accessed: Feb. 25, 2025. [Online]. Available: <https://www.unwto.org/tourism-in-2030-agenda>
- [20] .. S. auhiainen, C. Krohn, and J. Junnila, "Metaverse and Sustainability: Systematic Review of Scientific Publications until 2022 and Beyond," *Sustainability*, vol. 15, no. 1, p. 346, 2022. <https://doi.org/10.3390/su15010346>
- [21] A. U..., "Metaverse for UN SDGs—An Exploratory Study," *Science-Policy Brief for the Multistakeholder Forum on Science, Technology and Innovation for the SDGs*, vol. 5, 2022.
- [22] N. G. Narin, "A Content Analysis of the Metaverse Article," *Journal of Metaverse*, vol. 1, no. 1, pp. 17-24, 2021.
- [23] I. P. Tussyadiah, D. Wang, T. H. Jung, and M. C. Tom Dieck, "Virtual reality, presence, and attitude change: Empirical evidence from tourism," *Tourism Management*, vol. 66, pp. 140–154, 2018. <https://doi.org/10.1016/j.tourman.2017.12.003>
- [24] A. Sabb hanthan and A. Good, "A Virtual World Model to Enhance Tourism Destination Accessibility in Developing Countries," *arXiv preprint arXiv:1302.5199*, 2013. <https://doi.org/10.48550/arXiv.1302.5199>
- [25] P. De Giovanni, "Sustainability of the Metaverse: A Transition to Industry 5.0," *Sustainability*, vol. 15, no. 7, p. 6079, 2023. <https://doi.org/10.3390/su15076079>
- [26] S. M. C. Loureiro and J. Nascimento, "Shaping a View on the Influence of Technologies on Sustainable Tourism," *Sustainability*, vol. 13, no. 22, p. 12691, 2021. <https://doi.org/10.3390/su132212691>
- [27] X. Hui, S. H. Raza, S. W. Khan, U. Zaman, and E. C. Ogadimma, "Exploring Regenerative Tourism Using Media Richness Theory: Emerging Role of Immersive Journalism, Metaverse-Based Promotion, Eco-Literacy, and Pro-environmental Behavior," *Sustainability*, vol. 15, no. 6, p. 5046, Mar. 2023, <https://doi.org/10.3390/su15065046>
- [28] Z. Elkhwesi, Y. El Manzani, and I. Elbayoumi Salem, "Driving hospitality and tourism to foster sustainable innovation: A systematic review of COVID-19-related studies and practical implications in the digital era," *Tourism and Hospitality Research*, vol. 24, no. 1, pp. 115–133, 2024. <https://doi.org/10.1177/14673584221126792>
- [29] .. Christina, "Meta-Synthesis Of Qualitative STUDIES: Background, Methodology and Applications," *NORDSCI Conference on Social Sciences*, 2018. <https://doi.org/10.32008/NORDSCI2018/B1/V1/13>
- [30] M. Sandelowski and J. Barroso, *Handbook for Synthesizing Qualitative Research*. Springer Publishing Company, 2007.
- [31] S. al Iwar, P. Kaur, R. Nunkoo, and A. Dhir, "Digitalization and sustainability: virtual reality tourism in a post pandemic world," *Journal of Sustainable Tourism*, vol. 31, no. 11, pp. 2564–2591, 2023. <https://doi.org/10.1080/09669582.2022.2029870>
- [32] A. Ali, S. M. Rasoolimanesh, and C. Cobanoglu, "Technology in Tourism and Hospitality to Achieve Sustainable Development Goals (SDGs)," *Journal of Hospitality and Tourism Technology*, vol. 11, no. 2, pp. 177–181, 2020. <https://doi.org/10.1108/JHTT-05-2020-146>
- [33] A. Rueda Márquez De La Plata, P. A. Cruz Franco, and J. A. Ramos Sánchez, "Architectural Survey, Diagnostic, and Constructive Analysis Strategies for Monumental Preservation of Cultural Heritage and Sustainable Management of Tourism," *Buildings*, vol. 12, no. 8, p. 1156, 2022. <https://doi.org/10.3390/buildings12081156>
- [34] I. Oncioiu and I. Priecu, "The Use of Virtual Reality in Tourism Destinations as a Tool to Develop Tourist Behavior Perspective," *Sustainability*, vol. 14, no. 7, p. 4191, 2022. <https://doi.org/10.3390/su14074191>
- [35] F. Bruno *et al.*, "Digital technologies for the Sustainable Development of the Accessible Underwater Cultural Heritage Site," *JMSE*, vol. 8, no. 11, p. 955, 2020. <https://doi.org/10.3390/jmse8110955>
- [36] M. R. Sánchez, P. R. Palos-Sánchez, and F. Velicia-Martin, "eco-friendly performance as a determining factor of the Adoption of Virtual Reality Applications in National Parks," *Science of The Total Environment*, vol. 798, p. 148990, 2021. <https://doi.org/10.1016/j.scitotenv.2021.148990>
- [37] T. B. T. Nguyen, .. B. N. ee, and N. .. Chau, "How VR technological Features Prompt Tourist Visiting Intention: An Integrated Approach," *Sustainability*, vol. 15, no. 6, p. 4765, 2023. <https://doi.org/10.3390/su15064765>
- [38] X. Zhang *et al.*, "Metaverse for Cultural Heritage," *Electronics*, vol. 11, no. 22, p. 3730, 2022. <https://doi.org/10.3390/electronics11223730>
- [39] T. Caciara *et al.*, "The Use of Virtual Reality to Promote Sustainable Tourism: A Case Study of Wooden Churches Historical Monuments from Romania," *Remote Sensing*, vol. 13, no. 9, p. 1758, 2021. <https://doi.org/10.3390/rs13091758>
- [40] S. Monaco and G. Sacchi, "Travelling the Metaverse: Potential Benefits and Main Challenges for Tourism Sectors and Research Application," *Sustainability*, vol. 15, no. 4, p. 3348, 2023. <https://doi.org/10.3390/su15043348>
- [41] S. al Iwar, P. Kaur, O. Ochoa, and S. al Iwar, "Virtual reality tourism to satisfy wanderlust without wandering: An unconventional innovation to promote sustainability," *Journal of Business Research*, vol. 152, pp. 128–143, 2022. <https://doi.org/10.1016/j.jbusres.2022.07.032>



Sousan Esmi is a Ph.D in Tourism at the University of Science and Culture, specializing in technology and smart tourism. With 18 years of experience in the travel services industry, she brings valuable practical and professional expertise. Her research interests include the application of innovative technologies and artificial intelligence to enhance tourist experiences and promote sustainable tourism development.



Dr. Seyed Saeed Hashemi Hashemi is a faculty member of the University of Science and Culture and is the editor-in-chief of the bi-quarterly journal *Tourism and Leisure* and the editorial board of the bi-quarterly journal *Interdisciplinary Studies of Iranian Architecture*. He has published 2 conference papers and 12 journal articles in domestic journals. He has had direct scientific collaboration with 6 different researchers over the past 13 years. His published articles are mostly on the topics of entrepreneurship, rural development, sustainable development, and social capital.