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Article

Exploring the transformation of wine tourism through metaverse technology

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Abstract: This study explores how Metaverse technologies can be applied to wine tourism. First, the background section reviews sensory mapping and experience economy theories and introduces the definition of Metaverse, technologies related to wine tourism, and differences from traditional tourism. Second, the research analyzes the application scenarios of immersive vineyard tours, simulated wine-tasting environments, online cultural activities, remote wine knowledge learning, experiential shopping, visitor interaction, and post-tour experience sharing. This study adopts a qualitative approach based on a literature review to explore these themes. Then, the changes of Metaverse technology on tourism organization are proposed, including benefit sharers, co-creation of tourism product value, personalized product customization, virtual digital communication, virtual product promotion, technology bridging, and non-fungible token (NFT) wine investment. Meanwhile, possible problems and coping strategies for Metaverse wine tourism are discussed. Finally, suggestions and practical guidance for future research are presented to promote the further development of the field.

Keywords: metaverse tourism; technology-driven tourism innovation; immersive vineyard tourism; virtual wine tasting environment; personalized product customization; wine experience

1. Introduction

In the era of pandemics, consumer attitudes and needs have changed significantly. Especially with the global COVID-19 outbreak, people have had to adjust their consumption patterns and shopping habits [1]. In the context of social distancing and home orders, online shopping is quickly becoming a mainstream practice, with far-reaching implications for traditional retail [2]. People are becoming more concerned about social responsibility, environmental conservation, and product quality at the same time. In addition, customers demand distinctive, personalized goods and services that cater to their particular requirements and preferences.

Technological advancements have sparked new consumer demands, particularly employing cutting-edge technologies in the consumer sector, like virtual reality, augmented reality, and artificial intelligence [3,4]. With the advancement of science and technology, humanity has reached a new digital age where the idea of the Metaverse has been put forth. By combining accurate and virtual aspects, artificial intelligence, virtual reality, and augmented reality technology can create a Metaverse that offers immersive experiences and interactive features [5]. In a metaverse users can communicate with others, explore different scenarios, and participate in multiple activities [6].

Metaverse technologies have been widely used in various fields [7]. Virtual reality and augmented reality in education provide students with immersive learning experiences. These technologies can be applied to surgery simulation and rehabilitation training in the medical field. Metaverse technologies are also widely

used in the entertainment industry, where virtual reality devices allow people to enter games or interact with artwork.

However, despite the growing interest in both the metaverse and wine tourism, limited studies have addressed the integration of metaverse technologies in wine tourism specifically. Although research on virtual reality (VR) and augmented reality (AR) applications in tourism has been expanding [8,9], the unique challenges and opportunities associated with Metaverse-driven wine tourism remain underexplored. Specifically, there is a lack of comprehensive studies on how Metaverse technologies—such as immersive vineyard tours, virtual wine-tasting environments, and NFT wine investments—can transform the consumer experience, tourism organization structures, and brand promotion strategies in the wine industry.

Furthermore, while existing research emphasizes the immersive potential of Metaverse technologies in various sectors (e.g., entertainment, education, and healthcare), no substantial framework has been developed to examine their applicability and impact in wine tourism. This study seeks to fill this gap by investigating the application of Metaverse technologies in creating personalized, interactive, and immersive wine tourism experiences that are not geographically constrained, offering new avenues for winemakers and tourism businesses to engage with a global audience.

Based on these discussions, this study proposes the following research hypotheses:

H1: Metaverse technology enhances the immersive experience of wine tourism and improves visitor satisfaction.

H2: Compared to traditional wine tourism, Metaverse tourism offers a more personalized and interactive experience for tourists.

For the tourism industry, the exploitation of the metaverse holds excellent promise [8]. Traveling in a metaverse wine offers a new experience for tourists. Virtual reality technology allows visitors to immerse themselves in vineyard tours, learn about winemaking, and interact with other tourists. Such a virtual experience is not limited by geography, giving travelers greater convenience and choice.

Metaverse wine tours also bring new opportunities for winemakers and brand promotion [9]. They can showcase their products and culture through virtual reality technology to attract more tourists and potential consumers. Meanwhile, virtual reality technology can also help wine lovers gain insight into the characteristics and taste of different wines and improve their understanding and enjoyment of wine.

Metaverse wine tourism contributes to the sustainable development of the wine industry [10]. Many wineries have adopted sustainable practices such as organic farming and environmentally friendly production methods. More wine tourists also choose wineries emphasizing environmental responsibility and ethical practices. Metaverse wine tours can give these wineries a stage to bring their sustainable philosophies to more tourists' attention.

Nevertheless, the integration of wine tourism and the Metaverse faces particular challenges. For example, there is a lack of existing research, and there is still little research on wine tourism supported by the metaverse, and the theoretical research still needs to be strengthened. Secondly, technological development and user experience must be continuously improved to ensure travelers have a truly satisfying experience

with the Metaverse. In addition, protecting user data and personal privacy is an important topic, and security measures must be strengthened. For this reason, it is necessary to carry out relevant research to meet the above challenges and to promote the sustainable development of the combination of wine tourism and the Metaverse.

Overall, there is excellent potential for Metaverse wine tourism with a promising future. It also provides innovative opportunities and business value to the wine industry while improving the experience and convenience of wine tourism. It is hoped that there will be cooperation and communication among wineries, tourism companies, virtual reality/augmented reality technology developers, and academia to promote the prosperous development of Metaverse wine tourism and bring more experiences to tourists.

Therefore, this study aims to promote the organic integration of wine tourism and the Metaverse, and at the same time, it is also hoped that it can serve as a guide for researchers and practitioners in related fields. The study is carried out in several parts: firstly, the background is delivered, with theoretical exploration as the main focus, supplemented by technical analysis; secondly, the application scenario study is carried out; the third part is the tourism organization change; fourthly, the possible problems and measures to cope with them; and lastly, suggestions are made for future research.

Based on the existing research gaps, this study aims to explore the following research questions:

How can Metaverse technology be applied to wine tourism?

What are the differences between metaverse-based wine tourism and traditional wine tourism?

What are the advantages and challenges of this new tourism model in terms of business opportunities and user experience?

2. Background

To better support our research and explain Metaverse technology applications, several aspects need to be focused on. First, we need to find appropriate theories to explain the application of Metaverse technologies in wine tourism. Secondly, there is a need to understand the technologies related to Metaverse applications and explore the performance of these technologies in virtual wine tourism. In addition, we need to compare the differences between Metaverse wine tourism and traditional approaches, focusing on the technologies involved in the background section to support wine tourism.

2.1. Theory review

For the phenomenon of combining wine tourism with the Metaverse, although specific tourism theories may not yet directly explain this combination, the following two theories may provide some relevant explanations:

2.1.1. Sensory mapping

“Sensory mapping”, as a research method and technique in sensory geography, aims to record and visualize human sensory experiences and perceptions of specific geographic environments [11]. Researchers can collect and display sensory data related to the location by conducting sensory mapping. This sensory data can include

sight, hearing, smell, touch, and taste.

This theory focuses on human sensory experiences and emotional connections to geographic space [12]. It well explains the intrinsic motivation for integrating wine tourism and the metaverse. Wine tourism emphasizes that tourists connect with the natural environment through visiting, tasting, and experiencing the atmosphere of vineyards. Metaverse technology can further strengthen this emotional connection through the virtual presentation of visual, auditory, and other sensory stimuli.

Application to Metaverse Wine Tourism:

Metaverse technology allows for multi-sensory virtual wine tourism experiences, simulating sight (vineyard visuals), sound (winemaking process), and even taste perception (AI-driven virtual tastings). For example, using haptic feedback devices and AI-enhanced olfactory technology, virtual wine tourism platforms can mimic the texture of holding a wine glass, the aroma of different grape varieties, or even the sensation of swirling wine in a glass. This aligns with sensory mapping, as metaverse wine tourism not only recreates the vineyard experience but also enhances sensory engagement beyond physical limitations.

As illustrated in **Figure 1**, sensory mapping in Metaverse wine tourism encompasses five key sensory dimensions: visual, auditory, olfactory, tactile, and taste stimulation. Through virtual reality (VR), artificial intelligence (AI), and haptic feedback technologies, Metaverse platforms replicate and enhance traditional wine tourism experiences beyond physical constraints[13]. This allows users to engage in immersive vineyard tours, AI-driven wine tastings, and sensory-rich winemaking processes, strengthening the emotional and experiential connection between tourists and virtual wineries.

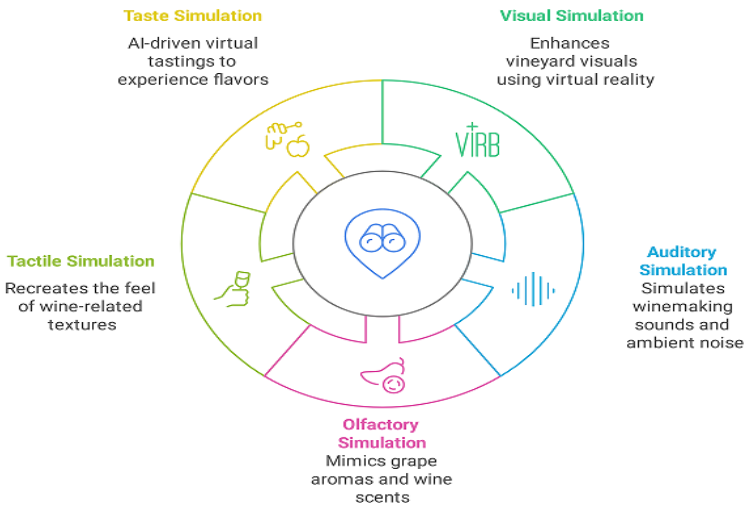

Figure 1. Sensory mapping in metaverse while tourism.

2.1.2. Experience economy theory

According to the Experience Economy Theory (EET), modern consumers emphasize satisfying their needs through unique, personalized, and meaningful experiences [14,15]. In wine tourism, virtual reality and Metaverse technologies can provide more diversified choices and customized experiences, catering to consumers' pursuit of personalized and meaningful experiences in wine consumption.

Specifically, when Metaverse is applied to wine tourism, customers can get a personalized, unique, and profound experience by virtually touring vineyards, understanding the winemaking process, and conducting wine tastings. These events can be presented in virtual reality environments, allowing customers to immerse themselves in the atmosphere and culture of natural wine.

Application to Metaverse Wine Tourism:

Metaverse wine tourism transforms traditional tourism into experience-driven, interactive digital tourism, aligning with the core principles of Experience Economy Theory.

Customization & Personalization: AI-driven recommendations in the Metaverse allow visitors to select virtual wine tours based on their taste preferences, interact with virtual sommeliers, or participate in customized wine-blending workshops.

Interactive Engagement: Unlike passive tourism, Metaverse wine tourism incorporates gamification elements, such as interactive challenges, NFT-based digital wine collections, and social wine-tasting events, reinforcing EET's principle that consumers seek memorable, engaging, and value-creating experiences.

Immersive Commerce: Metaverse wine tourism extends beyond traditional tourism by enabling experiential shopping, where users can sample virtual wines before purchasing and receive blockchain-verified authenticity certifications for their wine collections.

As illustrated in **Figure 2**, Metaverse wine tourism aligns with Experience Economy Theory by offering customization, interactive engagement, and immersive commerce. AI-driven personalization enhances individual experiences, while interactive gamification elements and NFT-based wine collections create a sense of engagement. Additionally, the integration of blockchain and VR technologies enables experiential shopping, allowing consumers to sample and verify wines before purchasing, thus enhancing value creation in virtual wine tourism.

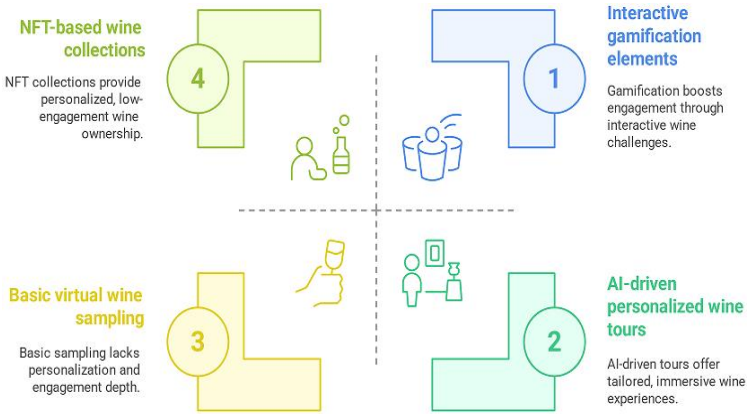

Figure 2. Mapping metaverse wine tourism experiences.

2.2. Metaverse technology

2.2.1. Metaverse definition

The metaverse is a virtual digital world comprising computer-generated environments where users can immerse themselves in the virtual world and interact with other users to create and share content [5]. To deliver a more open, accessible,

and rich interactive experience, it integrates virtual reality, augmented reality, and artificial intelligence.

Wine tourism is a type of tourism that is planned and carried out around activities and events linked to wine [16]. It involves visiting vineyards and wineries, tasting wine, learning about the tradition and background of wine, and participating in the grape-harvesting and winemaking processes. Wine tourism seeks to provide visitors with a thorough grasp of the traits of wine-producing regions, cultures, and people, as well as the opportunity to explore the world of wine and experience the joy and sentiments that wine gives to its consumers [17,18].

Metaverse wine tourism is a simulation of the digital world wine region experience with the help of virtual reality technology. Users can immerse themselves in vineyards, taste wines, and interact and share wine culture with other users. This form of tourism allows people to enjoy the pleasure and knowledge brought by wine tourism without actually going to the wine-producing areas.

2.2.2. Technologies related to metaverse wine tourism

Metaverse and wine tours can be utilized through a combination of virtual reality (VR) and augmented reality (AR) technologies to provide a richer and more interactive experience for tourists [19].

VR technology recreates actual vineyards and winery landscapes within the Metaverse. Tourists can wear VR headsets or use other equipment as if they were in a vineyard, enjoying the beautiful scenery of the vineyard and learning about the characteristics of various grape varieties. They can also enter a virtual winery and watch the entire process of wine, from picking to fermentation to maturation.

The Metaverse can also increase the fun and learning of actual winery tours through AR technology [20]. Visitors can scan real-world vineyard or bottle labels with AR devices like cell phones to obtain relevant information and interactive content. For example, they can learn about the type of wine, its origin, and taste characteristics and participate in fun interactive games, quizzes, and challenges through AR apps.

In addition, AI technology can provide personalized wine recommendations and tasting guides based on users' taste preferences and historical data. Blockchain technology ensures the traceability and authenticity of the wine, allowing users to know the production process and origin of each bottle of wine.

Combining the above technologies can provide users with an immersive, interactive Metaverse wine tourism experience [21]. Future developments may also involve more advanced and innovative technologies, leading to a more varied and richer experience.

2.3. Comparing traditional wine tourism

Table 1 compares metaverse wine tourism with traditional wine tourism. These comparisons show that Metaverse wine tours are different from traditional wine tours in terms of location restrictions, cost, mode of experience, social interaction, and verification of the authenticity of the wine tour. The comparisons show that Metaverse wine tours offer users a more flexible, convenient, and personalized wine experience with the help of technologies such as virtual reality, artificial intelligence, and

blockchain.

Table 1. Metaverse wine tourism and traditional one.

Item	Metaverse Wine Tourism	Traditional Wine Tourism
Place and time limits	Conducted at any time, any place.	Require physical travel to wine regions.
Cost and convenience	Lower cost, no travel expenses.	Airfare and lodging are required.
Field experience	Virtual simulation of wine regions, audio-visual experience.	Field visits to vineyards, wineries, and tasting of local flavors.
Social interaction	Interaction with other wine enthusiasts through social media platforms.	Requires interaction with on-site visitors.
Restricted environment	Unlimited by location and season.	Restricted by the location and season of the wine region.
Instant feedback and guidance	Personalized recommendations and tasting guidance through AI.	Direct access to winery staff and a professional sommelier.
Verification of wine authenticity	The traceability and authenticity of wines can be ensured through blockchain technology.	Need to trust the reputation and guarantee of the winery.

3. Methodology

This study adopts a qualitative and exploratory research approach to investigate the integration of Metaverse technology into wine tourism. The methodology consists of four key components: (1) Nature of the research; (2) research tools; (3) data collection and analysis; and (4) theoretical frameworks.

3.1. Nature of the research

This study is exploratory and qualitative, focusing on conceptual and theoretical analysis rather than empirical testing. Given the novelty and emerging nature of Metaverse applications in tourism, empirical data collection was not deemed feasible at this stage. Instead, the research relies on secondary data sources such as academic literature, industry reports, and case studies to explore the current state of Metaverse integration in wine tourism.

The exploratory nature of this research is crucial due to the limited empirical studies in the field. A qualitative approach allows for an in-depth examination of how Metaverse technologies reshape tourism experiences, business models, and user engagement. Through this approach, the study aims to uncover initial insights into the potential impact of the metaverse on wine tourism, providing a foundation for future empirical investigations.

3.2. Research tools

The study employs two primary research tools to address the research questions: Literature review and case study analysis.

3.2.1. Literature review

A systematic literature review was conducted to analyze existing research on Metaverse applications, virtual tourism, and wine tourism. Sources were selected based on relevance, academic rigor, and their impact on the field. To ensure transparency and reproducibility, the literature review was conducted using a systematic approach. Academic databases such as Scopus, Web of Science, and

Google Scholar were searched for peer-reviewed articles published between 2015 and 2024. The following keywords and combinations were used: “Metaverse tourism”, “virtual wine tasting”, “immersive wine tourism”, “blockchain in wine industry”, “AR/VR in tourism”, and “digital experience in wine tourism”.

The initial search yielded over 120 articles and reports. After screening for relevance, quality, and alignment with the research focus, about 45 sources were selected. These include empirical studies, theoretical papers, and industry white papers related to Metaverse technologies, tourism innovation, and wine tourism transformation.

The review covered the following key areas:

- Technological advancements: The role of VR, AR, AI, and blockchain in tourism and their potential to enhance user experiences.
- Tourism experiences: Digital immersion and customer engagement through virtual environments.
- Wine tourism evolution: A comparison of traditional wine tourism experiences versus Metaverse-based experiences, focusing on how digital technology alters consumer interactions with wine tourism.

The literature review serves as the conceptual foundation for this study, identifying key themes, trends, and research gaps. It also informs the development of the study’s research hypotheses and analysis categories.

3.2.2. Available cases approach

To support the conceptual analysis, this study adopted a case study approach focusing on practical implementations of Metaverse technology in wine tourism. Three representative cases were selected based on their technological relevance, visibility in public sources, and contribution to immersive wine experiences. These included 14 Hands Winery in the United States, which offers a 360-degree VR vineyard tour; WiV Technology, a blockchain-based platform enabling NFT wine investments; and Antinori Winery in Italy, which integrates virtual environments to promote wine heritage and tourism. Each case was examined across four dimensions: The type of technology applied, the user interaction design, the business value created, and potential operational challenges. This structured approach ensures the selected cases meaningfully support the thematic findings discussed in the following sections.

3.3. Data collection & analysis

This study primarily relies on secondary data from academic databases, industry reports, and digital tourism case studies. The collected data is analyzed using an inductive approach, allowing patterns to emerge naturally rather than testing pre-existing hypotheses.

The following two analysis techniques were used:

3.3.1. Thematic analysis

Thematic analysis was employed to systematically identify and categorize key patterns in Metaverse-based wine tourism research. The analysis followed Braun and Clarke [22] six-step framework:

- Familiarization with Data. Reviewing academic literature, case studies, and industry reports to identify relevant information.

- Generating Initial Codes. Assigning codes to relevant segments of data based on emerging themes related to Metaverse wine tourism.
- Searching for Themes. Grouping similar codes into broader categories, such as user engagement, technology adoption, and business model innovation.
- Reviewing Themes. Refining and merging themes to ensure they accurately reflect the collected data.
- Defining & Naming Themes. Finalizing key thematic categories that highlight the significant findings of this study.
- Writing Up Results. Synthesizing the identified themes into a coherent discussion on how Metaverse technologies influence wine tourism experiences.

By applying this structured approach, this study ensures a rigorous analysis of recurring trends and emerging themes in Metaverse-driven wine tourism. The thematic analysis was independently conducted by two researchers with academic backgrounds in tourism innovation and digital media. Following Braun and Clarke's six-step approach, the data was reviewed and coded iteratively. Through collaborative coding and theme refinement, three overarching themes were identified:

(1) Application Scenarios of Metaverse Wine Tourism—covering immersive vineyard tours, virtual wine tastings, remote learning, experiential shopping, and visitor interaction (as detailed in Section 4).

(2) Organizational Transformation through Metaverse Integration—including co-creation of value, personalized product customization, virtual communication, and NFT investments (as discussed in Section 5).

(3) Potential Challenges and Coping Strategies—analyzing credibility issues, technological limitations, privacy risks, and user experience gaps (explored in Section 6).

3.3.2. Comparative analysis

Since Metaverse wine tourism represents an innovative model distinct from traditional approaches, comparative analysis was conducted to systematically evaluate key differences. Instead of a descriptive comparison, the study applies a structured analytical framework to assess the impact of Metaverse wine tourism across multiple dimensions:

User Experience. Differences in sensory immersion, interactivity, and engagement levels.

Economic & Operational Feasibility. Evaluate cost advantages, accessibility, and logistical constraints in both models.

Technology Dependence. Assessing the role of VR, AI, and blockchain in shaping consumer experiences and business operations.

Scalability & Market Expansion. Examining the potential reach of Metaverse platforms versus location-bound traditional wine tourism.

This analytical approach allows for a rigorous comparison of Metaverse wine tourism's potential advantages and limitations, providing a structured foundation for evaluating its industry implications.

3.4. Theoretical frameworks

Two key theoretical frameworks are applied to structure the study's findings and

interpret the results of the data analysis:

3.4.1. Experience Economy Theory (EET)

Experience Economy Theory (EET), proposed by Pine and Gilmore [23], explains how immersive, personalized experiences enhance customer engagement in tourism. This study applies EET to Metaverse wine tourism by identifying four experiential dimensions that Metaverse technologies can enhance:

Entertainment: Gamified experiences such as virtual tours or interactive wine tastings in the Metaverse.

Education: AI-driven wine knowledge sessions that educate users about the history, production, and tasting of wines.

Esthetics: Virtual vineyard simulations and digitally enhanced wine cellars that create aesthetically immersive environments.

Escapism: The opportunity for full immersion in Metaverse wine culture, allowing users to escape into a digital world that mirrors the richness of traditional wine experiences.

This framework helps explain how Metaverse technologies can create engaging, multi-sensory experiences for users.

3.4.2. Sensory mapping

Sensory mapping, as outlined by Chan et al. [24], is a framework for analyzing how virtual environments replicate real-world sensory experiences. This study uses sensory mapping to explore how Metaverse technologies replicate the sensory elements of wine tourism, particularly:

Visual & Auditory Replication: Using VR, users can experience vineyards and wineries in visually rich, immersive environments, with accompanying sound effects to mimic real-world experiences.

Haptic Feedback: AI-driven systems simulate touch sensations during virtual wine tastings, enhancing the tactile aspect of the wine-tasting process.

Sensory mapping helps examine how Metaverse technologies bridge the gap between physical and virtual environments in wine tourism, enhancing overall consumer engagement and experience.

4. Application scenario exploration (theme 1)

Virtual reality and Metaverse technologies still have great potential for development in specific potential application scenarios [18,22]. With these technologies, people can experience wine tourism more intuitively and interactively under practically impossible conditions, expanding consumers' perception and experience of wine.

4.1. Immersive vineyard tourism

Virtual reality technology allows users to immerse themselves in the beauty of vineyards and learn about the wine-growing process[23,24]. They can explore the terroir and local culture of different wine regions and sincerely appreciate the relationship between wine and soil environment [25]. During the virtual vineyard tour, tourists can interact with a tour guide to learn knowledge and information about wine

[25]. The virtual tour guide will introduce the history, tradition, and unique characteristics of specific wine regions, allowing tourists to understand the local wine further.

Virtual reality technology allows consumers to understand each step of the winemaking process, including grape harvesting, wine fermentation, and even barrel aging, in detail. They can immerse themselves in the skills and knowledge of the winemakers and improve their understanding and appreciation of the winemaking process [26].

With virtual reality, wine connoisseurs can tour virtual wine cellars and collections at well-known wineries worldwide. They can learn about the wine's past, observe the maturing barrels, and learn how different wines are stored. A thorough comprehension of the background and production methods for each bottle of wine is provided through this immersion approach.

In recent years, several wineries have adopted virtual vineyard tours to enhance consumer engagement and expand their global reach [27]. For example, Hammersky Vineyards in California provides a 360-degree virtual tour that allows visitors to explore the vineyard, tasting rooms, and wine cellars through an interactive panoramic experience. Similarly, Buena Vista Winery has developed immersive online video experiences that guide visitors through its vineyards, historic sites, and winemaking process. Antinori Winery in Italy also offers a virtual experience that blends elegance and tradition, allowing remote visitors to immerse themselves in its rich wine culture.

Beyond video-based tours, 14 Hands Winery in Washington offers a 360-degree VR experience where visitors can virtually walk through the vineyard and observe different stages of grape growing and winemaking using VR headsets. This immersive approach enables consumers to feel as if they are physically present in the vineyard.

These practical implementations demonstrate how virtual vineyard tours enhance accessibility, provide educational opportunities, and offer immersive experiences that complement traditional wine tourism. By integrating various digital tools—ranging from simple online videos to fully interactive VR environments—wineries can create engaging digital experiences that appeal to both wine enthusiasts and casual visitors.

4.2. Simulated wine-tasting environments

Users can communicate with a virtual sommelier in these simulative wine-tasting environments to gain knowledge of wine and wine-tasting skills [28,29]. Tourists will be introduced to the qualities of each wine by the virtual sommelier, who will also offer suggestions for food pairings to assist them in better comprehending the wine's qualities and style.

The Metaverse platform additionally provides interactive wine-tasting events. To exchange experiences and feelings related to wine tasting, tourists might connect with other online sommeliers or wine enthusiasts [30]. They can take part in online wine-tasting tournaments where they can compete against other competitors while receiving feedback and improving their performance.

The best wines in the world are available for users to sample by traveling freely throughout the Metaverse's wine regions [31]. Whether tasting French classics or exploring the specialties of emerging regions, the metaverse can be realized through

virtual reality technology.

4.3. Online culture and events

Metaverse organizes virtual wine festivals, art performances, and cultural events that allow tourists to participate in and experience wine-related cultural extravaganzas [32]. Through the Metaverse platform, tourists can communicate with wine enthusiasts from all over the world [33,34]. They can exchange wine-tasting tips, recommend good wines, learn about regional wine cultures, and broaden their horizons.

4.4. Distance wine learning

The Metaverse platform provides rich, colorful remote knowledge learning [5]. The platform can also provide tourists with wine knowledge to meet the needs of a wide range of users [25].

First, tourism organizations design an online training course that covers a large amount of wine-related knowledge and tasting skills. Users can systematically learn the basics of wine, including grape varieties, characteristics of producing regions, and winemaking techniques. At the same time, it focuses on studying tasting techniques so that users can know how to evaluate wine's color, aroma, taste, and aftertaste factors.

Secondly, the tour organization provides an opportunity to communicate with famous winemakers, which deepens users' understanding and knowledge of wine. Virtual simulation technology lets users visit vineyards, experience grape harvesting and winemaking processes, and thoroughly understand wine production. They can also ask questions, share experiences, and get professional guidance through interaction with winemakers. This interactive approach helps tourists better understand the science and art behind the wine.

In addition, events such as master lectures and tastings on the Metaverse platform can also be attended by users in person. They can communicate with world-famous wine masters in real-time in the virtual space, listen to their experience sharing, understand the culture and history behind the stories, and participate in tasting sessions to improve their tasting skills in practice.

4.5. Experiential shopping

Virtual reality or augmented reality technology allows users to immerse themselves in a metaverse to experience shopping, expand their choices, and increase their confidence in products [35]. They can roam the virtual store and view detailed information about various alcohol products, including the brewing process, flavor descriptions, and food pairing suggestions [36]. They can also interact with a virtual image sales consultant to obtain recommendation information on different brands and styles.

In this virtual shopping experience, users can interact with their surroundings using joysticks, head-mounted displays, gesture controls, and other devices [37], such as picking up a bottle of wine, touching the label to view more information, and even virtually sampling the wine to experience its flavor and aroma. After making a purchase, the consumer can arrange for virtual or physical delivery and make payments online.

Events like wine knowledge competitions might also be provided to make shopping more entertaining and engaging. These activities can enhance the user's buying experience and aid in developing a greater appreciation for wine's history, culture, and knowledge.

4.6. Visitor interaction

Wine lovers from all around the world can get together in a virtual wine lounge or social area.

Visitors can interact with others in a virtual wine lounge using speech or text while using customized identities [25]. They can discuss their wine-tasting adventures, make wine recommendations, trade tasting advice, and participate in seminars or questions and answers (Q&A) sessions with winemakers. This social interaction can promote the interchange of wine cultures between diverse regions and increase people's knowledge of and interest in wine.

Through the Metaverse platform, users can access a virtual social environment [38]. They can communicate with other wine fans by participating in wine communities, chat rooms, or clubs. They can organize online gatherings, seminars, or competitions to discuss wine-related topics and to share their experiences and palates. This social interaction promotes cross-regional wine culture exchange, which broadens users' social networks.

4.7. Post-tour experience sharing

Create a platform for people to submit and exchange travelogues, wine reviews, and notes on tasting in the Metaverse. The platform can provide information to other users to help them better comprehend different wine varieties, regions, and winemaking methods. Users can learn and gain a new wine-tasting experience by browsing what others have shared.

In addition, with Metaverse technology, users can share information about their travel experiences and wine-tasting experiences on other social media platforms and communicate with the broader community [39]. They can comment and communicate with other users by posting virtual travel videos or wine-tasting notes. This kind of sharing can attract people to recognize and participate in the wine culture and bring more appreciation and learning to the users.

5. Travel organization transformation (theme 2)

Integrating Metaverse technology will bring the following transformations to tourism organizations.

5.1. Benefit sharers

The Metaverse provides a more open and tolerant stage for closer collaboration and sharing among wine tourism organizations and stakeholders, including wineries, travel agencies, tourists, and local communities. Through the Metaverse, all parties can share resources, collaborate on promotion and marketing, and achieve mutual benefits (see **Table 2**).

Table 2. Stakeholders and their benefits.

Stakeholders	Benefits
Wineries and wine producers	Increased brand awareness and exposure; Expanded sales channels; Provide unique wine experiences.
Tourists and visitors	Explore virtual wine tour; Enjoy immersive experiences; Learn about wine-related knowledge.
Metaverse technology providers	Provide technical solutions and platforms; Create immersive experiences for users.
Wine experts and consultants	Provide wine knowledge and professional advice; Participate in planning and designing Metaverse wine tours.
Digital content developers	Create and publish content for virtual wine tours. Explore new opportunities for virtual creativity.
Travel agencies and platforms	Promote Metaverse wine tours; Attract tourists and users.
Local governments	Promote tourism development and innovation; Increase employment opportunities and regional economic income.

5.2. Value co-creation of tourism products

By utilizing Metaverse technology, tourism organizations can engage in closer interaction and collaboration with customers at different stages of the travel experience, such as pre-travel, during travel, and post-travel, thereby co-creating rich travel experiences and tourism value [39]. It enhances customer satisfaction and loyalty and promotes continuous innovation and development in the wine tourism industry.

In the pre-travel stage, wine tourism organizations can use data analysis on the Metaverse platform to understand user preferences and tastes, thereby providing personalized itinerary planning. For example, based on user preferences, recommend specific vineyards to visit, participate in unique wine-tasting activities, or arrange private tour guide services. Personalized itinerary planning can meet user needs and enhance pre-travel expectations.

Wine tourism organizations can provide interactive wine-tasting experiences during the travel stage under the Metaverse platform. Tourists can select grapes, participate in pressing and fermentation processes, and personally experience wine tasting. This interactive experience enhances user engagement and immersion.

In the post-travel stage, wine tourism organizations can use the Metaverse platform to build a virtual communication community where users can stay connected even after their trip. Users can share their travel experiences and wine-tasting experiences and exchange winemaking techniques through the community. Wine tourism businesses have a fantastic opportunity to identify customer demands and enhance their offerings thanks to this community participation, which also improves user relationships.

5.3. Personalized product customization

Metaverse wine tours give visitors a customized wine-drinking experience by fusing the virtual and real worlds. Users can alter virtual or wine-tasting trips to suit

their tastes and preferences. They can go to a particular vineyard to suit particular requirements and learn more about a specific grape type [23].

Initially, the site offers tailored travel suggestions based on user preferences and interests, such as vineyard tours, wine tastings, and regional dining opportunities. Users can plan vacations to suit their preferences and learn about wine culture.

Second, the platform offers an online wine-ordering feature. It lets users immediately purchase their favorite wines while receiving the most recent wine suggestions and promotional information, making wine purchasing more accessible and individualized.

Additionally, AI-driven wine customization is transforming the industry. A notable example is Tastry AI, a company that has developed technology to "taste" wine using chemistry and artificial intelligence [40]. Tastry analyzes thousands of wines each year, identifying their chemical composition and creating detailed flavor profiles. This data powers its BottleBird recommendation system, which matches consumers with wines that best suit their taste preferences with an accuracy rate of up to 95%. Winemakers also use Tastry's insights to refine blending processes, optimize flavor profiles, and enhance marketing strategies. This AI-driven approach not only personalizes wine recommendations for consumers but also empowers producers with data-driven product customization.

Lastly, the platform facilitates user-to-user exchange of digital assets like virtual wine and collectibles. It provides a stage for wine collection enthusiasts to communicate and learn from each other and expand the circle of wine collection.

5.4. Virtual digital communication

The involvement of Metaverse technology will lead to reforms in how tourism organizations communicate, making communication more accessible, prosperous, and personalized [8]. Virtualization and digital methods will likely replace traditional face-to-face and traditional communication tools.

First, building a virtual communication platform will be how tourism organizations communicate with visitors, tourists, and stakeholders. The above platforms enable real-time communication between people through text, voice, and video. Whether it is to provide information, answer questions, or collect feedback, it will be instant and easy to communicate.

Secondly, the interactive experience will be enhanced. With the help of Metaverse technology, tourism organizations can communicate with tour guides, experts, and other travelers in real time. Visitors can remotely participate in guided tours, ask questions, participate in seminars and other activities through virtual reality technology, and exchange experiences with other visitors. This interactivity will increase the fun and engagement of the tourism experience.

In addition, digitalized information delivery will be the norm. Wine tourism companies can give guests digital information by displaying wine-related content and employing virtual reality and augmented reality technologies. Visitors can visualize the wine's history, culture, and other details through virtual situations, real-time statistics, and multimedia presentations.

The tourist gains a personalized communication experience [20]. Tourism

businesses can employ Metaverse technology to deliver recommendations, suggestions, and interactive material that is specifically tailored to the needs, preferences, and requirements of tourists. Visitors will be able to receive more customized services thanks to this individualized communication experience, which will also deepen their bond with the company and increase their loyalty.

5.5. Marketing of virtual products

Tourism groups should take creative steps to encourage the sale of virtual goods in a Metaverse setting [41].

Virtual displays. Organizations that promote wine tourism can employ Metaverse technology to build virtual galleries and event venues where winemaking and wine culture content can be exhibited. On the Metaverse platform, visitors may take part in virtual exhibitions to learn about the characteristics of the wines and the tales that go with them, raising interest in and brand awareness.

Interactive environment. Wine tasting can be realistically simulated via Metaverse technology, allowing users to engage in interactive tasting in a virtual setting [42]. They can choose from various wine types and flavors, participate in the tasting process virtually, and communicate their thoughts and impressions with other attendees.

Brand promotion. Organizations that promote wine can use the Metaverse platform to develop immersive branding materials and a narrative. Visitors can experience the unique charm and value of the brand in a virtual environment, deepening brand awareness and emotional resonance.

Social media. Organizations can publish and share Metaverse marketing content through social media platforms, websites, and apps to engage users and spread the word. At the same time, the organization can also combine offline activities to further improve the marketing effect by linking online and offline.

In addition, wine tourism organizations can also cooperate with related industry partners to jointly promote the Metaverse marketing campaign. For example, wine producers, hotels, and travel agencies can organize joint activities to promote the wine tourism experience.

It should be noted that wine tourism organizations using the Metaverse technology to carry out marketing and promotional work should ensure that the content is authentic and compliant under relevant laws and regulations and protect user privacy and data security.

5.6. Technological bridging

Using Metaverse technologies in tourism requires a technological connection and transformation [43]. Tourism organizations should take into account strategies such as technological bridging and transformation.

Existing wine tourism technologies and systems were evaluated to understand the strengths, limitations, and needs of these technologies and systems. Then, the Metaverse technologies were evaluated for their capabilities and applicability, and a decision was made to connect the existing technologies. A good interface was designed to allow the integration of the new Metaverse technology into existing wine tourism

systems. It includes the design of data exchange, functional extensions, and other interfaces.

The transition process can be advanced in parallel. That is to say, based on the Metaverse technology platform, new functions and experiences can be constructed while maintaining the operation of the existing system. Gradually introduce the attribute of Metaverse so that users can adapt and accept the new experience. Organizations must proactively collect user feedback and continuously optimize the functionality and experience of the Metaverse based on the feedback.

Tourism organizations should train and support team members to familiarize them with the technical development operation and maintenance of the Metaverse. The training includes utilizing the Metaverse platform for virtual presentation and interaction. Technical support should also be provided promptly to address difficulties encountered during the team's transition.

5.7. Wine NFT investment

NFT (non-fungible token) is a digital asset based on blockchain technology that can represent any item or interest in the real world [44,45]. NFTs can be used in the wine sector to represent unique wine collections, works of art, or other related assets [46].

Combining wine and NFTs allows the creation of a virtual wine collection platform that represents each wine as a unique NFT. Such a platform could provide the following features and experiences:

Digitized wine collection. Each wine is a unique NFT with explicit characterization and ownership information. Users can browse and collect NFTs for all types of wines to create their digital wine collection.

Exhibitions and community interaction. The platform can organize virtual wine exhibitions and community events for users to display their wine collection and communicate with other collectors.

Ownership verification as a digital asset in the blockchain, NFT can provide ownership verification and anti-counterfeiting functions [47]. Users can guarantee that their wine NFT is authentic and unique.

Asset trading. Like traditional wine trading, users can buy and sell NFTs in the marketplace. They can either participate in auctions and bid for them or be traded directly with other users.

A notable example of NFT-based wine investment is WiV Technology, a blockchain-based wine trading platform that tokenizes fine wine into NFTs, ensuring secure transactions and provenance verification [48]. The WiV Wineverse ecosystem provides a structured NFT investment model that progresses from fractionalized wine NFTs (representing portions of a bottle) to full-case NFTs that unlock additional benefits. These NFTs can be traded, sold back to WiV at varying buyback rates, or even used as collateral for loans. WiV ensures the physical storage of wine in professional-grade cellars, allowing investors to engage in wine trading without the need for direct handling or storage.

This NFT model enhances liquidity, security, and accessibility in wine investments, providing new opportunities for both collectors and investors in the

digital era.

6. Potential problems and solutions (theme 3)

The application of the metaverse in wine tourism may involve potential problems. The study suggests responses accordingly.

6.1. The gap between virtual experience and real experience

Wine tourism in the metaverse will only give a virtual experience rather than tasting the wine or going to the vineyard in person, which is a certain distance from the real experience. To solve this problem, the Metaverse can provide more auxiliary information, video, and audio content to enhance the user's virtual tour experience.

6.2. Credibility and authenticity

Metaverse wine tourism scenarios can have problems such as false information or forged content, which makes it difficult for users to judge the authenticity of wine. To address the issue, it is vital to build trustworthy platforms and mechanisms to ensure the provision of authentic wine tourism experiences and to certify and scrutinize the authenticity of the content.

6.3. User security and privacy

Wine tours using Metaverse require the provision of personal information and payment information, which may lead to issues such as user security and privacy leakage. To protect the security and privacy of users, it is essential to ensure that the Metaverse platform has a high level of security measures, encrypts user information, and complies with data privacy regulations.

6.4. Global time and region limitation

Metaverse wine tours can attract users worldwide, but the constraints of different time zones and geographic locations can cause coordination difficulties and experience differences. To solve this difficulty, flexible and diverse schedules should be provided to carry out activities in multiple time zones so that users can participate in tourism activities according to their own time and geographic location.

These are some of the problems and countermeasure suggestions that may arise in Metaverse wine tourism. The specific application process needs to be further analyzed with the characteristics of the Metaverse platform and users' needs to develop more detailed solutions.

7. Suggestions for future research

Future research should continue to explore the potential of Metaverse application in wine tourism in-depth and combine it with practice to promote academic research and industrial development in this field. It can start from the following aspects: it can focus on exploring the effects of Metaverse wine tourism on travelers' cognition, emotion, satisfaction, and other factors. A combination of quantitative and qualitative research methods can be used to understand the role of Metaverse technology in providing immersive experiences, enhancing interactivity, and personalizing services;

we can also discuss how to develop the wine industry chain by combining Metaverse technology, including wine production, supply chain management, marketing, and sales promotion. At the same time, research can be conducted on the use of Metaverse technology for wine quality improvement, traceability, and anti-counterfeiting; the use of Metaverse technology in wine tourism is inseparable from the concern for technical security and data privacy protection. Future research could focus on establishing a secure and reliable Metaverse platform to protect user information and digital assets; as Metaverse wine tourism involves many stakeholders and multiple technology applications, the research could focus on how to promote the development of related public policies and industry standards. Collaboration with government, business, and academia to develop norms to promote the sustainable development of wine tourism in the Metaverse; Metaverse wine tourism encompasses multidisciplinary research in tourism, computer science, culture, business management, and other disciplines. Future research could encourage interdisciplinary collaboration to meet the challenges and opportunities presented by applying Metaverse technologies to wine tourism.

8. Conclusion

This study explores the transformative potential of Metaverse technology in wine tourism, analyzing its applications, benefits, and challenges. By incorporating Experience Economy Theory (EET) and Sensory Mapping, we examined how immersive technologies can enhance visitor engagement, enable personalized experiences, and introduce new business opportunities for wineries and tourism organizations.

However, this study has several methodological limitations. First, it is based on qualitative analysis and secondary data, lacking empirical validation through primary data collection. Future research should incorporate quantitative methods, such as surveys, interviews, and experimental studies, to assess user perceptions and engagement with Metaverse wine tourism. Additionally, a longitudinal approach could help track the evolution of Metaverse applications and their long-term impact on the industry.

Despite these limitations, this study makes an innovative contribution to the academic field by bridging Metaverse technology and wine tourism, an emerging area with limited prior research. It provides a conceptual foundation for understanding immersive tourism experiences, virtual engagement, and digital transformation in the wine industry. By integrating theories from tourism, technology, and business innovation, this research expands the scope of experiential tourism studies and highlights the potential of digital ecosystems in enhancing wine tourism experiences.

For future research, empirical studies should be conducted to measure consumer behavior, technological acceptance, and the economic impact of Metaverse wine tourism. Additionally, interdisciplinary collaboration between tourism scholars, technologists, and industry professionals could further explore the development of AI-driven personalization, blockchain-based wine authenticity verification, and interactive VR experiences. Addressing data privacy, digital infrastructure, and user accessibility will also be crucial for the sustainable adoption of Metaverse technology in wine tourism.

In conclusion, while Metaverse wine tourism presents exciting opportunities, its implementation requires further empirical validation and technological refinement. This study provides a starting point for deeper academic inquiry and practical innovation, paving the way for a more immersive, accessible, and digitally driven future for wine tourism.

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