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# Metaverse Tourism: An Industrial Structure Analysis Based on the Digital Twin

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***Abstract:*** *Metaverse virtual tour is an emerging technology that utilizes digital transformation to replace offline activities. It has promising applications in the fields of cultural creativity and tourism, such as virtual museums and virtual tours. The aim of this paper is to explore the factors that influence the propensity of companies to adopt virtual tour technology and how these factors affect the formation of the virtual tour industry. This paper adopts a qualitative comparative analysis (QCA) approach to compare different types of virtual tour programs using the architecture of the meta-universe as an analytical framework. This paper hopes to provide useful references and predictions for the development of the virtual tour industry.*

***Keywords:*** *Non-fungible Tokens, NFT trading platform, copyright management and protection, Metaverse, Virtual tour, Digital twin*

## 1. Introduction

This paper examines the concepts and techniques of meta-universes and virtual tours, as well as their application and impact in the tourism industry. A metaverse is a digital reality that creates a digital twin of the real world and provides an immersive experience. Virtual tours utilize VR devices to map the physical world in the meta-universe, allowing users to visit museums, art galleries, places of interest, and other venues in a digital space. This paper analyzes the antecedents and influencing factors for the formation of the virtual tour industry, as well as the tendencies and conditions for enterprises to apply virtual tour technology. The paper adopts the method of qualitative comparative analysis and studies from the perspective of multiple concurrent causality.

The paper begins by describing the basic principle of contemporary museums, which is that they should be a special tool of communication, assisting the cultural experience and, where appropriate, utilizing technology and broad-spectrum systems. The paper argues that museums must be able to diversify their structures to meet the needs and expectations of different types of users. The paper also mentions that science museums are more likely to utilize new technologies to communicate and promote their heritage and compensate the stress of visiting with playful educational activities.

Secondly, the paper describes the concepts and technologies of meta-universes and virtual tours, as well as their applications and impacts in the tourism industry. The paper points out that the meta-universe is the next iteration of the Internet with great potential to transform the digital world and open up new opportunities in every end-use industry. The paper gives examples of how the meta-universe can create unique and memorable experiences for the tourism industry, such as 3D virtual tours, digital twins, anonymity and authenticity.

Finally, this paper explores the factors affecting the formation of the virtual tour industry, as well as the tendencies and conditions for enterprises to apply virtual tour technology. This paper analyzes and organizes research on multiple concurrent causality of the antecedents of the formation of the virtual tour industry from a holistic perspective. This paper analyzes the material in depth and thinks about it, finds the essence of the problem from the surface to the inside, finds the reasons for the high and low tendency of enterprises to apply virtual tour technology according to the theoretical basis, and predicts what kind of factors will be better to help the implementation of the virtual tour industry in the virtual tour industry afterward.

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## 2. Related Concepts and Literature Review

### *2.1 Related Concepts of the Metaverse*

A metaverse is a virtual world that people can explore and live in using avatars. The concept of metaverse first appeared in science fiction and was later interpreted in movies and other works. Meta-universes require advanced technologies to support them, such as digital twins, XR, blockchain, etc. Metaverse can be categorized into four types: virtual worlds, mirror worlds, augmented reality and living records. [1]Virtual museums are a type of meta-universe application, a digital extension of museums in cyberspace. There are seven layers of the metaverse: experience layer, discovery layer, creator economy layer, spatial computing layer, decentralization layer, human-computer interaction layer, and infrastructure layer.

### *2.2 Related Concepts of Digital Twins*

Digital twin is a technique for mapping physical entities into a virtual information space that reflects and predicts the behavior and state of physical entities. The concept of digital twin first appeared in NASA's Apollo program in the United States, and was later formally introduced by Michael Grieves of the University of Michigan in the product full-cycle life management (PLM) course. Initially used in the aerospace and military sectors, digital twin technology was later introduced into the framework of Industry 4.0 by companies such as Siemens in Germany, driving the development of smart manufacturing and full-cycle product lifecycle management[2]. Digital twin technology has also been integrated with AI, 3R (VR, AR, MR), edge computing, 5G, blockchain, cloud computing, IoT, big data, and other informatization and intelligence technologies, expanding its application areas, such as automotive, marine, electric power, healthcare, and smart cities. Digital twin technology requires the support of hardware and software technologies, such as sensor technology, IoT technology, artificial intelligence technology, data science, blockchain, etc. The concept and definition of digital twin technology varies among researchers and fields, but all emphasize its relevance and interaction with physical entities[3].

### *2.3 Related Concepts of Blockchain*

Blockchain is a technology that uses cryptography and consensus mechanisms to achieve decentralized, tamper-proof, traceable and anonymous data transactions and storage. The concept of blockchain was first introduced by NASA in the Apollo program and later formally defined by Michael Grieves of the University of Michigan in the Product Life Cycle Management (PLM) course. Blockchain technology has been integrated with informationization and intelligence technologies such as artificial intelligence, 3R (VR, AR, MR), edge computing, 5G, blockchain, cloud computing, Internet of Things, big data, etc., expanding its application areas, such as automotive, shipping, electric power, medical care, smart cities, etc. Blockchain technology includes six layers: data layer, network layer, consensus layer, contract layer, service layer and application layer. Blockchain technology can be divided into three categories according to different architectures: public (permissionless) chains, private (permissioned) chains, and federated (hybrid) chains[4].

## 3. Research Methodology

### *3.1 Analytic Strategies: Qualitative Comparative Analysis (QCA)*

Qualitative Comparative Analysis (QCA) is a social science research methodology that combines qualitative and quantitative methods and was proposed by American sociologist Charles Ragin in the 1980s[5].QCA can deal with three cases of multiple concurrent causation: intergrouping with equivalence, covariate causation, and asymmetry. QCA can also reflect the wholeness of the case, complexity and variability, as well as the adversarial nature between theory and data. QCA is a Boolean algebra-based technique that can be used for different purposes such as data summarization, consistency checking, theory testing, data exploration, and theory construction. QCA is also a transparent technique that requires the researcher to make and justify his/her choices. QCA can also consider phenomena that are qualitatively as well as quantitatively varied as well as different types of blockchains. There are three related techniques for QCA: crsip-set, MVQCA, and MSDO/MDSO. In this paper, we have chosen the crisp-set Qualitative Comparative Analysis method (csQCA) due to its

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aptness for analyzing the propensity of firms to use meta-universe virtual guided tours in relation to factors such as infrastructure, technology, and usage. It is also suitable for dealing with multiple concurrent causality, groupings with equiprobability, and co-temporal causality. This method can also handle natural phenomena, co-occurring causality, and asymmetric relationships.

### *3.2 Variable Definitions and Descriptions*

#### *3.2.1 VR/AR/MR*

Virtual Reality (VR) and Augmented Reality (AR) are immersive technologies that simulate visual, auditory, tactile, and motion realism to varying degrees. Mixed reality (MR) combines virtual and real-world content into the same user experience. VR and AR have found many applications in the gaming industry. For example, Pokemon Go, an AR game launched in 2016, grossed more than $4 billion by 2021 (Sensortower, 2020).In 2019, the VR gaming market in the U.S. is worth $7.7 billion (MordorIntelligence, 2020). In addition to gaming, significant applications of VR and AR technologies and content have been developed in healthcare, education, workforce development, and manufacturing (Shen et al., 2020). Although definitions remain somewhat fluid (Shen et al., 2020) [6], the use of these digital technologies is either fully immersive (in the case of VR) or superimposed (in the case of AR) on the user's digital environment, mapping onto, supplementing, augmenting, or replacing the physical reality of their bodies and surroundings. Other aspects of the immersive technology experience include physical simulation, physical presence, and even social companionship. The metaverse is currently a compendium of imaginative and futuristic engineering in which virtual worlds with telepresence and social media technologies are seamlessly connected to an enduring social space, a complex world of contained worlds that provide users with an extended digital self with virtual experiences (Belk, 2013). Extended Reality (XR) is an umbrella term for AR, VR and MR.

#### *3.2.2 Hardware (Physical Devices and Sensors)*

In the meta-universe, hardware not only plays an important role in immersive experiences, but it is also a technologically limiting barrier. In the metaverse, hardware has been rapidly enhanced by technological advances, but it still needs to be improved compared to real-world experiences. The basic hardware of the meta-universe is the head-mounted display (HMD) that blocks the line of sight, in addition to hand-type input devices, and assistive input devices (with eye-tracking, head-tracking, voice input devices, etc.) to enable immersive engagement.

#### *3.2.3 Software (Recognition and Rendering)*

Cognitive illusions play a crucial role in immersing the objective reality of the physical space and the subjective reality perceived by the user. There are two types of cognition: static and dynamic cognition. Static cognition is proprioceptive (e.g., visual, auditory, and tactile), while dynamic cognition is sensory balance and bodily movement. In dynamic cognition, adaptation, attention and behavior are important features. Incarnation is an important entity in the meta-universe, where incarnations are created and animations are used to mimic movements. Vision-based models estimate human posture, recognize gestures and predict gaze. To predict gaze, iris, facial profile and 3D gaze prediction are used. The software components are categorized in this research as scene and object recognition, sound and speech recognition, scene and object generation, sound and speech synthesis and motion rendering.

### *3.3 Basic Information of the Cases*

Table 1 displays 19 renowned cultural and creative industries worldwide, such as museums and art galleries, including Marriott Bonvoy, Peaceful Hill, and Philadelphia's Franklin Institute. The table also includes 12 companies primarily engaged in the tourism industry or tourism-related programs, such as LynKey, Ariva, and Samsara Luggage. These companies serve as case studies. Among them, 24 companies exhibit a high inclination towards the utilization of virtual tours.

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*Table 1: Basic information on the study cases*

| caseid | Hardware | Software | Blockchain | VR/AR/MR | Tourism | Cultural creation |
|---|---|---|---|---|---|---|
| Mytaverse | 1 | 1 | 1 | 1 | 1 | 0 |
| Marriott Bonvoy | 1 | 1 | 1 | 1 | 1 | 1 |
| LynKey | 1 | 1 | 1 | 1 | 1 | 0 |
| Ariva | 1 | 1 | 1 | 1 | 1 | 0 |
| Samsara Luggage | 0 | 1 | 1 | 0 | 1 | 0 |
| Color Star Technology Co. | 1 | 1 | 1 | 1 | 1 | 0 |
| Peaceful Hill | 1 | 1 | 0 | 1 | 0 | 1 |
| London's Tate Modern | 1 | 1 | 0 | 1 | 0 | 1 |
| The National Museum of Natural History | 1 | 1 | 0 | 1 | 0 | 1 |
| Hold the World | 1 | 1 | 0 | 1 | 0 | 1 |
| The Palace Museum | 1 | 1 | 0 | 1 | 0 | 1 |
| The Van Gogh Museum | 1 | 1 | 0 | 1 | 0 | 1 |
| Thyssen-Bornemisza Museum | 1 | 1 | 0 | 1 | 0 | 1 |
| Santa Cruz Public Libraries | 1 | 1 | 0 | 1 | 0 | 1 |
| CCPL | 1 | 1 | 1 | 1 | 0 | 1 |
| Museum of Modern Art | 1 | 0 | 0 | 0 | 0 | 1 |
| hipcamp | 1 | 0 | 0 | 1 | 1 | 0 |
| GETAWAY | 1 | 1 | 0 | 1 | 1 | 0 |
| Arrive Outdoors | 0 | 0 | 0 | 1 | 1 | 0 |

## 4. Data Analysis Results - Group Analysis

This paper introduces the concept, characteristics, uses and related techniques of Qualitative Comparative Analysis (QCA) and selects clear set (crsip-set) Qualitative Comparative Analysis (csQCA) as the research methodology to analyze the relationship between the degree of propensity of companies to use meta-universe virtual tours and the factors such as infrastructure, technology and uses. In this paper, based on the results of QCA, four groupings are derived, which are:

Grouping 1: ~ Software ~ Blockchain VR/AR/MR Tourism ~ Cultural and Creative. This grouping indicates that tourism companies without software and blockchain technology support have a low propensity to apply meta-universe virtual tours, even if they have VR/AR/MR technology.

Grouping 2: Hardware and Software VR/AR/MR Tourism ~ Cultural and Creative. This grouping indicates that the tourism industry enterprises with hardware, software and VR/AR/MR technologies have a high tendency to apply the meta-universe virtual tour because they have enough strength and opportunity to try new technologies. For example, Color Star Technology Co. Ltd. is a typical case.

Configuration III: Hardware and software VR/AR/MR ~ Tourism Culture and Creativity. This grouping indicates that cultural and creative enterprises with hardware, software and VR/AR/MR technologies have a high tendency to apply meta-universe virtual tours because they can utilize these technologies to create more innovations and experiences. For example, the Louvre in Paris is a typical case.

Configuration four: hardware software blockchain VR/AR/MR cultural and creative. This configuration is similar to configuration three, but with more blockchain technology, indicating that blockchain technology also has an important role in meta-universe virtual tours to provide more security and trust. Marriott Bonvoy, for example, is a case in point.

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## 5. Summary and Discussion

This paper applies the csQCA research methodology and uses groupthink to analyze the path of high and low tendency of enterprises to apply virtual tours for the meta-universe, aiming to explore the relationship between the tendency of virtual tours for the meta-universe and the existing technologies and infrastructures. Combined with the results of empirical analysis, the following conclusions are drawn:

First, tourism enterprises with strong infrastructure themselves, such as owning physical devices and sensors, mastering recognition and rendering techniques and VR/AR/MR technologies, will be more interested in the emerging technologies in the industry, and consider meta-universe virtual tours as an important part of the future tourism industry, investing in research and development and using them. The combined factors of hardware * software * blockchain * VR/AR/MR increase the propensity of tourism businesses for meta-universe virtual tour applications.

Secondly, similar to tourism enterprises, the cultural and creative category will also have a high degree of inclination towards the application of meta-universe virtual guided tours when they have the physical equipment and sensors, mastery of recognition and rendering techniques, VR/AR/MR technologies, and blockchain. The cultural and creative industries are the first to apply such cutting-edge technologies as virtual tours, so there are more good precedents, prompting some cultural and creative enterprises, which have difficulties in applying meta-universe virtual tours, to show a high degree of inclination to it. Contemporary museums are more than just places dedicated to placing and displaying collections and works of art; in fact, they are now considered a special form of communication that plays a central role in making culture accessible to the general public. One of the keys to reaching the masses is the use of new technologies and new modes of interaction. These means bring undeniable appeal and allow curators to modulate cultural proposals by constructing different courses for different user profiles. Immersive virtual reality (VR) may be one of the most attractive and potentially effective technologies for this purpose.

Thirdly, in the case of very limited development of enterprises, both in the tourism industry and in cultural and creative enterprises, ~hardware* ~software* ~blockchain* ~VR/AR/MR can result in a low tendency of enterprises for meta-universe virtual tour applications. Enterprises themselves are limited in their development, they will rarely choose to try new technologies that are cutting-edge and have uncertain returns, and it is difficult for them to afford the huge costs of meta-universe virtual tour applications, thus showing a low inclination towards meta-universe virtual tour applications.

To summarize, hardware, software, blockchain technology and VR/AR/MR technology and whether it is a tourism enterprise or a cultural and creative enterprise will have an impact on the degree of tendency to apply meta-universe virtual tours. And this technology will occupy a very important place in tourism and cultural and creative fields when the meta-universe industry is more perfect, and enterprises are gradually increasing the application of meta-universe virtual tours in the process of exploring and finding new opportunities.

Revenue from the hardware component will expand at a strong CAGR. Based on component, the metaverse in the global travel and tourism market has been segmented into hardware and software. The hardware segment is expected to register a strong revenue CAGR over the forecast period owing to the growing demand for immersive AR and VR technologies, rapid development of AR and VR devices, increasing use of AR and VR devices for virtual tours, theme park visits, in-flight entertainment, and commissioning of tourist attractions and sites. Moreover, increasing use of AR-powered glasses for immersive experiences and increased investments to accelerate the advancement of meta-technology are expected to further contribute to the segment's future revenue growth.

The extended reality (XR) segment is expected to account for a significant revenue share. Based on technology, the meta-universe in the global travel and tourism market has been segmented into blockchain, AR, VR, MR, and XR.The augmented reality (AR) segment is expected to account for a significant revenue share during the forecast period. AR navigation is increasingly being used for virtual destination tours. Technological advancements in AR devices are facilitating this trend. Additionally, AR is being applied more and more to improve local transportation. Augmented reality gamification is also on the rise, as is the use of AR for museum visits.AR technology can also aid the travel and tourism industry by whetting tourists' appetite and interest in new locations, helping travel agents to increase bookings for flights and hotels, and enhancing the travel experience.

The travel segment is expected to witness significant revenue growth over the forecast period. The

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travel segment is expected to record significant revenue growth over the forecast period, owing to the growing potential of meta-spaces to change the way consumers purchase destinations, accommodations, and attractions. Augmented reality is being widely used to provide metadata travel and tourism solutions such as the development of interactive hotel elements, AR-powered destinations, VR tours and digital avatars, and other solutions that provide customers with detailed information about the property, how big the hotel rooms are and what amenities are offered. Virtual Reality and Augmented Reality can help customers explore new places without having to physically travel, as well as allow travelers to experience destinations that are remote, hard to reach, and expensive. In addition, meta-universe virtual tour technology can help customers and travelers to test drive different tours and excursions in their chosen destinations, which can encourage bookings. These key factors are expected to further contribute to future revenue growth in this segment.

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