World Heritage Sites' Online Virtual Tour Evaluation and Expansion Prospects: A Case Study of the Suzhou Classical Gardens

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Abstract

Many world cultural heritage projects have used virtual technology to build a variety of no-contact online virtual tours. China's Suzhou Classical Gardens (SCGs) built an online virtual tour in 2016; however, the technology was outdated. This research explored the development direction of the SCGs' online virtual tour technology by analysing their existing technology and comparing it with the technology used by other World Heritage Sites (WHSs) during the COVID-19 pandemic. The researchers investigated and summarised the existing 1,301 World Cultural Heritage Online Tourism Systems and selected seven technological representatives for case studies and comparison to obtain the analysis results. The researchers found that the SCGs' existing technology lacked details of interaction and guidance. The study concluded that they should use the latest technology to focus on enhancing tourists' experiences and interactions. The research indicates that the SCGs can use the latest technology, such as the Metaverse, to enhance visitors' sense of experience and provide tourists with a more attractive and immersive experience.

Keywords: World Heritage Sites (WHSs), Online Virtual Tour, Suzhou Classical Gardens (SCGs), Tourism, Pandemics

Introduction

Research Background

Many World Heritage Sites (WHSs) have begun to build a variety of non-contact digital displays using real-world scanning and Virtual Reality (VR) technologies to attract tourists and expand their popularity and influence. The 4D digital scanning technology has helped Nuraghe in Sardinia (Italy) and provided new possibilities for dissemination, allowing people to easily access cultural heritage data and scientific information (Lai et al., 2015). Virtual-WHS tourism can help people discover the value of cultural heritage sites remotely. It is playing an increasingly important role in heritage tourism in China. Moreover, it satisfies the desire of many tourists to explore cultural heritage through the Internet (Ren & Chen, 2021).

Online virtual tour is a beneficial way to attract and educate tourists, and it can help world cultural heritage managers protect and operate projects better. However, getting honest feedback from tourists is challenging, making it difficult for tourists to socialise (Wiltshier & Clarke, 2017). How do we evaluate whether an online virtual tour project is attractive or has opportunities? Four aspects are considered: authenticity, interactivity, navigation evaluation, and learning. Furthermore, projects that are well-built in all aspects will be more attractive (Li et al., 2022).

The COVID-19 pandemic has triggered an unprecedented economic and social crisis (Frago, 2021). Its influence and impact on global tourism are significant. However, while adversely affecting the global tourism industry, it presented an opportunity to remotely promote cultural heritage through virtual-WHS tourism. When properly applied, virtual tours can help develop sustainable visitor capacity at WHSs while simultaneously enhancing and attracting visitors to less-known cultural programs (Zaimes et al., 2022).

In 1997, there were approximately 107 protected gardens in Suzhou. The nine Suzhou Classical Gardens (SCGs) that were appointed as World Cultural Heritage Sites are the Humble Administrator's Garden, Lingering

Garden, Net Master's Garden, Mountain Villa with Embracing Beauty, Canglang Pavilion, Lion Grove Garden, Garden of Cultivation, Couple's Garden Retreat, and Retreat and Reflection (United Nations Educational, Scientific and Cultural Organization (UNESCO), n.d.).

The SCGs are important components of the tourism industry. The aging phenomenon of tourism products has long been evident and may include the following: a single function, outdated content, lack of change in form, difficulty adapting to the needs of modern tourists, a single structure of garden culture tourism products, and monotonous tourism activities (Liqin & Fuzhao, 2007). Owing to the complicated and dynamic nature of the pandemic, fewer foreign visitors have visited the SCGs over the last three years. Online virtual tours have allowed visitors from other parts of the world to appreciate the SCGs' allure and increase their influence. Although the SCGs have created online virtual tours, the technology must be updated (Figure 1).

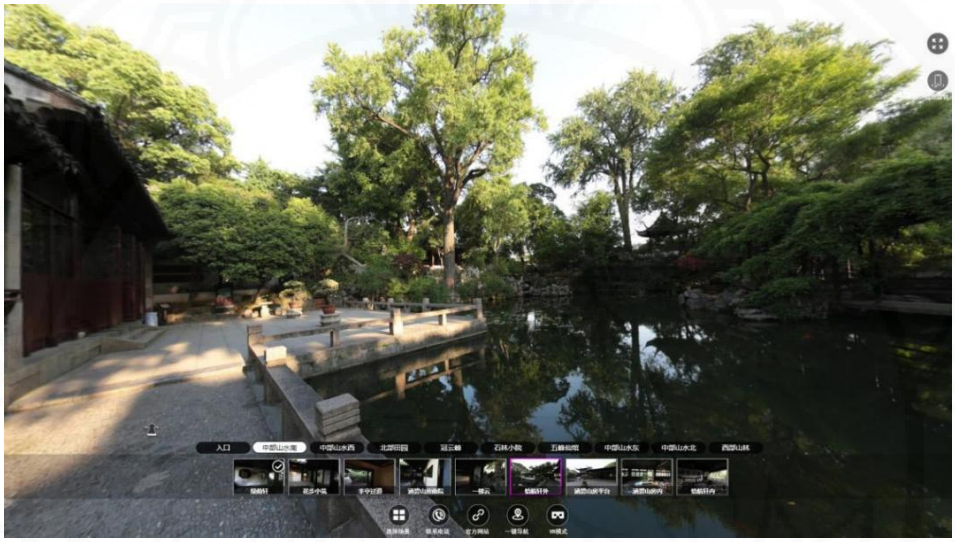

Figure 1 Suzhou lingering garden online virtual tour interface.

This interface has some pre-set scene navigations but lacks detailed navigation and introductory information.

Source: https://919vr.cn/hcvr/259/

Amongst the nine SCGs selected as world cultural heritage sites, five established an online virtual tour system. They used unified standards and realistic 360° photos to exhibit the beautiful scenery of the SCGs. On the tour interface, the user can operate relatively simple content, with only some scene selections, a lack of map navigation, a lack of detailed text or audio guides, and some invalid links because they have not been updated for a long time. As an essential means of attracting foreign tourists, this online virtual tour system requires multilingual options, which can reduce linguistic inconveniences faced by the tourists.

Research Objectives

- To analyse the existing digital display methods of online virtual tours.
- To categorise the virtual tour methods and latest technologies adopted by the selected world cultural heritage sites during the COVID-19 pandemic and possibly prevent future pandemics.
- To determine a digital solution for creating virtual SCGs.

Methods and Materials

Researchers searched through EBSCOhost and Google Scholar to ensure the independence and integrity of academic research. The keywords included 'online virtual tour', 'virtual experience technology', and 'impact of the COVID-19 pandemic on the application of virtual experience to WHSs'. The relevant information was extracted by reviewing 268 related documents.

Moreover, through the list of UNESCO's official websites (United Nations Educational, Scientific and Cultural Organization (UNESCO), n.d.), the researchers conducted a comprehensive survey of the 1,301 existing world cultural heritage online tourism systems, searched all the projects on Google, classified and sorted them according to the type of technology used, and finally selected seven different technology representatives for case study and comparison.

Literature Review

Online Virtual Tour

The origin of the 'online virtual tour' dates back to 1994. The first example of a virtual tour was an interpreted tour for museum visitors, which included a 'walk-through' of a 3D reconstruction of Dudley Castle in England from 1550 (Boland & Johnson, 1996). This included a computer-controlled laser disc system designed by the British engineer Colin Johnson. One of the first users of the virtual tour was Queen Elizabeth II, who officially opened a visitor centre in June 1994. Since the Queen's officials require titles, descriptions, and captions for all events, the system was named and described as 'The Virtual Tour', a cross between VR and the Royal Tour. The details of the original project are available online. This system was featured in a November 1994 conference at the British Museum and in a subsequent technical paper (Higgins et al., 1996).

An online virtual tour is a simulation of an existing location, typically consisting of 3D models, videos, panoramas (360° images) (Dawson et al., 2018), or a Metaverse. Additionally, it can use other multimedia elements, such as sound effects, music, narration, text, and floor maps. It is important to note that this is different from using the Internet to influence remote tourism.

Virtual Experience Technology

3D models are a virtual type of 3D presentation. Visitors can download the model for further studies and discoveries. This technique has been used in archaeology in several studies (Campiani et al., 2023; Dang et al., 2023; Smith et al., 2019; Ubik et al., 2022). Providing students and audiences with an understanding of the preceding cultural heritage conditions may enhance their comprehension and facilitate more intuitive and immersive learning experiences (Merillas et al., 2022). Moreover, it is possible to generate, alter, and develop a comprehensive understanding of the intricacies of cultural heritage (Abdelmonem & Abdulla, 2017). The tourists' experience is similar to strolling and observing in a video game environment when expressed through models. The actual sensation increases substantially after integrating realistic photographs, providing visitors with a better experience (Rainoldi et al., 2022).

A video tour refers to a dynamic visual representation of a specific geographical site or setting captured using a full-motion video. In contrast to a virtual tour's immersive and dynamic nature, a video tour offers a sequential exploration of a specific site. The camera apparatus is used to capture footage of the designated area using a consistent walking speed and to maintain continuous movement from one place to another over the entire spatial domain of the subject (Argyriou et al., 2020).

A 360° panoramic photo (or 360° photo) is a comprehensive visual representation that includes a sequence of photographs or panning video clips that provide holistic pictures. Nevertheless, 'panoramic tours' and 'virtual tours' are mostly linked to virtual tours generated using stationary cameras. A virtual tour comprises photographs captured from a particular vantage point. Cameras and lenses exhibit rotational movements around designated positions known as parallax-free spots (Bogicevic et al., 2019).

A Metaverse can be defined as a set of virtual sharing spaces that establish indices in the real world and access them through 3D interactions. Since Facebook's founder announced the creation of Meta, the term has rapidly become popular in the media field (Jones et al., 2022). Metaverse is the result of the interaction between equipment and self-setting for tourists and other audience members. Although the experience is virtual, the senses can indeed play a role by stimulating situations that they desire but cannot achieve at the time. Through an immersive experience, VR headphones or tactile sensors enable us to experience invisible things and re-establish contact with the sensory system (Buhalis et al., 2022). Through the incarnation, Metaverse users can reflect tourists by creating a virtual tourism route and interacting with other incarnations, so as to imagine their feelings. Although tourism in the virtual universe cannot replace the outdoor experience, governments can use it to promote attractions that are not easily reached or are typically ignored (Buhalis et al., 2023).

Impact of the COVID-19 Pandemic on the Application of Virtual Experience to WHSs

During the COVID-19 era, scheduled flights were cancelled, prominent tourist sites were closed, bustling streets became devoid of activity, and the absence of visitors was evident. Moreover, there was a need for growth in traditional tourism in most places. The ongoing expansion of the tourism industry is imperative for adapting to enduring and unparalleled travel limitations worldwide, which has had a substantial effect on many countries and enterprises. Nations must participate in a comprehensive re-evaluation of their tourism strategies. Simultaneously, cultural institutions must adapt to the current era, in which there are fewer visitors and fewer in-person interactions. This situation has risen because of the closure or imposition of restrictions on renowned landmarks, cities, and cultural heritage sites. Governments minimised the need for human interaction via innovation, digital experiences, and content. In 2020, a distinctive integration signified a pivotal moment in the convergence of virtual tours and cultural digitalisation (Palumbo, 2023).

Virtual tourism has become popular because of the COVID-19 pandemic and has created additional opportunities to provide content related to tourism worldwide and the ability to explore the additional advantages of VR technology (Giannini & Bowen, 2022). Many governments have carefully designed virtual tourism, hoping to attract audiences who want to visit cities worldwide without being responsible for the current travel risk of contracting the virus or epidemiological prohibitions and logistical complications brought about by restrictions (Kim et al., 2022).

Since the beginning of 2020, many WHS professionals engaged website visitors by virtually presenting their spaces and collections. The 'interactive webmap' technique is used by Greece's WHSs to combine the area's numerous attractions and give visitors a better virtual tour experience online. The Augtraveler software platform, which introduces not only sights but also local events and souvenirs, integrates the tourism industry in India (Zaimes et al., 2022).

Paris uses virtual technology to continue displaying iconic landmarks, using the interactive features of Google Arts & Culture: users interested in a place can use the clicking path navigation landscape to move from one favourable location to another (Verde & Valero, 2021). In response to rescheduling of the 2020 Summer

Olympics, the National Tourism Administration of Japan developed a technologically advanced solution known as 'Japan: Tradition and Future Encounter'. This innovative initiative enabled users to create virtual tours of renowned monuments in Tokyo using the immersive capabilities of smartphones and VR glasses. The tower effectively and captivatingly combines the elements of culture and technology (Ito et al., 2022).

Despite the widespread negative impact of COVID-19 on several economic sectors and the significant changes it has brought to daily life and travel, it has also presented unprecedented opportunities for VR tourism to fully manifest its capabilities (Lu et al., 2022). Virtual tourism has the potential to provide a worldwide experience to diverse international audiences by enabling access to places that may otherwise be unavailable. Moreover, this type of travel often incurs little or no cost for consumers. Virtual tours cannot fully replicate the experiential and sensory aspects of travel. However, they provide opportunities to experience many cultures (Geng, 2023).

Case Studies

Owing to economic and technological challenges, Osun-Osogbo Sacred Grove (CyArk, n.d.), a well-known World Cultural Heritage site in Nigeria, has not yet finished a virtual tour system online. Third-party businesses have produced 3D models that allow visitors to view and comprehend all details (Figure 2).

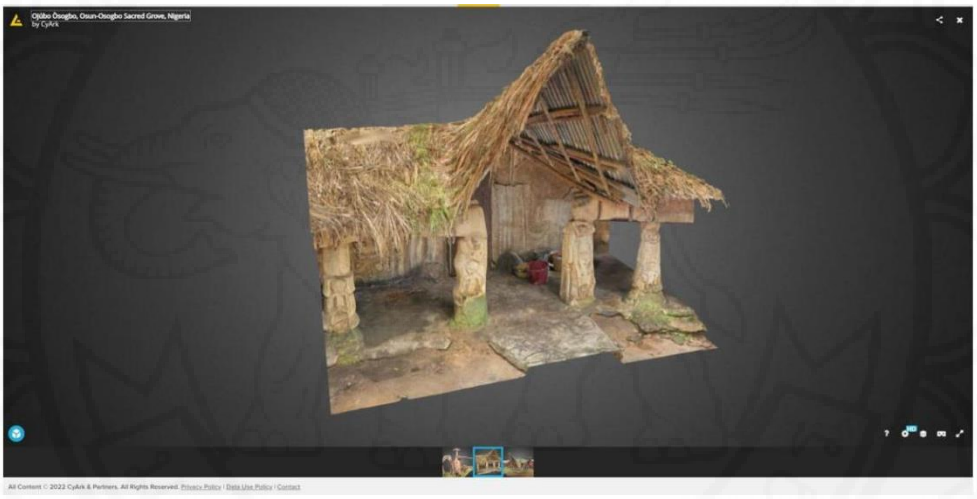

Figure 2 Osun-Osogbo Sacred Grove online virtual tour interface.

Only the Osun-Osogbo Sacred Grove can be viewed, and the model can be downloaded and used.

Source: https://www.cyark.org/projects/osun-osogbo-sacred-groves/3D-Explorer

Virtual Angkor (https://www.virtualangkor.com/) is an innovative display experience. An interface allows users to experience the different cultures and histories of each region through different panoramic animations that recreate the living conditions of Angkor from that year. However, tourists cannot choose their scenes, and participation is low (Figure 3).

Figure 3 Angkor online virtual tour interface.
A 360° view of the simulation of the Angkor Wat complex depicts animated agents along the grid network of roads and paths within the fourth enclosure.
Source: https://www.virtualangkor.com/360

Himeji Castle allows visitors to freely move around the scene (Hacosco, n.d.), take in nuances, and study the material. Additionally, it has placed only a few voiceovers and explanations in specific locations. Every room in the castle is rather small. Visitors frequently complain that the tours are crowded and uncomfortable. This issue has been resolved through online virtual travel as only one person will be in the castle regardless of when they click on the website (Figure 4).

Figure 4 Online virtual tour interface of himeji castle. The user interface is simple.
There is no choice other than to walk.
Source: https://hacosco.com/himeji-castle_en/

During the COVID-19 pandemic, the Historic Centre of Macao launched the most recent online virtual tour technology to increase its worldwide influence and appeal (https://vr.icm.gov.mo/). Although tourists cannot visit a particular location, they may enjoy it virtually. The interface settings include four languages, audio instructions, and two sets of navigation modes: scenes and maps. Changing between day and night scenery may also enhance visitors' experience (Figure 5).

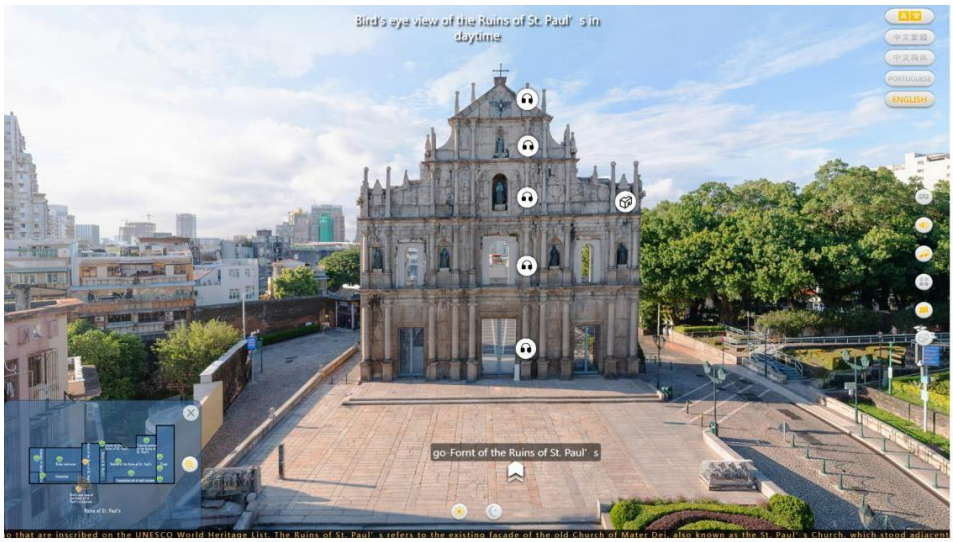

Figure 5 Ruins of St. Paul's college online virtual tour interface.

The online virtual tour system at the Macau Historical Centre is extensive and complete.

Source: https://vr.icm.gov.mo/wh/dashanbapaifang/

Owing to Myanmar's economic challenges, Bagan is being built by Google's Arts & Culture initiative (Hughes et al., n.d.). The general content and shape are more common than in other initiatives because of the maturation of professional technologies (Figure 6).

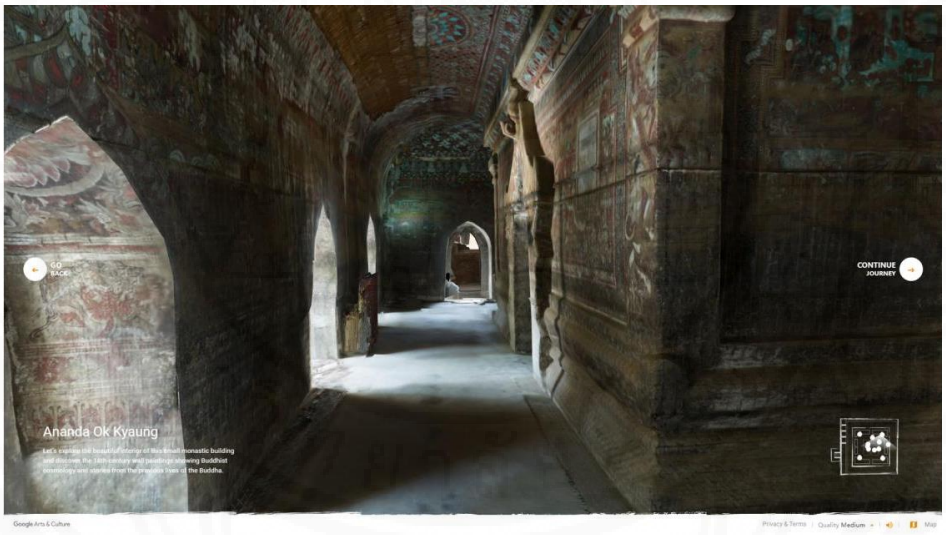

Figure 6 Ananda OK kyaung online virtual tour interface. Bagan is being built through google's arts & culture initiative.

Source: https://artsexperiments.withgoogle.com/bagan

Since 2009, the Versailles Palace has attempted to develop a new VR tour initiative through cooperation while using Google Arts & Culture (Château de Versailles, 2019). Through new materials and techniques, the goal is to share knowledge with real and digital travellers and inspire new tourists to visit the Palace of Versailles. The VR equipment is free to use in French, English, and Chinese when visiting the palace. Tourists may directly experience the magic of the palace in their cosy home at any time of the day or night. The only problem with this technology is that it requires its own VR devices, such as the Oculus Rift or HTC Vive (Figure 7).

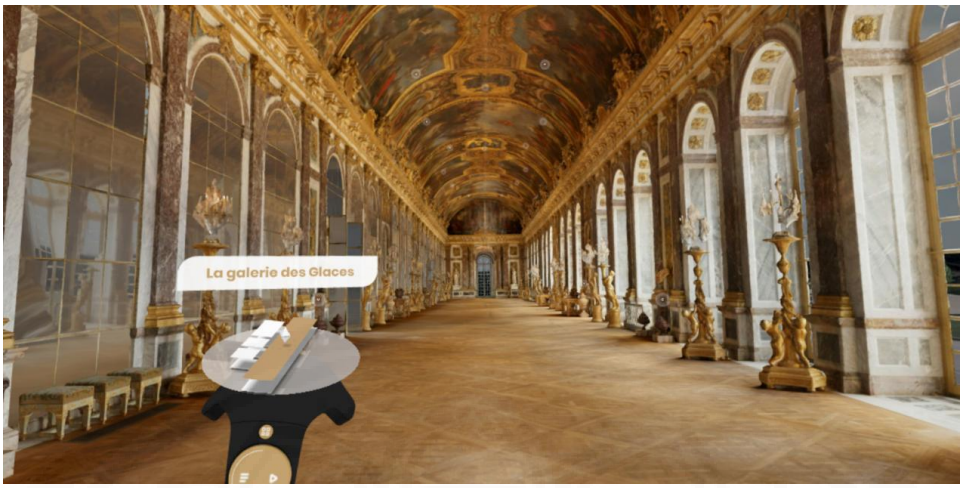

Figure 7 Hall of mirrors in the versailles virtual reality online tour interface.
This is the result of collaboration within Google Arts & Culture. Tourists may visit the Palace of Versailles using virtual reality.
Source: https://store.steampowered.com/app/1098190/VersaillesVR__the_Palace_is_yours/

Systems for creating online virtual tours now have more options because of the existence of Metaverse. Visitor interest in online virtual tours has considerably increased by the integration of social experiences and interactions with the core tour, which helps foster passion for WHSs. Visitors were invited to discover and explore the full-scale, fully immersive 3D model of Hegra's Tomb of Lihyan, Son of Kuza, an original UNESCO WHS, by the Royal Commission for AlUla (RCU), which recently debuted in the Metaverse. This fascinating, universally accessible, digital environment is home to the first UNESCO WHS (Royal Commission for AlUla (RCU), 2023).

The RCU uses Metaverse's extraordinary adaptability and aptitude and interacts with virtual visitors in thrilling new dimensions by launching an interactive hot-air balloon experience (Figure 8). The RCU Metaverse voyage will continue in collaboration with the Saudi Arabian Thermal Balloon Federation to premiere concurrently with the newest annual El Ora Heating Balloon Festival. The hot-air balloon experience is the most recognised landmark for Internet travellers. This exceptional surreal 360° scenery mixes all stimuli and provides unique experiences in the digital desert.

Figure 8 Royal commission for AlUla and hegra in the metaverse and ballon (PR Newsfoto/Royal Commission for AlUla).
Hegra's voyage across the metaverse is astounding, motivating, and engaging.
Visitors may see El Ora's most renowned and spectacular tomb, surrounded by a natural desert.
(Royal Commission for AlUla (RCU), 2023)

Results

The researchers compared the online virtual experiences of seven selected WHSs with those of the SCGs. They expanded 12 evaluation criteria based on the four key points of online virtual tour: authenticity, interactivity, navigation, and learning, and conducted a comparative analysis of the seven selected projects. It was found that the SCGs established early awareness of online virtual tours, in line with most cultural heritage practices. However, there are shortcomings in some aspects, such as awkward locomotion, incomplete audio guidance, and a lack of detailed display. Therefore, there is considerable scope for improvement. Table 1 compares the WHSs' Online Virtual Experiences.

Table 1 Comparison of World Heritage Sites' Online Virtual Experiences

World Heritage List	Osun-Osogbo Sacred Grove	Angkor	Suzhou Classical Gardens	Himeji Castle	Historic Centre of Macao	Bagan	Palace and Park of Versailles	Tomb of Lihyan Son of Kuza
Display Form	3D Model	360° Video	360° Photo	360° Photo	360° Photo	3D Model	VR	Metaverse
Style	3D	3D	Realistic	Realistic	Realistic	Realistic	3D	3D
Free View	✓	✓	✓	✓	✓	✓	✓	✓
Walking Experience				✓		✓	✓	✓
Background Music		✓	✓			✓	✓	✓
Audio Guide					✓	✓	✓	✓
Multi-lingual					✓		✓	✓
Detailed Guide					✓	✓	✓	✓
Scene Activity							✓	✓
VR Equipment							✓	✓
Avatar							✓	✓
Social Activities								✓

Note: 3D = Three-dimensional Presentation; VR = Virtual Reality.

As exhibited in Table 1, the display technology used in the SCGs is more straightforward than that used in other WHSs. This conventional platform caters to tourists' requirements and is the most commonly used method. This technology is the first generation of an online tour system. Regarding tourists' needs, it only meets the primary function of visual viewing. The second generation of technology focuses more on tourists' experiences, immersion, interactivity, and learning education, gradually increasing the realism of the experience. Tourists are afforded a heightened feeling of immersion, akin to physically traversing and meticulously exploring a featured destination, thus facilitating a more authentic experiential encounter. Sociality is the most difficult to satisfy among all previous technologies and is also one of the areas in which online virtual tours can be improved. In the most recent iteration of technological advancements, travellers now have the opportunity to engage in social activities via the platform, enhancing the authenticity and enjoyment of their tour experiences.

Discussion

Technology and Tourism

The ongoing advancement of digital and virtual technology offers many experiential approaches to engaging in online virtual tourism and presents novel prospects for the growth and progress of the tourism industry. According to the comparison results in Table 1, the existing technology is divided into three generations. The first generation of online virtual tourism was mainly centred on passive observation, whereas the second generation emphasised engaging and interactive encounters. The third generation primarily emphasises the realm of social interaction.

The SCGs use outdated online virtual tourism technology because they continue to use first-generation technology. With regard to technological advancements, it is possible to include additional interactive technologies to augment the user experience. The project's ability to provide captivating experiences heightens the audience's interest, thus fostering an increased influx of visitors to Suzhou to explore the region.

Proposed Tourism Solution for Future Pandemics

The worldwide tourism industry has been severely impacted by the COVID-19 pandemic and will need to adapt to digital transformation (World Tourism Organization, 2021). Additionally, numerous businesses have developed various platforms and made use of a range of technologies to provide fresh opportunities for the online virtual tourism of WHSs.

After experiencing the pandemic, tourists look forward to essential social experiences and interactions between people. Social attributes are essential for future technological choices and for enhancing the sense of experience and immersion. In the future, when new diseases emerge, human society can replicate global experiences online in an orderly manner via online VR for travel.

Approach to Utilising Technology to Promote the SCGs' Tourism

In contrast to conventional online virtual tours, the virtual experience in Metaverse emphasises interaction and sociability. Visitors can interact with WHSs through avatars and take photos together in addition to viewing them, which is an unachievable feat using other technological means and is a form of mapping real-world visits.

Currently, China requires a comprehensive and extensive Metaverse infrastructure. As the SCGs are an important part of Suzhou's tourism industry, an innovative Metaverse platform may be employed to enhance their appeal, thereby attracting a more significant influx of visitors. In the Metaverse, some regions inside gardens are distinct from their real-world counterparts because they cannot be accessed or opened. Early in 2023, the Suzhou government unveiled a Metaverse development plan, which included tourism as a key component. This provides an opportunity to improve the online virtual tourist system for the SCGs.

Since Suzhou is in the initial conceptual stage of Metaverse construction and development, many problems still need to be solved in the construction of SCGs Metaverse. For example, China needs a relatively mature Metaverse infrastructure platform for tourists worldwide to visit smoothly, which will be a significant limitation for the construction of SCGs Metaverse. Of course, there are also tremendous opportunities behind these challenges. For global tourists, this may be a brand-new experience.

As our research method comprised a review and case research, predominantly second-hand literature was used, and the relevant empirical research and experimental data are lacking. The searched studies may not have fully collected the latest technology. Moreover, in the existing case research, although the existing technology was evaluated, researchers may be unaware of small ongoing updates of various systems. In future research, many aspects of investigations on tourists and VR experts should be added to pay more attention to the needs and

experience evaluations of users. At the same time, they should continue to monitor the development of related technologies in a timely manner to enhance the timeliness of research.

Conclusion

Online virtual tour experience systems have been utilised for several years, and the technology is still maturing. The COVID-19 pandemic has boosted the acceptance of online virtual experiences amongst travellers. The SCGs are an early user of the online virtual experience; however, their virtual experience system should be continuously enhanced to provide a more engaging and immersive experience for tourists. To achieve this objective, the SCGs should incorporate VR, include animation, and offer more cultural and social activities for tourists to appreciate fully. Once combined, the aforementioned features can be referred to as the 'SCGs Metaverse', which will not only utilise cutting-edge technologies for tourism but also be socially and economically beneficial.

There are many challenges in achieving this goal, such as constructing the metaverse basic platform, differing from reality, enhancing the sense of immersion, including more interactive projects, making navigation easier, enhancing social attributes, and being more inclusive to all kinds of tourists around the world. With the continuous development of online virtual tourism technology, these problems will eventually be solved.

In the future, after the completion of the 'SCGs Metaverse', more international tourists can experience the SCGs through this platform. In addition to the immersive experience of tourism culture on the platform, the Suzhou government can provide users the opportunity to purchase tourism transportation services, accommodations, dinner bookings, souvenirs, and other services, bringing new possibilities to the economic growth of Suzhou's tourism industry.

Geological Information

The scope of this research included China's nine SCGs selected to be WHSs: the Humble Administrator's Garden, Lingering Garden, Net Master's Garden, Mountain Villa with Embracing Beauty, Canglang Pavilion, Lion Grove Garden, Garden of Cultivation, Couple's Garden Retreat, and Retreat and Reflection. In addition, it included seven other projects selected as WHSs: Osun-Osogbo Sacred Grove; Angkor; Himeji Castle; Historic Centre of Macao; Bagan; Palace and Park of Versailles; and Tomb of Lihyan son of Kuza.

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Declaration of Interest

The authors declare that they have no competing interests.

References

Abdelmonem, M. G., & Abdulla, K. M. B. (2017). *Virtual Heritage: Global Perspectives for Creative Modes of Heritage Visualisation* (Research Report). Nottingham: Nottingham Trent University. Retrieved from https://irep.ntu.ac.uk/id/eprint/32469/

Argyriou, L., Economou, D., & Bouki, V. (2020). Design Methodology for 360° Immersive Video Applications: The Case Study of a Cultural Heritage Virtual Tour. *Personal and Ubiquitous Computing*, *24*(6), 843-859. https://doi.org/10.1007/s00779-020-01373-8

Bogicevic, V., Seo, S., Kandampully, J. A., Liu, S. Q., & Rudd, N. A. (2019). Virtual Reality Presence as a Preamble of Tourism Experience: The Role of Mental Imagery. *Tourism Management*, *74*, 55-64. https://doi.org/10.1016/j.tourman.2019.02.009

Boland, P., & Johnson, C. (1996). Archaeology as Computer Visualization: 'Virtual Tours' of Dudley Castle c.1550. In *British Museum Occasional Paper Number 114, Imaging the Past: Electronic Imaging and Computer Graphics in Museums and Archaeology* (pp. 227-234). London: British Museum Press. Retrieved from https://archive.org/details/imagingpastelect0000unse

Buhalis, D., Leung, D., & Lin, M. (2023). Metaverse as a Disruptive Technology Revolutionising Tourism Management and Marketing. *Tourism Management*, *97*, 104724. https://doi.org/10.1016/j.tourman.2023.104724

Buhalis, D., Lin, M. S., & Leung, D. (2022). Metaverse as a Driver for Customer Experience and Value Co-creation: Implications for Hospitality and Tourism Management and Marketing. *International Journal of Contemporary Hospitality Management*, *35*(2), 701-716. https://doi.org/10.1108/IJCHM-05-2022-0631

Campiani, A., McAvoy, S., Lercari, N., Stuardo, R. L., Delgado, G. J., Mejía, J. L., ... Kuester, F. (2023). Developing an Interoperable Cloud-based Visualization Workflow for 3D Archaeological Heritage Data: The Palenque 3D Archaeological Atlas. *Digital Applications in Archaeology and Cultural Heritage*, *31*, e00293. https://doi.org/10.1016/j.daach.2023.e00293

Château de Versailles. (2019). *Versailles VR: The Palace is Yours*. Retrieved from https://en.chateauversailles.fr/news/life-estate/versaillesvr-palace-yours

CyArk. (n.d.). *Iya Moopo, Osun-Osogbo Sacred Groves, Nigeria: 3D-Explorer*. Retrieved from https://www.cyark.org/projects/osun-osogbo-sacred-groves/3D-Explorer

Dang, X., Liu, W., Hong, Q., Wang, Y., & Chen, X. (2023). Digital Twin Applications on Cultural World Heritage Sites in China: A State-of-the-Art Overview. *Journal of Cultural Heritage*, *64*, 228-243. https://doi.org/10.1016/j.culher.2023.10.005

Dawson, P. C., Porter, C., Gadbois, D., Keith, D., Hughes, C., & Suluk, L. (2018). 'Some Account of an Extraordinary Traveller': Using Virtual Tours to Access Remote Heritage Sites of Inuit Cultural Knowledge. *Études Inuit Studies*, *42*(1–2), 243–268. https://doi.org/10.7202/1064503ar

Frago, L. (2021). Impact of COVID-19 Pandemic on Retail Structure in Barcelona: From Tourism-phobia to the Desertification of City Center. *Sustainability*, *13*(15), 8215. https://doi.org/10.3390/su13158215

Geng, W. (2023). Whether and How Free Virtual Tours can Bring Back Visitors. *Current Issues in Tourism*, *26*(5), 823–834. https://doi.org/10.1080/13683500.2022.2043253

Giannini, T., & Bowen, J. P. (2022). Museums and Digital Culture: From Reality to Digitality in the Age of COVID-19. *Heritage*, *5*(1), 192–214. https://doi.org/10.3390/heritage5010011

Hacosco. (n.d.). *Himeji Castle – Photogrammetry*. Retrieved from https://hacosco.com/himeji-castle_en/

Higgins, T., Main, P., & Lang, J. (1996). *Imaging the Past: Electronic Imaging and Computer Graphics in Museums and Archaeology*. London: British Museum Press. Retrieved from https://archive.org/details/imagingpastelect0000unse

Hughes, B., Green, A., & CyArk. (n.d.). Bagan. *Google Arts & Culture*. Retrieved from https://artsexperiments.withgoogle.com/bagan

Ito, E., Higham, J., & Cheer, J. M. (2022). Carbon Emission Reduction and the Tokyo 2020 Olympics. *Annals of Tourism Research Empirical Insights*, *3*(2), 100056. https://doi.org/10.1016/j.annale.2022.100056

Jones, P., Osborne, T., Sullivan-Drage, C., Keen, N., & Gadsby, E. (2022). *Virtual Reality Methods: A Guide for Researchers in the Social Sciences and Humanities*. Bristol, UK: Policy Press.

Kim, J., Shinaprayoon, T., & Ahn, S. J. (2022). Virtual Tours Encourage Intentions to Travel and Willingness to Pay Via Spatial Presence, Enjoyment, and Destination Image. *Journal of Current Issues & Research in Advertising*, *43*(1), 90–105. https://doi.org/10.1080/10641734.2021.1962441

Lai, L., Sordini, M., Campana, S., Usai, L., & Condò, F. (2015). 4D Recording and Analysis: The Case Study of Nuraghe Oes (Giave, Sardinia). *Digital Applications in Archaeology and Cultural Heritage*, *2*(4), 233–239. https://doi.org/10.1016/j.daach.2015.09.001

Li, J., Nie, J.-W., & Ye, J. (2022). Evaluation of Virtual Tour in an Online Museum: Exhibition of Architecture of the Forbidden City. *PLoS ONE*, *17*(1), e0261607. https://doi.org/10.1371/journal.pone.0261607

Liqin, J., & Fuzhao, H. (2007). Classical Garden Reform: Expand the Development of Cultural Connotation and Develop New Tourism Products—Take the Garden Park of Wuxi City as an Example. *Chinese Science and Technology Journal Database*, *11z*, 223–223. Retrieved from https://www.cqvip.com/qk/95786a/200711z/25801703.html

Lu, J., Xiao, X., Xu, Z., Wang, C., Zhang, M., & Zhou, Y. (2022). The Potential of Virtual Tourism in the Recovery of Tourism Industry During the COVID-19 Pandemic. *Current Issues in Tourism*, *25*(3), 441-457. https://doi.org/10.1080/13683500.2021.1959526

Merillas, O. F., Martínez, B. A., Ballesteros-Colino, T., & de Castro Martín, P. (2022). Heritage Conceptualization in Digital Environments Through Trainee Teacher Identity Referents. *Educação and Sociedade*, *43*, e255396. https://doi.org/10.1590/ES.255396

Palumbo, R. (2023). Surviving COVID-19: What Museums and Cultural Institutions can Do to Attract Cultural Tourists and Get Through the Pandemic. *International Review on Public and Nonprofit Marketing*, *20*(4), 905-926. https://doi.org/10.1007/s12208-022-00359-x

Rainoldi, M., Winckel, A., Yu, J., & Neuhofer, B. (2022). Video Game Experiential Marketing in Tourism: Designing for Experiences. In J. L. Stienmetz, B. Ferrer-Rosell, & D. Massimo (Eds.), *Information and Communication Technologies in Tourism 2022, Proceedings of the ENTER 2022 eTourism Conference, January 11-14, 2022* (pp. 3-15). Cham, Switzerland: Springer. https://doi.org/10.1007/978-3-030-94751-4_1

Ren, W., & Chen, X. (2021). Evaluation of an Online 360° Virtual Reality World Heritage Site During COVID-19. *Open Archaeology*, *7*(1), 1192-1215. https://doi.org/10.1515/opar-2020-0188

Royal Commission for AlUla (RCU). (2023, February 20). Royal Commission for AlUla's Exciting New Hot Air Balloon Experience Offers Bird's Eye View of Hegra UNESCO World Heritage Site in the Metaverse. *PR Newswire*. Retrieved from https://www.prnewswire.com/news-releases/royal-commission-for-alulas-exciting-new-hot-air-balloon-experience-offers-birds-eye-view-of-hegra-unesco-world-heritage-site-in-the-metaverse-301750840.html

Smith, M., Walford, N. S., & Jimenez-Bescos, C. (2019). Using 3D Modelling and Game Engine Technologies for Interactive Exploration of Cultural Heritage: An Evaluation of Four Game Engines in Relation to Roman Archaeological Heritage. *Digital Applications in Archaeology and Cultural Heritage*, *14*, e00113. https://doi.org/10.1016/j.daach.2019.e00113

Ubik, S., Kubišta, J., & Dvořák, T. (2022). Interactive 3D Models: Documenting and Presenting Restoration and Use of Heritage Objects. *Digital Applications in Archaeology and Cultural Heritage*, *27*, e00246. https://doi.org/10.1016/j.daach.2022.e00246

United Nations Educational, Scientific and Cultural Organization (UNESCO). (n.d.). World Heritage List. *UNESCO World Heritage Convention*. Retrieved from https://whc.unesco.org/en/list/

Verde, A., & Valero, J. M. (2021). Virtual Museums and Google Arts & Culture: Alternatives to the Face-to-Face Visit to Experience Art. *International Journal of Education Research*, *9*(2), 43-54.

Wiltshier, P., & Clarke, A. (2017). Virtual Cultural Tourism: Six Pillars of VCT Using Co-creation, Value Exchange and Exchange Value. *Tourism and Hospitality Research*, *17*(4), 372-383. https://doi.org/10.1177/1467358415627301

World Tourism Organization. (2021). *UNWTO Inclusive Recovery Guide-Sociocultural Impacts of COVID-19, Issue 2: Cultural Tourism*. Madrid, Spain: UNWTO. https://doi.org/10.18111/9789284422579

Zaimes, G. N., Iakovoglou, V., Maclaren, F. T., & Manchanda, P. (2022). Adopting Digital Tools & Technology to Evolve Sustainable Tourism at World Heritage Sites: Case Studies from India and Greece. In M.-T. Albert, R. Bernecker, C. Cave, A. C. Prodan, & M. Ripp (Eds.), *50 Years World Heritage Convention: Shared Responsibility-Conflict & Reconciliation* (pp. 363-375). Cham, Switzerland: Springer. https://doi.org/10.1007/978-3-031-05660-4_28