

Evaluation of the Online Virtual Reality 360° World Cultural Heritage Tourism under the Charter on Interpretation and Presentation of Cultural Heritage during the Covid-2019 Outbreak

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Abstract

This study has formulated an evaluation framework for the interpretation and presentation performance of Online virtual reality 360° world cultural heritage tourism (OVRWCHT) approach during the covid-2019 break. The research framework is based on seven main principles of the Charter of the World Cultural Heritage Interpretation and Presentation theory, and establishes evaluation criteria for each principle. The World Cultural Heritage Site Hailongtun Tusi was selected as the case study, the Online virtual reality 360° system for this site was established and evaluated accordingly. A collection of 1062 effective online questionnaires were support the evaluation. The results show that the OVRWCHT made by the research team which has received relatively wide recognition from stakeholders during the COVID-2019 outbreak period. However, it still needs more data support to improve technology and theory, especially transferability of OVRWCHT in other countries besides China. Finally, this study suggests that the ICOMOS should continue to issue relevant charters (documents) on how emerging technologies which may activate cultural heritage interpretation and presentation.

1. Introduction

Online virtual reality 360° world cultural heritage tourism (OVRWCHT) interpretation and presentation technology helps many tourists learn the outstanding universal value of world cultural heritage remotely. Although a significant numbers of tourists still hope to go to the world cultural heritage site in person, the COVID-2019 outbreak from 2020 to present interrupted the trip of the vast majority of world cultural heritage enthusiasts. Under the COVID-2019 outbreak, many countries have implemented strict community isolation policies, limiting the normal travel of the vast majority of people. Nations across the world have imposed travel restrictions, even 93 percent of the global population lives in countries with coronavirus-related travel restrictions, during the COVID-2019 outbreak[1]. Network and remote technology have become an important way for the general public to understand the outside world. While people staying at home, they get more nostalgic for their past field trips. Emerging technologies, especially artificial intelligence, three-dimensional visualization and other advanced technologies give new ideas to avoid distant and dangerous trips. OVRWCHT played an increasing important role for the heritage tourism in China.

Online virtual reality 360° is not a new concept, nor is it a new attempt to apply it to world cultural heritage. However, this technology still satisfies many Chinese people's exploration of world cultural heritage during the COVID-2019 outbreak. Therefore, the questions have been raised on what is the role of cultural heritage interpretation and presentation during the covid-2019 outbreaking? How the heritage interpretation and presentation may help to promote the outstanding universal value during the COVID-2019 outbreaking? Is that possible that emerging technologies would really do better than the traditional approach in cultural heritage interpretation and presentation?

This research believes that better service for world cultural heritage is not only from a technical point of view, but also needs to focus on the nature of World Heritage interpretation and presentation.

Therefore, the aim of this research is to evaluate the interpretation and presentation performance of OVRWCHT during the covid-2019 outbreak period. In order to achieve the purpose of the research, this study establishes a theoretical framework to analyze the effectiveness of OVRWCHT based on the seven principles of the *Charter of Cultural Heritage Interpretation and Presentation*. An OVRWCHT was established fitted the interpretation and presentation of world heritage site Hailongtun Tusi. A questionnaire survey was launched in China from May 28th to June 2nd, 2020. One of the purposes of the questionnaire survey is to verify the effectiveness of OVRWCHT. A total of 1062 valid questionnaires were collected, which verified the effectiveness of OVRWCHT in the interpretation and presentation of world cultural heritage.

2. Literature Review

Lacking enough research on cultural heritage during the COVID-2019 outbreak

Various heritage originations published their statements on cultural heritage during the COVID-19 outbreak, for example, International Centre for the Study of the Preservation and Restoration of Cultural Property (ICCROM) published the statement on heritage in times of COVID, suggested how to support cultural bearers, artists, and craftspersons during COVID-19 outbreak [2]. Montlaur (2020) from World Monuments Funds expressed the concerns on the safety of those engaged in work around the world and economic support [3]. Council of Europe promised that education, heritage and culture do not stop to exist, and positively support the emerging technology applying to the heritage sector [4]. Nevertheless, Nadia Al-Said from the International Peace Institute argued that the lockdowns and no cure or vaccine caused a significant negative impact on economic and social life during the COVID-19 outbreak [5].

However, there are very limited academic researches combined the Cultural Heritage and COVID-19 Outbreak, but the concept that COVID-19 reformulated the lifestyle of humanity to access to cultural heritage have been accepted widely. Kuzelewska and Tomaszuk (2020) supported this opinion and also research on the case-law of the European Court of Human Rights in this field [6].

Interpretation and Presentation of Cultural Heritage

Charter on Interpretation and Presentation of Cultural Heritage (Tilden's Charter) has been ratified by the 16th General Assembly of ICOMOS, on 4th October 2008, with the aim to define the basic principles of Interpretation and Presentation as essential components of heritage conservation efforts [7]. An increasing number of researches concerns on various aspects of heritage interpretation globally, some research claimed Tilden's Charter would be a useful tool for cultural conservation, protection and management [8–10]. Other researches applied the 2008 Charter to the community in the museum [11]; investigate the effect of tour interpretation on perceived heritage values base on tour guiding interpretation at a heritage destination [12, 13]; satisfaction, attitudes and experience of visitors [14, 15]; Heritage and hermeneutics [16]; visitors' preferences for interpretation [17, 18]; interpretation and city heritage [19, 20]; geoheritage interpretation [21] and heritage tourism interpretation [22, 23].

However, Van Den Dries (2016) argued the Tilden's Charter lead to the dilemma base case research of Tell Balata, Palestine [24]. Asfaw and Gebreslassie (2016) supported it and suggested to develop appropriate interpretation system, preparing different interpretation infrastructures could be useful remedies [25]. Villasante (2019) also redefined the concept of heritage interpretation by a stakeholders approach with theoretical and practical value, for their use in educational context [26].

Along with the development of emerging technologies, the Virtual reality augmented reality, artificial intelligence, 3D printing, panoramic camera and other technologies began to be more widely used in the interpretation of cultural heritage. Rahaman (2018) proposed a conceptual framework for digital heritage interpretation with fifteen considerations, then implemented and tested on an online platform to assess its impact on end-users' interpretation level [27].

Furthermore, given that the Charter only provides the essential points for heritage, there are still need detailed indicators and principles for assessing approaches for heritage interpretation and presentation. For example, an increasing number of the emerging technologies had been applied to cultural heritage interpretation and presentation, but few types of research focus on its standards, guidance and ethic.

The virtual reality technology and tourism experience

The application of the virtual/ augmented reality technology is not a new topic. Chung et al. (2015) focus on the role of augmented reality application for a heritage site from the tourists' intention to visit a destination, their research result base on shows that technology readiness was a predictor of perceived usefulness [28]. The role of augmented reality have different forms than virtual reality, and this research only uses 145 cases for analyzing may not able to reflect a comprehensive pictures on emerging technology. Tussyadiah et al. (2017) although pointed out the virtual reality technology offers opportunities for tourism, the challenges existing in understand the effectiveness of VR experience. Their research indicated that the feeling of being in the virtual environment increases the enjoyment of VR experiences, it provides empirical evidence to confirm the effectiveness of VR in changing the tourists' attitude and behavior [29]. However, some researchers believe the desire of tourists may have a stronger role than the nature of VR design. For example, Gonzalez-Rodriguez et al. (2020)evaluated the tourists' virtual tour experience during the visiting a cultural heritage destination by assessed 119 online comments, the findings indicating the importance of desire of tourists on tourism sector [30] Nevertheless, this research considered that the 119 online comments still show the limited data for support the conclusion.

The development of 360 degrees HD technologies in China

China had introduced panorama technology into the interpretation and presentation of cultural heritage since last century. The virtual visit service of the 2008 Beijing Digital Olympics project restored the buildings and key cultural relics of Prince Gong Mansion with the help of 360 degrees HD technology. It provided global tourists with online experience. Shanghai World Expo, established a 5.28 square kilometer virtual park on the Internet to provide panoramic roaming services for tourists. The Imperial

Palace, Dunhuang and other panoramic virtual roaming systems enable visitors to visit presentation and historic sites without need of leaving home [31]. Shanghai Museum, Nanjing Museum and other museums with first-class facilities also introduced the panoramic technology to build a virtual museum earlier [32]. The application of panoramic technology can break the shackles of geography and space, and interpret the connotation of cultural heritage more vividly, so as to achieve the widespread and effective dissemination of cultural values[33, 34]. Basically, this consensus has been reached in academia in China.

Research Gap between Online Virtual Reality 360 applied and cultural heritage

However, the application of panoramic technology in the scope of cultural heritage mostly lies in the technology of realizing virtual reality on the computer platform based on static images[32]. Lacking research on multimedia immersive experience and interaction design, and in the process of utilization, the application of panoramic technology is also facing conflicts between digital technology and traditional culture, as well as the inability to reproduce the primordial nature of culture, and so on. Furthermore, these are lack of research to discuss the interrelationship between panoramic technology and *Charter of Cultural Heritage Interpretation and Presentation*. To address these problems, it requires panoramic technology to respect the original culture in the process of cultural heritage interpretation and presentation, further expand the application possibility of panoramic technology, and complement each other with the physical presentation of cultural heritage entities, and ultimately achieve the sustainable development of cultural heritage[35, 36].

At present, the research is mainly based on the development of emerging technologies, while scenario application research is a supplement. Currently, the primary application research is mainly from the perspective of users. There is very limited research on the emerging technologies effectiveness of interpretation and presentation, nor has it tested its effectiveness in the COVID 19 epidemic stage. The study has formulated an analytic framework for this topic. The research framework is established mainly based on the seven main principles of *the Charter on Interpretation and Presentation of Cultural Heritage*, which serve as the important theoretical basis for interpretation and presentation of heritage. Based on these seven principles, relevant impact factors were made to be used for evaluation.

3. Methodology

The methodology of this study mainly consists of three components. The first part is to select a World Cultural Heritage as a case study, and customize the OVRWCHT for it. The second part is to establish the OVRWCHT evaluation framework. The third part is to applying the case to evaluation framework with the support data of a questionnaire survey.

3.1 Developing the OVRWCHT for Hailongtun Tusi Site

Hailongtun, a world cultural heritage site, was selected as a case study for applying the OVRWCHT system with the follows reasons. Firstly, the authors of this research have participated in UNESCO World

Heritage and sustainable tourism project from 2017 to 2019, authors had deep understanding of this site. The 3D point cloud of Hailongtun heritage had been established based on the UAV in 2019 by authors. Secondly, from a practical point of view, the Hailongtun cultural heritage administration is looking forward to building an online panoramic interpretation system but lack of a professional technology team. Hailongtun Tusi site is faced with the problem of inaccurate heritage interpretation of outstanding universal values. Moreover, during the epidemic period, the number of tourists decreased significantly, so it is urgent to use magnetic system for publicity. Therefore, The Hailongtun cultural heritage administration is very supportive of this study. Thirdly, From the perspective of feasibility, the Hailongtun is only 1.6 square kilometers, so that can established such system quickly in the case of limited human resource in this study.

The production process of online virtual reality 360 degrees is as follows. For the purpose of comprehensive presentation the world heritage Hailongtun Tusi Site cultural relic and its environment, the panoramic spherical mapping technology was used to complete the shooting and production of 360° panoramic images of the planned shooting point. Establish panoramic roaming to increase good interaction between audience and application terminal. The virtual roaming combines the two forms of direct mouse click operation and button setting operation to achieve the right and left rotation, upward-looking, overlooking and scene pushing and pulling operations of the audience during the roaming process. In the roaming process, the smooth transition between the scene points is achieved. The presentation of the overall layout is combined with the plan to create navigation, so that the audience can always grasp the actual position of the observation point, and at the same time not lose the direction of the overall layout of the scenic area. The interactive link between navigation map and 3D panorama is realized, and the combination of navigation map guide, picture presentation, text introduction and voice explanation enables the audience to obtain more information about the outstanding universal value of the world cultural heritage Hailongtun Tusi Site, when browsing and viewing. It is convenient for the audience to quickly switch to the presentation of interest through navigation Settings.

3.1.1 Collection and stitching of panoramic images of presentation

The image of the Hailongtun Tusi Site panorama navigation system is captured by DETUF4FD121 camera. The DETUF4FD121 camera is equipped with 4 full glass fish eye lenses. It can take pictures of 360 degrees around the center of the shot spot. (Fig. 1–4). More than 200 key points were selected within 160.42 hectares of Hailongtun property zone in 7 days, and more than 2000 scene pictures were taken for post collage, covering all the important relics and roads of Hailongtun Tusi Site property zone. More than 2000 pictures were taken for later processing. The presentation selected covers all the important sites and roads in Hailongtun Tusi Site property zone (Fig. 5).

With DetuStitch software from DETUF4FD121 camera the collage of panorama is completed (Fig. 6). Image processing software (Photoshop) is used to repair and unify the exposure and color of some images.

3.1.2 World Heritage Site Series Release

Finally, 153 panoramic images reflecting the whole landscape of Hailongtun property zone were selected to establish a one-way roaming path from the sight-seeing bus stop of Hailongtun Village Nianfang Bay(the start point) to Tou Dao Pass(the final point). At the nine heritage Pass, restoration models, archaeological site survey map, voice and text interpretation of gateways had been added. Important points and intersections are added to highlight the outstanding universal value of Hailongtun (Fig. 7 and Fig. 8). The audience can choose the content they are interested in by clicking on the hot spot icons in the panorama.

Create navigation on the basis of the property zone plan, so that the audience can understand the location of the current panoramic picture in real time, and a more three-dimensional overall impression of the whole world heritage site could be created. At the same time, a variety of scene switching modes, such as hot spots, small pictures, navigation, etc., make it convenient for the audience to jump to any tour location at will in the virtual tour, so that the audience can have an "immersive" tour experience in the panoramic virtual tour. Finally, the system is imported into the network cloud and is free of charge. Users can use any mobile phone or computer with network connection to access it. The link for the system is still available, <http://m.detu.com/zh/pano/show/691589?from=timeline>. So far, the system has reached 3.76 thousand online visitors.

3.2 Hailongtun OVRWCHT effectiveness evaluation research method

Effectiveness evaluation is based on the authenticity and accuracy of information. First, this study used the literature review method to study international teams in the related fields. Second, this research published a set of network questionnaires, based on the information obtained from the questionnaire, the indicators employed for evaluation had been selected. During the COVID 19 epidemic period, this study mainly tested the awareness of the public on OVRWCHT. Therefore, the test was conducted in the form of network questionnaire. The test is conducted in China, so the language of the questionnaire is mainly Chinese. Third, a combination research method in accordance with the actual situation in China is developed in this study to formulate a framework for evaluating the effectiveness of OVRWCHT. The evaluation effectiveness is mainly based on a set of indicators. How to evaluate the effectiveness is the focus of the study. Evaluation can be divided into two main forms: qualitative evaluation and quantitative evaluation. The qualitative evaluation mainly refers to the author's evaluation of OVRWCHT according to Charter of cultural Heritage interpretation and presentation, while quantitative evaluation focuses on the effect of the model in the form of online questionnaire(Table 1).

Table 1

Assessment framework based on Charter of cultural heritage interpretation and presentation

Principle	Assessment focus	Evaluation indicators and questions
Principle 1: Assessment and Understanding	Interpretation and presentation program should facilitate physical and intellectual access by the public to cultural heritage sites.	<p>Assessment based on the questionnaire</p> <ol style="list-style-type: none"> 1. To what extent do users think that the following ways to presentation the value of world cultural heritage can bring a better sense of experience when users visiting the world cultural heritage? 2. To what extent do users think the following ways to presentation the value of world cultural heritage can help users better understand its outstanding universal value after visiting the OVRWCHT? <p>Authors' assessment based on platform features</p> <ol style="list-style-type: none"> 1. Does the OVRWCHT inspire further interest of learning, experience, and exploration? 2. Does the OVRWCHT identify and assess their audiences demographically and culturally? 3. Does the OVRWCHT encourage the diversity of language? 4. Is the OVRWCHT physically accessible to the public and off-site?
Principle 2: Information Sources	Interpretation and presentation should be based on evidences gathered through accepted scientific and scholarly methods as well as living cultural traditions.	<p>Authors' assessment based on platform features</p> <ol style="list-style-type: none"> 1. Are the sources of heritage interpretation information documented, archived, and made them accessible to the public? 2. Is the interpretation (includes traditional storytelling or the oral heritage interpretation) of the OVRWCHT based on a well researched multidisciplinary study of the site and its surroundings? 3. Are the visual reconstructions (computer modelers) based upon detailed and systematic analysis of environmental, archaeological, architectural, and historical data?

Principle	Assessment focus	Evaluation indicators and questions
Principle 3: Context and Setting	<p>The Interpretation and Presentation of cultural heritage sites should be related to their wider social , cultural, historical, and natural contexts and settings.</p>	<p>Authors' assessment based on platform features</p> <ol style="list-style-type: none"> 1. Does the OVRWCHT explore the significance of a site in its multi-dimensional historical, political, spiritual, and artistic contexts? 2. Does the OVRWCHT clearly distinguish and date the successive phases and impacts in its evolution? 3. Does the OVRWCHT take into account of all groups that have contributed to the historical and cultural significance of the site? 4. Does the OVRWCHT consider the surrounding landscape, natural environment, and geographical setting? 5. Does the OVRWCHT consider intangible elements of a site's heritage and cross-cultural significance of heritage sites?
Principle 4: Authenticity	<p>The Interpretation and presentation of cultural heritage sites must respect the basic tenets of authenticity in the spirit of the Nara Document (1994).</p>	<p>Authors' assessment based on platform features</p> <ol style="list-style-type: none"> 1. Does the OVRWCHT respect the traditional social functions of the site and the cultural practices and dignity of local residents and associated communities? 2. Does the OVRWCHT contribute to the conservation of the authenticity of a cultural heritage site? 3. Is the OVRWCHT sensitive to the character, setting and the cultural and natural significance of the site? 4. Does the OVRWCHT harm the authenticity of a cultural heritage site in term of on-site concerts, dramatic performances, and other interpretation program?

Principle	Assessment focus	Evaluation indicators and questions
Principle 5: Sustainability	The interpretation plan for a cultural heritage site must be sensitive to its natural and cultural environment, with social, financial, and environmental sustainability among its central goals.	<p>Assessment based on the questionnaire</p> <ol style="list-style-type: none"> 1. Do users agree with that artificial intelligence, three-dimensional visualization, light and shadow vision and other emerging technologies are one of the important attempts to promote the sustainable tourism of world cultural heritage? 2. Authors' assessment based on platform features 3. Is the OVRWCHT an integral part of the overall planning, budgeting, and management process of cultural heritage sites? 4. Does the OVRWCHT consider potential effect of interpretive infrastructure and visitor numbers on the cultural value, physical characteristics, integrity, and natural environment of the site in heritage impact assessment studies? 5. Does the OVRWCHT serve a wide range of conservation, educational and cultural objectives? 6. Is the OVRWCHT an integral part of the conservation process? 7. Does the OVRWCHT provide equitable and sustainable economic, social, and cultural benefits to all stakeholders?

Principle	Assessment focus	Evaluation indicators and questions
Principle 6: Inclusiveness	The Interpretation and Presentation of cultural heritage sites must be the result of meaningful collaboration between heritage professionals, host and associated communities, and other stakeholders.	<p>Authors' assessment based on platform features</p> <ol style="list-style-type: none"> 1. Can the OVRWCHT be integrated in the multidisciplinary expertise of scholars, community members, conservation experts, governmental authorities, site managers and interpreters, tourism operators, and other professionals? 2. Does the OVRWCHT note and respect the traditional rights, responsibilities, and interests of property owners and host and associated communities? 3. Does the OVRWCHT open for public comment and involvement in expansion or revision? 4. Does the OVRWCHT clarify legal ownership and right to use images, texts, and other interpretive materials?
Principle 7: Research, Training, and Evaluation	Continuing research, training, and evaluation are essential components of the interpretation of a cultural heritage site.	<p>Authors' assessment based on platform features</p> <ol style="list-style-type: none"> 1. Does the OVRWCHT involve continuously monitoring and evaluation, continuing research and consultation, and regular review? 2. Does the OVRWCHT take into account its possible uses in school curricula, informal and lifelong learning program, communications and information media, special activities, events, and seasonal volunteer involvement? 3. Does the OVRWCHT may help training of qualified professionals in the specialized fields of heritage interpretation and presentation?

3.3 Questionnaire survey

In this study, 1283 online questionnaires were collected, and the authenticity and validity of all the questionnaires were analyzed and screened, and the results were verified. Finally, 1062 valid questionnaires were obtained after removing the questionnaires with the similar IP address, suspected wrong email address and answers. The collection was conducted from May 28 to June 2, 2020. According to the questionnaire, the automatic access function of IP addresses of respondents was shown, and the respondents' geographical scope included all Chinese mainland provinces and Taiwan

and Hongkong special administrative regions. There are more people filling in the questionnaire in the densely populated coastal provinces. In addition, 93 of the valid questionnaires were from abroad, accounting for 8.76% of all respondents (Fig. 9).

The age of the investigated population is under 60 years old, and it is distributed in several different age groups. The proportion of 18–25 years old is the highest, followed by 31–40 years old and 26–30 years old (Fig. 10). Due to the high proportion of young Internet users in China, many of the respondents are relatively young. The age range filled in the Internet questionnaire is basically consistent with that of the actual Internet users in China.

Therefore, the survey samples cover the whole country and the main population age groups. Based on the demographic perspective, 1062 valid questionnaire samples can be considered to be representative and can be used for research and analysis.

4. Research Findings

Based on the research framework and indicators of *Charter of Cultural Heritage Interpretation and Presentation* listed in methodology, this research summarizes the research finding as follow.

Principle 1: Assessment and Understanding

The evaluation focuses on whether the access of the general public to OVRWCHT is convenient, easy to use and easy to understand. Therefore, according to the results of the questionnaire (Table 2 and Table 3), in terms of the world cultural heritage interpretation and presentation experience, the visitors' scores on the use of emerging technologies are higher than that of traditional interpretation and presentation methods. In the total score of 5 points, the OVRWCHT approach score is 3.65, the traditional heritage site guide or audio guide score is 3.49, and the traditional world heritage site publicity board and brochure score is 3.20.

In terms of interpretation and presentation effect of highlighting outstanding universal values of world cultural heritage, the visitors' scores on the use of new technologies are also higher than that of traditional presentation methods. In the total score of 5 points, OVRWCHT score is 3.61, heritage site guide or audio guide score is 3.49, and World Heritage site publicity board and brochure score is 3.31.

Therefore, the data shows that the general public thinks that the application of OVRWCHT has a better sense of experience, is easy to use, and is easier to understand than the traditional way. In addition, OVRWCHT can promote the understanding and appreciation of cultural heritage, cultivate public awareness and public participation in cultural heritage protection. From the perspective of geographical-statistics, OVRWCHT has carried out cultural heritage publicity in a broader geographical range of China's population areas, so that the public can directly access the main contents of cultural heritage online. OVRWCHT is one of the important ways of off-site interpretation and presentation.

However, this study has not yet proved that OVRWCHT can definitely inspire more level of interest, learning, and needs in-depth study. The main language of this system is Chinese, which cannot show the diversity of language.

Table 2

Respondent's satisfaction in the interpretation and presentation of different world cultural heritage

Item \ scores	1	2	3	4	5	Average score
Traditional exhibition boards and paper brochures of world cultural heritage sites	98 (9.23%)	168 (15.82%)	361 (33.99%)	290 (27.31%)	145 (13.65%)	3.2
Traditional Heritage Guide or audio guide	25 (2.35%)	135 (12.71%)	377 (35.5%)	347 (32.67%)	178 (16.76%)	3.49
OVRWCHT	35 (3.3%)	96 (9.04%)	300 (28.25%)	407 (38.32%)	224 (21.09%)	3.65

Table 3

Respondents' cognition of different world cultural heritage interpretation and presentation technologies to highlight the effect of outstanding universal value

Item \ scores	1	2	3	4	5	Average score
Traditional exhibition boards and paper brochures of world cultural heritage sites	76 (7.16%)	171 (16.1%)	309 (29.1%)	360 (33.9%)	146 (13.75%)	3.31
Traditional Heritage Guide or audio guide	19 (1.79%)	131 (12.34%)	382 (35.97%)	373 (35.12%)	157 (14.78%)	3.49
OVRWCHT	26 (2.45%)	116 (10.92%)	301 (28.34%)	420 (39.55%)	199 (18.74%)	3.61

Principle 2: Information Sources

The second principle concerns on evidences gathered through accepted scientific and scholarly methods and traditions.

From the perspective of the producer of OVRWCHT, the online platform takes the main contents of the world cultural heritage as words, pictures, voice and other forms, so that the users of the online platform can get more information about the outstanding universal value. Based on the information source rules,

the main heritage sites in the of the world cultural heritage Hailongtun Tusi heritage are recorded in the form of digital panoramic photos, and the online form is used to publicize the outstanding universal value of the heritage during the COVID-2019 outbreak period. The world cultural heritage information explained in the system, especially the introduction of key sites, and the three-dimensional reconstruction of key sites, all have accurate sources. The content of heritage interpretation is mainly based on the existing archaeological findings, for example the *Study of the Application for the World Heritage*, and the *Research Report on the Basic Information of Hailongtun Site*. These information sources are reliable and evidence-based, which can be considered as evidences gathered through accepted scientific and scholarly methods.

However, there is no introduction of oral history in OVRWCHT, and it is not directly related to the existing interpretation system of Hailongtun world cultural heritage.

Principle 3: Context and Setting

This principle concerns on the interpretation and presentation should relate to their wider social, cultural, historical, and natural contexts and settings.

Because OVRWCHT' users do not fully understand the context and setting of world cultural heritage before using this platform, so the assessment of this principle is mainly based on the authors' perspectives. This study believes that OVRWCHT attaches importance to the combination of natural and cultural environment, and uses panoramic technology to complete the digital recording of the surrounding environment. OVRWCHT marks the human history of Hailongtun, briefly describes 725 year long history of Yang's rule over Bozhou, the architectural pattern of Hailongtun, and the military events, main landscapes, historical changes and important events of Hailongtun as a military castle in the Ancient Era of Bozhou Administration (A.D. 876–1571). These historical backgrounds are combined with the digital information of historical relics to a certain extent, and digital presentation is carried out by various means. OVRWCHT gives a brief introduction to the Han, Gelao, Miao and other ethnic groups related to Hailongtun heritage.

However, OVRWCHT failed to cover the local folk customs, intangible cultural heritage and local villagers' cultural customs in depth.

Principle 4: Authenticity

This principle concerns on how to respect the basic tenets of authenticity in the spirit of the *Nara Document (1994)*. Because OVRWCHT' users may not fully understand the authenticity of world cultural heritage before using this platform, so the assessment of this principle is mainly based on the authors' perspectives.

This study believes that OVRWCHT strictly abides by the principle of authenticity, especially the interpretation of Heritage Authenticity in *Nara Document (1994)*. This system also reduces the field pressure of world heritage tourism, uses online digital guide to presentation and explain the current

situation of heritage relatively accurately, avoids harm to presentation facilities, and basically achieves the purpose of protecting the authenticity of world heritage.

However, OVRWCHT failed to fully demonstrate the link between heritage and local communities in terms of authenticity. Due to the need of heritage protection, local community residents in Hailongtun have moved away, and this assessment has nothing to do with this system. This system does not use live concert and other forms to interpret the heritage value.

Principle 5: Sustainability

This principle concerns on the interpretation and presentation should be sensitive to its environment, with social, financial, and environmental sustainability among its central goals.

According to the questionnaire, up to 93.79% of the respondents agree that artificial intelligence, three-dimensional visualization, light and shadow vision and other emerging technologies are important technologies to promote the sustainable tourism of world cultural heritage. Through cross analysis, the older the respondents are, the more supportive they are in the application of new technology in the field of world cultural heritage interpretation and presentation. (Fig. 11 / 12)

OVRWCHT shows that the objectives are consistent with the sustainable development objectives, and promotes heritage site protection, education and cultural services. Online system is also one of the ways to reduce the pressure of tourism and protect the world heritage during the epidemic.

However, OVRWCHT is not included in the current legal planning requirements of Hailongtun world cultural heritage, but the interpretation purpose of OVRWCHT does not conflict with the legal planning goal. The OVRWCHT is not integrated with the heritage assessment and does not involve the elements of permanent heritage facilities and maintenance. The OVRWCHT is closely related to the network system, and has little relationship with the existing interpretation facilities and tourists.

Principle 6: Inclusiveness

This principle concerns on the result of meaningful collaboration between heritage professionals, host and associated communities, and other stakeholders.

Because OVRWCHT users may not fully understand the inclusiveness of world cultural heritage, so the assessment of this principle is mainly based on the authors' understandings.

From the perspective of stakeholders, world heritage managers, local residents and world heritage tourism practitioners all support the positive impacts of the OVRWCHT. The vast majority of stakeholders think that OVRWCHT is effective in promoting the outstanding universal value of world cultural heritage of Hailongtun, and the vast majority of stakeholders have a positive evaluation on it. For users, OVRWCHT is easy to be operated and heritage value information can be easily obtained. For heritage

managers, OVRWCHT operation is more accurate, convenient and effective in explaining the core heritage value of world cultural heritage, and the cost is controllable. This OVRWCHT can provide navigation for a large number of tourists, facilitate world heritage management, and facilitate remote promotion of world heritage sites, so it is highly praised by local heritage management departments, and as an important digital project of heritage management institutions, this system was launched on World Heritage Day on June 13, 2020. For tourism practitioners and community residents, online tourism can attract more tourists. There are many problems in the development of heritage tourism under the period of epidemic, and the profit rate is reduced. OVRWCHT can promote tourism development and community development.

OVRWCHT allows the managers of world cultural heritage to directly contact tourists, so the middlemen of tourism operation industry may be eliminated. The content production of OVRWCHT heritage interpretation is based on the collaborative efforts of different stakeholders, respects for the opinions of stakeholders, and widely and repeatedly collecting the modification opinions. The online platform is produced by authors, whom worked for Tongji University, with clear copyright and use right.

Principle 7: Research, Training, and Evaluation

This principle concerns on continuing research, training, and evaluation which are essential components of the interpretation of a cultural heritage site.

Similar to the previous principle, this principle is evaluated by the author based on the research framework. This study believes that this assessment is an ongoing study of OVRWCHT, and the main purpose of this study is to assess the effectiveness of this platform. The OVRWCHT is continuously improved with the continuous research. This study collected the feedback of some stakeholders on the interpretation and presentation of the world cultural heritage Hailongtun Tusi through questionnaires. This study is at the initial stage. At this stage, there is no plan and action for any professional training, nor international cooperation.

5. Discussion

Although this study tried its best to ensure the authenticity of information, most of the people who filled in the questionnaire are effected from epidemic during the COVID-2019 outbreak, so they may have different perceptions when providing data than during the non epidemic period. However, the impact on the overall authenticity of the research data may be very small.

6. Conclusion

This study proposes an evaluation framework for the interpretation and presentation performance of OVRWCHT approach during the covid-2019 break. The research framework is based on seven main principles of the *Charter of the World Cultural Heritage Interpretation and Presentation* theory, and establishes evaluation criteria for each principle. The research object is based on OVRWCHT of

Hailongtun Tusi world cultural heritage made by the author's team. The research data is mainly based on the collection of 1062 effective online questionnaires and the analysis of the above online system in this study.

The results show that, whether in terms of users' experience or interpretation of outstanding universal value, the OVRWCHT is a three-dimensional heritage interpretation and presentation technology made by the research team which has received relatively wide recognition from stakeholders during the COVID-2019 outbreak period. According to the research framework, OVRWCHT generally conforms to the seven interpretation and presentation principles. However, at present, some of the detailed rules of the presentation principles are not related to online interpretation, so it cannot be evaluated. Panoramic 3D can be used as one of the important ways of heritage presentation and interpretation during the epidemic. Emerging technologies such as artificial intelligence and 3D visualization have significant advantages over traditional technologies in this field. However, it still needs more data support to improve technology and theory, especially transferability of OVRWCHT in other countries besides China. Finally, this study suggests that the ICOMOS should continue to issue relevant charters (documents) on how emerging technologies which may activate cultural heritage interpretation and presentation.

7. Declarations

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Authors' contributions: Wei Ren designed/conducted the practical and scientific work, evaluated/interpreted the data and wrote the major parts of the manuscript, evaluated/interpreted data and wrote the parts of the manuscript. Xianhong Chen designed the scientific part and coordinated the study in Hailongtun Tusi. All authors read and approved the final manuscript.

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Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on request.

Competing interests

The authors declare that they have no competing interests.

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Figures



Figure 1

ABCD presentation selected in Feilong Pass.



Figure 2

ABCD presentation selected in Feilong Pass.



Figure 3

ABCD presentation selected in Feilong Pass.



Figure 4

ABCD presentation selected in Feilong Pass.



Figure 5

Panoramic shooting at heritage sites



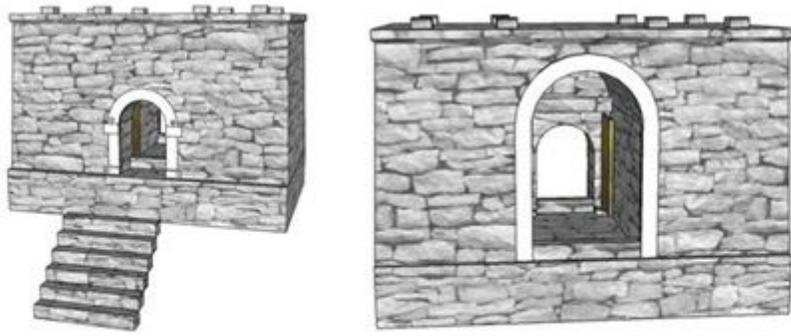
Figure 6

Panorama after collage of images of Feilong Pass.

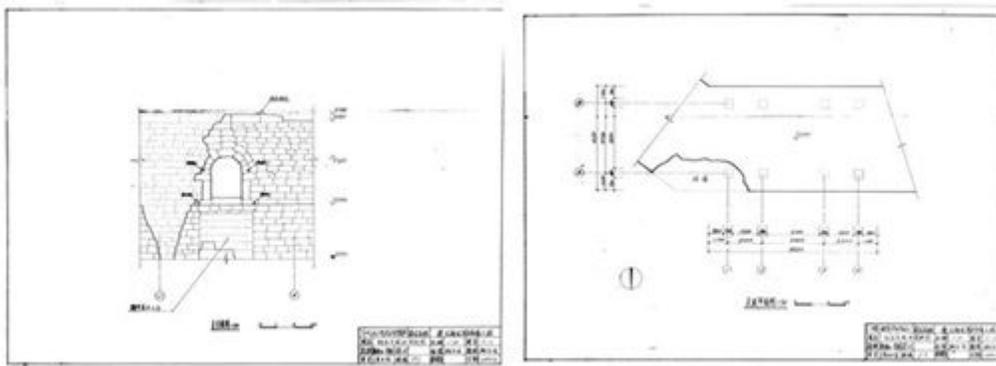


Figure 7

System interface based on panoramic image



Three-dimensional digital restoration Picture of Tiezhu Pass



Archaeological Survey Map of Tiezhu Pass

Figure 8

Mapping and restoration sets used in the system for interpretation of heritage

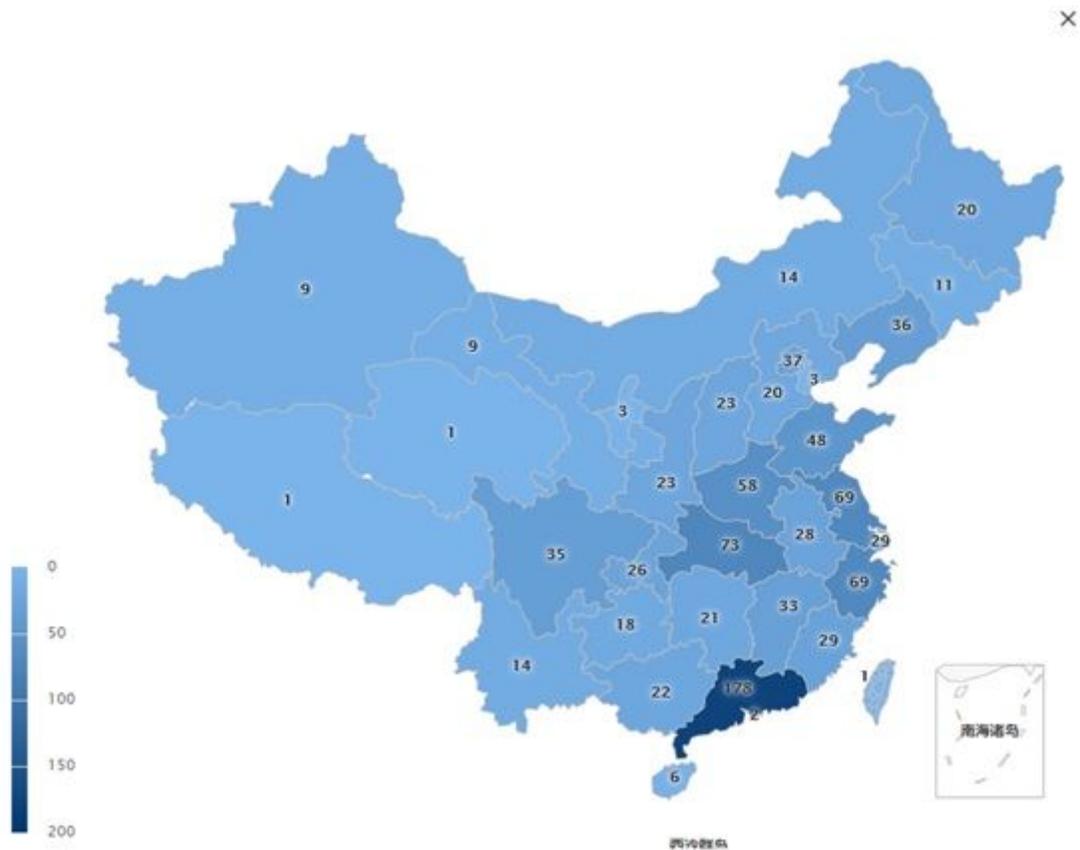


Figure 9

Geographical Scope of respondents. Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.

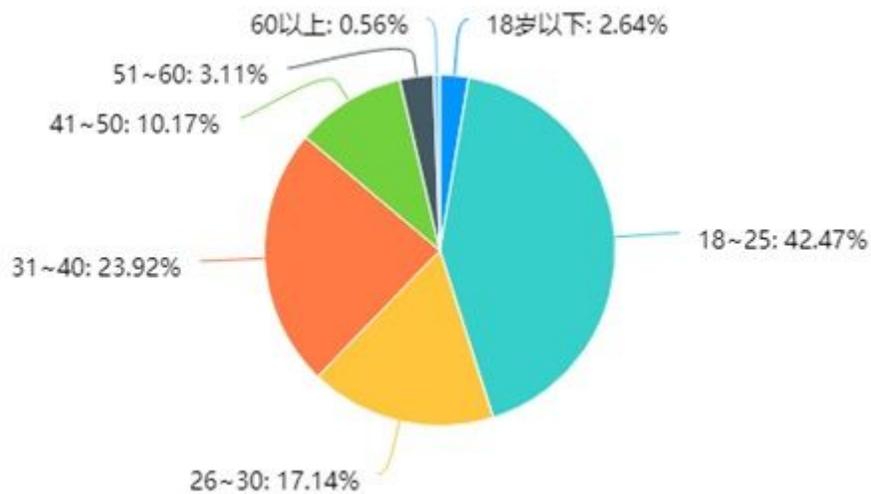


Figure 10

Age distribution of respondents

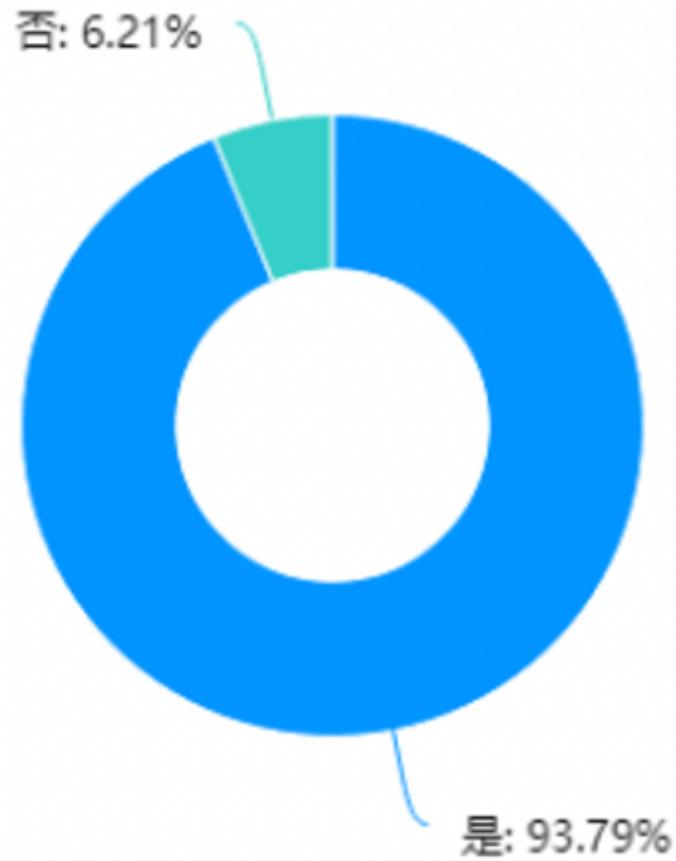


Figure 11

do respondents agree that artificial intelligence, three-dimensional visualization, light and shadow vision and other emerging technologies serve the presentation and interpretation of world cultural heritage as one of the important attempts to promote sustainable tourism of world cultural heritage

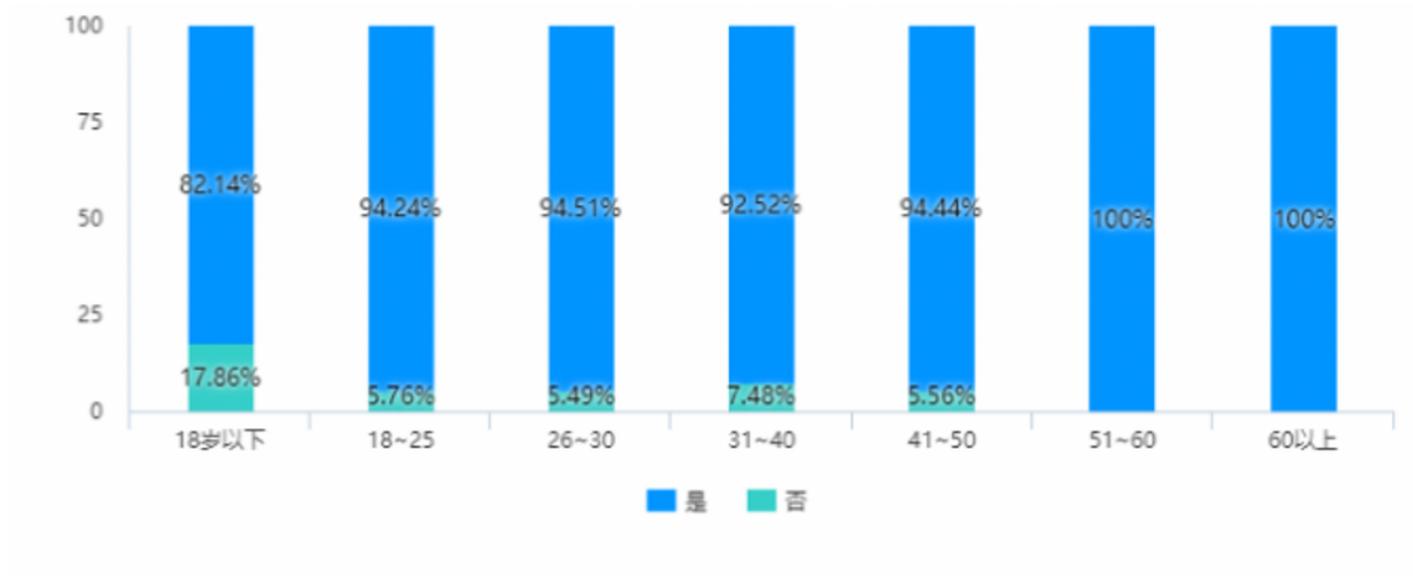


Figure 12

views of different age groups on whether new technologies are supported by digital interpretation