PERINATAL JOURNAL

Original Article

Perinatal Journal 2026; 34(1):1150-1163

https://doi.org/10.57239/prn.26.034100116

Interactive interpretation tools enhance sustainable development of cultural heritage tourism

Shiwan Zhou[1], Raja Norashekin Raja Othman[2*], Ahmad Nazrin Aris Anuar[3], Yinxue Weng[4]

[1,2,3,4]College of Built Environment, Universiti Teknologi MARA, Malaysia

Abstract

This study utilizes the Jinggangshan Scenic Area as a case study to examine the role of interactive interpretation tools (including augmented reality, virtual reality, mobile apps, electronic touchscreens, and audio guides) in promoting the sustainable development of cultural heritage tourism. The study employed field research methods to systematically observe and analyze the application scenarios, tourist usage behaviour, and feedback from scenic area management regarding interactive interpretation tools within the Jinggangshan Scenic Area. The aim was to reveal the impact of interactive interpretation tools on sustainable development across economic, socio-cultural, and ecological dimensions. Research has found that interactive interpretation tools provide strong support for the sustainable development of cultural heritage tourism in Jinggangshan by enhancing the cultural experience of visitors, optimizing the efficiency of information dissemination, and reducing resource consumption. At the same time, the research also pointed out issues such as insufficient technical compatibility and lagging content updates in the application of these tools and put forward targeted recommendations for improvement.

Keywords: Interactive interpretation tools, Cultural heritage tourism, Sustainable development

1.Introduction

Cultural heritage sites serve as irreplaceable carriers of collective memory and identity, playing a crucial role in connecting the past, present, and future (Cataldo, M. 2024). However, their status as tourist attractions also exposes them to conservation pressures stemming from large-scale tourism activities. Striking a balance between economic benefits and resource conservation has become a core challenge. Traditional static interpretation tools (such as text boards and printed brochures) are unable to meet the needs of today's digital audience. They often feature one-way communication, which lacks appeal and fails to fully explain the significance of the site (Abah & Nonyelum, 2024). In contrast, interactive interpretation tools leverage technologies such as AR, VR, smartphones, and multimedia interfaces to provide dynamic, immersive, and personalized experiences. Not only can they enhance the quality of the visitor experience, but they also have the potential to serve as proactive interventions that guide sustainable behaviour (Karthikeyan & Aruna, 2025). As the "cradle of the Chinese revolution," Jinggangshan is a core destination for red tourism in China. In recent years, interactive interpretation tools such as AR, VR simulations, mobile apps, touchscreen terminals, and audio guides have been prioritized in order to modernize the tourist experience and protect the cultural and natural resources of the scenic area.

This study focuses on the following three core research questions:

(1) What is the current application status of interactive interpretation tools in Jinggangshan?

(2) How do these interactive interpretation tools influence the sustainable development of cultural heritage tourism in economic, socio-cultural, and ecological dimensions?

(3) What optimization strategies can be proposed to enhance the role of interactive interpretation tools in the sustainable development of cultural heritage tourism?

2. Literature Review

2.1 Sustainable development of cultural heritage tourism

The sustainable development of cultural heritage tourism emphasizes the coordinated development of

Correspondence: Raja Norashekin Raja Othman, College of Built Environment, Universiti Teknologi MARA, Malaysia, **e-mail:** rnora747@uitm.edu.my,
Received: October 29, 2025 **Accepted:** December 24, 2025

economic benefits, cultural preservation, and environmental sustainability. It requires balancing the demands of tourism development with cultural heritage preservation to ensure that the needs of contemporary tourists are met while passing on the value of heritage to future generations. Existing research indicates that sustainable cultural heritage tourism should focus on three dimensions: economic sustainability (such as stable tourism revenue and job creation), socio-cultural sustainability (such as cultural heritage preservation and community participation), and ecological sustainability (such as resource conservation and reduction of environmental pollution) (Ye, Qin, & Wu, 2024).

The sustainable development of cultural heritage tourism is a focus of academic attention. Sustainable tourism emphasizes a balance between economic, socio-cultural, and environmental factors, requiring tourism activities to meet the needs of tourists while protecting destination resources and promoting the well-being of local communities (Sonuç, 2023). The sustainable development of cultural heritage tourism focuses particularly on balancing visitor access with heritage protection. Traditional interpretation methods, such as static display boards and guided tours, have their value, but they have limitations in attracting visitors' attention, providing in-depth information, and creating immersive experiences (Liu, Y. 2020).

2.2 Interactive interpretation tool of cultural heritage tourism

Brezovec, A. (2022) proposed that the forms of Interpretative are usually static, interactive, and participatory according to the information transmitted about cultural heritage. German, A. (2024) pointed out that Interpretative forms are usually divided into flat and three-dimensional forms according to the spatial characteristics of cultural heritage. This study combines the above two classifications to obtain Interpretative forms of cultural heritage (Table 1), which will help scenic spots provide more abundant, interactive, and personalized Interpretative forms so that visitors can more directly participate in the Interpretative and interaction of cultural heritage.

Table 1. Interpretative forms of cultural heritage tourism

Interpretative Form	Interpretative Characteristic	Example
Static flat form	Low engagement, one-way messaging, fixed content, flat objects	Brochure; Photo; Art Paintings
Static three-dimensional form	Low engagement, one-way messaging, fixed content, three-dimensional objects	Old Site; Statues; Building
Interactive flat form	Medium engagement, two-way messaging, fixed content, flat objects	Electronic touch screen; Electronic guide system
Interactive interpretation tool	Medium engagement, two-way messaging, fixed content, three-dimensional objects	Augmented Reality (AR); Virtual Reality (VR); Three-dimensional digital(3D)
Participatory flat form	High engagement, two-way messaging, active participation, transforming content, flat objects	1.Mobile application games 2.Media Platform
Participatory three-dimensional form	High engagement, two-way messaging, active participation, transforming content, three-dimensional objects	1. On-site activity games 2. On-site production of products

Source: Author, 2025

Interactive interpretation tools refer to digital platforms and devices that provide visitors with information, guidance, and experiences through human-computer interaction. These include augmented reality, virtual reality, mobile applications, electronic touch screens, audio guides, and more. These tools are interactive, personalized, and visual, effectively improving visitors' information acquisition efficiency and experience satisfaction (Sibian & Untaru, 2023). Augmented Reality (AR) and virtual reality (VR) technologies create immersive experiences by simulating virtual scenes or overlaying virtual information onto real-world environments, enabling visitors to “re-experience” historical events or “visit” inaccessible heritage sites, thereby enhancing their perception and

understanding of cultural heritage (Guo, Lu, Shen, Huang, Yi, & Zhang, 2024). Mobile applications integrate navigation, information retrieval, and cultural interpretation functions, providing visitors with personalized and convenient services (Genctürk, 2024). Electronic touchscreens and audio guides, as traditional digital tools, play a crucial role in providing on-site information and diverse interpretations (Piccoli, 2020). However, the application of technology also comes with challenges, such as high initial investment and maintenance costs, the digital divide (some tourists may be unfamiliar with or unable to use these technologies), and the need to balance entertainment and education in content design.

2.3 The relationship between interactive interpretation tools and sustainable development

Existing research shows that interactive interpretation tools can promote the sustainable development of cultural heritage tourism in a variety of ways. In terms of socio-cultural sustainability, these tools can enhance tourists' cultural awareness and emotional resonance through in-depth interpretation of cultural connotations, thereby promoting cultural inheritance and dissemination (Sonuç, N. 2023). In terms of ecological sustainability, interactive interpretation tools reduce the use of paper materials and physical signage, thereby reducing environmental pollution and resource consumption (Rane, Choudhary, & Rane, 2023). In terms of economic sustainability, improved visitor experience and satisfaction can increase repeat visits and word-of-mouth recommendations, thereby driving growth in tourism revenue (Samaddar & Mondal, 2024). However, current research still has limitations. Most studies focus on the application effects of a single tool or the improvement of visitor experience, lacking a systematic analysis of the impact of multiple interactive interpretation tools on the sustainable development of cultural heritage tourism.

There is a lack of empirical research on how interactive interpretation tools can balance cultural heritage, environmental protection, and economic benefits in cultural heritage sites. This study fills this gap by using the Jinggangshan Scenic Area as a case study to explore the role of interactive interpretation tools in promoting sustainable development.

3.Research Methodology

This study uses field research methods, taking the Jinggangshan Scenic Area as its research object, and through systematic on-site observation, recording, and analysis, obtains first-hand information on the application of interactive interpretation tools and their impact on sustainable development.

The inspection was scheduled for the 2024 tourist season (July-August), covering both weekdays and weekends, to comprehensively reflect the application of the tools at different times. The scope of the inspection included four cultural scenic spots in the Jinggangshan Scenic Area: the Ciping Scenic Spot, the Maoping Scenic Spot, the Huangyangjie Scenic Spot, and the Longshi Scenic Spot. These areas are typical representatives of the concentrated deployment of interactive interpretation tools and outstanding cultural heritage value.

The inspection mainly covered three aspects: first, the basic information of interactive interpretation tools, such as the distribution, quantity, functional settings, and technical status of various types of tools (augmented reality, virtual reality, mobile applications, electronic touchscreens, and audio guides).

The second is tourists' usage behavior, including the frequency of use of different tools, duration of use, operational proficiency, feedback performance (such as expressions, communication content), etc. The third is the impact of the application of interactive interpretation tools on the sustainable development of scenic spots, such as the reduction in the use of paper materials, changes in passenger flow distribution, and cultural communication effects (such as the length of time tourists stay to learn).

During the investigation, the researchers collected data by recording on-site, taking photos, and shooting videos, and also sorted and analyzed public information such as scenic spot announcements and tourist instructions. By summarizing and refining the investigation data, the application characteristics of interactive interpretation tools and their specific impact on sustainable development were summarized.

4.Analysis

4.1 Overview of Jinggangshan scenic area

Jinggangshan Scenic Area is located in Jinggangshan City, Ji'an City, Jiangxi Province in Figure 1. It is one of the important birthplaces of the Chinese revolution and also one of the first batch of national key scenic spots and classic red tourism scenic areas (Yin, Li, & Yang, 2025). As of 2023 statistics, the total area of Jinggang Mountain Scenic Area is 261.43 square kilometres. There are more than 100 well-preserved old revolutionary sites in Jinggang Mountain, of which 26 are listed as national key cultural relics protection units, 6 are listed as provincial key cultural relics protection units, and 35 are listed as municipal civilization protection units, which is regarded as "the cradle of the Chinese revolution" and "the foundation stone of the People's Republic of China." Jinggangshan is a unique mountainous scenic spot that combines revolutionary relics, natural scenery, and idyllic views, featuring rich humanistic landscapes and beautiful natural scenery (Tan, Jia, Kang, Peng, & Zhang, 2020). The Jinggangshan Scenic Area is divided into four cultural scenic spots and seven natural scenic spots, comprising a total of 11 scenic spots. The scope of this study is cultural heritage tourism, so the four cultural scenic spots in Jinggangshan Scenic Area are selected, distributed as Tsiping Scenic Spot, Maoping Scenic Spot, Huangyangjie Scenic Spot, and Longshi Scenic Spot.

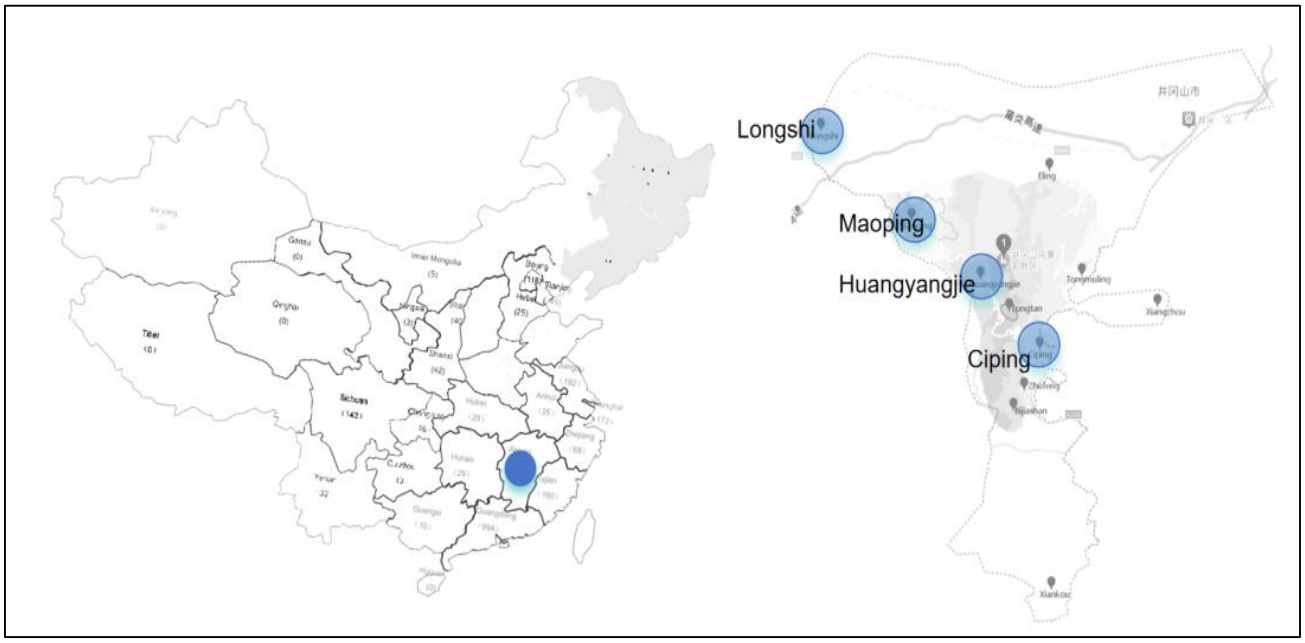

Fig.1. Floor map of Jinggang Scenic Area
(**Source:** https://www.jgsgmbwg.com/, 2025 year)

4.2 The application of interactive interpretation tools in jinggangshan scenic area

Interactive interpretation tools increase the degree of user participation and personalisation of the experience through technological means, mainly including new technologies such as AR, VR, APP, audio guides, and WeChat public numbers. The following discusses the application situation of interactive interpreting tools in the selection of study area.

a) Ciping scenic spots

In recent years, Ciping Scenic Spot has achieved significant results in the field of interactive interpretation tools. Through a series of innovative projects in table 1 such as VR Red Experience Hall, VR Panoramic Online Exhibition Hall, and Interactive Story Exploration APP, it has greatly enhanced the visiting experience of tourists and enabled the wider and deeper dissemination of red culture.

Table 2. Interactive interpretation tools in ciping scenic spots

Interactive Interpretation Tools	Locations	Function
VR Red Experience Museum	2020, Training building of the Red Culture Training Centre	Step into history, touch history
"Catching Fire" 720°VR panoramic online exhibition hall	2021, Jinggangshan Revolutionary Museum	Full Element Presentation of Museum Internal Exhibitions
Immersive Night Tour Programme	2022, Ciping Tianjie	AR and VR immersive performing arts, audio-visual multimedia experience
Cloud Travel Exhibition	2022, The 13th Rhododendron Festival	Online display of cultural tourism, green ecology, and local customs
"A Tribute to the Passing of the Salary" AR Interactive Storytelling Exploration App	2022, Jinggangshan Revolutionary Museum	Explore museums based on storylines on mobile applications to enhance engagement and interactivity.
Metaverse • Jinggang Project	2022, Rhododendron Square, Ciping Town	"Meta-universe + Cultural tourism "new business format, immersive experience
AR smart glasses guide service	2023, Jinggangshan Revolutionary Museum	Automatic identification of cultural relics, intelligent guide interpretation, immersive tour experience
Audio guide	Ciping Scenic Spot	Tourists can stay informed about relevant information about the attractions at any time.
Electronic touch screens	Jinggangshan Revolution Museum	Tourists can access detailed information about scenic spots.
WeChat official account	Jinggangshan Revolution Museum	Tourists can get detailed information about the Jinggangshan Revolutionary Museum

Source: Author, 2024

In 2018, the VR Red Experience Hall in the training building of Jinggangshan Red Culture Training Centre was built with an investment of 8 million yuan by Jiangxi Junheruiwen Creative Technology Co., Ltd (Ji'an Daily, 2018). In 2020, it was publicly put into use. By utilizing VR technology, students can step into and touch history, thus gaining a deeper understanding and experience of revolutionary history. This experience greatly enhances students' understanding and perception of history (Jinggangshan Municipal People's Government, 2020).

In 2021, the Jinggangshan Revolution Museum launched the "Spark Ignites the Prairie" 720 ° VR panoramic online exhibition hall, breaking the limitations of time and space. Through online platforms, tourists can browse the internal exhibitions of museums in all aspects and enjoy convenient and intuitive learning experiences. This measure not only improves the service level of the museum, but also provides rich red education resources for tourists who cannot attend in person (Jinggangshan Municipal People's Government, 2021).

In 2022, an immersive night tour project was launched in Ciping Tianjie, Jinggangshan, using AR and VR technologies and integrating multiple new media technologies in Figure 2. Through sculpture and stage performances, we have created a new night tour experience that focuses on immersive performance and is supplemented by sound, light, and multimedia. This digital means showcases the red culture of Jinggangshan, integrating the spirit of Jinggangshan with new exhibition methods for output (Lin & Shen, 2022). In 2022, the 13th Jinggangshan Rhododendron Festival moved its exhibition online for the first time. Through the form of "cloud travel", the cultural tourism, green ecology, and local customs of Jinggangshan were showcased. This form of online exhibition and virtual tourism breaks the limitations of time and space, allowing more people to experience the natural beauty and red culture of Jinggangshan (Lu, 2022). In 2022, the Jinggangshan Revolution Museum developed an AR interactive story exploration APP called "Salute to the

Passing of the Torch". Tourists can download and install it on their personal mobile devices and tour the museum according to the storyline. This APP not only enhances audience participation and interactivity, but also allows viewers to gain a deeper understanding of the story of the revolutionary struggle in Jinggangshan while completing tasks (Jinggangshan Revolution Museum, 2022). In 2022, the Metaverse Jinggang project located at Dujuan Square in Ciping Town officially opened. This project has gained popularity among many young tourists through the new format and gameplay of "metaverse + cultural tourism". By creating offline spaces and operating online platforms, we have fully integrated the entire industry chain of red culture tourism, bringing tourists a brand new immersive experience (Ji'an Municipal Government, 2022).

Fig.2. Interactive interpretation tools of Jinggangshan Scenic Area
Source: Author, 2024

In 2023, the Jinggangshan Revolution Museum collaborated with Jiangxi Scenic Duhao Communication Operation Co., Ltd. to launch an AR smart glasses guided tour service. This service utilizes augmented reality technology and high-precision modelling of cultural relics, enabling tourists to automatically recognize cultural relics and obtain intelligent guidance and interpretation when wearing AR smart glasses, achieving the integration of "digital +technology +cultural and museum", making tourists feel like they are traveling through time and space to have a dialogue with history (Jinggangshan Revolution Museum, 2023).

As one of the important channels for modern people to obtain information, WeChat official account also plays an important role in Ciping Scenic Spot. By following the WeChat official account of the Jinggangshan Revolutionary Museum in Ciping Scenic Spot, tourists can get detailed information about the Jinggangshan Revolutionary Museum, such as scenic spot introduction, scenic spot distribution, and tour route suggestions. This form of commentary tool can update content at any time, maintain the freshness and accuracy of information, and facilitate users to view it anytime and anywhere.

There are multiple rental points within the Ciping Scenic Spot, where tourists can rent professional audio guide equipment. The device contains rich interpretation content, covering various scenic spots and historical and cultural backgrounds of the scenic area. By listening through headphones, tourists can stay informed about relevant information about the attractions at any time during their visit, enhancing the fun and educational value of the tour.

In the Jinggangshan Revolution Museum, tourists can access detailed information about scenic spots, historical backgrounds, and character introductions through electronic touch screens. They can also perform multi touch operations to browse high-definition images and video materials. This explanation method not only contains a large amount of information, but also has a good interactive experience, suitable for tourists of all ages to use (Jinggangshan Revolution Museum, 2023).

The application of interactive interpretation tools in Ciping Scenic Area Spot is rich and diverse, combining traditional teaching with modern technology, constantly innovating and optimizing, aiming to provide more vivid and profound red education experiences for tourists. These explanatory tools not only showcase the charm of the revolutionary history of Jinggangshan, but also inherit and carry forward the great spirit of Jinggangshan.

b) Maoping Scenic Spot

With the continuous development of new technology, the interactive interpretation tools of Maoping Scenic Spot are becoming more and more abundant. It mainly has touch screen information query system, intelligent voice interpreter, digital display platform, WeChat public number in Table 2.

Table 3. Interactive interpretation tools in maoping scenic spots

Interactive Interpretation Tools	Locations	Function
Electrical touch screen	Octagonal Tower, Mao Zedong's former residence, etc	Access to detailed information via touch screen
Intelligent voice interpreter	2016, Octagonal Tower, Mao Zedong's former residence, etc	Auto-trigger Interpretation Service
Digital display platform	Maoping Scenic Spots	changes the traditional static exhibition mode, like AR, VR
Smart tourism service platform	Maoping Scenic Spots	One Mobile Tour of Jinggangshan has improved functions such as voice explanation and time-sharing reservation.
WeChat public number	2020, Maoping Scenic Spots	Provide travel information and services, and make online reservations for tour guides

Source: Author, 2024

Maoping Scenic Spot has introduced a touch screen information query system, allowing tourists to have a more intuitive understanding of the revolutionary history and important events in Jinggangshan. For example, in the former residences of Mao Zedong, Zhu De, and Chen Yi, tourists can check detailed living backgrounds, living conditions, and important decisions and activities they made here through touch screens.

During the 2016 National Day holiday, the Maoping Scenic Spot widely used intelligent voice interpreter to provide personalized tour services for tourists. This type of guide automatically triggers corresponding explanation content based on the location of the tourist, without the need for manual operation, greatly improving the convenience and experience of the tourist's tour. For example, when tourists walk to the former residence of Mao Zedong, Zhu De, and Chen Yi in the Octagonal Tower, the guide will automatically play about this historical building and the revolutionary stories behind it, allowing tourists to feel as if they have travelled through time and space, experiencing those turbulent years first-hand (Xiong, 2023b).

Maoping Scenic Spot actively utilizes digital display platforms and changes the traditional static exhibition mode through new technologies such as AR and VR, allowing tourists to touch history up close in interactive participation, enhancing their experience, participation, and immersion (Hong et al., 2023b).

Maoping Scenic Spot has created a smart tourism service platform called "One Mobile Tour of Jinggangshan", which has improved functions such as voice explanation and time-sharing reservation, and enhanced the ability of online services, online marketing, and online management (Yuan, 2021).

Maoping Scenic Spot also provides tourists with rich tourism information and convenient services through Jinggangshan Tourism official WeChat public number and other online platforms. Tourists can follow the public number to keep abreast of the latest news about the scenic area, tour routes, traffic guides and other information, as well as book tickets and interpretation services online (Yuan, 2021).

Through the comprehensive application of these interpretation tools, Maoping Scenic Spot not only allows tourists to obtain a wealth of knowledge and information in the process of visiting, but also greatly enhances tourists' knowledge and understanding of the revolutionary process under the leadership of the Communist Party of China, and further transmits the red genes and promotes the spirit of patriotism.

c) Huangyangjie scenic spots

The interactive interpretation tools of Huangyangjie Scenic Spot mainly include wrap-around AR scene experience, VR Huangyangjie defence experience, audio guide, electronic touch screen, and digital Web3D modelling in Table 3. It helps tourists to better understand the culture of Huangyangjie Scenic Spot.

Table 4. Interactive interpretation tools in huangyangjie scenic spots

Interactive Interpretation Tools	Locations	Function
Wrap-around AR scene experience	2020, Former site of the Huangyangjie Defense War	To experience the battle of the Fourth Army of the Chinese Workers' and Peasants' Red Army defending Jinggangshan.
VR Huangyangjie defence experience	Former site of the Huangyangjie Defense War	Tourists can immerse themselves in real combat scenes through surround AR technology.
Audio guide	Former site of the Huangyangjie Defense War	
Electronic touch screen	Tourist Service Center of Huangyangjie Scenic Spot	These devices present information in various forms such as images, sounds, and text
Digital Web 3D modelling	Former site of the Huangyangjie Defense War	To build a specific historical scene and battle situation of the Huangyangjie Battle.

Source: Author, 2025

In 2020, the Huangyangjie Scenic Spot set up a surround AR "Huangyangjie Defence Battle" scene experience. Tourists can immerse themselves in real combat scenes through surround AR technology. The application of this new technology brings historical events back to life, greatly enhancing the sense of experience and immersion (National Development and Reform Commission, 2020).

Through VR virtual reality technology, tourists can experience the "VR Huangyangjie Defence Battle" and return to the revolutionary base of Jinggangshan 90 years ago, experiencing the battle of the Fourth Army of the Chinese Workers' and Peasants' Red Army defending Jinggangshan (VR Party Building, 2023).

Electronic touch screens are used in tourist service centres, exhibition halls, and other places in the Huangyangjie Scenic Spot to showcase the historical background, battle process, cultural relics, and other content of Huangyangjie to tourists. These devices present information in various forms such as images, sounds, and text, allowing tourists to have a more intuitive understanding of various aspects of the scenic area (Lin et al., 2020).

The online virtual Huangyangjie battlefield DIY reproduction system, using Web3D modelling technology, builds a specific historical scene and battle situation of the Huangyangjie Battle, so that tourists can get a stronger sense of presence and realism online, providing a new mode of virtual tourism and education.

The application of these technologies not only enhances the experience of tourists, but also strengthens the influence and dissemination effect of red education. By combining visual, auditory, and even tactile experiences, the explanatory tools of Huangyangjie Scenic Spot effectively convey the rich historical and cultural information of the scenic area.

d) Longshi scenic spots

The revolutionary cultural resources in Longshi Scenic Spot are relatively few and scattered (Zhu, 2024). Interactive interpretation tools in Longshi Scenic Spot have less investment funds, and fewer types of interactive interpretation tools appear, mainly VR simulation of the two armies meeting, electronic touch screen, and audio guide in Table 4.

Table 5 Interactive interpretation tools in longshi scenic spots

Interactive Interpretation Tools	Locations	Function
VR devices	Huishi Square	VR devices are used to simulate historical scenes such as the military meeting of the past.
Electronic touch screen	Longshi Scenic Spot	Including voice explanation, site introduction, and tour routes and

		so on.
Audio guide	Longshi Scenic Spot	To understand the history and cultural background of various scenic spots.

Source: Author, 2025

In key attractions such as the Huishi Square in Longshi Scenic Spot, VR devices are used to simulate historical scenes such as the military meeting of the past, allowing tourists to experience historical moment's first-hand (Hong et al., 2023b). Tourists can inquire several of information about Longshi Scenic Spot through the electronic touch screen device, including voice explanation, site introduction, and tour routes and so on. There is already an audio guide in Longshi Scenic Spot. It records the commentary of professional guides, and tourists can listen to it through headphones and other devices to understand the history and cultural background of various scenic spots (Xiong, 2023a).

5.Discussion

5.1 Types of interactive interpretation tools in Jinggangshan Scenic Area

Through observing study area, it is found that the interactive interpretation tools used in Ciping scenic spot and Maoping scenic spot are complete, including AR, VR, APP, Audio Guides, WeChat public number and Electronic touch screen. There are few types of interactive interpretation tools used in Huangyangjie scenic spot and Longshi scenic spot, mainly VR, Audio Guides and Electronic touch screen, lacking the use of AR and APP interactive interpretation tools in table 5. Although there is the integration of VR and A technology, there is still a lack of extensive application and popularization of interactive interpretation tools.

In cultural heritage tourism, the quality of interactive interpretation tools is crucial to the visitor experience and cultural heritage preservation. This section focuses on the Jinggangshan Scenic Area, analyzing four key dimensions—information quality, system quality, service quality, and interaction quality—through real-world tool examples to provide insights for optimizing the interactive interpretation system in cultural heritage tourism.

Table 6. Interactive interpretation tools of selection of study area

Name of Scenic Spot	AR	VR	APP/ WeChat public number	Audio Guides	Electronic touch screen	Other
Ciping	AR Interactive Storytelling Exploration App	VR Red Experience Museum; 720°VR panoramic online exhibition hall	AR Interactive Storytelling Exploration App; Jinggangshan Revolution Museum	Self-Service Audio Guide in Jinggangshan Revolutionary Museum; Audio Guide in the Revolutionary Site of Ciping; Audio Guide in Jinggangshan Revolutionary Museum	Jinggangshan Revolution Museum	Cloud Travel Exhibition; Immersive Night Tour Programme
Maoping		Digital display platform	Smart tourism service platform; Maoping Scenic Spot	Audio Guide in The Revolutionary Site of Maoping	Octagonal Tower, Mao Zedong's former residence, etc	
Huangyangjie	Wrap-around AR scene experience	VR Huangyangjie defence experience		Audio Guide in the former site of Dajing	Tourist Service Center of Huangyangjie Scenic Spot	Digital Web 3D modelling
Longshi		VR devices Huishi Square		Audio Guide in Longjiang Academy	Longjiang Academy	

Source: Author, 2025

Augmented reality and virtual reality equipment are mainly distributed in key scenic spots such as the site of the Huangyangjie Defense Battle and the Maoping Octagonal Building, restoring revolutionary historical

events through immersive scenes. For example, in the virtual reality experience area set up at the Huangyangjie scenic spot, visitors wearing the device can "personally experience" the battle scenes of the 1928 defense war and feel the battle process of the revolutionary martyrs. The equipment runs stably overall, but there are queues during peak tourist hours.

The official tourism application provides scenic area navigation, scenic spot explanations, red story push and other functions. Visitors can download it by scanning the code or rent a smart device on site. The application has a built-in multi-language explanation module, which supports automatically triggering the explanation content of the corresponding scenic spot according to the location of the tourist. It also includes a real-time passenger flow query function to guide tourists to visit during off-peak hours.

Electronic touch screens are widely distributed in scenic area entrances, museum exhibition halls, visitor service centers and other areas, providing information query services such as scenic area overview, cultural relics introduction, tour route planning, etc. Some touch screens also have interactive Q&A, historical knowledge test and other functions to enhance tourists' sense of participation.

Audio guides are mainly rented, and tourists can rent them at the entrance of the scenic area with their ID cards. They cover detailed explanations of all major attractions, support personalized operations such as speech speed adjustment and content jump, and are suitable for the needs of tourists of different age groups.

Jinggangshan Scenic Area has initially built a diversified interactive interpretation tool system, and various tools play a role in different scenarios.

5.2 The Multi-Dimensional impact of interactive explanation tools on sustainable development

a) Social and cultural dimension: strengthening cultural communication and identification

Interactive interpretation tools have significantly improved the depth and breadth of cultural communication. Augmented reality and virtual reality transform abstract revolutionary history into concrete sensory experience through scenario-based experience, which prolongs the tourists' stay time at scenic spots (the average stay time is found to be more than 40% longer than that of traditional interpretation scenes), helping tourists to have a deeper understanding of the connotation of red culture.

The interactive question-and-answer function of the electronic touch screen and the red story push of the application have stimulated the interest of tourists in active learning, and are especially popular among young people. During the investigation of the Revolutionary Museum, it was found that tourists who used the electronic touch screen to query the information of cultural relics read the introduction of cultural relics more carefully than tourists who only viewed the static display cabinets.

In addition, the multilingual interpretation function (such as the English version of the electronic touch screen) has expanded the scope of cultural dissemination, enabling Chinese culture to be understood and accepted by a wider range of domestic and foreign tourists, and enhancing cultural identity and influence.

b) Ecological dimension: Promoting resource conservation and environmental friendliness

The application of interactive interpretation tools has effectively reduced the consumption of paper resources. The investigation found that the distribution of traditional paper guide maps and brochures in the scenic area has been significantly reduced, and they have been replaced by information query services on electronic touch screens and applications. The scenic area’s announcement shows that since the promotion of interactive interpretation tools, the annual purchase of paper materials has dropped by about 35%, reducing paper waste and printing pollution.

At the same time, the real-time passenger flow guidance function of the application plays a positive role in optimizing the distribution of passenger flow in scenic spots. During peak hours, the electronic screen at the entrance of the core scenic spot will display the real-time passenger flow density and push diversion suggestions through the application, which to a certain extent alleviates the congestion

pressure in key areas and reduces the potential impact of tourism activities on the cultural relics and the ecological environment.

c) Economic dimension: Improving experience quality and economic benefits

Interactive interpretation tools improve the overall quality of tourists' travel experience. During the inspection, it was observed that most tourists who used augmented reality and virtual reality devices showed high satisfaction and repeated experience; the personalized services of audio guides and applications reduced tourists' complaints due to poor information acquisition. High-quality experience helps to improve the reputation of scenic spots and indirectly promotes tourists' willingness to revisit.

From an operational perspective, interactive interpretation tools have reduced reliance on manual interpretation to a certain extent and optimized human resource allocation. Although the initial equipment investment is large, in the long run, it reduces continuous expenses such as manual training and salaries, and improves the operational efficiency of scenic spots. In addition, the characteristic interactive experience has become a new attraction for scenic spots, driving the consumption growth of surrounding cultural and creative products and experience projects.

Finding

6.1 The positive role of interactive interpretation tools in sustainable development:

Field investigations have shown that interactive interpretation tools have had a multi-dimensional positive impact on the sustainable development of Jinggangshan cultural heritage tourism by innovating cultural communication methods, optimizing resource utilization, and improving experience quality.

In terms of social culture, the immersive and interactive features of interactive interpretation tools effectively solve the problems of shallow and homogeneous cultural information dissemination in traditional interpretation models, and enhance the appeal and inheritance effect of red culture.

In terms of ecology, digital information transmission replaces some paper materials, and intelligent passenger flow guidance alleviates environmental pressure, practicing the concept of green development. In terms of economy, the improved visitor satisfaction and optimized operational efficiency brought about by the experience upgrade provide support for the sustainable growth of the scenic spot's economic benefits.

Different types of interactive interpretation tools present differentiated advantages: augmented reality and virtual reality devices are effective in deepening cultural experience, and applications play a significant role in comprehensive services and passenger flow guidance. Electronic touch screens and audio guides perform well in terms of the convenience of information dissemination. The four types of tools complement each other and jointly promote the sustainable development of scenic spots.

6.2 The main problems of interactive interpretation tools

Although the application of interactive interpretation tools has achieved positive results, field investigations have also found some problems that restrict their effectiveness: First, the technical adaptability is insufficient. In some areas, the network signal is unstable, resulting in slow application loading and slow response of electronic touch screens, which affects the tourists' experience. Second, content updates lag behind. The update frequency of augmented reality/virtual reality scenes and commentary content is low, which makes it difficult to meet the novelty needs of repeat visitors. Third, service coverage is uneven.

Elderly tourists have low proficiency in operating smart devices, but the scenic spot’s auxiliary guidance services for this group are insufficient, resulting in some elderly tourists failing to effectively use interactive tools. Fourth, management coordination is insufficient.

The tourist behavior data collected by the tool has not been fully integrated into the scenic spot’s management decisions, affecting the tool’s potential value in resource allocation and service optimization.

Conclusion and Suggestion

7.1 Conclusion

Through a field investigation of Jinggangshan Scenic Area, this paper analyzes the impact of interactive interpretation tools on the sustainable development of cultural heritage tourism. The study shows that interactive interpretation tools such as augmented reality, virtual reality, mobile applications, electronic touch screens, and audio guides have played a positive role in promoting the sustainable development of Jinggangshan cultural heritage tourism in the three dimensions of social culture, ecology, and economy by innovating cultural communication forms, reducing resource consumption, and improving tourist experience.

These interactive interpretation tools have built a diversified cultural interpretation system, effectively making up for the shortcomings of traditional interpretation models and providing a new path for the living inheritance and sustainable use of cultural heritage. At the same time, the study also found that there are problems in the application of tools in terms of technical adaptability, content updating, service coverage, and management coordination, which need further optimization and improvement.

7.2 Suggestion

In view of the problems existing in the application of Jinggangshan interactive interpretation tools and in combination with the sustainable development goals, the following optimization suggestions are put forward:

First, strengthen technical support and maintenance. Optimize the network infrastructure of scenic spots, improve the quality and stability of network coverage, and ensure the smooth operation of applications, electronic touch screens and other tools. Regularly inspect and upgrade augmented reality and virtual reality equipment to reduce the impact of technical failures on tourist experience; increase the number of equipment or adopt a reservation mechanism during peak hours to alleviate queuing problems. Second, promote content innovation and updating. Establish a regular content update mechanism, combine new cultural and historical research results and changes in tourist needs, regularly update interpretation content and augmented reality and virtual reality scenes; enrich content forms, add innovative modules such as interactive games and virtual character dialogues, enhance the attractiveness and educational functions of tools; strengthen the cultural authenticity of content and ensure the accuracy of red culture dissemination.

The third is to improve the service guarantee system. For special groups such as elderly tourists, we will add operation guidance posts to provide one-on-one tool usage teaching. Simplify the device operation interface, add voice control, large font mode and other elderly-friendly designs. Optimize the multi-language support of the tool to enhance the user experience of international tourists.

Fourth, deepen the collaborative application of management. Establish a docking mechanism between interactive interpretation tool data and scenic area management system, and optimize tool layout and resource allocation by analyzing tourist usage behavior data. Use passenger flow guidance data to formulate dynamic scenic area management strategies to improve the accuracy of resource protection and tourist services. Strengthen cooperation among scenic spots, technology companies, and cultural research institutions to form a collaborative development model of "technical support + content development + management application".

8.Contribution and limitation

8.1 Contribution

The theoretical contribution of this study is that it uses cultural heritage scenic spots as cases to empirically analyze the comprehensive impact of various interactive interpretation tools on the three dimensions of sustainable development, enriching the research results in the field of cultural heritage tourism digitalization and sustainable development. The practical contribution is that through field investigations, the specific characteristics and problems of the application of interactive interpretation tools in Jinggangshan are revealed, and the optimization suggestions put forward can provide practical references for Jinggangshan and other cultural heritage scenic spots to improve the

quality of interactive interpretation services and promote sustainable development.

8.2 Limitation

This study uses the field investigation method, and the data mainly comes from on-site observation and records, which may be subjective to a certain extent; the investigation time is concentrated in the peak tourist season, and the reflection of the application of tools in the off-season is not comprehensive; no large-scale questionnaire surveys or in-depth interviews were conducted on tourists, and the exploration of tourists' inner feelings and needs was not in-depth enough. Future research can combine questionnaire surveys, interviews and other methods to expand the research period and scope, and further deepen the understanding of the impact mechanism of interactive interpretation tools.

Acknowledgment

I would like to express my sincere gratitude to my supervisor, for their continuous support, insightful guidance, and constructive feedback throughout my research journey. Their expertise and encouragement have been invaluable in shaping this dissertation. I also would like to express my deepest gratitude to my family for their unwavering love, patience, and belief in me throughout this journey. Their support has been my greatest strength.

Funding

This work was supported by Jiangxi Provincial Department of Education Science and Technology Research Project Funding (GJJ2404705).

References

Abah, R. T., & Nonyelum, O. F. (2024). Traditional and Modern Methods for Web and Media Analysis and Design: A Comparative Study. IUP Journal of Computer Sciences, 18(4), 69- 87.

Brezovec, A. (2022). Interpretation of heritage for tourists: an interactional view. In Handbook on heritage, sustainable tourism and digital media (pp. 210-227). Edward Elgar Publishing.

Cataldo, M. (2024). A RIGHT TO DESTROY? THE LEGAL BOUNDARIES OF CULTURAL MEMORY. An Examination of the Role of the International Community in the Protection of National Heritage Sites against Deliberate Destruction.

Genctürk, I. C. (2024). Development of a Location Based Interactive Mobile Web Application For Enriching Visitors' Knowledge And Experience (Doctoral dissertation, Leibniz University Hannover).

German, A. (2024). 3D artistic mapping of the urban environment for tourism information support. Polish Cartographical Review, 56.

Guo, Y., Lu, S., Shen, M., Huang, W., Yi, X., & Zhang, J. (2024). Differences in heritage tourism experience between VR and AR: a comparative experimental study based on presence and authenticity. ACM Journal on Computing and Cultural Heritage, 17(2), 1-21.

Lin, Y. Q., & Shen, Y. (2022). Immersive experience: The integration of creativity, technology, and tourism. Tourism Tribune, 37, 6–8.

Liu, Y. (2020). Evaluating visitor experience of digital interpretation and presentation technologies at cultural heritage sites: a case study of the old town, Zuoying. Built Heritage, 4(1), 14.

Lu, S. (2022, April 11). The 13th Jinggangshan Rhododendron Festival (Cloud Version) Offline Opening Ceremony in 2022 Jinggangshan. JX News. https://m.jxnews.com.cn/jxja/system/2022/04/11/019593051.shtml

Karthikeyan, G., & Aruna, P. (2025, March). User Experience Optimization in Immersive Technologies: Techniques, Challenges, and Opportunities. In 2025 International Conference on Intelligent Computing and Control Systems (ICICCS) (pp. 908-917). IEEE.

Ji'an Daily. (2018). Jinggangshan Red Culture Training Center introduces VR technology to enhance training experience [News report]. Page 3.

Ji'an Municipal Government. (2022, June 29). First metaverse in Jinggangshan—"Metaverse · Jinggang" opens on July 1. Retrieved from https://www.jian.gov.cn/news-show-

72976.html.

Jinggangshan Municipal People's Government. (2020, April 16). Construction of Jinggangshan Red Culture ARVR Experience Hall Project [News Report]. Jinggangshan Municipal People's Government Official Website.Retrieved from http://www.jgs.gov.cn/xxgk-show-10200232.html.

Jinggangshan Municipal People's Government. (2021, January 21). Jinggangshan Revolution Museum National Cultural Gene Bank Red Gene Bank Construction Project (Second Phase) Competitive Negotiation Announcement. Retrieved from http://www.jgs.gov.cn/xxgk- show-10207124.html

Jinggangshan Revolution Museum. (2022, January 25). Good News | Our Museum's AR Exploration Game and Collection AR Interactive Exhibition App "Salute to the Passing of the Torch" Launched!. Retrieved from https://m.sohu.com/a/519008304_121107011.

Jinggangshan Revolution Museum. (2023, August 4). "Immersive Tour! Experience a Different Museum". Ji'an Tourism. Retrieved from http://m.toutiao.com/group/7263485932161008147/?upstream_biz=doubao.

Rane, N., Choudhary, S., & Rane, J. (2023). Sustainable tourism development using leading-edge artificial intelligence (AI), blockchain, internet of things (IoT), augmented reality (AR) and virtual reality (VR) technologies. Blockchain, internet of things (IoT), augmented reality (AR) and virtual reality (VR) technologies (October 31, 2023).

Piccoli, A. (2020). Are digital platforms and touchscreen devices. Discourses of Care: Media Practices and Cultures, 69.

Samaddar, K., & Mondal, S. (2024). AR and VR-based travel: A responsible practice towards sustainable tourism. International Journal of Tourism Cities, 10(1), 105-128.

Sibian, A. R., & Untaru, E. N. (2023). An Overview of Interpretation in Tourism and Its Role in Sustainable Tourism Development. Journal of Smart Economic Growth, 8(2), 127-146.

Sonuç, N. (2023). Culture, Tourism, and Sustainability (Cultural Heritage and Sustainable Tourism, Social Sustainability of Tourism, Socio-cultural Sustainability of Tourism). In Encyclopedia of sustainable management (pp. 1083-1089). Cham: Springer International Publishing.

Tan, Y., Jia, J., Kang, Y., Peng, S., & Zhang, B. (2020). Architecture design of Jinggangshan virtual tourism system based on WebVR. Smart Tour, 1, 1-7.

Ye, J., Qin, Y., & Wu, H. (2024). Cultural heritage and sustainable tourism: unveiling the positive correlations and economic impacts. Current Psychology, 43(47), 36393-36415.

Yin, Chengqiang, Wenming Li, and Xingzhu Yang. "A Study of the Mechanism of Environmental Education and Awe on Tourists' Pro-Environmental Behavior." International Journal of Tourism Research 27.2 (2025): e2798.

Wang, J., Wang, G., Liu, Y., Lei, T., Sun, J., & Wang, X. (2021). Spatiotemporal distribution and network structure characteristics of red tourism flow in Jinggangshan. Journal of Natural Resources, 36(7), 1777–1791.