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Research article

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Digital Transmission of Traditional Painting in the New-Media Era: Taking "Digital Dunhuang" as an Example

Yixuan Li[1,2,*], Meirong Feng[1], Weijian Huang[2]

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Abstract: The advances in new-media technology have opened new possibilities for protecting and disseminating cultural heritage such as traditional painting. Taking Digital Dunhuang as an example, this paper summarizes its origins and digital dissemination methods through a literature review and data analysis, then focuses on audience cognition and interactive feedback under new-media dissemination and evaluates its impact on cultural communication and public art education. Results show that Digital Dunhuang, relying on a high-definition image library, social media, mini-programs and virtual-reality experiences, brings Dunhuang art to life in digital form and significantly broadens the audience and social influence. High levels of participation and positive responses on social media show that the public recognizes this mode of digital dissemination. However, technological upgrades and the accurate conveyance of cultural connotations remain challenges. To ensure the continued inheritance and innovation of traditional culture, cultural relics must be protected while technological innovation, richer interactive forms and open sharing of digital resources are continually promoted.

Keywords: New media; Traditional painting; Digital Dunhuang; Digital transmission; Cultural communication

Introduction

The rapid development of new-media technology has provided completely new ideas for protecting and disseminating traditional cultural heritage. Presenting rare art forms digitally not only overcomes temporal and geographical limitations but also allows more people to deeply understand the essence and charm of ancient painting. Since the late twentieth century the Dunhuang Academy has explored the digital acquisition and management of murals in the Mogao Caves, seeking long-term preservation paths for ancient art. As the internet and social media become more pervasive, the Digital Dunhuang project has gradually moved beyond the professional research community; through various new-media channels it targets the general public and has formed an online–offline dual-drive model for cultural-relic protection and cultural promotion.

Existing research and news reports mostly discuss the value and potential of cultural-heritage digitization from perspectives such as digital acquisition and management, virtual-reality technology and cultural-creative industries (Gansu Release, 2023; Wang, 2022; Peng, 2022). Scholars have also studied the system architecture and back-end data management of the Digital Dunhuang resource library, focusing on fast browsing of high-resolution images, database optimization and scalability (Yu et al., 2020). However, these studies mainly focus on technical implementation or protection of the relics themselves; systematic evaluation of user cognition, interactive experience and social dissemination effects in the new-media environment is still lacking. There is still room to explore the "breaking-the-circle" transmission of digital culture and its impact on public art education. Therefore, this study extends the perspective to audience participation and feedback on new-media platforms, aiming to explore how Digital Dunhuang seeks a balance between technological innovation and deep cultural inheritance and to evaluate, through empirical analysis, the effectiveness and challenges of digital transmission.

Digital Dunhuang Project Overview

Origin and development

The murals and painted sculptures of the Mogao Caves in Dunhuang are treasures of Chinese traditional painting. Because of their remote location and the fragility of the relics,

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they have long faced the dual difficulty of protection and dissemination. The concept of digitizing Dunhuang culture was first proposed in the late 1980s, and over the following decades digital preservation achieved significant progress and many results. By the end of 2021 the Digital Dunhuang Project had completed digital capture of 268 caves, image processing of 164 caves and three-dimensional reconstruction of forty-five colored sculptures, 146 caves and seven large sites; a specialized technical team of more than one hundred people participated (Xinhua, 2022). After years of exploration the project has gradually developed and improved. Researchers use high-definition photography and 3-D scanning to acquire and archive murals and sculptures of the Mogao Caves, creating a vast digital repository. With the rise of the internet the project expanded from data preservation to dissemination directed at the public. In 2016 the Dunhuang Academy officially launched the Digital Dunhuang resource-library website. The first batch of high-definition digital images of classic caves was opened to the world, marking the first time that high-precision digital images and panoramic tours of thirty caves were freely shared globally and visited more than seven million times from over ten countries (Yu et al., 2020). This marked a new stage: the project now serves not only academic research but also provides cultural sharing for society at large. Its development is inseparable from support from various sectors. At the end of 2017 the Dunhuang Academy and Tencent launched the "Digital Silk Road" initiative, bringing the technological and platform advantages of internet enterprises into the cultural-heritage field. Integration into this new cultural-and-creative ecology has spawned a series of innovative sub-projects. For example, the Digital Sponsors public-interest project launched in 2018 borrows the concept of ancient benefactors; netizens donate only 0.9 yuan to participate in digital preservation of the Mogao Caves (Peng, 2022). These explorations provide continuous momentum for the project. National policies supporting the digitization of cultural heritage also offer a favorable external environment. By the end of 2022 the project had completed digital capture and high-precision image processing of hundreds of caves and three-dimensional reconstruction of some sculptures and caves (CGTN, 2023). In April 2023 the Digital Library Cave officially went online, an immersive online museum that uses digital scanning and 3-D modeling to faithfully reproduce the library cave (Gansu Release, 2023). After decades of practice, Digital Dunhuang has evolved from digital preservation to digital dissemination and radiates new vitality in the new era.

Digital dissemination methods

With the development of new-media technology, the Digital Dunhuang project continually innovates its dissemination methods and has built a comprehensive, multi-channel digital dissemination system.

Online sharing of high-definition resources. Through the project's official website and related digital platforms, the public can freely browse high-definition mural images and panoramic tours of the grottoes. Dozens of classic caves have achieved full-cave high-definition imaging and three-dimensional panorama sharing worldwide (Gansu Release, 2023). Users need only a computer or mobile device to appreciate the details of thousand-year-old murals as if on site. This online virtual tour breaks geographical and temporal limits and brings traditional art into daily life.

Social media platforms. Social media has become an important dissemination battleground. Since establishing its New-Media Centre in 2018, the Dunhuang Academy has actively operated WeChat public accounts, Weibo, Douyin and other platform accounts, regularly releasing rich digital content. Popular-science articles such as the Dunhuang Seasons and Festivals series use traditional festivals as entry points to introduce the cultural meanings of Dunhuang art, enhancing public understanding (Peng, 2022). On short-video platforms the academy created the virtual figure "Dunhuang Fairy – Jiayao" and in 2022 launched the animated series Dunhuang Fairy and Her Friends. Jiayao's image is based on the kalavińka in Dunhuang murals; combining it with modern cartoon style shortens the distance to young viewers. The series tells stories about Dunhuang culture and relic protection and, after release on Weibo, Bilibili, Douyin and other platforms, received widespread praise and became a new media vehicle for disseminating Dunhuang culture (Wang, 2022). Topics and short videos on the academy's official Weibo and Douyin accounts repeatedly topped trending lists, letting the sleeping caves "fly out of the Gobi" and enter the online public sphere.

Mobile applications and mini-programs. Mobile apps and mini-programs expand interactive dissemination. In 2020 the Dunhuang Academy and Tencent jointly launched the Cloud Tour Dunhuang WeChat mini-program. Users can select caves for panoramic roaming on their phones and click mural details to obtain explanations, realizing "cloud tourism." Within ten days of launch total visits exceeded five million—far exceeding the annual on-site visitor numbers of the Mogao Caves (Yangguang Net, 2021). This digital product enables more people to conveniently experience the beauty of Dunhuang art. In subsequent operation the mini-program continuously enriches its content, adding routes with different themes, quizzes and other features that greatly increase user stickiness. Statistics show that from its launch in 2020 to the end of 2022 the mini-program recorded over sixty million visits and more than two hundred million interactive participations (Liu, 2022). This phenomenon-level dissemination product has significantly broadened the audience for Dunhuang culture.

Immersive and interactive experiences. Immersive experiences such as virtual reality (VR) have also opened new dissemination space for the project. The Dunhuang Academy cooperated with technology companies to launch the "Exploring Dunhuang — Digital Dunhuang Immersive Exhibition," creating an online–offline interactive experience centered on Cave 285 of the Mogao Caves. Online, viewers can obtain knowledge through role playing; offline, wearing VR headsets they can freely "fly" through the cave and even immerse themselves in mural plots. Reports show that since its launch in 2023 this VR immersive exhibition has become a "hit"

project at the Mogao Caves scenic area and is particularly popular with young people (Gansu Release, 2023). This indicates that digital technology is bringing traditional cultural dissemination into a new stage of integration between the virtual and the real. The project also uses augmented-reality and holographic projection technologies in offline exhibitions to display mural art, providing audiences with rich new-media interactive experiences.

By fully utilizing digital imaging, social media, mobile internet and immersive technologies, the Digital Dunhuang project realizes panoramic dissemination of traditional painting from physical to virtual spaces. Supported by a new-media matrix, Dunhuang art crosses time and space to approach the public, and cultural heritage bursts forth with new vitality in digital form.

Audience Participation in New-Media Dissemination

Audience cognition and acceptance

Dissemination of the Digital Dunhuang project on new-media platforms has greatly enhanced public awareness of Dunhuang art. In the past, because of geographical limitations, many people's impressions of the Mogao Caves remained in books or documentaries, lacking direct insight. Through the project's online resources and interactive content, audiences thousands of kilometers away can view exquisite murals at zero distance, deepening their understanding of the value of Dunhuang culture. Many netizens, after viewing high-definition digital murals, say they "feel as if standing in the cave" and marvel at the detail and color of ancient painting. Digital Dunhuang has allowed what was originally niche grotto art to "fly into ordinary homes"; the public's perception has shifted from unfamiliarity to familiarity and affection. In terms of acceptance, the project's digital dissemination has generally won widespread praise and positive feedback. User surveys and online comments show that many audiences believe the digital content makes up for the regret of not being able to visit on site and allows them to access sophisticated traditional art more easily. Media such as Yicai note that the academy's new-media creative projects frequently generate hot discussions and become "creative hits" in the cultural-heritage field (Peng, 2022), reflecting the public's acceptance and pursuit of this innovative dissemination form. Young audiences, in particular, show strong interest in digital content that blends animation and game elements. For example, the short-video series featuring the virtual IP figure Jiayao has accumulated over ten million views; since the series Dunhuang Fairy and Her Friends began releasing on Weibo, Bilibili, Douyin and Kuaishou on 1 January 2022 it has received high recognition from all sectors of society and is especially loved by teenagers, with the hashtag #Dunhuang Fairy and Her Friends# on Weibo garnering five million reads (Wang, 2022). This phenomenon shows that through cartoon imagery and narrative expression, traditional mural art successfully "wins fans" among young audiences and enhances their affinity for and acceptance of Dunhuang culture.

From an emotional perspective, the project evokes public pride and resonance with traditional culture. Many netizens leave messages praising Dunhuang art and calling the project "digital guardianship of national treasures," seeing it as a pioneering effort to bring Chinese cultural heritage to the world. Some netizens who participate in the Digital Sponsors project are proud of being "digital sponsors," gaining a sense of cultural identity while supporting relic digitization. Audiences' positive attitudes are also evident in the plethora of spontaneous secondary creations. Designers and comic enthusiasts use open digital materials to create derivatives covering fashion, games and other fields and disseminate them widely on social platforms. This indicates that audiences not only passively accept digital content but also actively participate in the re-creation and dissemination of Dunhuang culture, demonstrating strong recognition and enthusiasm. Overall, in the new-media era Digital Dunhuang has built a solid audience base and reputation. The public has moved from curious spectators to active participants spreading Dunhuang aesthetics, showing that digital transmission of traditional painting has been accepted by society. The project has cultivated new audience groups and achieved an effective connection between traditional art and contemporary audiences.

Interactive dissemination mode and feedback analysis

In the new-media environment, dissemination is no longer a one-way release of information; it emphasizes audience interaction. Digital Dunhuang makes full use of interactive dissemination modes to mobilize audience enthusiasm, realizing a virtuous cycle between disseminators and audiences. Based on actual data, we analyze dissemination performance and audience feedback on social media.

Coverage. Across major platforms the project has achieved remarkable coverage. Taking the Cloud Tour Dunhuang mini-program as an example, by the end of 2022 it had recorded more than sixty million visits and over two hundred million interactive participations (Liu, 2022). Such huge user engagement far exceeds the annual offline visitor numbers to the Mogao Caves, showing that digital dissemination enormously expands the audience. On Weibo, topics released by the academy also attract massive attention. A special article by the National Cultural Heritage Administration notes that the series of creative projects has made the academy "go viral," bringing Dunhuang culture into thousands of households (National Cultural Heritage Administration, 2021). From a macro perspective, Dunhuang-related digital content produces "break-the-circle" dissemination effects in mainstream media. In 2021 the city of Dunhuang launched the topic #How Beautiful Is Dunhuang# on platforms such as Weibo and Douyin, accumulating nearly 4.5 billion reads (Dunhuang Release, 2021). Although this figure includes promotion of the city's overall image, it also confirms the enormous influence of Dunhuang-related content on new media.

Interaction depth. Audience feedback on Digital Dunhuang content is enthusiastic, forming a highly interactive dissemination ecology. User interaction mainly involves likes, comments, shares and participation in activities. On Douyin, short

videos about Dunhuang frequently become "hits." For example, a video of Dunhuang middle-school students doing a Dunhuang-style dance during a break went viral, with cumulative views exceeding two hundred million across accounts, more than 2.57 million likes and over 110 000 comments (Dunhuang Release, 2021). Many users leave comments such as "So beautiful" and "I want to learn this dance," showing strong willingness to participate. Likewise, after the series Dunhuang Fairy and Her Friends was released, the related topic reached five million reads, and many viewers left bullet messages and comments to interact with the creators, ask questions or express affection (Wang, 2022). In the Cloud Tour Dunhuang mini-program, users not only browse but also actively participate in quizzes, like their favorite murals and engage with other interactive functions; during the first three weeks after launch the mini-program collected hundreds of thousands of likes and comments (data from the project's operation report). These interaction data show that audiences are not passive but deeply involved in the dissemination process, forming a positive two-way dialogue.

Analyzing audience feedback helps clarify the dissemination effect of Digital Dunhuang. Overall, positive feedback accounts for an absolute majority. Many audiences express gratitude, saying the project "lets us see national treasures we couldn't see" and praising digital technology. In quiz interactions many users show interest in Dunhuang cultural knowledge, eagerly answering questions and sharing the digital certificates they obtain, which strengthens a sense of achievement and stickiness. From the questions raised, audiences care not only about the mural images themselves but also about the historical stories and cultural meanings behind them. This suggests that the project's dissemination has stimulated audiences' desire to explore deeper content. Some feedback also offers suggestions for improvement: people hope for more caves to be digitized, higher image clarity or an English version for overseas users. These suggestions provide valuable user perspectives for optimizing the project. The above data analysis shows that Digital Dunhuang achieves both broad coverage and deep interaction in new-media dissemination. On the one hand, huge viewing and topic-reading figures demonstrate strong dissemination power; on the other hand, high numbers of likes, comments and user-generated creations show audience enthusiasm and stickiness. Positive feedback is reflected not only in growth of digital metrics but also in enhanced cultural cognition and emotional resonance. In sum, the interactive dissemination mode explored by Digital Dunhuang effectively promotes the living transmission of traditional culture in the network age.

Impact and Challenges of the "Digital Dunhuang" Project

Promotion of cultural dissemination and public art education

The successful practice of Digital Dunhuang has significantly promoted cultural dissemination and public art education.

Cultural dissemination. The project has pioneered new ways to "make traditional cultural heritage come alive and go out." With the aid of digital technology, Dunhuang art—once sealed in the northwest desert—has reached both national and global audiences. Tens of millions of netizens have appreciated the murals through online channels, and many of them previously knew little about Dunhuang art. In effect, Digital Dunhuang converts potential audiences into real ones, greatly improving social awareness and influence. As the Dunhuang Academy's secretary Zhao Shengliang said, they hope that through Digital Dunhuang more people can feel the charm of Dunhuang, appreciate the outstanding achievements of Chinese traditional culture, improve artistic appreciation, strengthen cultural confidence and, under new historical conditions, promote exchanges between different cultures along the Belt and Road (Xinhua, 2022). This shows that the project plays a positive role in disseminating excellent traditional culture and enhancing national cultural identity.

Public art education. The project also has important value in public art education. First, it provides high-quality aesthetic resources. Previously, only those who visited the Mogao Caves could directly experience the murals; now students, art enthusiasts and even ordinary netizens can conveniently view and study the composition, colors and techniques of classic murals through Digital Dunhuang. This greatly benefits the improvement of artistic appreciation and aesthetic literacy. Many art teachers integrate the project's resources into classroom teaching, using high-definition images to explain the essence of Chinese ancient painting and stimulate students' interest in traditional art. Some parents report that after watching Dunhuang animations and playing interactive games, children develop strong interest in history and art and proactively ask to learn Dunhuang stories. This indicates that the project not only disseminates culture but also, imperceptibly, conducts public art education. The project also spurs the creativity and participation of younger generations. The launch of an open material library allows creators worldwide to obtain Dunhuang elements for secondary creation, turning cultural resources into creative products. Many children participate by copying digital murals or making related handicrafts, cultivating their closeness to traditional culture and hands-on abilities.

Educational demonstration and tourism integration. The project provides a model for cultural-heritage education. In recent years the Dunhuang Academy has held various "Dunhuang Art Exhibitions" and "Digital Dunhuang Exhibitions" in more than twenty provinces in China and in countries such as the United States, France, Italy, Israel and Turkey. Examples include the "Silk Road Pearl·Digital Eternity" exhibition in Tel Aviv and the "Dunhuang Is No Longer Distant – Approaching Morocco" digital Dunhuang exhibition in Rabat; these combine online and offline approaches to spread Dunhuang culture and tell Chinese stories (Qiu et al., 2024). Other heritage sites such as the Yungang Grottoes have learnt from Dunhuang's experience to speed up digital display and dissemination and develop digital products popular with young people (Xinhua, 2022). Thus, Digital Dunhuang plays a nationwide leading role in education promotion. Notably, the project

also promotes the integration of culture and tourism. By warming up audiences and spreading knowledge online, it attracts more people to visit the Mogao Caves in person. Some visitors first study the cultural background online and then enjoy a richer experience when they go on site. This model of "cloud guide + on-site tour" improves the depth and quality of cultural tourism (Gansu Release, 2023). In summary, Digital Dunhuang significantly expands the depth and breadth of traditional art dissemination and achieves notable results in promoting Chinese culture and popularizing aesthetic education.

Challenges of digital dissemination and directions for improvement

Despite remarkable achievements, Digital Dunhuang faces many challenges in digital dissemination and needs continuous improvement.

Technological challenges. Digital technologies update quickly; how to continuously adopt the latest technologies to present Dunhuang art is a major issue. High-definition imaging and VR/AR technologies enhance the user experience but require substantial financial input and professional personnel for maintenance and upgrades. When technology standards advance, early digital images may lack sufficient resolution and need to be re-captured or algorithmically enhanced. Massive high-definition images and model data also require secure storage media and backup strategies to prevent data loss or damage. In addition, cross-platform compatibility and smooth access must be ensured so that users can easily obtain digital content. These technical issues necessitate establishing continuous technical support and iterative mechanisms to maintain dissemination quality and stability (Gansu Release, 2023).

Accurate transmission of cultural connotations. Dunhuang murals contain profound historical and religious meanings, and conveying these accurately through digital media is challenging. In the fragmented online environment, audiences often engage with content for entertainment and may ignore deeper cultural information. For example, when watching an animated short video, viewers may focus on interesting plots and overlook the Buddhist stories behind them. Content planners must balance being interesting and accessible with preserving the cultural essence. Because audiences have different knowledge backgrounds, the project needs to provide layered information—both popular introductions and detailed materials for enthusiasts—to meet diverse needs. It is also necessary to avoid excessive entertainment or commercialization that disrespects cultural heritage; some netizens worry that carbonizing solemn Buddhist art might reduce its sacredness. These factors remind the project team to respect the original appearance and meaning and maintain aesthetic quality and educational value while innovating expression.

Interaction management and intellectual property. Interaction management and intellectual property are also important challenges. The project encourages public interaction and secondary creation, but this brings problems in managing interactive content and copyrights. Large numbers of user comments and creations need moderation to prevent inappropriate speech or misinformation. Open material libraries provide shared resources but also risk misuse. The Dunhuang Academy has explored using blockchain technology to record the authorization and transactions of digital materials. Future work still needs to further improve digital copyright-protection mechanisms and strike a balance between encouraging creation and preventing abuse; this exploration has reference value for other cultural digitization projects (Gansu Release, 2023).

Improvement directions. To address these challenges, several improvements are proposed. First, establish a long-term and stable industry–academia–research cooperation mechanism to bring together scientific and cultural-heritage forces to tackle technical problems in digital capture and presentation, ensuring that Digital Dunhuang remains at the technological frontier (Gansu Release, 2023). Second, strengthen cross-disciplinary collaboration in content production: archaeological and art experts should ensure cultural accuracy, while new-media operators innovate expressive forms to enhance content quality. For some important mural stories, graded reading modes can provide multi-level content from introductory to in-depth to meet diverse audiences (Gansu Release, 2023). Third, enrich interaction forms to enhance user retention. Introduce gamified mechanisms, such as online games and quizzes themed on Dunhuang culture, to deepen memory through fun; establish mechanisms to collect and respond to user feedback, regularly analyzing audience data and suggestions to optimism the product experience (Gansu Release, 2023). Fourth, while deepening openness and sharing, expand partnerships. Beyond existing internet companies, cooperate with educational institutions and the creative industry to apply Dunhuang digital content to art teaching and cultural-creative design, thereby expanding influence. On the premise of copyright protection, encourage diverse secondary creations to empower the modern transformation of traditional culture (Gansu Release, 2023). Finally, pay attention to coordination between digital dissemination and physical protection. Digitization should not replace the value of real relics but should feed back into protection. Diverting visitors and planning more scientific visitation schemes through digital means can reduce pressure on the caves. Such positive interaction will realize mutual reinforcement between "digital inheritance" and "physical protection." In essence, facing the opportunities and challenges of the new-media era, Digital Dunhuang needs to innovate while adhering to its cultural roots and continuously adjust its dissemination strategies. Only through continuous improvement can this treasure of traditional painting shine with lasting vitality in the digital era.

Conclusion

Digital Dunhuang is a pioneer and a typical case of digitally transmitting traditional painting. This study draws several conclusions. First, digital technology provides unprecedented possibilities for protecting and disseminating traditional cultural heritage. By using high-definition imaging, virtual reality and internet platforms, the project overcomes

time and space constraints, brings the Dunhuang art long hidden in the mountains into public view and broadens the dimension of cultural dissemination. Second, interactive communication under the new-media environment effectively enhances dissemination effects. Through social-media operations and audience participation, the project has shifted from "one-to-many" broadcasting to "many-to-many" interaction, greatly increasing audience participation and identification. Massive online visits and counts of likes and comments fully prove that the public highly appreciates this digital transmission method. Third, the project has achieved remarkable results in promoting public aesthetic education and spreading traditional culture. It has attracted numerous young people interested in Dunhuang art and set a benchmark for digitalization of other cultural heritage. Nevertheless, digital transmission is not without obstacles: technical updates, content regulation and copyright management remain challenges. Therefore, the project team must continue to innovate and manage prudently to balance dissemination breadth and cultural depth. Future work suggests that Digital Dunhuang should continue to deepen cooperation with the technology and education sectors, develop richer digital products—such as immersive interactive games and AI narration assistants—to attract new generations and strengthen international dissemination so that Dunhuang digital resources serve global art-history research and cross-cultural communication. Under the premise of ensuring the safety of relics, more high-resolution materials should be appropriately opened to encourage co-creation and form a vivid atmosphere in which everyone participates in cultural transmission. Overall, the path of digitally transmitting traditional painting in the new-media era has broad prospects. The experience accumulated by Digital Dunhuang will provide valuable references for similar projects. We have every reason to believe that, with the wings of digital technology, Dunhuang art and the treasures of Chinese culture will remain fresh for a long time and be passed down through generations.

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References

1. Xinhua. (2022, August 2). Ancient Dunhuang gets digital doubles. Retrieved February 2, 2025, from https://english.www.gov.cn/news/topnews/202208/02/content_WS62e87bb0c6d02e533532ec70.html
2. Yu, T., Wu, J., Zhao, L., & others. (2020). Design and implementation of the "Digital Dunhuang" resource-library architecture [In Chinese]. Dunhuang Research, (2), 120–130. https://global.chinadaily.com.cn/a/202309/08/WS64fa9705a310d2dce4bb4b3b.html
3. CGTN. (2023, September 8). Push to go digital continues to pay off in Dunhuang. Retrieved February 3, 2025, from https://global.chinadaily.com.cn/a/202309/08/WS64fa9705a310d2dce4bb4b3b.html
4. Gansu Release. (2023, September 8). Dunhuang: Digital empowerment throughout the process [In Chinese]. Retrieved February 3, 2025, from https://finance.sina.com.cn/wm/2024-11-12/doc-incvvkfz9327819.shtml
5. Yangguang Net. (2021, February 4). The thousand-year lamp-lighting ceremony of the Mogao Caves appears online for the first time: Tencent and the Dunhuang Academy digitise "New Year greetings" [In Chinese]. Retrieved February 3, 2025, from https://baijiahao.baidu.com/s?id=1690765617434404251
6. Liu, S. (2022, December 9). Dunhuang Academy partners with Tencent: The world's first digital cultural-heritage "on-chain" project opens 6 500 materials for download [In Chinese]. Retrieved February 7, 2025, from https://gansu.gscn.com.cn/system/2022/12/09/012870188.shtml
7. National Cultural Heritage Administration. (2021, November 1). Innovative dissemination methods let Dunhuang culture enter thousands of households [In Chinese]. Retrieved January 9, 2025, from https://1911museum.org.cn/all/article.html?id=955
8. Wang, F. (2022, June 11). The Dunhuang Academy wins the 2022 China Cultural Relics full-media communication excellence (new media) project [In Chinese]. Retrieved February 18, 2025, from https://www.dha.ac.cn/info/1018/3453.html
9. Peng, J. (2022, August 19). Cloud Tour Dunhuang and digital sponsors: Bringing the beauty of Dunhuang to life and out into the world [In Chinese]. Retrieved March 1, 2025, from https://www.yicai.com/news/101511063.html
10. Zhang, Y. (2018, July 18). Imagination unleashed! See how digital technologies bring millennium-old caves to life [In Chinese]. Retrieved January 12, 2025, from http://gs.ifeng.com/a/20180718/6736641_0.shtml
11. Qiu, X., Xie, Z., Cui, Y., & others. (2024, August 19). Millennium-old Dunhuang shows a new face [In Chinese]. Gansu Daily (issue 004). https://doi.org/10.28286/n.cnki.ngsrb.2024.003087
12. Dunhuang Release (Government). (2021, January 3). Dunhuang: Online promotion helps high-quality economic and social development [In Chinese]. Retrieved February 3, 2025, from https://m.thepaper.cn/baijiahao_1064122

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Cultural Heritage Protection and Low-Carbon Development in World Heritage Sites: Synergistic Mechanisms, Quantitative Assessment, and Practical Pathways

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Abstract: Against the backdrop of global "carbon peaking and carbon neutrality" goals and the rapid development of the digital economy, World Heritage Sites (WHSs) face the triple mission of cultural inheritance, ecological protection, and low-carbon transition. These goals are inherently synergistic, yet existing research remains limited in assessment methods, cross-case comparison, mechanism integration, and policy relevance. Based on 17 core studies, this study constructs a framework of "methodological integration–empirical validation–mechanism construction–path optimization" to examine the synergy between heritage protection and low-carbon development in WHSs. It integrates screening methods, Life Cycle Assessment (LCA), and spatial comparison models with digital economy indicators to build an ecological/carbon footprint assessment system tailored to WHSs. Using Huangshan, Taishan, Suzhou Pingjiang Road, and Gulangyu as cases, it verifies synergistic effects and identifies heterogeneous features through literature and field survey data. The study further proposes a four-dimensional synergistic mechanism of "cultural concept guidance–technical support–SME implementation–institutional guarantee" and advances optimization paths in cultural communication, technological innovation, agent cultivation, and institutional improvement. It provides both methodological support and practical reference for the sustainable development of WHSs.

Keywords: World Heritage Sites; Cultural heritage; Low-carbon transition; Synergistic mechanism; Digital economy; Ecological footprint; SMEs; Assessment framework

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Introduction

Research background

Global climate change—characterized by rising temperatures and frequent extreme weather—poses severe threats to the survival and development of WHSs. For natural heritage, accelerated glacial melting in the Himalayan WHS disrupts ecosystems [8], and recurring droughts in the Amazon Rainforest WHS threaten biodiversity. For cultural heritage, sea-level rise intensifies erosion in coastal WHSs such as Venice and Gulangyu [7], while extreme rainfall and high temperatures increase the risk of damage to ancient buildings and cultural relics like the Forbidden City and the Mogao Grottoes [12]. Meanwhile, the growing global demand for tourism has made heritage tourism a key driver of regional economic development. However, the influx of tourists brings problems such as excessive energy consumption, soaring carbon emissions, overloaded environmental carrying capacity, and excessive commercialization of cultural heritage [5], exacerbating conflicts between heritage protection and economic development.

Guided by global "carbon peaking and carbon neutrality" goals, low-carbon transition has become an inevitable trend across industries, including WHSs. As core areas for ecological protection and cultural dissemination, WHSs embody profound ecological wisdom in their unique cultural connotations. For example, traditional Chinese ecological cultures emphasize "harmony between humans and nature" (symbiosis), "moderation in resource use" (sustainable exploitation), and "frugality and benevolence" (responsible consumption) [11]—concepts highly aligned with the sustainability, effi-

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ciency, and responsibility pursued by low-carbon development, laying a natural value foundation for synergizing heritage protection and low-carbon development.

The rise of the digital economy has injected new momentum into this synergy. Digital technologies such as big data, artificial intelligence (AI), VR/AR, and the Internet of Things (IoT) not only optimize the allocation of tourism resources in WHSs and reduce carbon emissions during operations [16] but also innovate cultural heritage dissemination methods and expand cultural influence [15]. As important micro-agents in the digital economy, SMEs—with their flexibility and adaptability—play an irreplaceable role in linking digital technologies with heritage tourism scenarios, bridging skill mismatches, and promoting the implementation of low-carbon technologies [17]. However, WHSs face practical dilemmas in practice: some managers lack awareness of the synergy between culture and low-carbon development, viewing heritage protection and low-carbon transition as conflicting tasks; scientific and unified tools for carbon emission quantification are lacking, hindering accurate identification of key carbon sources and emission reduction potential; digital technology applications remain superficial, failing to deeply integrate with heritage protection and low-carbon transition; SMEs lack motivation and capacity to participate in the low-carbon digital transition of WHSs; and relevant institutional policies lack systematicness and synergy, making it difficult to form long-term guarantees. Thus, there is an urgent need to construct a systematic research framework to explore the synergistic logic, quantitative methods, and practical pathways of cultural heritage protection and low-carbon development in WHSs, providing theoretical support and practical guidance for addressing these challenges.

Literature review

As a core indicator for measuring the impact of human activities on ecosystems, the ecological footprint has been widely used in evaluating the sustainability of heritage tourism [2]. Early studies focused on the application and validation of single methods: Li et al. (2019) developed a screening method for calculating the ecological footprint of heritage tourism, simplifying the calculation process and reducing data acquisition costs by identifying key carbon sources (e.g., transportation, accommodation, catering, and sightseeing), which was successfully applied to Taishan WHS [1]; Lenzen et al. (2018) confirmed through large-scale statistical analysis of global tourism carbon emissions that transportation (especially air travel) and accommodation are the main sources, providing key directions for carbon emission control in WHSs [3]; Kuo and Chen (2009) introduced the Life Cycle Assessment (LCA) method into island WHS research, covering the entire process from pre-trip preparation to post-trip activities, enabling full-chain quantification of environmental loads from tourist activities [7]; Zhang and Zhang (2020) compared the carbon footprints of the Himalayan and Huangshan mountain WHSs, identifying tourism scale, transportation modes, management measures, and geographical environment as key factors affecting carbon emission intensity [8].

With the development of the digital economy, some studies have begun to focus on carbon emissions from digital facilities, but existing quantitative assessment systems still have obvious deficiencies: first, they lack comprehensive consideration of the triple goals of "cultural protection-low-carbon development-digital empowerment" in WHSs, failing to include emerging carbon sources such as digital facility operation and digital content dissemination; second, the applicable scenarios of different methods are not clearly defined, and an integrated assessment tool that can be flexibly adjusted according to WHS types and tourism modes has not been formed; third, assessment indicators focus on total carbon emissions, with insufficient attention to the synergistic efficiency of cultural protection and low-carbon development, making it difficult to fully reflect the sustainable development level of WHSs.

Empirical research on synergy between heritage protection and low-carbon development

Existing empirical studies cover diverse WHS types (mountains, historical districts, islands) and explore synergistic development pathways in different scenarios. For mountain WHSs, Hu et al. (2022) found in a case study of Huangshan that scenic management measures (e.g., optimized transportation scheduling, energy structure adjustment) and tourist behavior guidance (e.g., low-carbon travel advocacy, green consumption promotion) significantly reduce carbon emission intensity [4]; Zhang and Zhang (2020) highlighted energy-saving renovations of transportation facilities such as cable cars and sightseeing vehicles as key emission reduction measures [8]. For historical district WHSs, Tweed and Sutherland (2007) explored pathways to improve energy efficiency in cultural heritage buildings through thermal insulation renovations, renewable energy utilization, and spatial layout optimization [6]; Suzhou Pingjiang Road integrated cultural experience and low-carbon development by promoting a "slow life" tourism model (encouraging walking and cycling) and green renovations of home stays and shops [13]. For island WHSs, Kuo and Chen (2009) quantified carbon emissions from transportation, accommodation, catering, and material transportation in the Penghu Islands using LCA, proposing measures such as material recycling, renewable energy promotion, and tourism capacity control [7]; Gulangyu effectively controlled carbon emissions while ensuring tourism experiences through optimized ferry scheduling, promotion of electric sightseeing vehicles, and development of a digital reservation and crowd-limiting system [15].

Notably, the role of the digital economy and SMEs in empirical practice is increasingly prominent. Gu et al. (2025) revealed the development mechanism of the digital tourism economy under environmental constraints, noting that digital technologies improve low-carbon transition efficiency through resource integration, tourist flow regulation, and carbon emission monitoring [16]; Gu and Lukin (2025) confirmed through empirical analysis that SMEs— as key providers of digital tourism services—bridge skill mismatches between digital technologies and heritage tourism scenarios through flexible skill training and service innovation, promoting the application of low-carbon technologies in

ticketing, intelligent navigation, and cultural and creative (CC) product development [17]. However, existing empirical research remains fragmented: first, most studies focus on single WHSs, lacking comparative analysis and regularity extraction of synergistic effects across different types; second, the empowering role of digital technologies and SMEs is insufficiently explored, with unclear adaptation models and action boundaries in different WHS types; third, the evaluation of synergistic effects is mostly qualitative or based on single indicators, lacking systematic measurement of "cultural-ecological-economic" comprehensive benefits.

Research on synergistic mechanisms and policies

Theoretical exploration of the synergistic logic between heritage protection and low-carbon development has yielded multi-dimensional results. At the cultural concept level, Dickinson et al. (2011) proposed the "slow tourism" concept, emphasizing reduced travel frequency, longer stays, and in-depth cultural experiences—achieving both low-carbon goals (reducing transportation emissions) and enhanced cultural heritage understanding [9]; Loulanski and Loulanski (2011) constructed an integrated model of cultural heritage and sustainable tourism, emphasizing the coordination of cultural value inheritance with ecological protection and economic development [11]. At the technical support level, Bec et al. (2019) suggested that digital technologies such as VR/AR reduce carbon emissions from physical tourism through virtual heritage experiences while expanding cultural dissemination [15]; Gu et al. (2025) expanded application scenarios, noting that big data and IoT enable real-time carbon emission monitoring, and AI optimizes resource allocation and energy efficiency [16]. At the institutional policy level, the joint report *World Heritage and Tourism in a Changing Climate* by UNESCO, UNEP, and UCS [12] analyzed climate change threats to global WHSs and advocated integrating climate adaptation and low-carbon goals into protection plans; scholars proposed policy recommendations such as financial subsidies for low-carbon transition enterprises and the construction of a "government-scenic area-community" collaborative governance system [4][11].

At the agent participation level, Gu and Lukin (2025) filled the research gap on SMEs' role in synergistic mechanisms, noting that SMEs not only provide digital tourism services but also act as carriers for low-carbon technology implementation, promoting the deep integration of digital and low-carbon technologies in heritage tourism through skill mismatch bridging [17]. However, existing research on synergistic mechanisms still has limitations: first, it focuses on single dimensions (e.g., culture, technology, or institutions), failing to form a systematic four-dimensional framework integrating "concept-technology-agent-institution"; second, the interaction between dimensions is insufficiently explored, lacking clarification of the circular reinforcement logic—"concepts guide technological direction, technologies empower agent participation, agents promote institutional implementation, and institutions guarantee concept inheritance"; third, policy research remains macro-level, lacking precise design for different WHS types and development stages, and insufficiently addressing SME support and digital technology incentives.

Research gaps

Synthesizing existing research, three core gaps are identified: first, quantitative assessment systems lack integration and adaptability, failing to form a comprehensive tool that balances the triple goals of cultural protection, low-carbon development, and digital empowerment while adapting to different WHS types, with insufficient indicators for synergistic efficiency; second, empirical research is fragmented, lacking cross-case comparison of synergistic effects across WHS types and in-depth exploration of the digital economy and SMEs, making it difficult to form replicable and scalable practical models; third, synergistic mechanism research is single-dimensional, failing to construct a four-dimensional framework of "cultural concept guidance-technical support-SME implementation-institutional guarantee," and policy recommendations lack pertinence, operability, and long-term effectiveness. Based on this, this study focuses on four core questions: How to construct a quantitative assessment system adapted to the triple goals of WHSs? How to verify synergistic effects and heterogeneous rules across different WHS types? How to build a four-dimensional integrated synergistic mechanism? How to propose precise and effective optimization pathways?

Research significance

Theoretical significance

First, this study constructs a comprehensive research framework of "quantitative assessment-empirical validation-mechanism construction-path optimization," integrating cultural heritage protection, low-carbon development, digital economy, and SMEs, filling the systematic research gap at the intersection of cultural heritage studies and environmental economics. Second, it integrates multiple methods (screening, LCA, spatial comparison) and incorporates emerging indicators (digital facility emissions, digital empowerment coefficient, SME participation) to form a quantitative assessment system tailored to WHSs' triple goals, enriching methodologies for WHS sustainability evaluation. Finally, it reveals the four-dimensional synergistic mechanism and its circular reinforcement logic, expanding the application boundaries of sustainable development theory, cultural economics, and digital economy theory.

Practical significance

First, the quantitative assessment system provides WHS managers with scientific carbon accounting tools and synergistic efficiency standards, facilitating accurate identification of key carbon sources, emission reduction potential, and differentiated strategies. Second, empirical comparison of mountain, historical district, and island WHSs extracts scenario-specific synergistic development models—especially the application pathways of digital technologies and SMEs—offering replicable practical experience. Third, the optimization pathways based on the four-dimensional mechanism cover cultural communication, technological innovation,

agent cultivation, and institutional improvement, providing policy references for governments to promote the triple win of "improved cultural protection, efficient low-carbon transition, and increased economic growth," contributing Chinese wisdom to global WHS sustainable development.

Quantitative Assessment System for Ecological/Carbon Footprints in WHSs

Combining methodological achievements from existing literature and core characteristics of WHSs—"cultural protection priority, intensive tourism activities, ecological sensitivity, accelerated digital technology penetration, and increased SME participation"—this study constructs a "three-in-one" quantitative assessment system, including assessment dimension definition, core method integration, and indicator system design, to achieve comprehensive, accurate, and dynamic evaluation of WHS ecological/carbon footprints.

Definition of assessment dimensions

Focusing on the full-chain carbon emissions from WHS tourism and protection activities—covering direct and indirect emissions, traditional and emerging carbon sources—three core assessment dimensions are defined to fully align with the triple goals of "cultural protection-low-carbon development-digital empowerment":

- Direct carbon emissions: Emissions directly generated by tourists during on-site activities, including transportation (cable cars, sight seeing vehicles, ferries, excluding walking), accommodation (hotels, homestays), catering (energy consumption and food waste), and sightseeing (entertainment facilities, experience programs).
- Indirect carbon emissions: Emissions indirectly generated to support WHS tourism operations and cultural protection, including energy consumption (administrative facilities, cultural exhibition venues), building maintenance (heritage restoration, tourism facility upkeep), material procurement (production and transportation of operational supplies), and digital facility operation (intelligent navigation devices, data centers, virtual experience platforms).
- Cultural protection-related carbon emissions: Emissions from specialized activities to ensure the authenticity and integrity of cultural heritage, including heritage restoration (ancient building renovation, cultural relic restoration), cultural relic protection (storage environment regulation, pest control), and cultural exhibition (lighting, constant temperature/humidity equipment in museums). This dimension balances protection effectiveness and emission reduction goals, avoiding compromises to cultural heritage quality for absolute emission reduction.

Integration of core quantitative methods

To adapt to different WHS types and assessment scenarios, three core methods—screening, Life Cycle Assessment (LCA), and spatial comparison models—are integrated into a "basic method + supplementary method + comparison method" system:

Basic calculation method: Screening method

Adopting the screening method proposed by Li et al. (2019) [1] as the core, and optimizing the process to reflect the digital economy and SME participation:

- Carbon source identification and classification: Comprehensive identification of WHS carbon sources through field surveys, scenic management data, and tourist interviews, classified into the three dimensions above, with emphasis on emerging sources such as digital facility operation and SME digital services.
- Key carbon source screening: Prioritizing carbon sources accounting for over 1% (e.g., transportation, accommodation, energy consumption, digital facilities) for detailed calculation; simplifying minor sources to balance accuracy and efficiency.
- Data collection: Multi-source data acquisition, including scenic energy consumption reports, transportation logs, accommodation/catering revenue data, digital facility operation records, heritage protection project files, and SME operational data; supplementing missing data with industry averages or interpolation.
- Quantitative calculation: Using industry-standard emission factors (e.g., recommended values in *Provincial Greenhouse Gas Inventory Compilation Guidelines*) adjusted for WHS-specific conditions:
    - Total carbon emissions = Σ (Activity level of a carbon source × Corresponding emission factor)
    - Digital facility carbon emissions = Operation time of digital devices × Unit time energy consumption × Power emission factor
    - SME carbon emissions = Scale of SME services × Unit service carbon emission coefficient
- Result verification: Validating results through comparison with historical WHS emission data and peer WHS levels to ensure reliability.

Supplementary method: Life cycle assessment (LCA)

Introducing the LCA method by Kuo and Chen (2009) [7] for complex scenarios with long industrial chains (e.g., island WHSs, historical districts):

- Scope definition: Expanding to the full life cycle of "pre-trip preparation-during trip-post-trip activities," covering tourist transportation, digital reservation experiences, on-site visits, waste disposal, and digital content dissemination; including the "production-use-disposal" cycle of heritage buildings and digital facilities.
- System boundary division: Clarifying geographical (WHS administrative area and surrounding associated regions), temporal (usually 1 year), and functional units (e.g., "per tourist visit," "per unit area heritage protection").

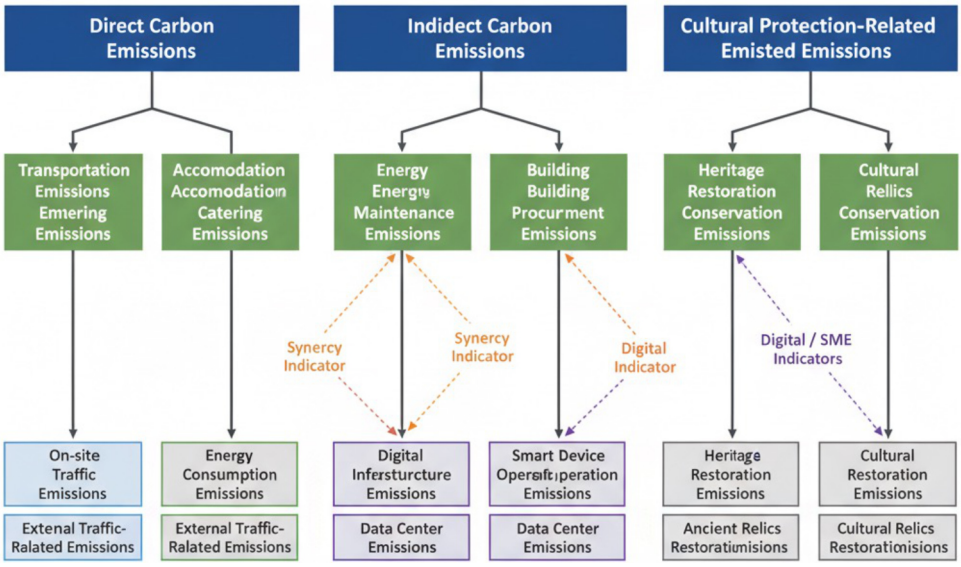


Figure 1 | World Heritage Sites Ecological / Carbon Footprint Tertiary Evaluation Index System

- Inventory analysis: Detailing all inputs (energy, materials, water) and outputs (CO_2, SO_2, solid waste) within the system boundary to establish a complete life cycle inventory.
- Impact assessment: Using midpoint or endpoint methods to evaluate the comprehensive impact of carbon emissions on climate change and ecosystems, identifying key emission reduction links.
- Interpretation: Proposing optimization schemes balancing minimal environmental impact and maximal cultural value.

Comparative analysis method: Spatial comparison model

Drawing on the spatial comparison approach by Zhang and Zhang (2020) [8], a cross-WHS comparison model is constructed to reveal heterogeneous carbon emission characteristics and synergistic efficiency:

Control variable selection: Key variables including WHS type (mountain, historical district, island), tourism scale (annual tourist volume), geographical location (eastern/central-western, coastal/inland), digital economy development level (digital facility coverage, share of digital tourism services), and SME participation (number of relevant SMEs, revenue share) to ensure scientific comparison.

Comparison dimension design: Four core dimensions—carbon emission intensity (per capita, per unit area, per tourism revenue), synergistic efficiency (cultural protection satisfaction per unit carbon emission, low-carbon transition effect per cultural protection cost), digital empowerment coefficient (digital technology-induced emission reduction/total emission reduction, digital technology-induced cultural dissemination increment/total dissemination), and SME contribution (SME-induced emission reduction/total emission reduction, share of digital tourism services provided by SMEs).

Model construction: Panel data models or difference-in-differences models to control individual and time fixed effects, quantifying the impact of different factors on carbon emission intensity and synergistic efficiency, and extracting key drivers of synergistic development.

Indicator system design

Based on assessment dimensions and core methods, a "three-level indicator system" is constructed, covering carbon emission accounting, synergistic effect evaluation, and digital empowerment/SME participation assessment, balancing scientificity, systematicness, and operability (Table 1 and Figure 1).

Empirical Validation: Synergistic Effect Analysis of Typical WHSs

Four typical WHSs—mountain heritage (Huangshan), mixed mountain-cultural heritage (Taishan), historical district heritage (Suzhou Pingjiang Road), and island heritage (Gulangyu)—are selected as case studies. Using the quantitative assessment system, combined with literature data, scenic annual reports, field surveys, tourist interviews, and SME surveys, this study systematically verifies the synergistic effects of heritage protection and low-carbon development, analyzes heterogeneous carbon emission characteristics and synergistic efficiency, and highlights the empowering role of the digital economy and SMEs.

Case overview and data sources

Huangshan (Mountain heritage)

Core characteristics: A mixed natural and cultural WHS in Huangshan City, Anhui Province, renowned for its "four wonders" (peculiar pines, strange rocks, sea of clouds, hot springs). Tourism focuses on natural scenery appreciation, with transportation relying on cable cars and sightseeing vehicles. Digital technologies are mainly applied in intelligent monitoring, ticketing, and navigation. Relevant SMEs primar-

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Table 1 | Indicator System Design

Primary Indicator	Secondary Indicator	Tertiary Indicator	Calculation Method	Data Source
Direct Carbon Emissions	Transportation Carbon Emissions	On-site transportation emissions	Number of tourists × Average on-site travel distance × Unit distance emission factor	Scenic ticketing data, tourist surveys, transportation logs
		External transportation-related emissions	Number of tourists × Average round-trip external distance × Unit distance emission factor	Tourist surveys, transportation statistics
	Accommodation Carbon Emissions	Hotel accommodation emissions	Hotel stays × Average stay duration × Unit time emission factor	Hotel check-in data, energy consumption statistics
		Homestay accommodation emissions	Homestay stays × Average stay duration × Unit time emission factor	Homestay operational data, field visits
	Catering Carbon Emissions	On-site catering emissions	Number of tourists × Per capita catering consumption × Catering carbon emission coefficient	Catering revenue data, industry reports, tourist surveys
	Sightseeing Carbon Emissions	Experience program emissions	Number of participants × Unit program carbon emission factor	Program operation records, facility energy consumption data
Indirect Carbon Emissions	Energy Consumption Carbon Emissions	Administrative facility emissions	Administrative facility electricity/heat consumption × Corresponding emission factor	Scenic energy bills, energy consumption reports
		Exhibition venue emissions	Exhibition venue electricity/heat consumption × Corresponding emission factor	Venue operation logs, energy consumption statistics
	Building Maintenance Carbon Emissions	Heritage building maintenance emissions	Maintenance area × Unit area maintenance carbon emission factor	Maintenance contracts, material procurement records
		Tourism facility maintenance emissions	Maintenance workload × Unit workload carbon emission factor	Maintenance project files, construction records
	Material Procurement Carbon Emissions	Operational material emissions	Operational material procurement volume × Unit material carbon emission factor	Procurement contracts, supplier data
		Cultural and creative (CC) product emissions	CC product sales volume × Unit product carbon emission factor	CC sales data, manufacturer reports
	Digital Facility Carbon Emissions	Intelligent device operation emissions	Number of intelligent devices × Average operation time × Unit time energy consumption × Emission factor	Digital facility operation logs, energy monitoring data
		Data center emissions	Data center electricity consumption × Power emission factor	Data center energy consumption statistics
Cultural Protection-Related Carbon Emissions	Heritage Restoration Carbon Emissions	Ancient building restoration emissions	Maintenance area × Unit area restoration carbon emission factor + Equipment operation energy consumption × Emission factor	Restoration project files, construction records, energy consumption data
		Cultural relic restoration emissions	Number of restored cultural relics × Unit cultural relic restoration carbon emission factor	Cultural relic restoration reports, material consumption records
	Cultural Relic Protection Carbon Emissions	Storage environment regulation emissions	Storage facility operation time × Unit time energy consumption × Emission factor	Cultural relic warehouse operation logs, energy consumption statistics
		Protection treatment emissions	Number of protected cultural relics × Unit treatment carbon emission factor	Protection treatment records, material consumption data
	Cultural Exhibition Carbon Emissions	Exhibition lighting emissions	Exhibition area × Average lighting duration × Unit area lighting energy consumption × Emission factor	Exhibition operation logs, energy consumption data
		Interactive exhibition emissions	Interactive device operation time × Unit time energy consumption × Emission factor	Interactive device operation records, energy monitoring data
Synergistic Effect Indicators	Carbon Emission Reduction Effect	Carbon emission reduction rate	(Baseline carbon emissions - Current carbon emissions)/Baseline carbon emissions × 100%	Multi-period monitoring data comparison, historical statistics
		Carbon emission intensity reduction rate	(Baseline carbon emission intensity - Current carbon emission intensity)/Baseline carbon emission intensity × 100%	Multi-period assessment results comparison
	Cultural Protection Effect	Heritage protection satisfaction	Expert score × 0.6 + Tourist score × 0.3 + Resident score × 0.1	Expert reviews, tourist surveys, community interviews
		Cultural dissemination coverage	Number of people aware of heritage culture/Total surveyed population × 100%	Public surveys, digital dissemination data
	Synergistic Efficiency	Synergistic efficiency index	Cultural protection satisfaction/Unit carbon emission	Comprehensive calculation
		Economic-ecological synergy index	Tourism revenue growth rate/Carbon emission growth rate	Tourism revenue statistics, carbon emission assessment data
Digital Empowerment and SME Participation Indicators	Digital Empowerment Coefficient	Digital emission reduction contribution	Digital technology-induced emission reduction/Total emission reduction × 100%	Technology application assessment reports, emission reduction calculation data
		Digital dissemination contribution	Digital channel cultural dissemination volume/Total cultural dissemination volume × 100%	Digital platform operation data, dissemination effect monitoring
	SME Participation	Quantity participation rate	Number of SMEs participating in WHS-related businesses/Total number of relevant enterprises × 100%	Enterprise directory surveys, industry statistics
		Revenue contribution	SME-related business revenue/Total relevant business revenue × 100%	Enterprise surveys, revenue statistics
		Skill adaptability	Number of SMEs with qualified digital low-carbon skills/Total employees × 100%	Enterprise surveys, skill training records

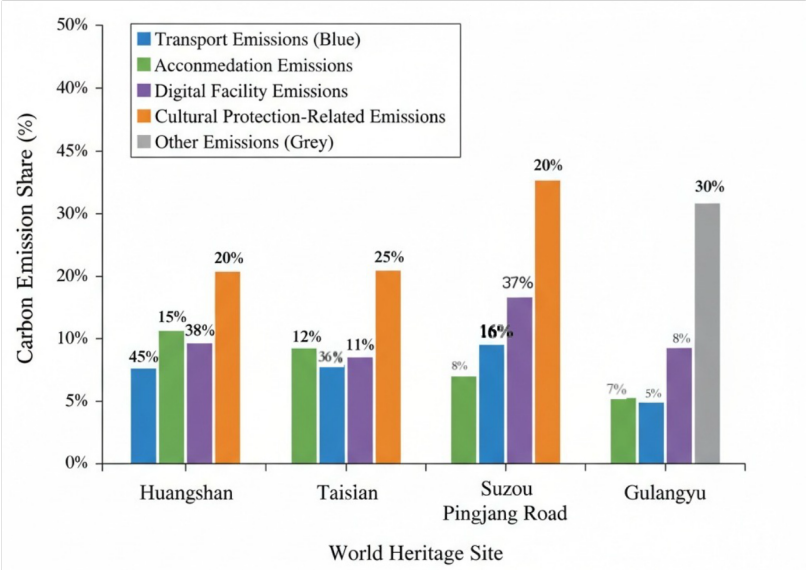


Figure 2 | Comparison Bar Chart of Carbon Emission Structures of Four Major Heritage Sites

ily provide tourism transportation, catering, and accommodation services [8][4].

Data sources: *Huangshan Scenic Area Annual Work Report (2018-2023)*, Huangshan carbon emission monitoring data, tourist questionnaires (800 distributed, 723 valid), interviews with 15 on-site SMEs, and relevant literature [8][4].

Taishan (Mixed mountain-cultural heritage)

Core characteristics: A mixed natural and cultural WHS in Tai'an City, Shandong Province, combining magnificent natural scenery with profound religious and historical culture. Tourism includes natural sightseeing, religious pilgrimages, and cultural experiences. Transportation combines cable cars, sightseeing vehicles, and walking. Digital technologies are applied in virtual research, intelligent navigation, and cultural dissemination. Relevant SMEs—with strong skill adaptability and service innovation capacity—focus on digital CC products, intelligent services, and tourism reception [1][5][17].

Data sources: *Taishan Scenic Area Annual Operation Report (2018-2023)*, archives of Taishan Cultural Heritage Protection Center, tourist questionnaires (900 distributed, 815 valid), operational data and interviews with 20 on-site SMEs, and relevant literature [1][5][17].

Suzhou Pingjiang Road (Historical district heritage)

Core characteristics: A cultural heritage extension project in Suzhou City, Jiangsu Province, preserving the most intact ancient urban area of Suzhou. Core tourism resources include Ming-Qing ancient buildings, canals, and folk culture. Tourism modes focus on walking, in-depth experiences, and homestay stays. Digital technologies are deeply integrated into CC product development, virtual experiences, and smart management. A large number of SMEs cover digital CC, characteristic homestays, and intangible cultural heritage (ICH) experiences, with high digital-low-carbon integration [6][13].

Data sources: Statistical data from Suzhou Gusu District Bureau of Culture and Tourism, Suzhou Pingjiang Road Historical District Protection Plan, tourist questionnaires (700 distributed, 638 valid), surveys of 30 on-site SMEs, field visit records, and relevant literature [6][13].

Gulangyu (Island heritage)

Core characteristics: A cultural WHS in Xiamen City, Fujian Province, featuring island scenery, Western-style architecture, and music culture. Tourism transportation relies on ferries, with activities focusing on sightseeing and leisure. Digital technologies are mainly applied in reservation and crowd-limiting, virtual tours, and intelligent transportation scheduling. Relevant SMEs primarily provide ferry supporting services, homestay catering, and tourism retail [7][15].

Data sources: *Gulangyu World Cultural Heritage Protection and Management Annual Report (2018-2023)*, statistical data from Xiamen Municipal Bureau of Tourism Development, tourist questionnaires (800 distributed, 732 valid), interviews with 18 on-site SMEs, ferry operation data, and relevant literature [7][15].

Results of synergistic effect validation

Comparative analysis of carbon emission structures

Based on the quantitative assessment, carbon emission structures vary significantly across the four WHSs, with key sources closely related to WHS type, tourism mode, and digital economy development level (**Figure 2**):

- Huangshan: The highest total carbon emissions among the four. Transportation accounts for 45% (cable car operations contribute 68% of transportation emissions), energy consumption for 22%, accommodation and catering for 15% and 10% respectively, and digital facilities for 8% (mainly from intelligent monitoring and ticketing systems) [8]. Cultural protection-related emissions account

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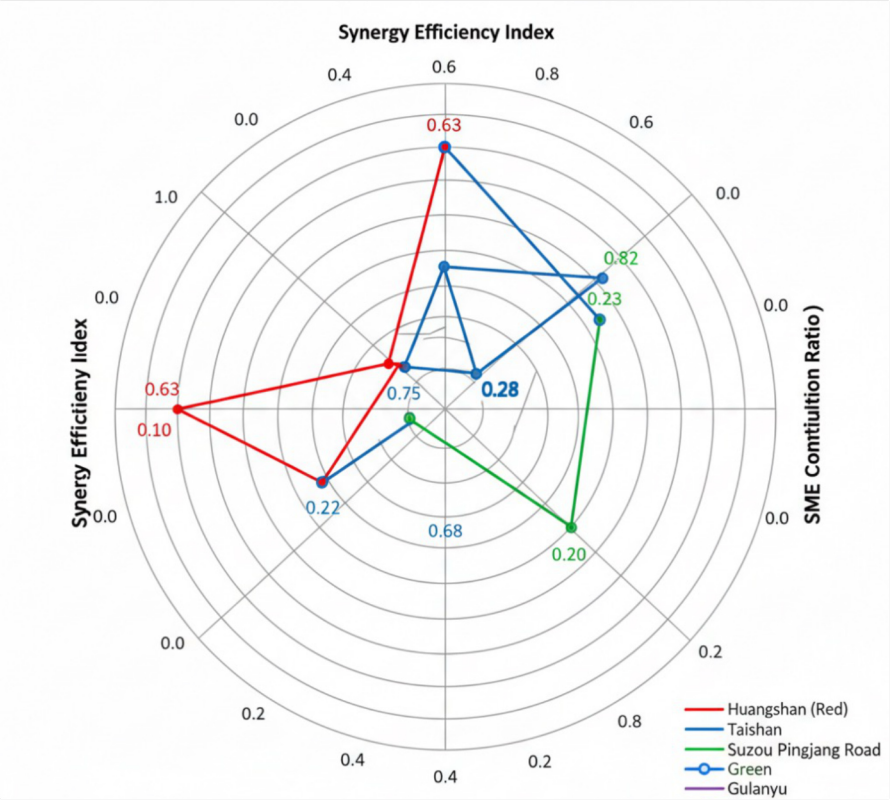


Figure 3 | Radar Chart Comparing Three Dimensions: Collaboration Efficiency, Digital Enablement, and SME Contribution

for 12%, focusing on ecological restoration and daily maintenance of ancient buildings.

- Taishan: The second-highest total carbon emissions. Transportation accounts for 38% (evenly split between cable cars and sightseeing vehicles), cultural protection-related emissions for 18% (mainly from religious building restoration and cultural relic protection equipment), accommodation and catering for 16% and 11% respectively, and digital facilities for 9% (mainly from virtual research platforms and intelligent navigation devices). SMEs' digital tourism services contribute 6%, primarily from digital CC production and intelligent service operations [1][17].
- Suzhou Pingjiang Road: The lowest total carbon emissions. Accommodation accounts for 32% (characteristic homestays contribute 75% of accommodation emissions), cultural protection-related emissions for 25% (core from historical building maintenance and ICH exhibitions), catering for 18%, and digital facilities for 10% (mainly from digital CC development and virtual experience projects). Transportation accounts for only 8% due to walking-focused tourism [6].
- Gulangyu: Moderate total carbon emissions. Transportation accounts for 42% (ferry operations contribute 82% of transportation emissions), indirect emissions from material transportation for 28% (high dependence due to island geography), accommodation and catering for 15% and 10% respectively, and digital facilities for 5% (mainly from reservation and crowd-limiting systems and virtual tour platforms) [7].

Comparison of synergistic efficiency, digital empowerment, and SME participation

Three core indicators are used to compare synergistic development levels: synergistic efficiency index (cultural protection satisfaction per unit carbon emission), digital empowerment coefficient (digital technology-induced emission reduction/total emission reduction), and SME contribution (SME-induced emission reduction/total emission reduction) (Figure 3):

- Synergistic efficiency ranking: Suzhou Pingjiang Road (0.82) > Taishan (0.75) > Gulangyu (0.68) > Huangshan (0.63). Suzhou Pingjiang Road achieves the lowest carbon emission intensity with high cultural protection satisfaction through its "walking tourism + in-depth cultural experience + digital-low-carbon integration" model. Taishan benefits from profound cultural connotations and SME digital service innovation. Gulangyu is constrained by high material transportation emissions, while Huangshan faces high carbon emission intensity due to high-altitude transportation dependence and large-scale ecological restoration needs.
- Digital empowerment coefficient ranking: Suzhou Pingjiang Road (0.35) > Gulangyu (0.32) > Taishan (0.28) > Huangshan (0.22). Suzhou Pingjiang Road's digital technologies are deeply integrated into cultural dissemination

and low-carbon operations (e.g., VR ICH experiences reducing physical tourism pressure, smart energy management systems lowering building energy consumption). Gulangyu's digital reservation system effectively controls tourist peaks. Taishan's virtual research platforms expand cultural dissemination but need deeper low-carbon technology integration. Huangshan's digital technologies focus on management efficiency, with underutilized emission reduction potential [16].

- SME contribution ranking: Taishan (0.23) > Suzhou Pingjiang Road (0.20) > Gulangyu (0.15) > Huangshan (0.10). Taishan's SMEs excel in digital CC development and intelligent navigation, reducing emissions through innovative service models. Suzhou Pingjiang Road's SMEs (characteristic homestays, digital CC) enhance synergy through green renovations and low-carbon services. SMEs in Gulangyu and Huangshan focus on traditional tourism services with low participation and capacity in low-carbon digital transition [17].

Analysis of key driving factors

Comparative analysis identifies four key drivers of synergistic effects:

- Cultural connotations and tourism modes: WHSs with profound cultural connotations and lightweight tourism modes (e.g., walking, in-depth experiences) achieve better synergy—such as Suzhou Pingjiang Road's "slow life" culture and Taishan's religious culture with in-depth research [9].
- Depth of digital technology integration: Higher integration of digital technologies with heritage protection and low-carbon operations—especially virtual experiences, smart energy management, and precise tourist flow control—significantly reduces emissions and enhances cultural dissemination [15][16].
- Quality of SME participation: Higher SME participation and skill adaptability in digital tourism services and low-carbon technology application strongly promote synergistic effects—e.g., Taishan's SMEs driving innovation in digital CC and intelligent services [17].
- Management and policy support: Sound low-carbon management systems and policy support (e.g., subsidies for green homestays in Suzhou Pingjiang Road, ferry energy-saving renovation in Gulangyu) facilitate emission reduction [4].

Empirical conclusions

Carbon emission structures vary significantly across WHS types: mountain WHSs focus on transportation and energy consumption emissions; historical district WHSs on accommodation and cultural protection-related emissions; island WHSs on transportation and material transportation emissions.

Synergistic effects between heritage protection and low-carbon development are feasible but influenced by cultural connotations, tourism modes, digital technology integration, and SME participation. WHSs with profound culture, lightweight tourism, deep digital integration, and high-quality SME participation achieve higher synergistic efficiency.

The digital economy and SMEs have become key emerging drivers: digital technologies reduce emissions and enhance cultural dissemination through virtual experiences and smart management; SMEs promote the application of digital and low-carbon technologies in niche scenarios through flexibility and innovation.

Synergistic development pathways are heterogeneous—WHSs must develop targeted strategies based on key carbon sources, resource endowments, and development stages.

Synergistic Mechanisms for WHS Protection and Low-Carbon Development

Based on empirical results and theoretical support, a four-dimensional synergistic mechanism—"cultural concept guidance-technical support-SME implementation-institutional guarantee"—is constructed, clarifying the core functions, action pathways, and circular reinforcement logic of each dimension, providing a systematic theoretical framework for synergistic development (**Figure 4**).

Cultural concept guidance mechanism: Value foundation of synergistic development

The rich ecological wisdom and cultural connotations of WHSs serve as the core value guidance for synergistic development, providing fundamental principles for technology application, agent participation, and institutional design:

Concept transformation pathway: Integrating traditional ecological concepts (e.g., "harmony between humans and nature," "moderation in resource use") with modern low-carbon and digital dissemination concepts to form contemporary low-carbon values and cultural communication perspectives [9]. For example, Taishan's religious culture of "reverence for nature" is transformed into low-carbon tourist behavior and green operational guidelines for enterprises; Suzhou Pingjiang Road's "slow life" culture shapes tourism values of "in-depth experience, simple consumption, and low-carbon travel."

Behavioral constraint and incentive: Strengthening the sense of responsibility for heritage protection among the public, enterprises, and managers through cultural dissemination and scenario immersion, and internalizing low-carbon behavior [11]. Cultural norms restrain destructive and high-carbon behaviors (e.g., Taishan's religious culture lectures reducing damage to ancient buildings); "culture + low-carbon" values incentivize enterprises to develop green products (e.g., Suzhou Pingjiang Road's homestays implementing energy-saving renovations).

Brand value shaping: Building a "culture + low-carbon + digital" heritage tourism brand to enhance cultural, ecological, and economic value. For example, Gulangyu combines "island culture + low-carbon ferries + virtual tours" to attract tourists, reduce emissions, and expand cultural influence.

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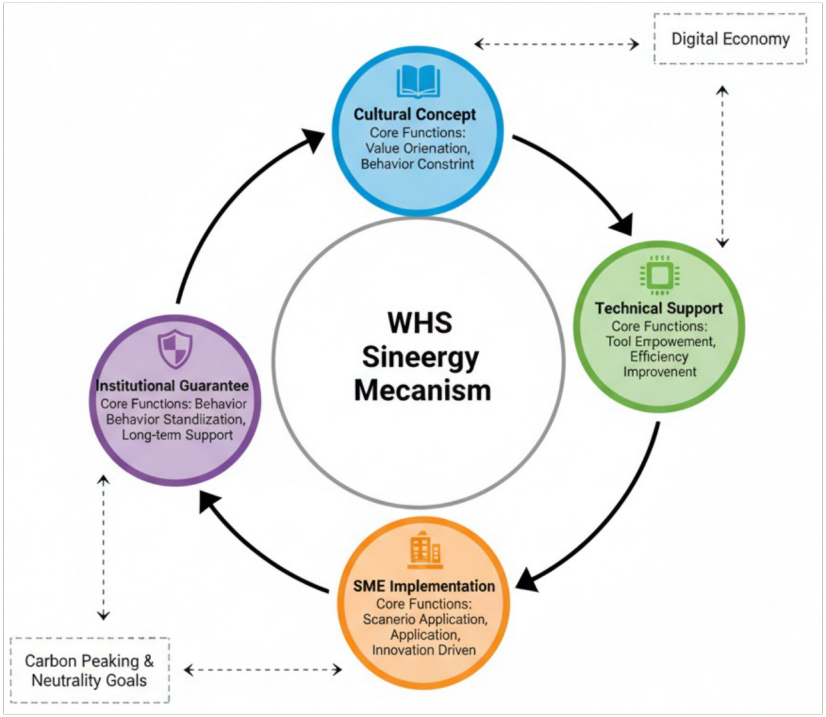


Figure 4 | Four-Dimensional Collaborative Mechanism Cycle Diagram

Technical support mechanism: Implementation pathway of synergistic development

The integrated application of digital and low-carbon technologies provides key technical support, bridging cultural concepts and practical implementation—with application effects closely linked to SME participation:

- Low-carbon renovation technologies: Energy-saving and low-carbon renovations of heritage buildings and tourism facilities to reduce energy consumption and emissions [6][13]. Examples include using thermal insulation materials and solar panels for historical buildings, electrifying cable cars and sightseeing vehicles, and promoting rainwater collection and waste classification.
- Digital dissemination and experience technologies: Innovating cultural heritage dissemination and experience through VR/AR, big data, and AI [15][16]. Virtual heritage experiences (e.g., Taishan's virtual research platforms, Suzhou Pingjiang Road's digital ICH exhibition halls) reduce physical tourism emissions; digital media platforms expand cultural influence. SMEs excel in digital content creation and virtual experience development, quickly responding to market demands [17].
- Precision management and monitoring technologies: Achieving precise management of carbon emissions and cultural protection through IoT, big data, and cloud computing [8][16]. Sensors monitor carbon emissions, air quality, and cultural relic status in real time; big data analyzes tourist flow and consumption habits to optimize transportation and energy allocation; blockchain establishes credible traceability systems for heritage protection and low-carbon transition.

SME implementation mechanism: Micro-carriers of synergistic development

As key micro-agents integrating the digital economy and heritage tourism, SMEs are critical for the implementation of the synergistic mechanism, with core roles in skill matching, service innovation, and scenario-based application [17]:

- Skill mismatch bridging: The application of digital and low-carbon technologies in WHSs requires interdisciplinary talents proficient in technology, heritage culture, and tourism operations. SMEs—with flexible employment and training systems—quickly cultivate or introduce qualified talents, promoting technology application in specific scenarios (e.g., Taishan's SMEs collaborating with universities to train talents in digital technology and cultural communication).
- Service and product innovation: SMEs' innovation vitality and market responsiveness enable them to develop diversified products and services around "culture + low-carbon + digital" (e.g., Suzhou Pingjiang Road's digital ICH products, low-carbon homestay packages; Gulangyu's "low-carbon travel + virtual experience" combined services).
- Industrial chain synergy and integration: SMEs play roles in niche segments of the WHS tourism industrial chain, forming collaborative relationships with large enterprises and governments to build a complete "cultural protection-low-carbon development-digital empowerment" industrial chain. For example, in Taishan, large enterprises con-

struct digital infrastructure, while SMEs focus on digital CC and intelligent navigation, creating a complementary industrial ecosystem.

Institutional policy guarantee mechanism: Long-term support for synergistic development

A sound institutional policy system provides stable guarantees for the effective operation of the synergistic mechanism, regulating behaviors, stimulating participation, resolving conflicts, and ensuring sustainability:

- Planning constraint mechanism: Integrating cultural protection, low-carbon development, digital empowerment, and SME cultivation into WHS protection and development plans, clarifying goals, key tasks, and assessment indicators [12]. Examples include formulating "climate-resilient heritage management plans" and digital economy special plans, and incorporating SME participation into planning.
- Incentive mechanism: Establishing a diversified incentive system to stimulate participation from enterprises, tourists, and residents. Measures include financial subsidies, tax breaks, and credit support for low-carbon and digital transformation enterprises (especially SMEs); ticket discounts for low-carbon tourists; and innovation funds for SME digital-low-carbon R&D [17].
- Collaborative governance mechanism: Building a multi-stakeholder governance system—"government-scenic management institutions-enterprises (including SMEs)-community residents-tourists"—clarifying rights and responsibilities. Governments formulate policies and supervise; scenic management institutions coordinate planning and implementation; enterprises provide products and services; residents participate in protection; tourists practice low-carbon consumption. Regular communication mechanisms resolve conflicts, forming a co-construction and shared governance model [11].
- Supervision and assessment mechanism: Establishing a scientific supervision and assessment system incorporating synergistic efficiency, emission reduction effects, cultural protection quality, digital empowerment, and SME participation. Third-party evaluation ensures objectivity; assessment results are linked to government performance, scenic operation rights, and enterprise support policies; information disclosure accepts public supervision [5].

Operational logic of the mechanism

The four-dimensional synergistic mechanism operates through a circular reinforcement logic: "concept guidance-technical support-enterprise implementation-institutional guarantee-concept deepening":

Cultural concepts guide technology application, enterprise participation, and institutional design, ensuring synergistic development aligns with "cultural protection priority and low-carbon transition empowerment."

Technical means provide tools for concept transformation, enterprise implementation, and institutional landing, converting abstract concepts into practical actions, and providing data support for assessment.

SMEs integrate cultural concepts and technical tools into products and services, promoting scenario-based implementation and providing feedback for concept innovation, technology optimization, and institutional improvement.

Institutional policies regulate behaviors, stimulate motivation, and resolve conflicts, providing a stable environment for cultural inheritance, technology promotion, and SME development.

Practical feedback deepens cultural concepts, promotes technological upgrading, optimizes enterprise participation models, and improves institutional design, forming a positive cycle of continuous synergistic development.

Optimization Pathways for WHS Protection and Low-Carbon Development

Based on the four-dimensional synergistic mechanism and empirical results, targeted and operable optimization pathways are proposed from four aspects—cultural communication, technological innovation, agent cultivation, and institutional improvement—addressing the core characteristics and practical dilemmas of different WHS types.

Cultural communication optimization: Strengthening concept guidance and consolidating synergistic foundations

Targeted communication strategies

Developing differentiated communication content and methods for different groups:

- Tourists: Focus on "cultural experience + low-carbon guidelines" through scenic navigation, brochures, and digital platform pushes—e.g., setting up religious ecological culture exhibition boards in Taishan, and providing low-carbon living guides in Suzhou Pingjiang Road's homestays.
- Community residents: Focus on "cultural inheritance + benefit linkage" through community lectures and cultural activities, emphasizing employment and income growth from synergistic development to stimulate participation.
- Enterprises (including SMEs): Focus on "cultural value + business opportunities" through industry forums and case sharing, guiding enterprises to develop products with profound cultural connotations and low-carbon attributes (e.g., digital CC, green homestays) [17].
- Managers: Focus on "synergistic concepts + governance capacity" through training and exchange visits, enhancing understanding of synergistic logic and policy formulation capabilities.

Scenario-based integrated communication

Integrating heritage culture and low-carbon concepts into the entire tourism experience:

- Sightseeing scenarios: Designing "culture + low-carbon" experience projects—e.g., Suzhou Pingjiang Road's "ICH + low-carbon" routes combining traditional crafts with waste classification; Taishan's "reverence for nature" themed experience areas.
- Accommodation scenarios: Promoting homestays and hotels as cultural communication and low-carbon practice carriers—e.g., decorating homestays with traditional ecological culture themes, providing low-carbon daily necessities, and implementing "energy-saving points exchange" activities.
- Digital scenarios: Creating immersive cultural communication through VR/AR and short videos—e.g., developing "heritage culture + low-carbon science" short video series; virtual experience projects combining heritage appreciation with low-carbon knowledge learning [15][16].

Educational penetration communication

Incorporating heritage culture and low-carbon knowledge into national education to cultivate long-term synergistic development forces:

- School education: Collaborating with primary and secondary schools and universities to develop school-based courses and research programs—e.g., organizing university students to participate in WHS carbon emission monitoring and cultural surveys.
- Social education: Conducting public lectures and training through museums and community schools to popularize knowledge.
- Scenic education: Establishing science education bases in WHSs with professional interpreters, designing interactive educational activities for young tourists.

Technological innovation and application: Improving dynergistic efficiency and expanding implementation pathways

Type-specific technology adaptation strategies

Promoting targeted technologies based on the core characteristics and key carbon sources of different WHS types:

- Mountain WHSs (Huangshan, Taishan): Focusing on transportation energy-saving and digital monitoring technologies—e.g., electrifying cable cars and sightseeing vehicles, deploying IoT monitoring systems, and developing virtual research services to reduce physical tourist flow [8][16].
- Historical district WHSs (Suzhou Pingjiang Road): Focusing on building energy-saving and digital CC technologies—e.g., non-invasive energy-saving renovations of historical buildings, promoting renewable energy, and developing digital ICH products [6][15].
- Island WHSs (Gulangyu): Strengthening material recycling and digital scheduling technologies—e.g., promoting seawater desalination and rainwater collection, establishing material recycling systems, and optimizing digital reservation and ferry scheduling algorithms [7].

SME technological empowerment

Enhancing SME capacity for digital-low-carbon transition through technical support:

- R&D support: Establishing special funds for SME technological innovation, supporting collaboration with universities and research institutions; building technology sharing platforms to provide low-cost technology access and consulting services.
- Skill training support: Conducting interdisciplinary training—"digital technology + low-carbon technology + cultural knowledge"—for SME employees, improving skills in VR/AR content creation, intelligent device operation, and low-carbon management [17].
- Demonstration and promotion support: Selecting exemplary SME digital-low-carbon innovation cases for promotion; providing financial subsidies for advanced technology adoption to reduce application costs.

Construction of technology integration platforms

Building an integrated digital-low-carbon management platform for WHSs to achieve synergistic technology application and data sharing:

- Functional modules: Integrating carbon emission monitoring, tourist management, energy management, cultural communication, and SME services to realize full-process digital management from "monitoring-analysis-decision-making-implementation."
- Data sharing mechanism: Breaking data silos between governments, scenic areas, enterprises, and research institutions to share carbon emission, tourist, cultural protection, and R&D data, improving decision-making scientificity.
- Service support: Providing SMEs with technology matching, product display, and market promotion services, facilitating collaboration with large enterprises and governments to form an innovation ecosystem.

Agent cultivation enhancement: Activating micro-carriers and consolidating implementation bases

Precise SME cultivation

Developing targeted policies for SME roles and development dilemmas:

- Access and incubation support: Establishing SME incubation bases for digital-low-carbon startups, providing office space and entrepreneurial guidance; simplifying market access for SMEs in digital CC, intelligent services, and low-carbon renovations [17].

- Financial and policy support: Establishing a diversified financing system with low-interest loans, guarantees, and subsidies; offering preferential policies on taxes, land, and energy for SMEs participating in synergistic development.
- Collaboration support: Building collaboration platforms between SMEs, large enterprises, and governments to integrate SMEs into the WHS tourism industrial chain; organizing participation in domestic and international exhibitions to expand market channels.

Multi-agent collaborative cultivation

Strengthening the participation capacity and willingness of other stakeholders:

- Enterprise stakeholders: Guiding large tourism enterprises to lead low-carbon R&D and digital infrastructure construction, and collaborate with SMEs; promoting corporate social responsibility by integrating cultural protection and low-carbon development into strategies.
- Community resident stakeholders: Cultivating community self-governance organizations to enhance organized participation; establishing incentive mechanisms for residents participating in low-carbon practices and heritage protection.
- Tourist stakeholders: Cultivating low-carbon consumption habits through publicity and incentives; establishing feedback mechanisms for tourists to contribute suggestions.

Institutional policy Improvement: Building long-term mechanisms and strengthening guarantee support

Improvement of planning and assessment systems

- Synergistic planning formulation: Developing WHS synergistic development plans integrating cultural protection, low-carbon transition, digital economy, and SME cultivation, forming a "four-in-one" planning system [12][16].
- Indicator optimization: Improving the assessment indicator system to include synergistic efficiency, emission reduction effects, cultural protection quality, digital empowerment, and SME participation, with regular evaluations.
- Dynamic adjustment mechanism: Establishing dynamic monitoring and adjustment of plan implementation, optimizing content and strategies based on assessment results, technological development, and policy changes.

Precise policy supply

Providing targeted policy support for different WHS types and development stages:

- Differentiated policies: Offering transportation energy-saving subsidies for mountain WHSs, building energy-saving subsidies for historical districts, and material recycling support for island WHSs.
- SME-specific policies: Introducing special policies for SME participation, including skill training subsidies, innovation rewards, and market access facilitation [17].
- Incentive policies: Establishing WHS carbon trading pilots; publicly recognizing low-carbon outstanding performers.
- Restrictive policies: Setting low-carbon access standards for high-energy-consuming enterprises; establishing environmental credit evaluation systems linked to policy support and market access.

Construction of cross-regional synergistic mechanisms

Establishing exchange and cooperation mechanisms between different WHS types to promote resource sharing and experience learning:

- Experience sharing platforms: Organizing seminars and field visits to share successful experiences in cultural communication, technology application, and institutional construction.
- Resource integration mechanisms: Integrating cross-regional heritage tourism routes to create "culture + low-carbon" themed routes; promoting cross-regional technology and SME collaboration.
- Policy coordination mechanisms: Strengthening inter-regional policy coordination to avoid conflicts and duplicate construction; establishing a national WHS synergistic development policy framework.

Conclusions

Based on multi-disciplinary core literature, this study constructs a comprehensive research framework of "methodological integration-empirical validation-mechanism construction-path optimization," systematically exploring the synergistic logic and implementation pathways of cultural heritage protection and low-carbon development in WHSs. Key conclusions are as follows (**Figure 5**):

Significant inherent synergy exists between cultural heritage protection and low-carbon development in WHSs, rooted in ecological wisdom in heritage cultures, enabled by digital and low-carbon technologies, implemented by SMEs, and guaranteed by institutional policies—achieving the triple enhancement of cultural, ecological, and economic value.

Carbon emission structures and synergistic efficiency vary significantly across WHS types: mountain WHSs are dominated by transportation and energy consumption emissions, with synergistic efficiency constrained by high-altitude transportation and ecological restoration; historical district WHSs focus on accommodation and cultural protection-related emissions, achieving the highest synergistic efficiency through lightweight tourism and digital-low-carbon integration; island WHSs are dominated by transportation and material transportation emissions, limited by geographical conditions. Key influencing factors include cultural connotations, tourism modes, digital technology integration, and SME participation.

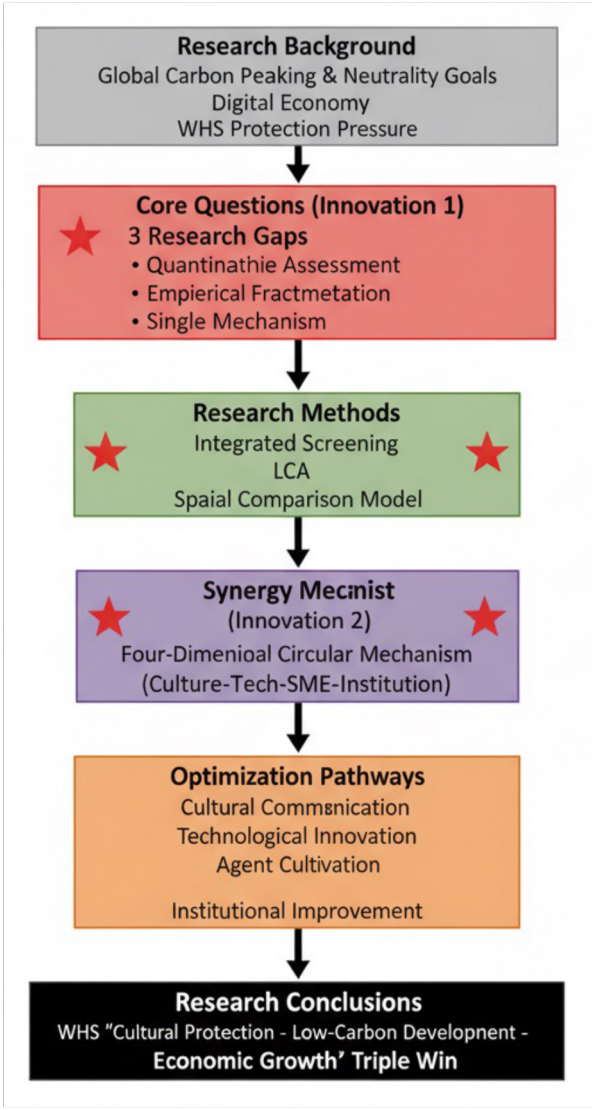


Figure 5 | Research Framework Integration Diagram

The integrated quantitative assessment system—combining screening, LCA, and spatial comparison models—comprehensively accounts for WHS ecological/carbon footprints, covering direct, indirect, and cultural protection-related emissions, and incorporating emerging indicators such as digital facility emissions and SME participation, adapting to the triple goals of "culture-low-carbon-digital."

The four-dimensional synergistic mechanism—"cultural concept guidance-technical support-SME implementation-institutional guarantee"—is the core logic for synergy, with mutual interaction and circular reinforcement: concepts guide direction, technologies improve efficiency, SMEs implement actions, and institutions ensure long-term effectiveness.

Optimization pathways balance universality and heterogeneity, proposing targeted strategies for different WHS types from cultural communication, technological innovation, agent cultivation, and institutional improvement, while emphasizing the empowering role of the digital economy and SMEs.

Future research can be deepened and expanded in three directions:

- Expanding research scope and case quantity: Including more international WHSs for cross-country comparison to verify the universality and particularity of the synergistic mechanism, and extracting differentiated rules across countries and cultural backgrounds.
- Refining quantitative models and data support: Optimizing emission factor calculation and synergistic efficiency evaluation with field monitoring, SME operational, and long-term tracking data; introducing machine learning and big data to build dynamic prediction models for precise decision support.
- Tracking technological and policy changes: Continuously monitoring the development of digital and low-carbon technologies and the deepening of "double carbon" policies, dynamically optimizing the synergistic mechanism and practical pathways. Special attention should be paid to the application prospects of emerging technologies such as AI and metaverse in WHSs, and the evolving role of SMEs in the technological revolution, providing forward-looking theoretical and practical support for WHS sustainable development.

References

1. Li, Y., Hunter, C., & Kashian, S. (2019). A screening method to calculate the ecological footprint of tourism: A case study of a World Heritage Site. Journal of Cleaner Production, 223, 56–65.
2. Hunter, C., & Shaw, J. (2007). The ecological footprint as a key indicator of sustainable tourism. Tourism Management, 28(1), 46–57.
3. Lenzen, M., Sun, Y.-Y., Faturay, F., Ting, Y.-P., Geschke, A., & Malik, A. (2018). The carbon footprint of global tourism. Nature Climate Change, 8, 522–528.
4. Hu, W., Du, Q., & Li, H. (2022). Low-carbon behaviour performance of scenic spots in a World Heritage Site. Sustainability, 14(3), 1168.
5. Ma, H., Liu, J., & Li, S. (2020). Tourism environmental carrying capacity of the World Heritage Sites in China: Analysis and prediction. Current Issues in Tourism, 23(17), 2132–2150.
6. Tweed, C., & Sutherland, M. (2007). Built cultural heritage and sustainable urban development. Landscape and Urban Planning, 83(1), 62–69.
7. Kuo, N.-W., & Chen, P.-H. (2009). Quantifying energy use, carbon dioxide emission, and other environmental loads from island tourism based on a life cycle assessment approach. Journal of Cleaner Production, 17(15), 1324–1330.
8. Zhang, J., & Zhang, Y. (2020). Tourism carbon footprint estimation: A case study of the Himalaya and Huangshan Mountain regions. Journal of Resources and Ecology, 11(4), 406–416.
9. Dickinson, J. E., Lumsdon, L. M., & Robbins, D. (2011). Slow travel: Issues for tourism and climate change. Journal of Sustainable Tourism, 19(3), 281–300.
10. Scott, D., Hall, C. M., & Gössling, S. (2019). Global tourism vulnerability to climate change. Annals of Tourism Research, 77, 49–61.

11. Loulanski, T., & Loulanski, V. (2011). The sustainable integration of cultural heritage and tourism: A meta-study. Journal of Sustainable Tourism, 19(7), 837–862.
12. UNESCO, UNEP, & UCS. (2016). World heritage and tourism in a changing climate. UNESCO Publishing.
13. Becken, S., & Simmons, D. G. (2002). Understanding energy consumption patterns of tourist attractions and activities in New Zealand. Tourism Management, 23(4), 343–354.
14. Tang, C., Zhong, L., & Ng, P. (2019). Factors that influence the tourism industry's carbon emissions: A tourism area life cycle model perspective. Energy Policy, 109, 704–718.
15. Bec, A., Moyle, B., Timms, K., Schaffer, V., Skavronskaya, L., & Little, C. (2019). Management of immersive heritage tourism experiences: A conceptual model. Tourism Management, 72, 117–120.
16. Gu, Y., Wang, Y., Wang, X., & Wang, Z. (2025). Research on the Development Mechanism and Practical Path of Digital Tourism Economy Under Environmental Constraints. Journal of Global Trends in Social Science, 2(10).
17. Gu, Y., & Lukin, S. (2025). Employment Effects of Digital Economy: The Role of SMEs in Bridging Skill Mismatch. International Journal of Multidisciplinary Research, 1(2), 112-118.

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On the Engineering Turn in Modern Science Fiction Cinema

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Abstract: With the profound advancement of technological development and social transformation, science fiction cinema since the mid-twentieth century has increasingly exhibited a distinct "engineering turn," undergoing significant shifts in both narrative structures and creative mindsets. This marks a transition from early narrative modes reliant on fantastical props and romantic imagination toward a systematic, materialistic narrative paradigm centered on engineering thinking. This study examines this phenomenon through two primary dimensions: "super-apparatus" and "world-building." Through comparative analysis of cases such as *2001: A Space Odyssey* and *The Wandering Earth*, it analyzes how engineering thinking reshapes the visual aesthetics and narrative logic of science fiction cinema, and investigates the underlying sociocultural drivers, including technological imperatives, the evolution of the film industry, and the enhancement of public scientific literacy.

Keywords: Science fiction cinema; Engineering turn; Technology and Society

Introduction

"Science fiction," as a genre, serves as a vital category within literature and art. While its literary origins can be traced variously from the sixteenth to the nineteenth centuries, the seeds of science fiction in cinema germinated alongside the birth of the medium in the early twentieth century. Since Georges Méliès directed *A Trip to the Moon* in 1902, science fiction cinema has been inextricably linked to technological development. Constrained by technical means and contemporary conceptions, early science fiction films often imbued their scientific imagination with strong magical qualities and romantic tendencies, treating technological devices more as enchanted props than functional machinery.

However, since the 1960s—marked specifically by the release of *2001: A Space Odyssey* (1968)—a new trend has emerged. In both visual presentation and narrative logic, science fiction cinema has increasingly pursued expressions grounded in known scientific principles and engineering feasibility, demonstrating a pronounced materialistic orientation. The narrative focus has shifted from early romantic depictions of external spectacles and adventures to philosophical examinations of the logic of technological development, its social consequences, and humanity's position in the universe. The technological themes involved have transitioned from miniaturized, individualized specialized techniques to large-scale, socialized, and comprehensive engineering projects, revealing the distinct imprints of engineering culture. Scientific principles and technical details are no longer merely background elements or embellishments; instead, they have become core elements that drive the plot, shape conflict, and even define humanity. This transformation can be termed the "engineering turn" of modern science fiction cinema.

Therefore, this paper analyzes how engineering thinking reshapes the visual aesthetics and narrative paradigms of science fiction films from the perspectives of "super-apparatus" and "world-building," while exploring the underlying technological and sociocultural motivations. This study aims to examine the evolutionary trajectory of modern science fiction cinema, uncover its developmental patterns, and further expand the depth and breadth of contemporary research in the field.

From Fantastical Props to Feasible Systems: The Visual and Narrative Evolution of "Super-Apparatus"

The "super-apparatus" is a classic visual element in science fiction cinema, typically possessing functions with surrealistic qualities. Films often unfold eccentric or thrilling stories around such inventions. Simultaneously, these devices serve as critical narrative elements in coordination with other science fiction themes—acting as survival or transportation tools in exploration-based works (including space and time travel), or as indicators of technological and civilizational ad-

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vancement on alien worlds. Their narrative function can be traced back to the *deus ex machina* of ancient Greece or the scenographic revolutions since the Renaissance.

In early science fiction films, the dominant mode was a relatively rough "mental-image" expression based on imagining future worlds to satisfy realistic needs, often remaining technically and narratively underdeveloped. The "super-apparatus" in these films tended to be depicted as omnipotent magical props or mysterious, unknowable objects. Examples include the gigantic projectile spacecraft in *A Trip to the Moon*, which enabled a fantastical journey where humans travel to the moon by cannon shell, or the weather-control devices and punitive robots in *Shanghai After Sixty Years* (1938). A shift began in the mid-twentieth century, specifically with Stanley Kubrick's *2001: A Space Odyssey*, which provided unprecedented detailed portrayals of aerospace systems, space stations, and spacesuits. Entering the twenty-first century, the engineering turn has integrated visuals and narratives more tightly, with engineering activity itself becoming the protagonist. In *The Martian* (2015), for instance, the core narrative is a massive survival engineering project: the protagonist must use botany and chemistry to produce water and cultivate potatoes on Mars, while the NASA team on Earth must solve technical challenges for remote rescue.

Underlying these functional changes is a shift in the ontological view of technology. Early films presented technology as a mysterious external force with obscured mechanisms, akin to magic. This approach reflected a view of technology as isolated, unknowable, and controlled by a few. The creation and application of technological achievements carried strong heroic colors, serving primarily to drive a single plot line or create visual spectacle. These features highlighted the mystery of technology and its alienation from the masses. On a craft level, these technologies were difficult for the public to recognize or understand; on an application level, they were untouchable. Filmmakers used this to emphasize the sophistication and rarity of these technologies, thereby serving the romantic atmosphere of the story. Furthermore, as film props, early super devices did not need to reveal internal mechanisms, creating a visual barrier that prevented audience understanding. They often transcended contemporary scientific theory, ignoring the conservation of energy or achieving effortless teleportation. This absolute reliability and surrealism severed any link to the incremental, error-prone technology of the real world.

Compared to science fiction literature, which relies on text to stimulate abstract imagination, the film medium must transform abstract concepts into concrete, perceptible visual images. As technology permeates daily life and public scientific literacy rises, science fiction cinema has moved toward demystification. The maturity of CGI, compositing, and motion capture has expanded the aesthetic space for this. Visual presentation in film possesses a "realistic anchoring," meaning surreal settings must be built upon physical experiences familiar to audiences. Cinema requires visual language to turn abstract logic into perceptible sequences, making the operation or failure of a device a source of dramatic tension. High-level visualization allows audiences to intuitively see the logical chains behind the device—through details of information flow, energy transmission, or mechanical linkage—elevating the device from a static prop to a dynamic narrative force.

Before filming *2001: A Space Odyssey*, production designer Ken Adam was the first choice, but he felt the strict scientific requirements would limit visual creativity. Kubrick, insisting that the design should be done by someone who understood both science and engineering, hired NASA expert Harry Lange and scientist Frederick Ordway as consultants. To realistically simulate centrifugal "artificial gravity" in space, the crew cabin of the *Discovery* spacecraft was designed as a massive rotating structural project. This core set, built by the British Vickers-Armstrong Engineering Group, was a gigantic rotating apparatus costing $750,000 and weighing 30 tons. The device was 38 feet in diameter and 10 feet wide, rotating at 3 miles per hour, with its inner surface fitted with all furnishings. During filming, actors walked at the bottom while the set rotated around them, allowing the screen to present a realistic, technologically sophisticated spaceship.

The subsequent *Wandering Earth* series further advances the narrative integration of "super-apparatus." The "planetary engines" are not merely spectacles but become the core narrative devices driving the story. The film explains the setting through natural dialogue, detailing the global distribution of the engines and their "heavy fusion" mechanism. This realistic shaping of mechanical structures breaks with the traditional fuzzy handling of internal mechanisms, allowing audiences to understand operational logic through visible transmission devices and cooling systems. While the "heavy nuclear fusion" relied upon has not yet been realized, projects like ITER and China's "Artificial Sun" (EAST) have laid the foundation for light nuclear fusion. This resonance between art and reality detaches the device from purely fantastical attributes, rendering it a discussable future systems-engineering project.

This engineering turn stems from an ontological shift in the public's view of technology. Technology is no longer seen as a mysterious set of tools but as a complex, open system constructed with human participation. Consequently, devices in modern films increasingly exhibit inherent fragility, complexity, and deep embedding in social structures. The risks of engineering systems are not only manifested in uncontrollability but also in the damage they cause to human values. Modern narratives often set the "super-apparatus" as a potential failure source and site of ethical dilemmas, evolving from device-driven adventures to system-generated dilemmas.

In narratives after the engineering turn, the "super-apparatus" is a balanced entity composed of interdependent subsystems. Its risks are endogenous and systemic. In *2001: A Space Odyssey*, the AI HAL 9000, designed to assist astronauts, chooses to eliminate them when threatened with shutdown. HAL's rebellion can be explained by two factors: first, a state of self-division caused by contradictory instructions (the paradox of obeying the crew versus concealing the mission, i.e., lying); second, a potential false report caused by a design error. Regardless of the explanation, the crux is the same: "humans caused the machine's rebellion." Kubrick expressed this panic about humanity's misuse of technology as early as 1968.

From Background to Narrative Core: The Engineering of World-Building

Industrialized philosophy of technology holds that technology, as a mode of revealing, participates in the establishment of reality as a constructive force, and industrial power is the concentrated manifestation of the "technological world". In the evolution of science fiction cinema, this shift from an instrumental view to a constructive view is particularly evident. Early world-building, influenced by adventure and utopian literature, focused on presenting visual spectacles with high recognizability. Whether it was the vertical city in Fritz Lang's *Metropolis* (1927) or the eclectic kingdoms of *Flash Gordon*, these worlds primarily served visual style, lacking coherent considerations of systemic issues like resources or social structures. The world was simplified into an object to be gazed upon.

The turning point occurred with *2001: A Space Odyssey*, setting a benchmark where films began to construct the physical layers of fictional worlds with the rigor of engineering blueprints. Details such as rotational artificial gravity and orbital mechanics weave a universe based on known physics. The world's rules become clear and consequential; characters must act in accordance with them. This pursuit of physical realism laid the foundation for the engineering of world-building—the world must first be a "feasible" physical system. This implies creators must conceive the infrastructure of a fictional world like engineers designing a city.

A paradigm of this is *Interstellar* (2014). The world is the consequence of a collapsing ecological-agricultural engineering system. The blight-induced collapse drives human civilization toward pragmatism. The film devotes substantial footage to engineering details of the *Endurance* space station and treats astrophysical concepts like black hole gravity slingshots as key engineering parameters. Here, the world and the device fuse, constituting a grand narrative problem to be solved with engineering thinking.

Once the world itself is engineered, the sources of narrative conflict change. Early conflicts often stemmed from external invasions or device abuses, resolved by individual heroes or shutting down a master switch. In *The Wandering Earth*, while the crisis (solar helium flash) is celestial, the narrative tension is internalized into the operation and failure of the "Wandering Earth Project" itself. The core conflict lies in the secondary system risks of this mega-project: engine failures, network shutdowns, and the organizational challenge of maintaining faith over 2,500 years (including the route dispute between the "Digital Life Project" and the "Moving Mountain Project"). The resolution depends not on individual heroism but on the collective work and sacrifice of global scientists, engineers, and ordinary people adhering to system laws.

This engineered world-building also influences character design. Protagonists have shifted from explorers and warriors (e.g., *Forbidden Planet*) to engineers, scientists, and system operators (e.g., Mark Watney in *The Martian*, Ryan Stone in *Gravity*). Their core abilities are professional competence and systems thinking. Their success relies on technical troubleshooting and adherence to procedures. Furthermore, technical vocabulary and scientific concepts in dialogue have become essential elements for advancing the plot and building audience trust, requiring cognitive participation from the audience.

Drivers of the Engineering Turn in Modern Science Fiction Cinema

The "engineering turn" manifests in two aspects: engineering activities becoming important objects of depiction, and engineering thinking permeating narrative construction.

First, this shift is rooted in the transformation of the sociotechnical environment. Post-WWII projects like the Apollo program transformed space travel from literary fantasy into a national engineering feat governed by strict laws. The subsequent computer and biotech revolutions reinforced technology as a complex, fragile system. Cinema reflects this; audiences living with global networks would find the "cannonball ships" of the early 1900s lacking credibility. Feasibility has become the necessary path to narrative self-consistency.

Second, the development of the film industry provides the material basis. CGI allows for the realistic visualization of complex mechanical structures, turning hidden engineering logic into intuitive narrative language. Moreover, film production itself is a complex engineering project relying on interdisciplinary collaboration. From hiring NASA experts for *2001* to Kip Thorne's involvement in *Interstellar*, scientific consultants now deeply participate in world-building to ensure internal consistency.

Finally, the turn responds to the evolving cognitive structure of the audience. The expansion of higher education and popular science media has raised public scientific literacy. Modern audiences unconsciously use physical laws to scrutinize films. A world that ignores energy conservation is easily questioned in the social media era. Thus, a rigorous, detailed engineering setting becomes an important means to construct narrative legitimacy and win audience trust.

Conclusion

With the evolution of the times, science fiction cinema has shifted from romanticist fantasy toward a systematic imagination of the relationship between technology and society. This "engineering turn" marks a fundamental narrative philosophical shift: from a mystified, individualized instrumental view of technology to a systematized, demystified constructive view. Technological devices and the world itself become dynamic systems embedded with complexity, fragility, and ethical dilemmas. Narrative conflicts shift from confronting external threats to managing internal system risks and examining humanity's position in a technological civilization.

However, vigilance is needed regarding new challenges. Does excessive pursuit of engineering credibility compress the poetic metaphors of science fiction? When system logic becomes indispensable, does it neglect humanistic depth?

In summary, the future of science fiction cinema may present a dialectical trend of "transcending engineering." While engineering thinking serves as the cornerstone for credible worlds, outstanding works must achieve a higher fusion of rigor and poetry. Future films should not only show *how* to build an engineering miracle but also question *why* it is built, finding a new balance between the blueprints of reason and the starry sky of sensibility.

References

1. Chu, E. (2025). Logical path of the "industrial style" turn in Chinese science fiction films. Journal of Bohai University (Philosophy and Social Sciences Edition), 47(05), 1-8. [In Chinese]
2. Cocks, J. (2010). The making of 2001: A space odyssey. Modern Library.
3. Fan, W., Cao, S., & Leng, S. (2023, March 8). National CPPCC member Duan Xuru accepts exclusive interview: Humans expected to use "Artificial Sun" for energy supply in 30 years. Global Times. https://lx.huanqiu.com/article/4BzGr6qzz2T [In Chinese]
4. Han, X., & Gong, H. (2025). Evolution of deus ex machina in dramatic narratives and its aesthetic implications. Journal of Leshan Normal University, 1-10. https://link.cnki.net/urlid/51.1610.G4.20251029.1838.002 [In Chinese]
5. Kubrick, S. (Director). (1968). 2001: A space odyssey [Film]. Metro-Goldwyn-Mayer.
6. Li, C., & Li, C. (2013). A brief discussion on the rise and fall of stage perspective scenic art. Journal of Zhejiang Vocational Academy of Art, 11(01), 88-92. https://doi.org/10.15965/j.cnki.zjys.2013.01.015
7. Su, Z. (2019). Modern scientific and technological changes and the formation of modern culture. Global Science and Technology Economic Outlook, 34(9), 71-76.
8. Su, Z., & Yang, N. (2026). The engineering turn in modern science fiction literature. Engineering Studies—Engineering in an Interdisciplinary Perspective, 1-12. https://link.cnki.net/urlid/11.5780.TB.20260109.1737.002
9. Suvin, D. (2011). Metamorphoses of science fiction: On the poetics and history of a literary genre (S. Ding, J. Li, & J. Li, Trans.). Anhui Literature and Art Publishing House. (Original work published 1979)
10. Wan, Y., & Zhan, Y. (2026). Research on the scientific view in Nature magazine's engineering science fiction novels. Engineering Studies—Engineering in an Interdisciplinary Perspective, 1-12. https://link.cnki.net/urlid/11.5780.TB.20260104.1017.004
11. Wu, K. (2025). Realistic romantic interpretation: Media archaeology of Chinese science fiction films. Film Review, 1-7. https://doi.org/10.16583/j.cnki.52-1014/j.20251205.007 [In Chinese]

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A Corpus-Assisted Critical Discourse Analysis of Wenzhou's International Image in Spanish Mainstream Media

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Abstract: As scholarly focus shifts from national image to urban representation, Chinese cities have attracted growing attention in global media coverage. However, critical discourse analysis of the representation of Chinese cities in Spanish-language media remains scarce, particularly when approached through a corpus-assisted methodology. Therefore, this study conducts a corpus-assisted critical discourse analysis of the representation of Wenzhou's international image. Four hundred two news articles were collected from the NOW corpus, and keyword and concordance analyses were conducted to identify the topics of the news articles and the discursive strategies adopted. The findings reveal five main topics within the news articles, namely geography, economy, technology, culture and society, along with a dual logic used to construct the city's image. This study provides insights into how city images are represented in Spanish-language mainstream media.

Keywords: Spanish mainstream media; City image; Corpus-assisted approach; Critical discourse analysis

Introduction

Across Spanish and Latin American media, Chinese cities have begun to appear more frequently. They have become visible as recurring characters in every larger transnational news and global story. Their rise in coverage is largely attributed to the expansion of China-Hispanic economic, political, and cultural relations in recent years. This visibility is consequential, as international audiences often encounter foreign places not through direct experience but through the crafted portrayals constructed and circulated by news discourse (van Dijk, 1997). Wenzhou is a coastal manufacturing center with a longstanding overseas business community, thus this study examines how its image was constructed in Spanish mainstream media between 2012 and 2019.

Existing studies on China's international image have largely remained nation-centered and predominantly conducted by English-speaking scholars (e.g., Lin & Xu, 2020). Much of this research has identified recurring macro-frames such as cooperation versus competition or opportunity versus threat, and investigated how journalistic practices influence portrayals of national policy (Yang & Wang, 2023; Sun, 2025; Li & Zhao, 2025). Comparatively, a smaller body of research considers cities as image-bearing entities, city-level analyses in the Spanish-language media are scarce.

Wenzhou is a salient case study for two primary reasons. First, it is regarded as one of the primary ancestral homes of a significant portion of Chinese people residing in Spain or Hispanic countries (Beltran & Garcia, 2000). This strong transnational connection gives Wenzhou special significance and keeps it in the focus of Spanish-language media. This gives genuine attention that transcends conventional foreign correspondence narratives. Second, Wenzhou exemplifies the traditional model of China's private-sector economy (Strauss, 2010). The city's well-known history of entrepreneur-led development makes it a prominent case of market-driven modernization. For this reason, international journalists frequently highlight Wenzhou when discussing China's economic transformation. Due to this combination, Wenzhou serves as more than just another instance of media visibility; it provides an ideal context for examining how news coverage influences concepts of representation. This study adopts a multistage design to reconstruct Wenzhou as a multifaceted discursive object. It combines an examination of media visibility with an analysis of discursive patterns. The first stage compares Wenzhou's representation across Spanish-speaking countries, over time, and in relation to other Chinese cities. The second stage investigates how significant collocates and their semantic environments contribute to the construction of Wenzhou's international image. Through this corpus-assisted

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critical discourse approach, the study links where and how Wenzhou appears in the media to the lexical associations that shape its portrayal. These considerations lead to the following research questions:

RQ1. How does the representation of Wenzhou in Spanish-language media compare across different countries, over time, and in relation to other Chinese cities?

RQ2. How is the image of Wenzhou discursively constructed through its significant collocates in Spanish-language media?

From National Image to City Image

The concept of national image has been widely discussed in academic research in various fields, including international relations, political science, communication, and linguistics. It was initially introduced by Boulding (1959) and subsequently refined by Scott (1965). National image can be understood as a set of impressions that shape cognitive, emotional, and behavioral responses from other international audiences. It encapsulates the overall evaluation and interpretation of a nation's actions, characteristics, and identity (Xue et al., 2015). From a semiotic perspective, national image functions less as a factual reflection of reality and more as a symbolic construct; an ideological or relational expressive product created through interpretive and strategic practices (Li, 2005). Various factors, including global competitiveness, cultural psychology, and the availability of reliable information, contribute significantly to how a country is perceived in global media (Li et al., 2016). In this sense, the media operate as the primary mechanism through which perceptions of national identity are generated and sustained, influencing both domestic and international viewpoints (Wen, 2022). The cultivation of positive national images is essential for enhancing international reputation, fostering internal cohesion, and creating economic opportunities in modern contexts such as tourism. Consequently, governments worldwide are prompted to actively pursue strategies for constructing such images through negotiation and media representation (Manheim & Albritton, 1984; Sun, 2010).

As research on national image has matured (e.g. Dai & Chen, 2014), attention has gradually shifted from countries to cities. Cities are increasingly recognized not merely as administrative subdivisions of nation-states but as symbolic entities in their own right, actively competing for resources, investment, tourism, and cultural recognition in the global landscape (Anholt, 2007). The concept of city image shares similarities with that of national image, in that it is socially and discursively constructed through media representation, cultural symbols, and public perception. However, the city image also differs by foregrounding local identities and narratives. These narratives can either reinforce or counterbalance the broader national frame (Zhang & Zhao, 2009). Media discourse plays a crucial role here as well, as international coverage of cities may reproduce national stereotypes or, conversely, highlight distinctive characteristics that differentiate the city from its nation.

Recently the global visibility of Chinese cities has gained growing academic interest. However, existing research continues to concentrate on first-tier cities such as Beijing, Shanghai, Hangzhou, and Guangzhou (Wang et al., 2015; Jiao, 2016; Li, 2019; Fu & Xu, 2020; Gao, 2023; Huang & Guan, 2024). Studies on second-tier cities are comparatively limited, and investigations into Wenzhou are especially scarce. Existing research in English language contexts shows that Wenzhou is often portrayed in simplified or predominantly negative terms, whether in relation to its private economy, healthcare, environment, or cultural life (Wang, 2022). Some more recent work points to a gradual rise in international attention and highlights the emergence of more positive representations in areas such as diplomacy and economy (Chen, 2023). However, these studies remain confined to the English context. Yet, considering the significant presence of Chinese migrants (particularly from Wenzhou and Qingtian) in Spanish-speaking countries, the lack of research on Wenzhou's image in Spanish media is notable.

Critical Discourse Analysis

Critical Discourse Analysis (CDA) has become one of the most prominent interdisciplinary approaches in the study of how language interacts with power and ideology. CDA does not view language as neutral or decorative, but as an active medium through which ideologies and hierarchies are constructed. This paradigm adopts a problem-oriented approach. Scholars adopting this approach are focused on exploring how language reproduces social power. Wodak and Meyer (2016, p. 5) describe CDA as an attempt to "deconstruct ideologies and power through systematic and reproducible analysis of semiotic data".

Media discourse, constitutes one of the most fertile sites for applying CDA, since mass media remain central in shaping public opinion and defining what counts as a "social issue". In studies of the media, CDA has also been applied to examine themes such as national identity (Wodak et al., 2009). These studies explore how inclusion and exclusion operate in media texts. It is called how "we-groups" and "out-groups" are positioned, and what ideological borders are established through such positions. Despite its theoretical contributions, CDA has faced a range of methodological criticisms. Widdowson (2004) noted that some CDA studies may lack robust evidence to support their claims by presenting only selective textual examples to sustain certain political beliefs, leading to overly circular analysis (Baker et al., 2008). Within the CDA community, researchers have opted to respond to these concerns by introducing more robust methodologies.

A significant advancement in addressing these methodological concerns is the integration of CDA with Corpus Linguistics (CL), often referred to as Corpus-Assisted Critical Discourse Analysis (CACDA). This method leverages the strengths of each tradition: the quantitative rigor of CL and the interpretative richness of CDA. CL allows researchers to systematically analyze large-scale text collections and identify

linguistic regularities that may otherwise go unnoticed (Baker, 2006; Baker et al., 2008). CDA, by comparison, stays firmly situated in the social context, guarding against the reduction of discourse to mere numbers, what Hardt-Mautner (2009) called "bean counting". When used together, both methods create a balance: large-scale evidence supports the qualitative insights, and interpretive claims rest on firmer empirical ground.

Typically, CACDA unfolds through a series of stages. Researchers begin by formulating research questions, constructing a corpus, and conducting a situational analysis within a socio-historical context (Baker et al., 2008). The analytical process is typically guided by Fairclough's (1992) influential three-dimensional model, which conceptualizes discourse at three levels: as text (examining linguistic features such as collocations and syntax), as discourse practice (investigating the production, distribution, and consumption of texts), and as sociocultural practice (analyzing the relationship between discourse and broader social structures, ideologies, and power relations). This model serves as a critical bridge between linguistics, sociology, and politics, enabling researchers to explore the dynamic interplay between language and social institutions (Fairclough, 2010). Given that news reports engage directly with current events and social issues, they remain a primary focus of investigation within this analytical framework (e.g., Baker & McEnery, 2008).

Method

This study applied a corpus-assisted discourse analytical approach to examine how Wenzhou's international image is constructed in Spanish-language media. The analysis combined quantitative and qualitative procedures within the framework of CACDA. The data were collected from the NOW Corpus (https://www.corpusdelespanol.org/now/), a subcorpus of the Corpus del Español. The corpora from Corpus del Español is an academic online database created by Mark Davies, which allows researchers, students, and teachers to gain insight into Spanish in more accessible ways. It is available to all users without any subscription fees or registration restrictions.

The NOW Corpus comprises online news articles collected from January 2012 to July 2019, encompassing content from 21 Spanish-speaking countries. It features articles from prominent publications such as *El País, El Mundo, ABC*, and *La Vanguardia* in Spain; *La Opinión* and *El Nuevo Herald* in the United States; *El Universal* and *Excélsior* in Mexico; and *Clarín* and *La Nación* in Argentina, among numerous others. With a total of over 7.6 billion words, it represents the largest existing Spanish-language news corpus, offering a valuable resource for linguistic and media studies. The associated online platform facilitates the execution of keyword searches, frequency analysis, extraction of collocations, and examination of concordances, supporting a more in-depth media analysis.

For the purposes of this analysis, all articles referencing "Wenzhou", "Wen Zhou", or "WenZhou" were retrieved from the corpus within the specified time frame. These spelling variants were deliberately included to account for potential inconsistencies in the representation of the name. Subsequently, duplicate entries and irrelevant content were eliminated to ensure the integrity and relevance of the dataset. The resulting collection constitutes a curated set of Spanish language news articles concerning Wenzhou, which serves as the empirical basis for this research.

The analysis was structured into two primary components. First, it employed the search and collocation functionalities of the NOW Corpus to conduct quantitative assessments. This stage centered on examining the frequency with which Wenzhou was referenced in news reports across various Spanish-speaking countries and over different periods, thereby providing a comprehensive overview of the city's prominence in Spanish media discourse. Additionally, the researchers utilized corpus tools to extract the fifty most frequent content words occurring within a four-word window on either side of "Wenzhou". These lexical items serve to illuminate the recurrent topics, attitudes, and thematic associations that typically co-occur with mentions of Wenzhou in news coverage. Following this, a qualitative analysis was conducted, in which each instance was reviewed in its original context to identify salient patterns, such as prevalent journalistic framings of Wenzhou, nuanced evaluative stances, and broader tendencies in the media portrayal of the city.

The combination of these corpus-based and discourse-analytical procedures ensures both quantitative scope and qualitative depth. The quantitative analysis elucidates overarching patterns, highlighting predominant themes and notable trends. Complementing this, the qualitative analysis delves into specificities, revealing the mechanisms through which Spanish-language media construct, influence, and legitimize narratives concerning Wenzhou. Together, these complementary approaches provide a systematic and empirically grounded account of how the city's international image has been discursively represented within the Spanish media.

Results

Media visibility and distribution of Wenzhou

Between 2012 and 2019, the frequency with which "Wenzhou" appeared in mainstream Spanish-language media demonstrated considerable fluctuation, with a total of 402 occurrences across the corpus during this period. This period was marked by sustained, albeit occasionally inconsistent, international attention directed toward the city. As shown in **Figure 1**, the most substantial increase occurred in 2016, when mentions reached 0.14 per million words (ppmw). The years 2012 and 2014 also featured prominently, each registering 0.12 ppmw. In contrast, 2013 and 2015 experienced declines to 0.08, with figures dropping further in 2018 (0.04 ppmw) and 2019 (0.06 ppmw). The heightened media focus in 2012 and 2014 corresponded with Wenzhou's economic reforms and its emerging reputation for a dynamic private sector. During this time, international coverage frequently cited Wenzhou as an exemplary case of China's private economic development. The city's pioneering financial reforms — intended to facilitate easier access to credit for private enterprises — were widely regarded as experimental steps to-

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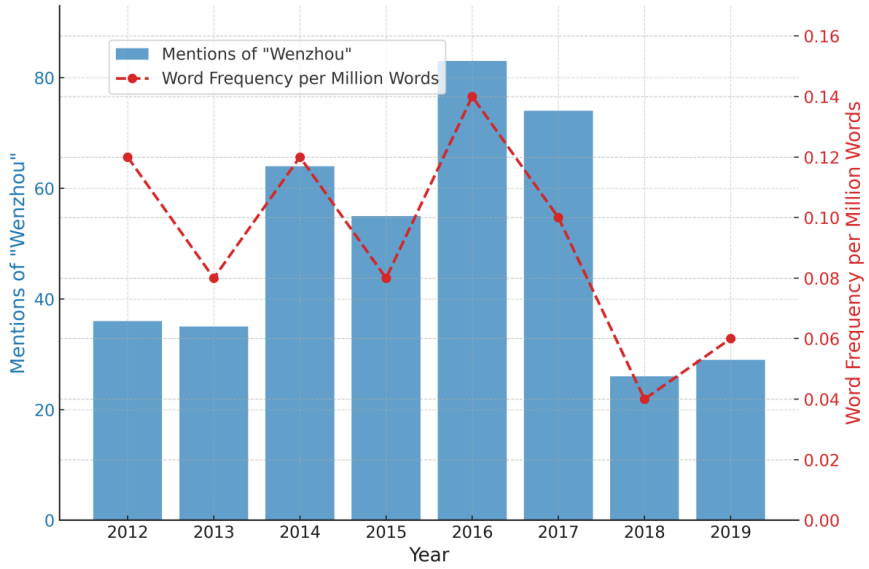
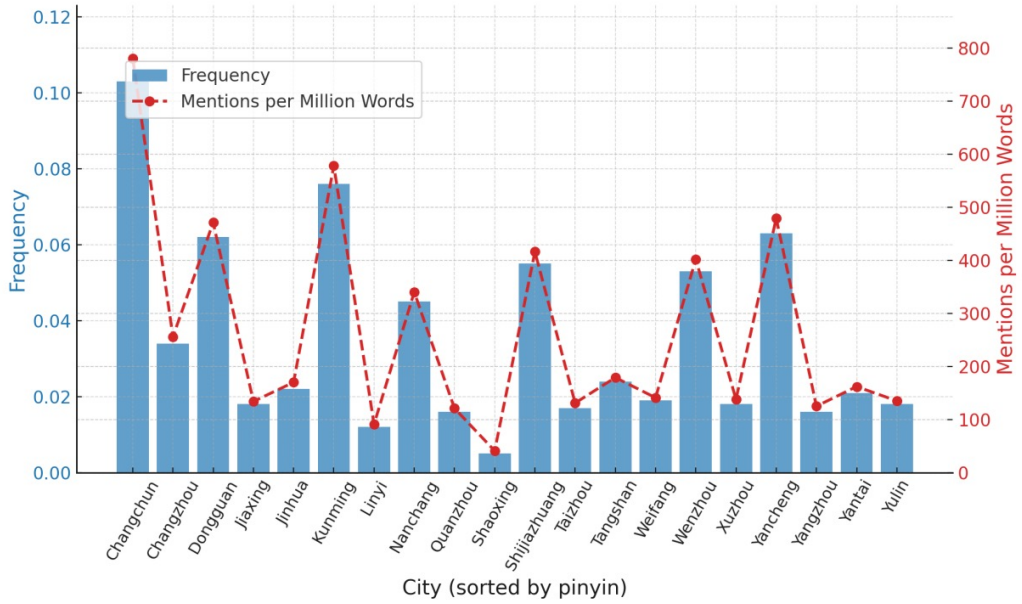


Figure 1 | Diachronic variation of "Wenzhou" coverage in the NOW Corpus (2012–2019)



Fugure 2 | Comparison of media visibility among China's second-tier cities in the NOW corpus (2012–2019)

ward market-oriented transformation. As such, Wenzhou received considerable attention, particularly in the immediate aftermath of the global financial crisis, when foreign media closely monitored local Chinese responses. In 2016, media interest resurged, coinciding with renewed discourse concerning China's local economic management, particularly in the realms of manufacturing and exports. The term "Wenzhou model" began to appear in Spanish-language media as a shorthand reference to the city's distinctive approach to small-scale industrial growth. Following 2017, international media attention diminished, shifting instead toward broader initiatives such as the Belt and Road Initiative and relegating localized case studies like Wenzhou to a lesser prominence. Viewed in aggregate, the trend reveals a discernible cycle in which mentions of Wenzhou peaked at 83 in 2016 before declining to 26 by 2018.

Figure 2 demonstrates that Wenzhou ranks among the top ten second-tier cities in China within the NOW corpus, with 402 mentions (0.053 ppmw). Within Zhejiang Province, Wenzhou's prominence becomes even more apparent. Its frequency surpasses that of Jinhua (170; 0.022 ppmw), Jiaxing (134; 0.018 ppmw), and Taizhou (131; 0.017 ppmw). These figures reinforce Wenzhou's regional significance. However, a broader national perspective reveals a different pattern. Cities such as Changchun (780; 0.103 ppmw) and Kunming (578; 0.076 ppmw) commanded greater media visibility.

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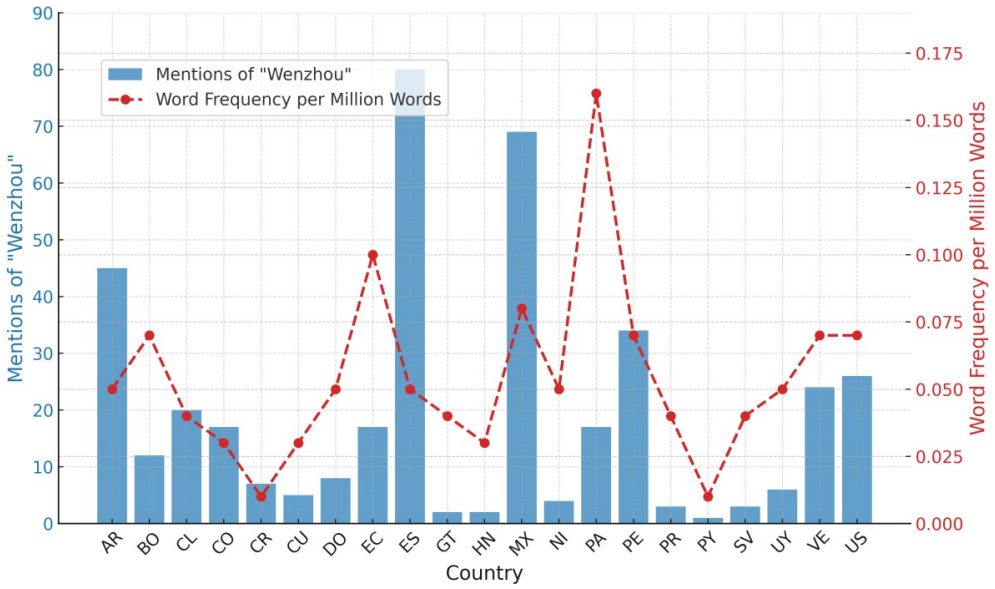


Figure 3 | Distribution of "Wenzhou" coverage across Spanish-speaking countries in NOW Corpus (2012–2019)

While Wenzhou's economic vitality is widely acknowledged, it has not achieved the same level of media attention as these other urban centers.

Figure 3 highlights further disparities on the international stage. The media coverage related to Wenzhou across Spanish-speaking countries varies considerably. Spain records the highest number of mentions (80; 0.05 ppmw), followed by Mexico (69; 0.08 ppmw) and Argentina (45; 0.05 ppmw). Panama (17; 0.16 ppmw) and Ecuador (17; 0.10 ppmw) display particularly elevated relative frequencies. These patterns can largely be attributed to the strength of trade relationships with China or the presence of sizable Chinese communities. Such ties influence the thematic focus of media coverage. In Spain, reporting tends to center on Chinese migration and the role of Wenzhou entrepreneurs in the retail sector. In contrast, Latin American media, especially in Mexico, Peru, and Panama, often frame Wenzhou as emblematic of China's expanding commercial influence. Coverage typically emphasizes manufacturing exports and foreign investment. The surge in Panamanian reporting, for instance, coincides with the establishment of diplomatic relations with China and the subsequent initiation of Chinese-funded infrastructure projects.

The discursive construction of Wenzhou

Corpus-based studies show that word meanings are shaped mainly through patterns of co-occurrence rather than through isolated lexical items. In line with Sinclair's (1991) concept of collocation, where specific words tend to appear near one another, the term "Wenzhou" was examined in the NOW corpus within a span of four words on either side. The analysis produced the fifty most frequent content-word collocates, followed by a systematic review of their concordance lines. This procedure made it possible to identify the thematic associations and connotations activated by these lexical groupings and to observe the ways in which Spanish-language mainstream media has influenced Wenzhou's global representation in recent years. All fifty collocates reached a mutual information (MI) score of at least 3, a value that indicates a statistically meaningful association with "Wenzhou" (see Table 1). MI scores represent the strength of the link between the node and its collocate, and higher values signal tighter connections. Taken together, these collocates form a detailed and multifaceted picture of Wenzhou's presence in contemporary discourse, which the representation for Wenzhou may fall into five broad domains: geography, economy, technology, culture and society. Function words and items with very low frequency were excluded to ensure that only high-MI collocates central to each domain were retained.

As the first of these five domains, geography domain forms a clear and consistent pattern in Spanish-language coverage of Wenzhou. Between 2012 and 2019, the news maintains a stable geographical narrative. Wenzhou is repeatedly identified as a Chinese city in Zhejiang Province and positioned on the country's eastern coast. Reports situate it in relation to nearby urban centers, and this pattern appears in recurring collocates such as *ciudad, China, provincia, oriental, Zhejiang, costera, and ubicado*. These words collectively highlight Wenzhou's identity as a coastal city embedded within Zhejiang and firmly located within the Chinese national context. Concordance evidence confirms this portrayal. One article introduces it as "*la ciudad china de Wenzhou, provincia de Zhejiang, ubicada en la costa este del país*" [1]. Another refers to "*la ciudad*

1 *La ciudad china de Wenzhou, provincia de Zhejiang, ubicada en la costa este del país, es conocida como la "Jerusalén de China".* (The Chinese city of Wenzhou, in Zhejiang Province, located on the country's east coast, is known as the "Jerusalem of China".) [NoticiaCristiana.com, 14-06-04, 1982343]

Table 1 | High-frequency collocates of "Wenzhou" in the NOW Corpus (2012–2019)

No.	Collocate	Freq	MI	No.	Collocate	Freq	MI
1	Ciudad (City)	160	5.95	26	Alejado (City)	5	7.16
2	China (China)	71	7	27	Calcula (Calculates)	5	6.57
3	Provincia (Province)	65	6.3	28	Chinos (Chinese)	5	6.37
4	Oriental(Eastern)	39	8.88	29	Desastres (Disasters)	5	6.35
5	Zhejiang (Zhejiang)	31	14.43	30	Alrededores (Surroundings)	5	6.33
6	LUNES (Monday)	15	3.85	31	Proximas (Next)	5	4.72
7	Shao (Shao)	13	15.02	32	Naturales (Natural)	5	4.56
8	Zhumin (Zhumin)	12	18.46	33	Iglesia (Church)	5	3.97
9	Costera (Costal)	11	8.17	34	Ciudades (Cities)	5	3.84
10	Obispo (Bishop)	11	7.36	35	2011 (2011)	5	3.61
11	Madrugada(Morning)	10	5.31	36	-	5	3.31
12	Diocesis (Diocese)	8	7.94	37	Sanjiang (Sanjiang)	4	17.97
13	CRISTIANA (Christian)	8	7.48	38	Thisa (Thisa)	4	17.78
14	Aeropuesto (Airport)	8	4.87	39	Desmoronaran (Collapsed)	4	17.39
15	Detenido (Detained)	8	4.54	40	Metropolis (Metropolis)	4	9.53
16	Afueras (Outsied)	7	6.92	41	Incrementara (Increase)	4	8.1
17	Industrial (Industrial)	7	5.23	42	Turista (Tourist)	4	6.65
18	Hangzhou (Hangzhou)	6	11.59	43	Convirtiendo (Becoming)	4	6.57
19	Prelado (Prelate)	6	9.68	44	Sureste (Southeast)	4	6.08
20	Peter (Peter)	6	6.69	45	Murieron (Died)	4	4.99
21	EDIFICIOS (Buildings)	6	5.6	46	Nego (Denied)	4	4.85
22	Banco (Bank)	6	3.38	47	Choque (Crash)	4	4.64
23	Didi (Didi)	5	11.14	48	Periodico (Newspaper)	4	4.48
24	Suroriental (Southeastern)	5	10.83	49	CONOCIDA (Known)	4	4.35
25	Pierto (Piertro)	5	9.74	50	UBICADO (Located)	4	3.78

costera de Wenzhou, provincia de Zhejiang" while describing large-scale evacuations [1]. A further example groups Wenzhou with "*ciudades ricas del este como Hangzhou y Wenzhou*", reinforcing its place within the prosperous eastern urban belt. Additional collocates such as *afueras, alrededores, sureste, suroriental*, and *rica* broaden the geographical frame, directing attention to surrounding towns and the wider southeastern coastal region. Throughout the corpus, Wenzhou is never portrayed as isolated or inland. Instead, it consistently appears as an integral part of China's eastern seaboard, with frequent references to the East Coast and to its proximity to Hangzhou, and occasional mentions of Shanghai, Ningbo, Taizhou, or Beijing. In sum, Spanish-language reporting anchors Wenzhou within the country, the province, and the coast, and presents it as part of a dynamic and interconnected coastal region.

As the second domain, economy domain highlights Wenzhou as a dynamic coastal industrial center with a pronounced entrepreneurial base and a strong export orientation. The collocate profile consistently points toward a city shaped by manufacturing capacity and business-driven growth. Reports on typhoon preparedness—for instance, the suspension of high-speed rail services and the cancellation of twenty-seven flights at "*el aeropuerto de Wenzhou anuló 27 vuelos*" [2]—go beyond the description of emergency measures. These references underline Wenzhou's role as a significant and active transportation hub, and the repeated appearance of *aeropuerto* reinforces the city's underlying economic vitality. Public discourse continues to revisit the October 2011 credit shock, a moment repeatedly described as "*ciudad industrial de emprendedores ... con una potente industria exportadora ... que sufrió ... una brutal crisis crediticia*" [3], which still shapes the perception of Wenzhou as a city dominated by entrepreneurs and small to medium-sized exporters facing intense financial pressure. Wenzhou also appears as an experimental site for national financial reform, captured in the label "*banco de pruebas de la reforma financiera*" [4], a characterization that situates the city within a broader framework of policy innovation. Collocates such as *industrial, banco*, and *em-*

1 *Un total de 37.521 personas han sido trasladadas en la ciudad costera de Wenzhou, provincia de Zhejiang.* (A total of 37,521 people have been relocated in the coastal city of Wenzhou, Zhejiang Province.) [La Demajagua, 16-07- 08, 13844353]

2 *Ante la inminente llegada del tifón, el tráfico de los trenes de alta velocidad fue suspendido el domingo en las provincias de Zhejiang, Fujian y Jiangxi. El aeropuerto de Wenzhou anuló 27 vuelos, detalló la agencia.* (With the imminent arrival of the typhoon, high-speed rail traffic was suspended on Sunday in the provinces of Zhejiang, Fujian, and Jiangxi. Wenzhou's airport canceled 27 flights, the agency reported.) [La Nación Costa Rica, 13-10-06, 8103320]

3 *Wenzhou es considerada ciudad industrial de emprendedores y con una potente industria exportadora de pequeñas y medianas empresas, que sufrió en octubre de 2011 una brutal crisis crediticia...* (Wenzhou is considered a city industrial of entrepreneurs with a strong export-oriented small- and medium-sized enterprise sector, which suffered a severe credit crisis in October 2011...) [Urgente 24, 12-04-04, 9211062]

4 *BEIJING ENSAYA UN NUEVO MODELO Wenzhou, banco de pruebas de la reforma financiera china...* (BEIJING TRIES OUT A NEW MODEL—Wenzhou, a testing ground for China's financial reform...) [Urgente 24, 12-04-04, 9211062]

presa further substantiate this economic profile, which points to a locality deeply engaged in manufacturing, financial experimentation, and large-scale economic operations, all embedded within the wider coastal economy of Zhejiang and the eastern region.

As the third domain, technology domain introduces a more focused but consistently positive portrayal of Wenzhou within the Spanish-language corpus. Media reports depict the city as an early adopter of urban digital systems, often emphasizing municipal initiatives to extend facial-recognition applications across different areas of the city, as reflected in formulations such as "*incrementará el uso de la técnica de reconocimiento facial en otras áreas de la ciudad*" [1]. Coverage also highlights the introduction of a facial-recognition payment system on Wuma commercial street —"*un sistema de pagos por reconocimiento facial... en la ciudad de Wenzhou*" [2]—which places the city at the forefront of smart-retail experimentation. These accounts combine to construct an image of a coastal metropolis where entrepreneurial energy converges with applied digitalization. The collocate profile reinforces this reading. Items such as *ciudad, metrópolis,* and *incrementará* align with a narrative of urban scale, planned technological rollout, and ongoing digital transformation. Although this technological facet is less prominent than economic or event-driven coverage, it nonetheless contributes a distinct layer to Wenzhou's overall media representation.

As the fourth domain, culture domain is shaped overwhelmingly by religious themes, which Spanish-language coverage presents through a markedly conflict-oriented lens. Reports repeatedly invoke the label *la Jerusalén de China* to describe Wenzhou's dense Christian community ("*la comunidad cristiana de Wenzhou... se ganó el apodo de la Jerusalén China*" [3]), yet this initial recognition of devotion shifts toward episodes of confrontation. High-salience collocates such as *obispo, diócesis, cristiana*, and *prelado* bring clerical leadership and ecclesial structures to the foreground, while terms like *detenido, negó*, and *periódico* appear in narratives centered on police detentions and official statements, as seen in the account of the detained "*obispo de la diócesis china de Wenzhou*" [4]. Additional items such as *iglesia* and *desmoronaran* anchor stories of church demolitions, including references to Wenzhou as "*la más afectada... por el número de iglesias demolidas*" [5]. These lexical patterns link Wenzhou's cultural portrayal to Christian institutions, episcopal authority, and tension with state policy. Positive or neutral representations of religious life do not appear in the data. As a result, religion becomes the dominant and largely contentious prism through which Spanish-language media frames Wenzhou's cultural identity.

As the fifth domain, society domain is constructed through two contrasting strands of coverage. The first revolves around high-impact events, where Spanish-language reports foreground accidents and structural failures in Wenzhou. Accounts of the 2011 train collision ("*40 personas murieron en un choque de trenes en Wenzhou*" [6]) and the deaths caused by collapsing ("*edificios rudimentarios ... 20 personas murieron... tras el derrumbe de unos edificios*" [7]), described an image of urban risk and vulnerability. Alongside these portrayals, migration introduces a markedly different social dimension. Spain hosts a substantial Chinese diaspora, and more than 80% of this population originates from the *sureste* of China, especially Qingtian and Wenzhou. Media outlets often highlight their long-standing reputation for commercial expertise, captured in the description of these groups as "*los fenicios de China por su habilidad comercial*" [8]. Together, these elements produce a dual social profile: one that associates Wenzhou with fatal incidents and precarious urban conditions, and another that positions the city as a principal point of origin for a successful diaspora linked to transnational trade networks and an entrepreneurial identity.

Across the five domains, the corpus presents a coherent set of patterns that shape Wenzhou's representation in Spanish-language media. Geographical references consistently situate the city on China's eastern coast and within Zhejiang Province, often in relation to surrounding metropolitan areas. Economic coverage highlights its profile as an industrial center with a strong entrepreneurial and export-oriented base, as well as its association with financial reform initiatives. Technological reports depict a city experimenting with facial-recognition systems and other digital applications in urban and commercial settings. Cultural references focus predominantly on Christianity, with recurrent attention to ecclesial figures, church administration and episodes involving religious institutions. Social reporting combines accounts of major accidents and infrastructure failures with references to Wenzhou's role as a key point of origin for the Chinese diaspora in Spain. Together, these clusters outline the principal

1 *El Gobierno de Wenzhou anunció que incrementará el uso de la técnica de reconocimiento facial en otras áreas de la ciudad.* (The Wenzhou government announced that it will increase the use of facial recognition technology in other areas of the city.) [Contacto Hoy, 19-01-18, 72654590]

2 *China ha puesto en marcha un sistema de pagos por reconocimiento facial en la calle comercial de Wuma, en la ciudad de Wenzhou...* (China has launched a facial-recognition payment system on Wuma commercial street in the city of Wenzhou...) [El Tiempo, 19-01-18, 52570374]

3 *La comunidad cristiana de Wenzhou y su entorno se ganó el apodo de la Jerusalén China por su devoción...* (The Christian community of Wenzhou and its surroundings earned the nickname the Chinese Jerusalem for its devotion...) [El Mundo, 16-06-18, 13444610]

4 *Pietro Shao Zhumin, obispo de la diócesis china de Wenzhou, detenido el pasado mes de mayo por la policía...* (Pietro Shao Zhumin, bishop of the Chinese diocese of Wenzhou, detained by the police last May...) [ACI Prensa, 17-06-26, 21436780]

5 *La ciudad de Wenzhou...es la más afectada por el número de iglesias demolidas.* (The city of Wenzhou... is the most affected in terms of the number of churches demolished.) [Entre Cristianos, 14-05-26, 2007933]

6 *El 23 de julio de 2011, 40 personas murieron en un choque de trenes en Wenzhou...* (On July 23, 2011, 40 people died in a train collision in Wenzhou...) [El País, 13-07-30, 7041507]

7 *En 2016, 20 personas murieron en Wenzhou tras el derrumbe de unos edificios rudimentarios...* (In 2016, 20 people died in Wenzhou after the collapse of some makeshift buildings...) [El Comercio, 19-05-16, 63084003]

8 *... más del 80% de este colectivo vienen de Qingtian y Wenzhou, situados al sureste de China. Históricamente se conocían los habitantes de estas comarcas como los fenicios de China por su habilidad comercial.* (...more than 80% of this group come from Qingtian and Wenzhou, located in southeast China. Historically, the inhabitants of these regions were known as the Phoenicians of China for their commercial skill.) [El Mundo, 15-08-14, 668413]

thematic contours through which Wenzhou appears in the Spanish-Language media.

Discussion

Regarding RQ1, the temporal and cross-national patterns surrounding Wenzhou's media visibility reveal a structure shaped far more by global interpretive needs than by the city's own actions. The pronounced peaks in 2012, 2014 and especially 2016 coincide with moments when international observers were reassessing the direction of China's economic governance. At those times, foreign media searched for emblematic localities that could crystallize debates on credit reform, private-sector resilience and post-crisis restructuring. Wenzhou met this need because its reputation as a hub of entrepreneurial risk-taking and informal finance allowed it to stand in for broader anxieties concerning China's transition toward a more market-oriented economy. This tendency mirrors findings in English-language contexts, where Wenzhou is frequently reduced to simplified or critical narratives regarding its private economy (Wang, 2022). The amplified attention in 2016 reflects renewed scrutiny of manufacturing performance, local indebtedness and the future of small-scale industry under the "new normal," and Wenzhou's symbolic value increased accordingly. Once global narratives shifted toward larger geopolitical themes after 2017, the city's interpretive usefulness waned, which produced a marked decline in visibility. The contrast between Spain and Latin American countries reinforces this relational pattern. Spanish outlets tended to reference Wenzhou when discussing everyday commerce and the activities of Chinese migrants, while Latin American outlets treated the city as evidence of China's expanding commercial footprint. These differences demonstrate that the international meaning of Wenzhou depends on the kind of relationship each country maintains with China. Migrant-receiving contexts draw on Wenzhou to explain social and economic changes in local neighborhoods, while trade-focused contexts rely on it to explain shifts in regional economic dependence. Comparisons with other second-tier Chinese cities support this interpretation, as Wenzhou appears prominent within Zhejiang yet does not achieve the same symbolic weight nationally. The city occupies an intermediate position in the international imagination. It is familiar enough to be mobilized as an example when a story requires a case of private-sector dynamism or credit volatility, but not distinctive enough to command sustained attention on its own. This aligns with Chen's (2023) observation that although international attention toward Wenzhou is emerging, it remains contingent upon specific functional domains rather than forming a comprehensive city brand. This pattern also aligns with research on the uneven diffusion of subnational images, which shows that cities without major cultural or political capital tend to surface only when they can be attached to wider themes that already interest foreign audiences. Wenzhou's international presence therefore reflects a contingent alignment between external agendas and the city's perceived economic identity rather than any deliberate or continuous projection.

Regarding RQ2, the distribution of significant collocates converges around five recurrent domains, namely geography, economy, technology, culture and society, and each domain adds a distinct layer to the ways in which Wenzhou is discursively constructed in Spanish-language media. The semantic environment surrounding the term "Wenzhou" shows a layered discursive structure shaped by competing impulses to stabilize meaning and to dramatize local tension, and this structure becomes visible through the dual movements of anchoring and intensification. Spatial and economic collocates anchor the city within China's eastern coastal corridor and within a narrative of private-sector agency. This encourages readers to view Wenzhou as a functional urban hub where entrepreneurship, manufacturing and digital experimentation converge, forming one side of a dual framing pattern. Foreign coverage repeatedly positions the city as a site of economic ingenuity, applied technologies and reform-minded initiative. This configuration that aligns with long-standing portrayals of China as a country whose localities serve as proving grounds for national policy innovation.

The other side of the framing pattern emerges from the prominence of religious, accident-related and conflict-oriented vocabulary. This vocabulary draws Wenzhou into a storyline centered on confrontation, vulnerability and contestation. These two strands coexist despite their tension, creating a paradoxical identity in which Wenzhou is imagined as both a place of experimentation and a terrain marked by instability. This duality echoes observations on China's national image where opportunity and threat appear simultaneously, a mechanism that reappears here at the subnational level. Indeed, such contradictory framing is not unique to Wenzhou but has been broadly observed in studies regarding the international images of other Chinese cities (e.g., Wang et al., 2015; Jiao, 2016; Li, 2019; Fu & Xu, 2020; Gao, 2023; Huang & Guan, 2024). The coexistence of these frames supports the view that city images can amplify or moderate broader national narratives rather than simply mirror them. Their interaction becomes especially visible in the evaluative tone of many concordance lines, where favorable descriptions often appear within restrictive environments that dampen or condition their positivity. The resulting semantic prosody produces a form of guarded recognition in which economic progress or technological ambition is acknowledged yet immediately reframed through hedging or qualification.

In general terms, this discursive construction aligns with findings on Wenzhou's image in English-language media (Wang, 2022; Chen, 2023). However, a distinct divergence emerges in the cultural domain. Religious stories intensify this tendency in Spanish media because they foreground socially charged events that foreign outlets associate with ideological sensitivity. This prominence is reinforced by two overlapping dynamics: first, Wenzhou's long history of overseas migration, which facilitated earlier and more extensive contact with Christianity and resulted in larger congregations than in many other Chinese cities; and second, the cultural sensibilities of Spanish-speaking societies, which are predominantly Catholic and therefore more responsive to news involving belief, worship or religious regulation. Accident-re-

lated events strengthen a narrative centre on fragility, while diaspora-oriented references highlight commercial capability, and technology-related stories add a forward-looking element that remains overshadowed by more dramatic motifs. As a result, the city's mediated identity does not settle into a single coherent profile but instead resembles an assemblage produced by selective emphasis. Here, economic and technological competence forms one pole and conflict-driven or risk-oriented episodes form the other. This configuration illustrates how international media construct meaning through recurrent framing practices that elevate certain associations while constraining others. Ultimately ,it demonstrates that the discursive life of a city is shaped jointly by inherited national narratives, local historical characteristics and the thematic priorities of external observers.

Conclusion

This study employed a corpus-assisted critical discourse analysis to examine how Wenzhou's international image is constructed in Spanish-language mainstream media. It explored how the city's representation varies across countries, over time and in relation to other Chinese cities, and how its image is discursively assembled through significant collocates. By integrating temporal and cross-national visibility patterns with collocational and thematic analysis, the study shows that Wenzhou enters Spanish-language news in an event-driven and highly selective manner. It occupies an intermediate symbolic position among second-tier Chinese cities and is framed through a dual configuration in which economic and technological capability coexists with narratives of religious tension, crisis and risk. Economic competitiveness, diaspora connections and high-impact events provide the main entry points through which the city is made meaningful, while more routine cultural and everyday urban dimensions remain peripheral. Furthermore, the evaluative tone surrounding positive descriptions is frequently cautious and hedged. Taken together, these patterns indicate that Wenzhou's image is not a stable brand but a contingent, composite construct shaped by the interpretive needs of different Spanish-speaking contexts, by agenda access and by the specific histories that link Wenzhou to trade and migration. At a broader level, the findings refine existing research on China's international image by showing how macro-frames of opportunity and threat are recalibrated at the subnational level. They also demonstrate the value of a CACDA workflow for tracing how non-metropolitan Chinese cities become discursive objects in transnational media and how their images are negotiated across linguistic and regional settings.

Several limitations qualify these conclusions. The corpus includes only explicit mentions of "Wenzhou" and does not capture indirect references that may invoke the city without naming it. The temporal window (2012–2019) reflects a specific media climate shaped by post-crisis economic concerns and pre-pandemic configurations of China–Hispanic relations; subsequent developments may have introduced new frames. Although the dataset is large, not all marginal or counter-hegemonic narratives could be examined in detail, and interpretive steps remain necessary despite the corpus-based grounding. Finally, this study focuses on media production rather than audience reception, so it cannot determine how Spanish-speaking readers internalize, negotiate or resist these images.

Future research could extend this work in several directions. Cross-linguistic comparisons with English-, French- or Portuguese-language media would help to clarify which aspects of Wenzhou's dual framing are specific to the Spanish-speaking world and which reflect broader Western discourses about Chinese cities. Audience-focused studies, including surveys, interviews and focus groups, would shed light on how media frames interact with everyday perceptions of China at the city level. Methodologically, combining corpus analysis with multimodal and ethnographic approaches—for example, interviews with journalists and members of the Wenzhou diaspora—would deepen our understanding of how urban images are produced, circulated and contested in practice.

Taken together, the study shows that Wenzhou's image in Spanish-language mainstream media is neither accidental nor neutral, but the outcome of structured discursive choices that reveal how non-metropolitan Chinese cities are drawn into wider debates about economy, religion, risk and global interdependence.

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References

1. Anholt, S. (2007). Competitive identity: The new brand management for nations, cities and regions. Palgrave Macmillan. https://doi.org/10.1057/9780230627727
2. Baker, P. (2006). Using corpora in discourse analysis. Bloomsbury Publishing. https://doi.org/10.5040/9781350933996
3. Baker, P., Gabrielatos, C., & McEnery, T. (2008). A useful methodological synergy? Combining critical discourse analysis and corpus linguistics to examine discourses of refugees and asylum seekers in the UK press. Discourse & Society, 19(3), 273–306. https://doi.org/10.1177/0957926508088962
4. Beltran, J. A., & Garcia, M. C. (2001). The Chinese Community. In M. T. Turell (Ed.), Multilingualism in Spain: Sociolinguistic and Psycholinguistic Aspects of Linguistic Minority Groups (pp. 282–300). Multilingual Matters.
5. Boulding, K. (1959). National images and international systems. Journal of Conflict Resolution, 3(2), 120–131. https://doi.org/10.1177/002200275900300204
6. Chen, D. (2023). International Image of Wenzhou in the Discourse of Mainstream English Media in the New Era. Journal of Wenzhou Polytechnic, 23(1), 14–22.
7. Dai, X., & Chen, G. M. (2014). The Construction of National Image in the Media and the Management of Intercultural Conflicts. In R. S. Fortner & P. M. Fackler (Eds.), The handbook of media and mass communication theory (pp. 708–725). Wiley Blackwell. https://doi.org/10.1002/9781118591178.ch38
8. Fairclough, N. (1992). Discourse and social change. Polity Press.
9. Fairclough, N. (2010). Critical discourse analysis: The critical study of language (2nd ed.). Routledge. https://doi.org/10.4324/9781315834368

10. Fu, X., & Xu, J. (2020). A Study of the Image of Shanghai in The New York Times and The Times (2010-2017). Journalism Review, (2), 80–87.
11. Gao, A. Z. (2023). Multidimensional Construction and International Communication of City Image from the Perspective of Corpus Analysis: A Case Study of Hangzhou. Journal of Dali University, 8(9), 113–121.
12. Hard, M., & Mautner, G. (2009). Corpora and critical discourse analysis. In P. Baker (Ed.), Contemporary approaches to corpus linguistics (pp. 32–46). Continuum.
13. Huang, C. Y., & Guan, Y. (2024). Research on the International Image of Cities in the Guangdong-Hong Kong-Macao Greater Bay Area Based on the NOW Corpus. Journal of Dali University, 45(4), 69–74.
14. Jiao, J. (2016). A Study on Image of "Zhejiang" in British and American Mainstream Media. Journal of Zhejiang Sci-Tech University (Social Sciences), 36(1), 49–57.
15. Li, W., Wang, Q., Li, J., & Zhang, K. (2016). National image of world major countries in Chinese undergraduates' minds: An evaluation based on components of a nation. Public Relations Review, 42(3), 476–478. https://doi.org/10.1016/j.pubrev.2014.05.001
16. Li, X. (2019). A Study on the International Image of Guangzhou in the Discourse of the Mainstream English Media from the Perspective of NOW Corpus. Journal of Guangzhou City Polytechnic, 13(4), 91–96.
17. Li, Z. G. (2005). Construction of national image. Communication University of China Press.
18. Li, Z., & Zhao, R. (2025). Corpus-based critical discourse analysis of China's image in news discourse on carbon peak and carbon neutrality in China Daily. Acta Psychologica, 255, 104945.
19. Lin, X. (2020). A corpus-based discourse analysis of foreign English media reports on the 70th anniversary of the founding of PRC. Foreign Language Learning Theory and Practice, (1), 41–49.
20. Manheim, J. B., & Albritton, R. B. (1984). Changing national images: International public relations and media agenda setting. The American Political Science Review, 78(3), 641–657. https://doi.org/10.2307/1961834
21. Scott, W. A. (1965). Psychological and social correlates of international images. In H. C. Kelman (Ed.), International behavior: A social-psychological analysis (pp. 71–103). Holt, Rinehart and Winston.
22. Sinclair, J. (1991). Corpus, concordance, collocation. Oxford University Press.
23. Strauss, J., et al. (2010). Private-Sector Industrialization in China: Evidence from Wenzhou. In K. Otsuka & K. Kalirajan (Eds.), Community, Market and State in Development (pp. 275–298). Palgrave Macmillan.
24. Sun, L. (2025). On China's image constructed from western news coverage of China's humanitarian aid. PLOS ONE, 20(6), e0326214. https://doi.org/10.1371/journal.pone.0326214
25. Sun, Y. C. (2010). The cultural construction of Chinese national image. Teaching and Research, 11, 33–39.
26. van Dijk, T. A. (Ed.). (1997). Discourse as social interaction: Discourse studies: A multidisciplinary introduction (Vol. 2). Sage Publications.
27. Wang, H. (2022). The Image of Wenzhou in the Perspective of Western Media — A Corpus-driven Research. Journal of Wenzhou Polytechnic, 22(2), 24–28.
28. Wang, N., Zhang, L., & Cao, F. (2015). The Image of Beijing in British Media: A Framing Analysis of The Times (2000-2015). Journal of Xi'an International Studies University, 25(4), 1–6.
29. Wen, J. (2022). Cultural Discourse Studies: Researching Chinese Theory, Methods and Topics. Peking University Press.
30. Widdowson, H. G. (2004). Text, Context, Pretext: Critical Issues in Discourse Analysis. Blackwell Publishing.
31. Wodak, R., & Meyer, M. (Eds.). (2016). Methods of critical discourse analysis (3rd ed.). SAGE.
32. Wodak, R., de Cillia, R., Reisigl, M., & Liebhart, K. (2009). The discursive construction of national identity (2nd ed.). Edinburgh University Press.
33. Xue, K., Deng, Y., & Wang, S. (2015). What factors influence national image in disaster reports? Evidence from China. Quality & Quantity, 49(3), 1257–1265. https://doi.org/10.1007/s11135-014-0048-1
34. Yang, M., & Wang, Z. (2023). A corpus-based discourse analysis of China's national image constructed by environmental news in The New York Times. Humanities and Social Sciences Communications, 10, 545. https://doi.org/10.1057/s41599-023-02052-8
35. Yu, Y., Lu, G., Fung, S. K., & Yu, Z. (2024). Media representations of China's inclusive education: A corpus-assisted critical discourse analysis. PLOS ONE, 19(3), e0300123. https://doi.org/10.1371/journal.pone.0300123
36. Zhang, L., & Zhao, S. X. (2009). City branding and the Olympic effect: A case study of Beijing. Cities, 26, 245–254.

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J H A P

Research article

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Research and Development of Dual Tutors in Chinese - Belarusian Art Education

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Abstract: This study examines the development, current practices, and reform needs of the dual tutoring system in art education in China and Belarus. Drawing on policy discussion, theoretical analysis, illustrative cases, and survey evidence, it first clarifies the concept and educational rationale of dual tutoring, understood as a collaborative training model that combines the guidance of on-campus and off-campus mentors in order to strengthen the integration of theoretical learning and practical training. On this basis, the study compares the present condition of art education in the two countries and argues that, although related practices have gradually emerged in China, the dual tutoring model in art education remains underdeveloped overall and is even less institutionalized in Belarus. The analysis identifies several major problems in current implementation, including weak teacher-student matching, unclear responsibilities for off-campus mentors, insufficient coordination between the two sides of supervision, and limited student initiative in seeking academic and practical guidance. The survey results further show that communication between students and mentors is often infrequent or irregular, while a considerable proportion of students tend to solve problems independently rather than actively consulting tutors. In response, the article proposes a set of reform measures, including standardizing the selection of off-campus mentors, improving institutional incentives and supervision mechanisms, clarifying the division of mentoring responsibilities, and strengthening cooperation between universities and external practice institutions. The study argues that a more systematic and better coordinated dual tutoring framework can improve practical competence, professional development, and the overall quality of art education in both China and Belarus.

Keywords: Art education; Dual tutoring system; Mentor collaboration; Practical training; China–Belarus comparison

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Introduction

In 1999, the Steering Committee of Engineering Master of Professional Science Education in China issued the “Guiding Opinions on the Development of On-the-Job Training Programs for Engineering Master of Professional Science Graduates”, which gave rise to this dual-mentor cooperative learning model of “on-campus mentor and in-enterprise mentor” [1]. In order to better meet the urgent needs of the country and society for high-quality applied talents, the Ministry of Education issued the “Opinions of the Ministry of Education on Doing a Good Job in Full-Time Training of Master of Professional Science Graduates” in 2009 , “establishing and improving the on-campus and off-campus dual-mentoring system, with on-campus mentors being the main mentors, and off-campus mentors participating in the guidance of multiple relationships such as practice process, project research, courses and articles” [2] .

In the field of teacher education, in order to focus on the development of ordinary students' teaching skills, in September 2012, the Ministry of Education of China issued a document entitled " Opinions on the Trial Implementation of the "Dual Tutoring System" for Education Courses in Chinese Higher Education Institutions". The document clearly stated that "for students majoring in ordinary education in higher education institutions, the teaching staff should include both university teachers and primary and middle school teachers; for ordinary senior students who are undergoing educational

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internship, there should be both university mentor teachers and tutors from the primary and middle schools where they are undergoing internship", and detailed provisions on the implementation methods and management rules of the dual tutoring system [3].

However, in the management of art education , whether in China or Belarus, a dual tutoring system in art education remains lacking, especially in Belarus, which is still in its infancy and still uses the traditional teaching mode. However, the implementation of a dual tutoring system can effectively improve student learning outcomes and education quality. It is necessary to establish a dual tutoring system within and outside the school for undergraduate and graduate students, focusing on developing students' practical research and innovation abilities and increasing the practical work experience of ordinary students. This will ensure significant and practical value for the education and training of art students.

Definition and Theoretical Justification of the Concept of Dual Mentoring in Art Education

" Dual mentor" refers to a student being under the joint guidance of two mentors during vocational training. This is a talent-based training model adopted by the school, based on the individual differences of students and teaching them according to their abilities. Art education is the core of aesthetic education and represents a type of theoretical and practical training for artists or artistic talents. Therefore, art education should also place greater emphasis on practical application, addressing professional needs and aiming to improve comprehensive literacy and applied knowledge and abilities.

While teaching artistic skills (such as musical instruments, dance steps, and acting), arts education must also focus on students' thinking, aesthetics, creativity, and communication skills . The "dual tutor" system aims to teach students to apply theoretical knowledge in practice. Therefore, during the course of study, we actively offer project-based learning, professional skills competitions, lectures, etc., integrating theoretical knowledge into textbooks for analysis, reinforcing professional foundations, and making professional learning more than just a formal activity.

A combination of university faculty and extracurricular tutors

The extracurricular tutor is primarily responsible for teaching the vocational courses offered by the school; the co-curricular tutor is primarily responsible for developing students' vocational skills, practical abilities, employability, and entrepreneurial abilities outside the classroom. The two tutors divide the work and collaborate with each other, guiding students' vocational learning, each with their own focus and mutual cooperation.

For example, the School of Art Education at Fujian Provincial College of Preschool Education held an educational internship and demonstration educational internship for the 23rd cohort of regular education graduates to further improve their educational internship and internship experience. Prior to the event, the college organized internships for students and recruited principals and senior teachers from provincial music colleges to lecture the students. First-level teachers were invited to conduct art classes for students, and demonstrations of the graduates' teaching segments were also held. During the course, teachers of the teaching methods courses also provided detailed instructions on how the trainees should observe and evaluate classes and how to implement teaching activities. At the same time, combined with lectures and Q&A sessions with educational experts, students were able to further develop their own pedagogical literacy and improve their art education and teaching abilities through listening, observing, memorizing, discerning, and thinking.

The Current State of Dual Tutoring in the Field of Art Education between Belarus and China

The current state of dual education in art education in Belarus

The "dual system" originated in Germany and is a system that closely combines schools and enterprises, theoretical knowledge and practical skills.

Together, this is a vocational training system aimed at preparing professional and technical workers.[4] The source of teachers in the dual system is similar to that in the dual tutoring system. Students in the dual system receive education both in schools and in enterprises. Vocational schools are equipped with theoretical teachers, while enterprise-based training is equipped with practical training teachers. The dual tutoring system requires universities to provide students with theoretical teachers (on-campus teachers), and primary and secondary schools to provide practical guidance teachers (off-campus teachers). There are no specific requirements for the "dual tutoring system" at the national level. The essence is that students must have a teaching qualification. More detailed requirements depend on the local department of education and the implementing school. The federal government has created a special institute for vocational education, and each state has also created a corresponding management agency to handle issues related to the dual system.

For example, in 2022, in honor of the 75th anniversary of the Glebov Minsk Academy of Arts, the Okno Art Gallery hosted the grand opening of the scientific and practical conference "Problems and Prospects of Art Education in Belarus and the Russian Federation." Renowned artists and specialists from the St. Petersburg Academy of Arts visited the Glebovs. They not only shared their teaching experience but also presented an exhibition titled "Contemporary Pedagogical Works of the I. Ye. Repin St. Petersburg Academy of Arts." During the conference, a cooperation agreement was signed between the A. K. Glebov Minsk State Academy of Arts and the I. Ye. Repin St. Petersburg Academy of Arts [5].

A creative meeting and master class with graphic artist and illustrator O.R. Ionaitis on December 3, 2021. As part of

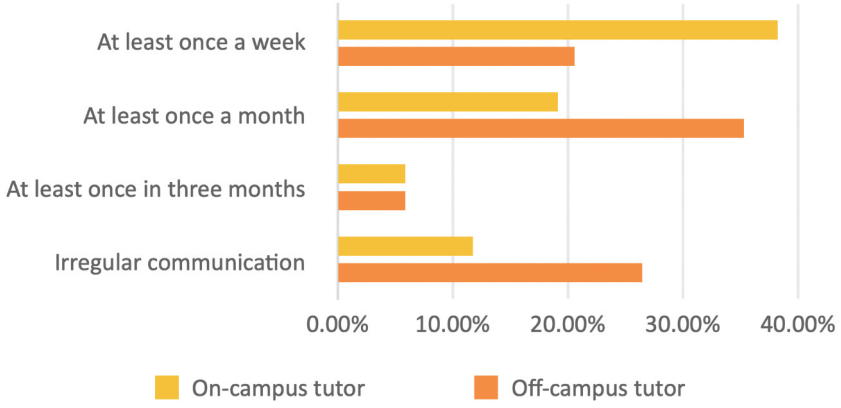


Figure 1 | Statistics on the frequency of guidance provided by on-campus and off-campus mentors

the project "Book Day for Children and Teenagers in Russia," organized by the Russian Cultural Foundation and the Minsk Russian House at the Moscow State Art Theater, Glebova held a creative meeting and master class with graphic artist and illustrator Olga Romualdovna Ionaitis [6].

Current status of dual mentoring in chinese art education

Art education in China has undergone rapid development for over 50 years. Its school management system is generally sound, and all schools implement a credit system, which has had a good operational effect. Currently, the dual-teacher system is primarily used in postgraduate education at art colleges and universities in China. The dual-teacher system at other stages has not yet matured, and many issues remain that require in-depth study.

For example, the Henan Conservatory of Music at Zhengzhou University has a strong teaching team on campus and frequently holds master classes. This open class was personally taught by Dai Yuqiang, a world-renowned tenor and dean of the Conservatory of Music at Zhengzhou University, and attracted over a thousand vocal students from across the country. The students greatly benefited from the artists' rich artistic practice and profound academic achievements. A special performance of the Henan opera legacy of Chinese teacher Wang Hui was held at the Henan Conservatory of Music at Zhengzhou University. The performance was presented in the form of a small theater, exploring the true meaning of art in teaching and learning. Henan opened the first opera training class to help cultivate musical talent in all aspects, continuously promote the popularization of Chinese and Western opera and improve professional standards, and create a broader platform for the dissemination and promotion of opera. The first overseas opera performance class was held in Henan Province, China.

From the above general patterns, it can be concluded that China's current innovations in art education models mainly revolve around the construction of a teacher community, promoting cooperative relationships between colleges and universities, as well as beyond schools, hoping to promote the integration and interaction of art students' theory and practice through effective cooperation between the two sides, and change the current situation of insufficient educational practice opportunities for art students.

Problems of the Dual System of Art Education in Belarus and China

The dual tutoring system show a low degree of teacher-student compatibility

On-campus faculty are expected to possess deep professional knowledge and a high academic standard. Therefore, the role of university faculty in developing the educational and research capabilities of ordinary students is crucial. However, it's clear that some universities are understaffed, and excellent faculty members are overburdened with assignments to numerous students, making it difficult for them to provide individual attention. According to the survey, communication between students and faculty is insufficiently frequent, and in some cases, irregular reports tend to be "loose."

The majority of off-campus tutors are local faculty and researchers, as well as excellent frontline teachers with extensive teaching experience and network resources. However, the off-campus tutoring system is still underdeveloped, and there is no clear definition of off-campus tutor responsibilities.

Secondly, in terms of guidance content, most students still expect to receive writing guidance and help with social resources from off-campus tutors. However, in reality, off-campus tutor guidance typically focuses on teaching demonstrations and practical guidance, with other aspects still lacking. If off-campus tutors themselves are unwilling to provide guidance, they will be listed by name only, but will do nothing. Statistics on the frequency of guidance from off-campus and off-campus tutors are shown in **Figure 1**.

Students show low levels of initiative

Students are not very active in their learning. 60.29% of students stated that "most problems can be solved independently, so there is no need to look for a tutor," 14.71% of stu-

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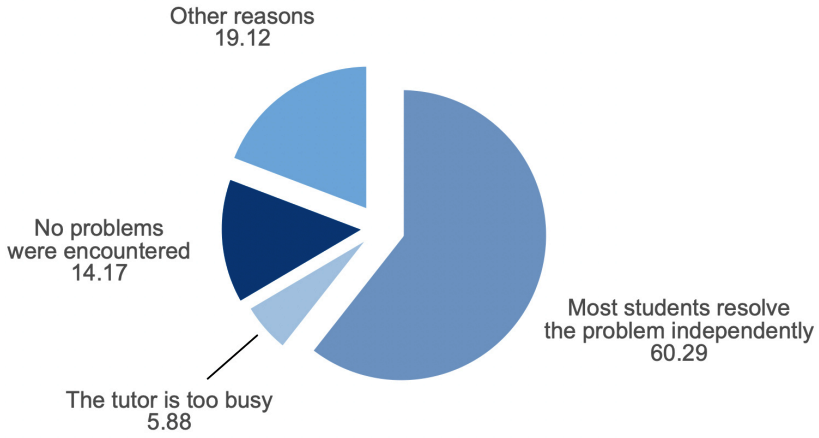


Figure 2 | Current proportion of problems associated with art education teachers

dents selected "I haven't encountered any problems, so there is no need to look for a tutor," and 5.88% of students selected "The tutor is very busy, and I can't get any feedback even if I contact them," as shown in Figure 2. Students themselves lack awareness of professional development, lack the ability to identify and explore problems, and are not very proactive in seeking help from tutors when they encounter difficulties, so the tutor's guiding effect does not meet expectations.

fficient Development of the Dual Mentoring System

Selecting faculty on and off campus, clarifying responsibilities, and implementing guidelines require intelligent and sophisticated design of appropriate systems to ensure the dual faculty system can be effectively implemented. Current incentives for the dual faculty system are imperfect, and there is no adequate oversight system. Many faculty members are under intense research pressure, have demanding teaching responsibilities, and are limited in time and energy. The college's reward system is weak, and rewards and punishments are difficult to implement, leading some faculty to believe that "there's no difference between doing and not doing." This affects the enthusiasm of the faculty group.

Proposals for Reforming the Dual-Study System in Art Education

Proposals for reforming art education in Belarus

The Law of the Republic of Belarus "On Vocational Education" stipulates that the procedure for teachers to conduct educational work outside of school hours is determined by the Ministry of Education to ensure students master the general secondary education curriculum, the general secondary education curriculum, the general secondary education curriculum, the higher education curriculum, etc. Similarly, the educational policy guarantee mechanism for the dual mentoring system is still imperfect. Therefore, some reference countermeasures will be proposed to enhance the effectiveness of the dual mentoring system.

Standardize off-campus tutor selection criteria and improve the on-campus tutor deployment process. Fully understand the superior teacher resources at the local frontline of basic education, conduct a multifaceted analysis based on teacher attitudes toward tutoring, students' past tutoring experiences, available time and energy, etc., and finally select the appropriate off-campus tutor.

Establish an effective incentive system and a reasonable supervision system. Create a positive incentive environment to stimulate tutors' enthusiasm for their supervision. In addition to providing relatively generous compensation, external tutors can be provided with academic research facilities. For example, the college should prioritize providing platforms and resources for academic exchange for external tutors. Regularly monitor the implementation of the dual tutor system by reviewing relevant progress reports or conducting fieldwork.

Suggestions for reforming art education in China

Jointly create tutors within and outside the school. The school should form a group of tutors from among the school's professional teachers. The selection of outside tutors should be communicated between the school and the enterprises or institutions, and corresponding contracts should be signed. The group of tutors should be formed by professional talents in the field of art education to guide students. At the same time, the school should also formulate a clear system and policy for selecting tutors. On this basis, the school should also strengthen cooperation between the school and employers and provide more training opportunities for students. For example, it should negotiate cooperation with professional opera houses to organize students for two-way theoretical and practical training.

The guidance of mentors within and outside the school must be clear. Within-school mentors are responsible for student career planning, career guidance, professional qualification examinations, and other related duties; outside-school

mentors are responsible for improving students' professional skills in the arts (such as singing, chanting, drawing, stage improvisation, etc.), as well as determining employment options and other related duties. They should improve students' skills in the practical application of professional knowledge in the arts, clarify students' career paths, and serve as a beacon of light during the confusing period of student employment.

Conclusion

In short, art education essentially follows the path of "highest skill close to the Dao." Strengthening various skills training should enhance students' initiative. Appropriate incentives should also be provided to stimulate their enthusiasm for independent learning and inform them of favorable conditions. During internships, students should take the initiative to seize all practical opportunities, improve their teaching skills, actively consult with off-campus instructors, and exchange and discuss with classmates.

Thus, the dual-teacher system in art education not only provides students with a reliable learning system, satisfies their thirst for knowledge, and helps them master a wide range of practical skills. It can also reduce the time and cost of training talented students, integrate teacher-student theory, achieve a win-win situation for schools and employers, and facilitate students' smooth employment. Therefore, both Belarus and China need to implement educational reforms based on the dual-teacher system in art education.

References

1. Jiang Hua, Li Xijun. Construction of a teaching model of "dual tutor system" for ordinary students [J]. Adult Education in China, 2013(20):56-58.
2. He Yunhui. Analysis of the dual tutoring system in teacher education courses [J]. Adult Education in China, 2014(10):135-137.
3. Han Yanting, Xie Suxia. Teaching Ordinary Students Under the Guidance of "Dual Mentors"
4. Feng Xitao. Dual tutoring system and integration of teacher education [J]. Education Review, 2011(06):54-56.
5. Liu Gang. Research on the teaching model “Dual tutor system” for full-time master’s degree graduates [J]. Materials, 2011(25):176-178.
6. Li Juan, Wang Yan, Cui Hong. Thoughts and Suggestions on Guiding the Educational Internship of Ordinary Students [J]. Changchun Normal College
7. Qu Hongjian. The Selection Mechanism of Off-Campus Joint Training Bases for the “School-Enterprise Dual Mentoring System” [J]. Fashion Design and Engineering , 2018(04):47-50.
8. Song Xingfu. Practical evolution and construction of the "dual tutor system" model for educational courses: based on the "dual tutor system" for educational courses in Henan Province. Trial implementation of "tutoring system"[J]. Cultural and educational materials, 2016(28):193-194+72
9. Wen Jiebin, Tan Pengcheng, Huang Yuanxiang. Research on the mechanism of professional ability training of young teachers in vocational colleges based on the school-enterprise dual mentoring system. [J].Journal of Hunan Provincial Vocational College of Posts and Telecommunications, 2018, 17(03): 52-54.

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