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Research on Pathways for Technology-Empowered Transformation and Development of Intangible Cultural Heritage (Postprint)

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Abstract

Purpose/Significance The research aims to explore pathways for the creative transformation and innovative development of intangible cultural heritage against the backdrop of culture-technology integration, emphasizing the pivotal role of modern technology empowerment in the transformation and development of intangible cultural heritage. **Method/Process** Through interpreting the connotation of “double innovation” (creative transformation and innovative development) for intangible cultural heritage, analyzing its significant contributions, and conducting categorical scenario analysis of technology applications in intangible cultural heritage “double innovation,” this study investigates six categories of common key technologies and a three-layer framework system for technology empowerment of intangible cultural heritage “double innovation.” Combined with a specific case of traditional intangible cultural heritage craftsmanship—the forging technique of Wuhu Iron Painting—it demonstrates the facilitating effect of modern technology in intangible cultural heritage “double innovation” and its impact on the protection, inheritance, and innovative development of intangible cultural heritage. **Results/Conclusion** The research findings indicate that through technological means, intangible cultural heritage can be effectively protected and inherited, achieving creative transformation and innovative development. Simultaneously, it is necessary to deeply consider and guard against potential risks and challenges that modern technology may pose to intangible cultural heritage projects.

Full Text

Preamble

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Research on the Path of Technology Empowering the Transformation and Development of Intangible Cultural Heritage

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Abstract:

[Purpose/Significance] This study explores the pathways for the creative transformation and innovative development of intangible cultural heritage (ICH) under the background of cultural and technological integration, emphasizing the crucial role of modern technology in empowering ICH transformation and development. **[Method/Process]** Through interpreting the connotation of ICH “dual innovation,” analyzing its significant contributions, and examining categorized technological application scenarios, this paper investigates six types of common key technologies and a three-tier framework system for technology-enabled ICH “dual innovation.” Using the specific example of the traditional craft of Wuhu iron painting forging, it demonstrates how modern technology facilitates ICH “dual innovation” and impacts ICH protection, inheritance, and innovative development. **[Results/Conclusions]** The findings indicate that technological means can effectively protect and inherit ICH, enabling its creative transformation and innovative development. However, it also requires careful consideration and precautions against potential risks and challenges that modern technology may pose to ICH projects.

Keywords: technology empowerment; intangible cultural heritage; creative transformation; innovative development; artificial intelligence; big data; virtual reality

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0 Introduction

Over the past decade, national leadership has attached great importance to the inheritance and innovation of China’s excellent traditional culture. The concept of “creative transformation and innovative development” was first proposed by President Xi Jinping during his inspection in Qufu, Shandong, in November 2013. Since then, these concepts have continuously evolved and become important strategic guidelines for inheriting and promoting Chinese culture. Intangible cultural heritage constitutes a vital component of China’s excellent traditional culture and plays a significant role in forging a strong sense of com-

munity for the Chinese nation and enhancing cultural confidence. In October 2023, the National Conference on Propaganda, Ideology, and Culture was held in Beijing, where President Xi Jinping explicitly emphasized the need to “continue Chinese cultural lineage and promote the creative transformation and innovative development of excellent traditional Chinese culture.” This represents not only respect for history but also the foundation for demonstrating the vitality of Chinese culture.

In August 2019, six ministries including the Ministry of Science and Technology jointly formulated the “Guidelines for Promoting the Deep Integration of Culture and Technology,” proposing to establish an innovation system for cultural and technological integration covering key areas and critical links. This research aims to utilize emerging technologies such as the metaverse, cloud computing, and the Internet of Things to construct a digital protection and inheritance system for ICH. By organically integrating traditional culture with modern digital technology, the goal is to both protect and inherit ICH while allowing it to gain new vitality in contemporary society.

1.1 The Connotation of ICH “Dual Innovation”

In theoretical research, China’s ICH protection has gone through three stages: inheritance-based protection, innovative development, and participatory communication, forging a unique path with Chinese characteristics. In practical research, scholars have analyzed the dilemmas and countermeasures of ICH “dual innovation” from the perspective of cultural entrepreneurship. Empirical research mainly includes case studies, with numerous examples such as the Fuzhou Xiniang custom, which achieves inheritance by expanding concepts and innovating poetic forms; the Nuo carving craft, which achieves dissemination through media promotion and school lectures; and the Bagongshan tofu tradition, which builds regional cultural positioning and brand awareness through training workshops and creative reconstruction.

From a regional perspective, research on Guizhou ICH has explored potential social and economic values through the concept of “seeing people, objects, and life,” while research on Henan ICH has analyzed the difficulty of value transformation and the degree of industrial integration from three angles. These studies demonstrate that “dual innovation” of ICH can be realized through various approaches in content and expression forms, adapting to the requirements of the times and promoting innovation.

1.2 Technology Empowering Traditional Culture

Technology empowerment of traditional culture has become a new path for cultural development. Many scholars have proposed research ideas, suggesting that cultural and technological innovation can solve problems such as insufficient cultural influence, unbalanced development, and shortcomings in cultural security in the construction of a culturally strong country. The construction

of a culturally strong country can provide value guidance, spiritual motivation, and market demand for China's scientific and technological innovation. AI and other modern technologies, while disrupting traditional cultural and creative industries, also create opportunities for Chinese cultural and creative industries to gain new competitive advantages.

In specific practices, the Dunhuang Mogao Grottoes have been used as examples to explore the specific application of technology empowerment in digital protection and display, proposing practical paths for technology in cultural heritage protection. Research on Jingdezhen ceramic cultural and creative industry bases has revealed corresponding countermeasures for industrial development. Chengdu's approach to technology empowering its cultural industry has been analyzed from perspectives of expanding new markets, developing new business forms, and building new safeguards. Jinan's spring culture has utilized technological archaeology and digital protection to promote preservation and inheritance.

1.3 Literature Review

Whether through specific case studies or industrial development research, technology applications have played an irreplaceable role in the development and utilization of traditional culture while promoting integration with modern society. Under the background of cultural and technological integration, ICH, as an important component of traditional culture, faces the important issue of how to better adapt to contemporary culture. Technology empowerment has become a key force in promoting the sustainable development of ICH. However, current research on technology-empowered ICH mainly involves case analyses or practices in specific regions, with insufficient discussion of practical cases. The development path should encompass scenario analysis of technology empowerment, common key technologies, and overall frameworks, which constitute the main objectives of this study.

2 Interpretation of Technology Empowering ICH Transformation and Development

ICH transformation and development aims to enable ICH projects to adapt to the diversified needs of modern society and achieve sustainable development in the new era. The core objective is to adopt effective strategies and measures to ensure the living protection and inheritance of ICH. The "dual innovation" of ICH integrates traditional culture into modern life, serving as an important strategic guideline for its transformation and development.

2.1 The Connotation of ICH "Dual Innovation"

For the creative transformation of ICH, it is necessary to adapt to the characteristics and requirements of the times, transforming those connotations and outdated expression forms that still have reference value, and endowing them

with new contemporary meanings and modern expression forms. The process requires drawing on and exploring elements from traditional culture. Some traditional expression forms may no longer suit modern aesthetics and need transformation. For innovative development, it is necessary to supplement, expand, and improve the connotations of excellent traditional culture according to new progress and developments of the times, maintaining the uniqueness of traditional cultural connotations while enhancing their influence and appeal.

For ICH, the goal is not only to ensure its inheritance and protection but also to achieve its 活化传播 (living transmission), which aligns with the core concept of creative transformation and innovative development of excellent traditional Chinese culture. Creative transformation and innovative development are also key to ICH adapting to the current era. Technology can help record and preserve endangered ICH projects while presenting them in more vivid and engaging ways.

2.2 Important Contributions of ICH “Dual Innovation”

The creative transformation and innovative development of ICH have made important contributions to society, economy, and cultural diversity. Socially, they have significantly enhanced people’s sense of identification and belonging to traditional culture, promoting social inclusiveness and cohesion. By closely integrating ICH with modern lifestyles, they have made traditional culture more accessible and acceptable. Economically, the combination of traditional skills and culture with modern products has provided new impetus for economic growth, enriching market diversity and enhancing product value. From a cultural diversity perspective, living inheritance helps protect and enrich human cultural diversity while stimulating the innovative vitality of traditional culture.

2.3 Technology Application Scenarios in ICH “Dual Innovation”

To better protect, inherit, and develop various types of ICH, China’s national list classifies ICH into ten categories. Modern technology, especially information technology, plays a technical supporting and critical role in the “dual innovation” of ICH. Specific technological application scenarios and innovative strategies can be adopted for different categories, as illustrated in Table 1.

For folk literature, digital technology can be used for information classification and storage, establishing databases to preserve traditional oral literature and enable wider dissemination. The “ICH + New Media” approach integrates folk literary works into new media platforms to enhance storytelling experiences. Traditional music can utilize digital music archives and high-quality recording technologies, combined with VR/AR to create immersive digital scenes for living inheritance. Traditional dance can employ stage technology assistance, laser rendering, and media imaging to enhance visual effects and help audiences understand complex movements.

Traditional drama faces challenges due to its traditional styles and plots. Modern technologies such as holographic imaging and DTS Dolby Atmos sound systems can create immersive experience scenes. The “ICH + Short Video” approach extracts materials from daily life and traditional drama culture, retaining core values while meeting modern audience needs. Quyi (folk performing arts) can use digital music archives and high-quality recording technologies, develop mobile apps, and establish social media accounts for multimedia interaction.

Traditional sports, games, and acrobatics can adopt modern equipment and virtual competition experiences to attract both technical enthusiasts and ordinary audiences. Developing related electronic games and applications can effectively promote cross-border integration between traditional sports ICH and the digital entertainment industry. Traditional fine arts can use digital art creation tools to create new artworks that blend traditional essence with modern aesthetics, while online galleries and virtual exhibitions expand display scope.

Traditional craftsmanship can reduce learning difficulties through online teaching courses and video tutorials. Using metaverse and virtual reality technologies to create immersive and interactive virtual experience platforms provides new possibilities for inheritance. Traditional medicine can adopt modern medical research methods to validate therapeutic principles and effects, using advanced component extraction technologies to explore new uses and efficacy. Folk activities can organize virtual events to innovate festival celebration methods, using social media platforms to increase participation among younger generations.

3 Construction of Technology Empowerment Path for ICH “Dual Innovation”

The creative transformation and innovative development of ICH cannot be separated from modern technology. Through the application of these technological tools, ICH can maintain vitality in modern society. Common key technologies in this process include digital technology, virtual reality and augmented reality, big data analysis, artificial intelligence, cloud computing, and the Internet of Things. Nanotechnology and other modern technologies also play important roles.

3.1 Common Key Technologies for ICH “Dual Innovation”

Digital Technology: Digital technology is fundamental for technology-empowered ICH “dual innovation.” Through digital recording and preservation, endangered ICH projects can be better protected. Digital databases and museums have become mainstream methods for protecting these precious cultural heritages. Digital technology not only preserves original information and details but also enables wide sharing and dissemination, increasing public awareness.

Virtual Reality and Augmented Reality: These technologies provide im-

mersive experiences, allowing audiences to personally experience ICH projects. VR and AR can reproduce historical scenes or simulate traditional craft production processes, enabling audiences to transcend time and space limitations. These technologies also provide new possibilities for ICH education through interactive and participatory learning experiences.

Big Data Analysis: With the rapid development of information technology, big data analysis provides a new methodology for ICH research and development. By mining and analyzing social media platforms, researchers can understand public attention trends toward specific ICH projects. Big data analysis can accurately reveal transmission patterns and public interest changes, providing personalized and differentiated marketing strategies for ICH protection and inheritance.

Artificial Intelligence: AI technology has shown great potential in assisting the creation or reproduction of ICH content such as music and literature. For example, Google's DeepDream in AI painting, AIVA's composition ability, and GPT-3 language processing models for literary creation demonstrate AI's possibilities in artistic creation. AI can also be used to automatically label and archive cultural heritage content.

Cloud Computing: Cloud computing provides massive storage space and efficient data management capabilities, offering secure storage and management solutions for various ICH materials. Combining ICH digital protection with cloud services to build collaborative platforms supports real-time access and sharing, promoting widespread dissemination and popularization of ICH education.

Internet of Things: Deploying sensors and networked devices at ICH events or exhibitions enables real-time monitoring and collection of environmental conditions, protection status, and audience interaction data. This helps managers understand audience interests and visiting habits, optimizing site layout and content. IoT can also enhance the interactivity of ICH experiences through smart guidance systems and interactive exhibits.

3.2 Path Implementation of Technology-Empowered ICH “Dual Innovation”

Technology empowerment serves as a bridge and catalyst in the process of ICH “dual innovation,” connecting traditional charm with modern social needs. The overall framework of the technology empowerment path is shown in Figure 1, consisting of three layers: the method layer, technology layer, and object layer.

[Figure 1: see original paper]

Method Layer: This layer provides the theoretical foundation and guidance for technology-empowered ICH “dual innovation.” Derived from President Xi Jinping's important thoughts on promoting excellent traditional Chinese culture, it defines the direction and goals for ICH innovation development, ensuring

alignment with social needs and development trends. The theoretical guidance of this layer is crucial for the key technologies provided by the technology layer.

Technology Layer: This layer provides key technical support for the transformation and development of ICH, offering the necessary technological means and tools. It includes six common key technologies: digital technology, virtual reality and augmented reality, big data analysis, artificial intelligence, cloud computing, and Internet of Things. The practice and application of this layer directly affect the object layer—the specific content of ICH projects.

Object Layer: This layer focuses on the specific content of ICH projects, including various expression forms such as traditional songs, social customs, and religious ceremonies. The application of technology layer tools directly acts on the object layer, enabling transformation and development in form and content to meet modern social needs. The content and practice feedback from the object layer can further promote the improvement of method layer theories, forming a dynamic cycle.

These three layers constitute a progressive relationship from theory to technology to specific practice. In the object layer, it is necessary to deeply explore the connotation of ICH, transform outdated expression forms, supplement and expand valuable connotations, and ultimately activate the vitality of ICH and enhance its influence.

4 Case Study: Technology Empowerment for Wuhu Iron Painting Forging Technique

With the rapid advancement of technology, each category of ICH has numerous examples of using technological means to promote creative transformation and innovative development. This study selects the traditional craft of Wuhu iron painting forging as a case study, applying the common key technologies and framework system summarized above.

4.1 Overview of Wuhu Iron Painting Forging Technique

Wuhu iron painting forging technique originated in the Song Dynasty, reached its peak in the Northern Song period, and became unique in Anhui during the Kangxi period of the Qing Dynasty, with a history of over 340 years. In 2017, the “Wuhu Iron Painting Protection and Development Regulations” issued by the Wuhu Municipal People’s Congress marked the importance attached to this traditional art form. Iron painting integrates Chinese traditional painting layout techniques with various traditional methods such as paper-cutting and inlay, demonstrating the resilience of the Chinese nation and embodying the exquisite skills of iron painting masters.

Wuhu iron painting has experienced fluctuations from past glory to facing multiple challenges including protection difficulties, outdated themes and styles, and low economic benefits. Various iron craft items and decorative iron flowers that

were once popular have faded from daily life, making it difficult to achieve good economic returns.

4.2 Technology Empowerment for Wuhu Iron Painting “Dual Innovation”

Facing the global digital wave and rising aesthetic demands, local cultural management institutions and iron painting practitioners have actively transformed and integrated modern technology. The technology empowerment of Wuhu iron painting can be demonstrated through four key technological dimensions:

Digital Technology: Wuhu iron painting has actively utilized digital technology to build iron painting databases and digital exhibition halls. Through collecting and processing forging technique resources, interviewing iron painting masters, and producing craft documentaries, multimedia products have been developed around the theme of iron painting. For young people, animated promotional videos and e-books have been developed to introduce the culture and skills of Wuhu iron painting in vivid and interesting ways. In 2023, at the 18th China International Cultural Industry Fair held at the Shenzhen International Convention and Exhibition Center, Wuhu iron painting launched its first 3D digital collection, “Tie Wei Ji Gu Hua Wei Hun” (Iron as Bone, Painting as Soul), using advanced digital technology and 3D scanning. The 1,900 digital collections were quickly sold out on the Xingzhou APP, proving market recognition for this innovative development of ICH.

Virtual Reality and Augmented Reality: Through VR technology, traditional iron painting artworks have been endowed with new dimensions, allowing traditional iron painting art to be appreciated more widely in new ways. The integration of technology and traditional craft forms has expanded the artistic expression of Wuhu iron painting.

Artificial Intelligence-Assisted Design: Wuhu iron painting has signed strategic cooperation agreements with technology companies such as iFLYTEK for “Iron Painting AI Creation” and “Iron Painting Digital Collections,” providing AI technical support for the ICH iron painting technique. The integration of AI technology with traditional craft forms has provided new perspectives and innovative space for the modern expression of traditional culture.

Cloud Platform Application: Cloud platforms have achieved remarkable results in promotion and sales. Using online cloud platforms and other emerging sales channels, the promotion and dissemination efficiency of Wuhu iron painting has been greatly improved. In the field of vocational education through cloud courses, the Wuhu iron painting online cloud course education project launched in May 2019 has released 66 class hours to date, becoming an important achievement in promoting the construction of professional teaching resource libraries for ethnic cultural inheritance and innovation.

4.3 Case Discussion

Through the case analysis of Wuhu iron painting forging technique, the important impact of technology empowerment on ICH “dual innovation” can be clearly seen, including three aspects: protection, inheritance, and innovative development.

ICH Protection: The application of digital technology has played a core role in protecting the iron painting technique. Digital solutions such as developing iron painting databases and digital exhibition halls have provided reliable guarantees for the long-term preservation of the ICH iron painting technique and broadened channels for its dissemination and teaching.

ICH Inheritance: Modern technology has injected fresh blood into traditional skills and found new inheritance pathways. The development of e-books, animated promotional videos, AI-assisted design creation, and digital teaching resources has presented the iron painting technique in new forms, strongly supporting and promoting its inheritance.

ICH Innovative Development: Technology-empowered Wuhu iron painting forging technique has demonstrated strong market potential in innovative development. The innovative development and operation management of valuable digital collections, especially through VR technology and digital collections, have successfully achieved the transformation to digital artworks, expanding new channels for digital transactions and collection.

While modern technology brings positive impacts to ICH, it also entails potential risks and challenges. First, ICH digitization may trigger intellectual property issues, as unauthorized digitization and dissemination may infringe upon the rights of ICH product creators. Second, the digital divide deserves attention, as excessive digitization of ICH resources may exacerbate inequality for information-vulnerable groups in accessing ICH resources. Third, technological intervention may lead to the indirectness and virtualization of ICH experiences, weakening people’s direct experience and profound perception of traditional culture.

5 Conclusion

Modern technology empowerment has played a vital role in the “dual innovation” of ICH, providing strong technical support for its protection and inheritance. With the continuous development of technology, especially breakthroughs in the metaverse, cloud computing, and the Internet of Things, the integration of technology and culture will be further strengthened. These advanced technological applications not only bring transformation and development to traditional culture but also enhance its influence and appeal in contemporary society.

These emerging technologies will not only help protect and inherit traditional culture but also inject new connotations and expressions into it, ensuring that its unique value and charm continue to play out in an ever-changing world.

The “dual innovation” of ICH is a movement that integrates ancient wisdom with modern innovation. It requires us to protect and inherit these intangible cultural treasures with an open mind and innovative means, while allowing them to bloom with new brilliance in new socio-cultural environments.

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