Research on the Digital Living Inheritance of Yaozhou Porcelain Culture

GONG Ting[1], HU Qing[1, 2]

1 Shaanxi University of International Trade & Commerce, Xi'an, Shaanxi 712046, China
2 International University of Kyrgyzstan, Bishkek 720000, Kyrgyz Republic

Abstract: As the sole living inheritance site of Yaozhou porcelain craftsmanship from the iconic Yaozhou Kiln, Chenlu Ancient Town embodies the millennia-long historical and cultural legacy of northern China's ceramic tradition. Yet this heritage now faces interconnected, existential challenges: progressive weathering of physical heritage sites, looming extinction of traditional craftsmanship, restricted cultural dissemination, and stagnant industrial development. Employing digital technologies as our core analytical framework, this paper systematically maps the current research landscape and on-the-ground predicaments of Yaozhou porcelain culture in Chenlu Ancient Town. We establish a holistic protection strategy for this intangible cultural heritage (ICH), deliver actionable implementation pathways for its living inheritance, and provide a transferable theoretical framework for the digital advancement of analogous traditional ceramic ICH globally.

Keywords: Digitalization; Yaozhou Porcelain Culture; Protection and inheritance

I. Introduction

As one of the most iconic celadon kiln systems in ancient northern China, the Yaozhou Kiln boasts a continuous porcelain-making heritage spanning over a millennium. Chenlu Ancient Town, the sole surviving site that has preserved the craftsmanship originating from the Huangbao Kiln—the historical core of the Yaozhou Kiln system—stands as the central carrier for the living inheritance of Yaozhou porcelain culture, renowned for its unbroken millennium-long tradition of porcelain firing. Its Yaozhou porcelain cultural system integrates tangible heritage, including ancient kiln sites and historic workshops, with intangible cultural heritage (ICH) such as time-honored porcelain-making craftsmanship and ceramic-related folk customs. This dual legacy has earned Chenlu Ancient Town official inscription on both China's National List of Famous Historical and Cultural Towns and the National Intangible Cultural Heritage Register.

Yet, amid the dual forces of rapid modernization and large-scale cultural tourism development, the protection and transmission of Chenlu's Yaozhou porcelain culture face a cascade of interconnected and escalating challenges. First, the tangible heritage sites suffer severe and progressive degradation from both natural weathering and anthropogenic disturbance, while conventional manual documentation and preservation methods are fundamentally unable to achieve high-fidelity, permanent retention of these fragile cultural assets. Second, the inheritor pool for core craftsmanship is experiencing severe generational aging, and the traditional master-apprentice oral transmission model—long the cornerstone of skill inheritance—carries inherent

spatial and temporal constraints that drastically limit the reach of knowledge dissemination. Third, cultural dissemination remains reliant on narrow, offline channels, resulting in strikingly low public awareness and a cultural reach confined almost exclusively to niche ceramic enthusiast circles. Finally, the local ceramic industry remains dominated by small, traditional family workshops with negligible integration into the digital economy, creating a critical failure to translate the culture's profound intrinsic value into sustainable economic returns.

Against this backdrop, the exponential advancement of digital technologies has emerged as a transformative force, presenting both unprecedented opportunities and critical new challenges for the transmission of Yaozhou porcelain culture. In China, a series of landmark national policy frameworks—including the Opinions on Strengthening the Protection of Intangible Cultural Heritage, the 14th Five-Year Plan for Cultural Development, and the Overall Layout Plan for Digital China Construction—have been promulgated by the State Council. These documents explicitly underscore the strategic importance and necessity of digital preservation for intangible cultural heritage, define clear objectives and roadmaps for digital development in the heritage sector, and provide robust policy safeguards and a supportive macro-environment for the digital transmission of intangible cultural heritage.

However, despite the growing body of scholarship on Chenlu Ancient Town and Yaozhou porcelain culture, critical and unresolved research gaps persist. Domestic studies have predominantly focused on archaeological excavation, craftsmanship documentation, landscape design optimization, and tourism development of the site, while international scholarship has centered almost exclusively on the artistic value and historical overseas dissemination of Yaozhou Kiln celadon. Strikingly, both research streams have largely overlooked the deep, systemic integration of digital technologies into the protection and transmission of Yaozhou porcelain culture. Most notably, there is a complete absence of rigorous research establishing a holistic digital framework and evidence-based practical implementation pathways tailored to the unique characteristics of this heritage.

To address these critical gaps, this paper employs digital technologies as its core analytical and practical framework to systematically explore the protection, transmission, and activation pathways of Yaozhou porcelain culture in Chenlu Ancient Town. We aim to resolve the entrenched intergenerational transmission dilemmas facing this heritage and advance the living, sustainable development of this iconic intangible cultural heritage. Centered on the three core pillars of protection, transmission, and activation, we construct a systematic digital development system for Yaozhou porcelain culture. This work ultimately provides a transferable theoretical reference and evidence-based practical paradigm for the digital advancement of analogous traditional ceramic intangible cultural heritage sites globally.

II. Overview of Yaozhou Porcelain Culture in Chenlu Ancient Town

A. Historical development context

Chenlu Ancient Town is located in Tongchuan City, north of Xi'an, Shaanxi Province, with a total administrative area of approximately 99.7 km². The town rose to prominence through the household-wide production of Yaozhou porcelain, establishing itself as the largest ceramic hub in northwest China.

Its porcelain-making history dates back to the Tang Dynasty, when it began firing black-glazed and white-glazed porcelain. While the craftsmanship at this stage remained relatively unsophisticated, it laid a foundational bedrock for the subsequent prosperity of Yaozhou porcelain culture.

The Song Dynasty marked the golden age of the Yaozhou Kiln system. As one of the best-preserved and longest-operating kiln sites within the Yaozhou Kiln complex, Chenlu Ancient Town gained widespread acclaim for the exceptional craftsmanship of its celadon during this period. The glaze featured a warm jade-like texture with a subtle yellowish tint within the celadon base, while decorative techniques including carving, incising, and relief engraving reached full maturity. The sharp, fluid knife work and decorative motifs—encompassing peonies, lotus flowers, children at play, and swimming fish—forged a highly distinctive artistic style, cementing Chenlu celadon as a pivotal representative of northern Chinese celadon art.

Following the Yuan Dynasty, the Huangbao Kiln—the historical core of the Yaozhou Kiln system—gradually declined due to frequent warfare, depletion of high-quality porcelain clay resources, and the geographic shift of China's ceramic industry. Chenlu Ancient Town, by virtue of its exceptional endowment of ceramic raw materials and well-established porcelain-making craftsmanship, emerged as the sole surviving inheritor of Yaozhou Kiln techniques, maintaining large-scale porcelain production. During the Ming and Qing Dynasties, the town's ceramic industry expanded further, with product lines extending from daily-use ware to ornamental porcelain and ritual ware. These products not only met civilian demand across northwest China but were also exported to Gansu, Ningxia, Qinghai, and even Central Asia via the Qin-Long Trade Route and the Silk Road, becoming a critical pillar of the regional economy.

In the modern era, the traditional ceramic industry in Chenlu gradually contracted under the impact of mechanized industrial production, with numerous kilns ceasing operations. Nevertheless, a number of hereditary ceramic families persisted in upholding traditional craftsmanship, employing age-old techniques including hand wheel-throwing and dragon kiln firing, thus preserving the living continuity of Yaozhou porcelain techniques. In 2006, the ceramic firing craftsmanship of the Yaozhou Kiln was inscribed in the first batch of China's National Intangible Cultural Heritage List. Chenlu Ancient Town has also been successively designated as a National Famous Historical and Cultural Town of China and a Traditional Chinese Village. Its millennium-unbroken kiln firing tradition represents a rare living specimen in the history of Chinese ceramics.

B. Composition of cultural value

Over a millennium of continuous development, Chenlu Ancient Town has forged a distinctive Yaozhou porcelain cultural system with a multi-dimensional, composite value structure, encompassing material cultural value, intangible cultural value, industrial economic value, and social-spiritual value.

1. Material cultural value

Chenlu Ancient Town preserves an extensive body of material cultural heritage, including ancient kiln sites, ceramic workshops, traditional dwellings, porcelain industry relics, and porcelain-making tools, forming a complete and living heritage system of Yaozhou porcelain culture. These relics are notable not only for their substantial quantity and diverse typology but also for their unparalleled historical significance derived from a millennium of continuous use.

Among these, ancient kiln sites such as dragon kilns and horseshoe-shaped kilns serve as critical physical evidence of Yaozhou Kiln porcelain-making technology. Dragon kilns are built along mountain slopes, with their elongated kiln chambers leveraging natural gradients to generate draft and achieve high firing temperatures. Horseshoe-shaped kilns, with a compact structure and superior thermal insulation performance, are named for their horseshoe-shaped floor plan. These kilns fully retain the original form, masonry techniques, and firing processes of ancient northern Chinese ceramic kilns, providing invaluable physical data for research on the history of northern ceramic firing, kiln evolution, and thermal engineering technology. Structural features including firewood holes, fireboxes, and kiln beds remain identifiable in several kiln sites, making them irreplaceable living specimens for ceramic archaeology and the history of science and technology.

The continuously operating ceramic workshops in the town still preserve traditional porcelain-making equipment and production workflows, with all production stages adhering to traditional handcraft techniques to form a complete living production chain. These workshops function not only as production spaces but also as on-site classrooms for craftsmanship transmission, serving as a core carrier for the living inheritance of Yaozhou porcelain techniques.

Chenlu Yaozhou porcelain is dominated by celadon ware, featuring a diverse array of decorative techniques including carving, incising, and relief engraving. The vessels boast an elegant, rustic form inspired by natural forms, with bold, concise lines; the decorative patterns are exquisitely detailed, executed with sharp, fluid knife work and themed around auspicious motifs such as peonies, lotus flowers, swimming fish, and children at play; the glaze presents a warm, subtle yellowish-celadon hue with the characteristic robust texture of northern Chinese celadon. Balancing the practical functionality of daily use with profound artistic and aesthetic value, Yaozhou porcelain stands as an exemplary model of northern celadon art, occupying a unique position in the history of Chinese ceramics.

2. Intangible cultural value

The Yaozhou porcelain culture of Chenlu Ancient Town encompasses a complete technical system of porcelain making, covering the entire production workflow from raw material mining, clay preparation, wheel-throwing, and trimming, to decorative carving, glazing, firing, and final finishing. Each stage embodies the exquisite handcraft skills and accumulated practical experience of generations of artisans. This technical system not only encapsulates the defining technological characteristics of northern celadon production but also carries profound technical rationality and aesthetic pursuit. The Yaozhou Kiln ceramic firing craftsmanship, inscribed in the National Intangible Cultural Heritage List, underscores the significance of this heritage within traditional Chinese craftsmanship, with its raw material selection, wheel-throwing, and decorative carving techniques bearing distinct regional characteristics and historical inheritance value.

In parallel, Chenlu Ancient Town has developed a unique ceramic folk culture, including folk activities such as kiln god worship, ceramic temple fairs, and handcraft porcelain-making experiences, as well as oral histories and folk legends tied to ceramic production. These folk phenomena are not merely a social extension of porcelain-making craftsmanship but constitute the spiritual core of Yaozhou porcelain culture,

reflecting the deep interconnection between ceramic production and the daily life, belief systems, and festival traditions of local residents. The integration of the technical system and folk culture collectively shapes the holistic identity of Chenlu Yaozhou porcelain culture, establishing it as a pivotal component of Guanzhong regional culture. For this reason, intangible cultural heritage requires both protection and development: protection drives development, and development in turn reinforces protection.

3. Industrial economic value

The ceramic industry has long served as the core pillar industry of Chenlu Ancient Town, underpinning local economic development and household income growth. Traditional Yaozhou porcelain products, combining practical utility and collection value, hold a well-established reputation in China's domestic ceramic market. In recent years, with the sustained development of the cultural tourism industry, ceramic handicrafts and porcelain-making experience programs have gradually become core tourist attractions of the ancient town, driving significant growth in local tourism revenue.

Furthermore, the industrial value of Yaozhou porcelain culture is reflected in its employment generation effect. Sectors including traditional porcelain making, ceramic sales, and tourism services provide extensive employment opportunities for local residents, serving as a key driver for the implementation of China's rural revitalization strategy. The deep integration of the ceramic industry with the millennium-old Yaozhou porcelain culture and the town's unique settlement landscape has formed a cultural tourism resource system integrating cultural experience, craft appreciation, and rural tourism, providing critical support for the town's economic and social development within the context of rural revitalization.

4. Social-spiritual value

Yaozhou porcelain culture carries the collective memory and cultural identity of Chenlu Ancient Town residents, acting as a vital bond for maintaining regional social cohesion. For over a millennium, the transmission of porcelain-making craftsmanship has entailed not only the continuation of technical skills but also the intergenerational transmission of craftsmanship spirit, integrity ethics, and community culture, shaping the town's distinctive humanistic temperament and social structure. The spirit of craftsmanship, ecological wisdom, and cultural character embodied in Yaozhou porcelain culture reflect the core values of excellent traditional Chinese culture. These spiritual resources retain profound guiding significance in contemporary society, providing robust ideological support and value orientation for cultural heritage protection, rural cultural revitalization, and sustainable development.

III. Practical Dilemmas in the Living Inheritance of Yaozhou Porcelain Culture

Despite its profound historical accumulation and multi-dimensional cultural value, the protection and inheritance of Yaozhou porcelain culture in Chenlu Ancient Town face multiple entrenched practical dilemmas amid the process of modernization, which are elaborated in the following four dimensions.

A. Severe degradation of material cultural heritage

The material cultural heritage of Chenlu Ancient Town faces dual threats of natural deterioration and anthropogenic destruction. Most ancient kiln sites are constructed with brick-stone

and earth-wood structures, and long-term exposure to wind and rain erosion, temperature fluctuations, and other natural factors has resulted in widespread kiln collapse, wall peeling, and decorative pattern damage. A number of kiln sites, lacking effective protection measures, have also suffered anthropogenic damage including overgrown vegetation and illegal waste accumulation. Traditional ceramic workshops present prominent structural safety hazards due to years of disrepair, with a portion of workshops having ceased operations and facing the risk of permanent abandonment. In addition, the preservation of Yaozhou porcelain collections is inadequate, with many precious pieces exhibiting glaze cracking and color fading due to improper storage conditions. Conventional protection methods, dominated by manual restoration, text documentation, and ordinary photography, are fundamentally unable to achieve high-fidelity, permanent preservation of material heritage, nor can they provide accurate data support for heritage restoration and conservation.

B. Severe intergenerational transmission crisis of porcelain-making craftsmanship

The inheritance of Yaozhou porcelain-making craftsmanship is confronting a critical intergenerational gap crisis. On the one hand, the inheritor population exhibits severe aging: current master craftsmen of Yaozhou porcelain are predominantly aged between 40 and 59, with an extreme scarcity of young masters and a complete transmission gap among practitioners under 35 years old. On the other hand, the traditional master-apprentice inheritance model carries inherent limitations. Yaozhou porcelain-making craftsmanship involves complex procedures and a long learning cycle (typically 3–5 years to master core skills), coupled with high labor intensity and low financial returns, creating significant barriers to attracting young learners. Furthermore, existing inheritance practices prioritize hands-on practical training, while lacking systematic collation and summarization of the theoretical framework and cultural connotations of the craftsmanship. This has resulted in the gradual loss of technical details due to the constraints of oral transmission, undermining the completeness and accuracy of craftsmanship inheritance.

C. Singular and restricted cultural dissemination channels

The dissemination of Yaozhou porcelain culture in Chenlu Ancient Town remains confined to traditional models, failing to adapt to the communication requirements of the new media era. Dissemination channels rely heavily on offline exhibition halls, on-site scenic spot commentary, and local media promotion, with severely underdeveloped online dissemination infrastructure limited to basic information published on rudimentary websites and social media accounts, lacking diversified communication methods. Dissemination formats are dominated by text and static images, with content focused predominantly on craftsmanship introduction and tourism promotion. There is insufficient excavation of in-depth content including the historical connotations, spiritual value, and craftsmen's stories of Yaozhou porcelain culture, resulting in limited appeal to the general public, especially younger demographics. The reach of cultural dissemination is restricted almost exclusively to niche ceramic enthusiast circles, with low social awareness and influence, failing to achieve the widespread dissemination and sharing of the culture's intrinsic value.

D. Lagging development of the ceramic industry

The ceramic industry in Chenlu Ancient Town remains dominated by small, traditional

family workshops, with a low level of industrial development and insufficient capacity to translate cultural value into market value. On the production side, the small scale of workshops results in low production efficiency and severe product homogenization. Most products are simple replicas of traditional vessel shapes, lacking innovative design and modern aesthetic adaptation, and are unable to meet the diversified and personalized demands of the market. On the marketing side, sales channels rely primarily on offline physical stores and tourist retail, with an underdeveloped online sales system. There is a distinct lack of brand operation and digital marketing thinking, resulting in low product added value and weak market competitiveness. In addition, the integration between the ceramic industry and cultural tourism industry remains superficial, limited to basic porcelain-making experiences and product sales. An industrial development model with deep integration of culture, tourism, and creativity has yet to be established, and the industrial driving effect of the heritage is in urgent need of enhancement.

IV. Digital Living Inheritance Strategies for Yaozhou Porcelain Culture

A. Digital protection of cultural heritage

Digital protection constitutes the foundational pillar for the inheritance and activation of Yaozhou porcelain culture. Its core objective is to achieve high-fidelity, permanent archiving of cultural heritage through digital technologies, providing data support for heritage conservation, restoration, and academic research. Tailored to the distinct characteristics of tangible heritage and intangible craftsmanship, we employ targeted digital technologies to construct a digital resource repository of Yaozhou porcelain culture, realizing the transformation from static documentation to dynamic protection.

1. Digital archiving of material cultural heritage

For the tangible cultural heritage of Chenlu Ancient Town, including ancient kiln sites, historic buildings, ceramic workshops, and representative Yaozhou porcelain collections, we adopt high-precision digital acquisition and virtual restoration technologies to achieve comprehensive, high-fidelity digital archiving, addressing the inherent limitations of traditional protection methods.

First, 3D laser scanning technology is employed to conduct high-precision scanning of the facades, internal structures, and carved decorations of ancient kiln sites and historic buildings, acquiring millimeter-level 3D point cloud data to construct 3D digital models of the heritage. This achieves accurate digital documentation of tangible heritage and provides precise data support for heritage restoration and conservation. Second, UAV photogrammetry technology is utilized to conduct aerial surveys of the overall settlement landscape and ceramic industrial park of Chenlu Ancient Town, constructing a 3D real-scene model of the town to achieve digital preservation of its entire cultural space. Third, high-resolution photography and digital vectorization technology are applied to capture the shape, decorative patterns, and color of representative Yaozhou porcelain collections, with digital vectorization processing of the patterns to preserve the original stylistic features of Yaozhou porcelain decorations, providing raw materials for academic research and innovative design of Yaozhou porcelain art. Fourth, digital restoration technology is implemented to digitally reconstruct damaged ancient kiln sites and porcelain collections, reconstituting the form and decorative patterns of damaged sections through 3D modeling to realize the digital rebirth of cultural heritage. These

technical approaches form a complete closed-loop digital protection system from settlement landscape to porcelain decoration, enabling the permanent preservation of tangible heritage and laying a robust data foundation for subsequent research, exhibition, and activation utilization.

2. Digital documentation of intangible porcelain-making craftsmanship

Yaozhou porcelain-making craftsmanship is the core of Chenlu's Yaozhou porcelain culture. In response to its characteristics of oral transmission and difficulty in concretization, we construct a digital gene bank of Yaozhou porcelain craftsmanship to achieve systematic, standardized digital documentation of the techniques.

First, 4K ultra-high-definition videography and slow-motion shooting technology are used to fully document the entire production workflow of Yaozhou porcelain making, with a focus on capturing the operational details and technical nuances of core procedures including raw material preparation, decorative carving, and dragon kiln firing, realizing the visual documentation of the craftsmanship process. Second, digital oral history documentation is conducted through in-depth interviews with intangible cultural heritage inheritors, recording their porcelain-making experiences, technical insights, folk legends, and ceramic folk customs. A digital oral history repository of Yaozhou porcelain culture is constructed through a combination of audio, video, and text formats. Third, digital genes of Yaozhou porcelain craftsmanship are extracted: core technical indicators in the production process, including clay formulation, shaping parameters, decorative pattern specifications, and firing temperature, are digitally extracted and encoded to build the digital gene bank, realizing standardized, digital inheritance of the craftsmanship and providing technical support for skill learning and innovative development. Fourth, digital documentation of folk activities and cultural rituals related to Yaozhou porcelain culture is carried out, preserving the process, form, and cultural connotations of folk events through video, photography, and live broadcasting, to construct a digital resource repository of Yaozhou porcelain folk culture. These digital documentation methods break through the limitations of traditional craftsmanship inheritance and oral transmission, while fully preserving the core technical content and cultural connotations of the craftsmanship, providing traceable, reusable digital support for the living inheritance and innovative development of Yaozhou porcelain techniques.

3. Construction of the Yaozhou porcelain culture digital resource repository

On the basis of completing the digital acquisition of tangible heritage and intangible craftsmanship, we construct a comprehensive digital resource repository of Yaozhou porcelain culture in Chenlu Ancient Town, realizing the systematic management and efficient utilization of digital resources.

The repository encompasses sub-libraries including a 3D model library of tangible heritage, a Yaozhou porcelain collection library, a porcelain-making craftsmanship video library, a craftsmanship digital gene bank, an oral history library, and a folk culture library. Big data and cloud computing technologies are adopted to realize classified storage, keyword retrieval, online viewing, and downloading of digital resources. Meanwhile, a tiered access permission system is established for the repository: basic cultural resources are open to the public free of charge to provide cultural reference for the general public and researchers, while core technical data are subject to graded access protection to safeguard the

intellectual property rights of intangible cultural heritage inheritors. In addition, a dynamic update mechanism for the digital resource repository is implemented, with regular supplementary surveys and updates of Yaozhou porcelain cultural heritage in Chenlu Ancient Town. New technical achievements, cultural research outcomes, and industrial development results are added in a timely manner to ensure the timeliness and integrity of the repository. Through systematic integration and standardized management, the digital resource repository realizes the centralized preservation, secure protection, and efficient reuse of Yaozhou porcelain cultural resources.

B. Digital dissemination of Yaozhou porcelain culture

Digital dissemination is the key to resolving the intergenerational transmission gap of craftsmanship and enhancing public cultural awareness. Its core is to innovate inheritance models and expand dissemination channels through digital technologies, advancing the transition of Yaozhou porcelain culture from inheritance by a small group of practitioners to shared access by the general public.

1. Advancing craftsmanship inheritance

To break through the limitations of the traditional master-apprentice inheritance model, immersive technologies such as Virtual Reality (VR) are employed to construct a craftsmanship inheritance platform. A virtual porcelain-making workshop is built based on the digital gene bank, where learners can simulate the full porcelain-making process including raw material processing, wheel-throwing, and decorative carving. The system provides real-time error correction and technical explanation to optimize learning outcomes. A craftsmanship guidance system is integrated into physical workshops, offering real-time instruction for learners through virtual prompts, organically combining virtual teaching with hands-on operation to enhance the efficiency of master-apprentice inheritance. An online communication platform is launched, inviting inheritors to conduct live-streamed teaching and work reviews, enabling wider public access to Yaozhou porcelain culture and expanding the inheritor population. A digital craftsmanship experience hall is constructed in the ancient town to provide offline immersive experiences for tourists and students, enhancing public understanding of traditional craftsmanship and learning motivation, thereby driving the living continuation of Yaozhou porcelain techniques.

2. Enhancing cultural influence

A multi-faceted dissemination system is constructed through the integration of diverse digital communication channels. For example, new media platforms including Douyin, Xiaohongshu, and WeChat Channels are utilized to release short videos of Yaozhou porcelain craftsmanship, inheritor stories, and cultural knowledge, engaging younger demographics through content formats aligned with their preferences. A digital museum of Yaozhou porcelain culture is established, integrating digital resources into an online exhibition hall open to the public free of charge, breaking temporal and geographical barriers. An AR scenic spot tour guide mini-program is developed, which automatically presents cultural introductions and historical stories during on-site visits to the ancient town, realizing the deep integration of offline tourism and online dissemination. With the support of international digital cultural platforms, Yaozhou porcelain cultural content is translated into multiple languages to promote its global reach and enhance international influence.

3. Innovating dissemination content

The depth of dissemination is enhanced through

in-depth exploration of the historical, technical, and humanistic values of Yaozhou porcelain. From a historical perspective, the development history of the Yaozhou Kiln and Chenlu Ancient Town is systematically sorted to showcase the millennium-long accumulation of Yaozhou porcelain culture. From a technical perspective, the integration of traditional craftsmanship with modern design is presented to reflect the innovative vitality of Yaozhou porcelain techniques. From a humanistic perspective, the stories of inheritors upholding the craftsmanship spirit are told to imbue Yaozhou porcelain culture with emotional resonance. From a regional perspective, combined with the rural revitalization strategy, the interactive outcomes of Yaozhou porcelain culture and the town's development are demonstrated to highlight its contemporary value, ultimately creating more engaging and influential dissemination content.

C. Digital activation of the Yaozhou porcelain industry

Digital activation is the ultimate objective of the protection and inheritance of Yaozhou porcelain culture. Its core is to advance the deep integration of Yaozhou porcelain culture with the digital economy and cultural tourism industry, realizing the transformation of cultural value into market value, and using industrial development to reinforce cultural inheritance.

1. Innovation of cultural and creative products

Relying on the digital resource repository of Yaozhou porcelain culture, cultural elements including decorative patterns and vessel shapes are extracted to develop diversified cultural and creative products in combination with digital technologies. Digital modeling and parametric design are utilized to innovate the traditional shapes and patterns of Yaozhou porcelain, launching daily-use and craft porcelain products that integrate traditional charm with modern aesthetics. Digital cultural and creative products, such as digital collections of decorative patterns, cultural IP images, and virtual ornaments, are developed to facilitate the issuance of digital collections and expand industrial boundaries. Yaozhou porcelain elements are integrated into daily products including stationery and home furnishings, with large-scale production realized through digital printing and 3D printing technology. A digital design platform is established to solicit cultural and creative design proposals from the public, with outstanding works selected for industrial transformation to stimulate cultural innovation vitality.

2. Expansion of sales channels

An integrated online-offline digital sales system is constructed. For instance, official online stores are opened on e-commerce platforms including Taobao and JD.com, and live-streamed e-commerce is conducted via Douyin and Kuaishou to break geographical restrictions and expand sales scope. Meanwhile, a digital product traceability system is established, assigning a unique traceability QR code to each product to display production techniques and inheritor information, thereby enhancing product added value and credibility. For offline channels, the digital upgrading of physical stores is promoted to create a new retail model combining offline experience with online purchase. In addition, digital brand building is strengthened through the design of a public brand image for Chenlu Yaozhou porcelain and brand promotion via new media, driving the industrial transformation from product sales to brand operation.

3. Integration of digital cultural tourism

Leveraging the cultural tourism resources and digital resources of the ancient town, a smart cultural tourism model with deep integration of digital technology, culture, and tourism

is developed. For example, a smart tourism mini-program for the ancient town is created, integrating functions including online ticket purchase, intelligent tour guidance, and experience reservation to improve scenic spot operational efficiency. Immersive projects including a VR experience hall and AR ancient kiln site restoration area are constructed to enhance tourists' cultural tourism experience. Digital cultural tourism routes themed on Yaozhou porcelain culture are designed, combining online digital experience with offline on-site visits to optimize the allocation of cultural tourism resources. The integration of Yaozhou porcelain culture with rural tourism is promoted to drive the development of surrounding homestays, catering, and related industries, forming a collaborative development model of Yaozhou porcelain culture and rural tourism to support rural revitalization.

V. Conclusions

As a cornerstone of China's outstanding traditional culture, the Yaozhou porcelain culture of Chenlu Ancient Town embodies profound historical accumulation and multi-dimensional cultural value, yet its conventional protection and inheritance models have become incompatible with the demands of the contemporary era. This study centers on digital technologies to establish an integrated three-dimensional framework encompassing the digital protection, transmission, and activation of Yaozhou porcelain culture.

Our findings yield four definitive contributions: First, digital technologies enable high-fidelity, permanent preservation of cultural heritage through high-precision data acquisition and virtual restoration, addressing the inherent limitations of traditional conservation methods. Second, the integration of VR/AR immersive technologies and new media platforms innovates craftsmanship transmission paradigms and cultural dissemination channels, facilitating the living continuation of techniques and enabling widespread public access to the culture. Third, digital empowerment drives the effective transformation of cultural value into market value, fostering an initial virtuous cycle wherein culture nourishes industry and industry sustains cultural heritage. Fourth, the organic synergy of digital protection (foundation), digital transmission (core), and digital activation (fulfillment) constitutes the prerequisite for the sustainable development of Yaozhou porcelain culture, with each dimension mutually reinforcing the others.

Future research avenues include exploring the application of cutting-edge technologies such as artificial intelligence and the metaverse, piloting the implementation of our findings in Chenlu Ancient Town, strengthening cross-regional cooperation in ceramic cultural digitalization, and cultivating interdisciplinary talents proficient in both digital technologies and intangible cultural heritage. Against the backdrop of China's Digital China initiative and rural revitalization strategy, this systematic digital development framework provides robust support for the living inheritance and innovative advancement of the millennium-old Yaozhou porcelain culture.

References

[1] Zhou Y, Xu X. A review of research on the digitalization of intangible cultural heritage[J]. Library and Information Service, 2017, 61(2):6-15.

[2] Zhang Z R, Peng Y D, Liu W R. Research on the activation of ancient town resources in the new media environment — A case study of Chenlu Ancient Town. Unpublished Manuscript, 2021.

[3] Wu Y, Wei B W. Value and protection strategies of ceramic cultural space elements in Chenlu Ancient Town[J]. Future Urban Design and Operation, 2024(3):72-75.

[4] Wang W Z. An Introduction to Intangible Cultural Heritage[M]. Beijing: Educational Science Press, 2008:1-314.

[5] Cui Y. Research on the protection and inheritance of porcelain-making craftsmanship of Yaozhou Kiln from the perspective of intangible cultural heritage[D]. Xi'an: Xi'an International Studies University, 2011.

[6] Geng G H, Gao J, Tang W, et al. Review of research on the digital protection and application of cultural heritage[J]. Journal of Northwest University (Natural Science Edition), 2025, 55(1): 1-22.

[7] Qin S, Liu B J, Bai X B, et al. Research on the construction and reshaping of traditional peony patterns on Yaozhou celadon based on generative artificial intelligence. Packaging Engineering, 2025, 46(18): 380-389.

[8] Liu Z J, Liu Y C. Feature identification and gene extraction of traditional ceramic culture of Yaozhou Kiln[J]. Shandong Ceramics, 2025, 48(6): 29-37.

[9] Hu Y J. Extraction of aesthetic characteristics and research on innovative design of Song Dynasty Yaozhou Kiln[D]. Xi'an: Xi'an University of Science and Technology, 2023.

[10] Xi'an University of Arts and Science. "Chenlu Rejuvenated—Research on AIGC-empowered digital content and application of cultural tourism in Chenlu Ancient Town"[Z]. National College Students' Innovation and Entrepreneurship Training Program, 2025.