

Original Paper

Research on a Sustainable Protection Model for Jingdezhen's Cultural Heritage Across the Entire Region

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Abstract

Against the global digital economy and cultural heritage sustainable governance background, cultural heritage protection has shifted from traditional passive salvage conservation to comprehensive, dynamic and sustainable ecological governance worldwide. Jingdezhen, the world-famous porcelain capital with over 2,000 years of ceramic civilization, boasts integrated whole-region cultural heritage covering tangible kiln ruins, ancient architectural clusters, handmade intangible porcelain craftsmanship, porcelain specimen relics and porcelain-related folk customs. These precious heritage resources constitute a complete industrial and cultural chain of ancient Chinese ceramic manufacturing, bearing unique historical, artistic, scientific and social values. For a long time, scattered departmental management, insufficient long-term fiscal input, continuous outflow and aging of inheritor groups, as well as single protection and development paths have seriously restricted the sustainable inheritance and innovative development of Jingdezhen's all-round cultural heritage. The traditional protection model that overemphasizes physical relic maintenance while ignoring dynamic inheritance and industrial activation has led to the gradual marginalization of folk ceramic craftsmanship and the waste of massive heritage resources. The construction of full-chain digital industrial chain opens up a new sustainable development path for cross-regional integrated heritage protection, realizing the organic integration of cultural preservation, digital innovation and industrial economic circulation. Centered on upstream standardized digital resource archiving, midstream intelligent conservation and immersive content development, downstream cultural creative industrialization and digital cultural tourism operation, this study adopts literature research, field investigation and case empirical analysis, sorts out the practical achievements and prominent drawbacks of Jingdezhen's existing digital heritage construction represented by the Ancient Ceramic Gene Bank and Taoyangli digital scenic project, and constructs a four-dimensional closed-loop sustainable protection framework integrating whole-domain data integration, refined intelligent

protection, industrial value feedback and institutional guarantee from the perspective of digital industrial chain construction. Empirical analysis shows that the industrial closed-loop mode of “heritage digitization – intelligent protection – industrial realization – profit feedback to heritage maintenance” can effectively break the over-reliance of traditional protection on financial appropriation, resolve resource fragmentation and insufficient inheritance problems, and realize the virtuous cycle of heritage protection and industrial development. The research conclusions can provide operable practical references for Jingdezhen’s holistic heritage conservation and deliver replicable digital protection experience for global historical and cultural cities with similar handicraft heritage resources.

Keywords

Digital Industrial Chain, Whole-Region Cultural Heritage, Sustainable Conservation, Jingdezhen Ceramic Heritage, Digital Empowerment, Industrial Feedback Mechanism, Intangible Cultural Heritage Activation

1. Introduction

Jingdezhen’s whole-region ceramic cultural heritage breaks the boundary of single-site relic protection and forms a spatially linked heritage ecosystem spanning urban and rural areas, covering tangible imperial kiln ruins, ancient workshop sites, ancient ceramic roads and millions of unearthed porcelain fragments as well as intangible handmade porcelain craftsmanship, kiln-building techniques and porcelain-related folk customs such as porcelain trading culture and craft inheritance rituals. Different from ordinary single-type cultural heritage, Jingdezhen’s ceramic heritage presents distinct characteristics of industrial integrity, spatial continuity and cultural diversity, recording the complete development track of Chinese ceramic technology and maritime trade culture. Conventional segmented management by different functional departments leads to isolated resource allocation, repeated construction and fragmented protection plans; meanwhile, passive relic restoration, backward preservation technology and offline single inheritance channels gradually result in the loss of minority folk craftsmanship, skill fault between generations and continuous aging of inheritor teams. In recent years, driven by China’s digital cultural strategy, cultural heritage activation policy and global digital heritage governance trends, digital industrial chain construction has evolved into an important innovative path to realize systematic, standardized and sustainable all-round heritage protection. On the basis of field research on Jingdezhen Imperial Kiln Museum, Taoyangli Historic District, Hutian Ancient Kiln Site and local inheritor workshops as well as sorting official statistical data and project reports of Jingdezhen’s digital cultural projects, this paper first clarifies the internal logical correlation between digital industrial chain layout and whole-region heritage sustainable development, analyzes practical advantages and existing constraints of Jingdezhen’s current digital protection practices, and further puts forward targeted optimization paths and systematic sustainable protection mode from upstream, midstream and downstream industrial links plus supporting guarantee dimension, so as to

promote the organic integration of heritage conservation, craft dynamic inheritance, cultural dissemination and industrial economic development in Jingdezhen.

2. Theoretical Connotation and Internal Logical Correlation of Core Concepts

2.1 Definition of Whole-Region Cultural Heritage Sustainable Protection in Jingdezhen

Different from the scattered single-site relic conservation mode adopted in traditional cultural heritage management, whole-region heritage protection takes Jingdezhen's urban and rural spatial layout and historical porcelain industry development context as the overall boundary, realizing integrated governance of tangible relics, intangible craftsmanship, associated folk culture and supporting industrial ecology along the chronological evolution of local porcelain industry. Its core sustainable goal includes three dimensions: first, physical preservation of ancient kiln sites, porcelain specimens and ancient architectural relics to avoid natural weathering and artificial damage; second, dynamic inheritance of handmade porcelain intangible heritage to solve the dilemma of inheritor shortage and skill fault; third, coordinated development of heritage-related cultural industry to realize endogenous economic supply for long-term protection instead of excessive dependence on government finance. Such integrated protection requires breaking administrative segmentation between cultural relic, tourism and industry departments and realizing unified resource scheduling and overall planning across the whole city.

2.2 Connotation of Cultural Heritage-Oriented Full-Length Digital Industrial Chain

The digital industrial chain for cultural heritage runs through three core upstream-midstream-downstream industrial links plus terminal supporting operation, forming a closed-loop industrial ecosystem supported by big data, artificial intelligence, AR/VR and blockchain technologies. The upstream link focuses on standardized digital collection, classification and centralized database construction of all types of whole-region heritage resources, transforming scattered offline relic information into structured digital assets; the midstream link centers on intelligent relic restoration and immersive digital scene development, applying 3D scanning, AI fragment splicing and virtual reproduction technologies to realize scientific protection and diversified cultural display; the downstream link targets derivative cultural creativity development, digital collection issuance and immersive cultural tourism operation, converting digital heritage resources into market-oriented cultural products to generate stable operating income; terminal support covers copyright confirmation, talent cultivation and policy guarantee for digital asset transaction and industrial operation. Distinguished from simple single digital scanning of cultural relics, complete industrial chain construction can realize value conversion from static heritage resources to dynamic market assets and feed industrial profits back to heritage protection, forming endogenous sustainable development momentum.

2.3 Internal Logic between Digital Industrial Chain Construction and Whole-Region Heritage Sustainable Protection

Digital industrial chain fundamentally remedies the inherent defects of Jingdezhen's traditional finance-dependent heritage protection mode and constructs a "protection-development-feedback protection" closed-loop sustainable logic: Upstream unified big data integration realizes permanent digital archiving of fragile porcelain fragments and endangered handmade craftsmanship, avoiding irreversible loss of cultural resources caused by natural disasters and artificial destruction; midstream intelligent technology reduces manual restoration cost and improves relic preservation precision and efficiency, meanwhile digital immersive display expands public inheritance channels beyond offline workshop learning; downstream industrialized operation converts heritage cultural value into tangible economic benefits from cultural and creative commodities, digital collections and smart tourism, and standardized profit distribution mechanism feeds partial industrial revenue into relic maintenance and inheritor subsidy funds, thus realizing self-sustaining of heritage protection beyond single fiscal subsidy. This internal causal relationship lays solid theoretical foundation for constructing digital-driven whole-region sustainable protection mode in Jingdezhen.

3. Current Practical Achievements of Jingdezhen's Digital Industrial Chain and Whole-Region Heritage Protection

Combined with official project data and field survey results of Jingdezhen Culture and Tourism Bureau, the city has formed preliminary three-stage digital industrial layout covering upstream data construction, midstream intelligent development and downstream industrial operation after years of digital exploration, represented by Ancient Ceramic Gene Bank and Taoyangli digital scenic spot projects.

3.1 Upstream: Whole-Region Heritage Digital Archiving and Database Construction

Launched in June 2022 and jointly developed by Jingdezhen Imperial Kiln Museum, Tsinghua University and Palace Museum, the world's first Ancient Ceramic Gene Bank adopts the "8+X" standardized data framework, collecting eight core indicators including porcelain shape, glaze color, decorative pattern and raw material attribute of ancient porcelain specimens, plus extended data of historical documents and archaeological records. By the end of 2025, the project has sorted over 1 million pieces of typical ancient porcelain information from more than 20 million unearthed porcelain fragments excavated from imperial kiln, Hutian Kiln and other ancient sites since the 1980s, completing standardized digital coding of over 1.25 million specimen data entries and selected as one of China's top ten digital cultural innovation demonstration projects in 2024. Meanwhile, local government applies blockchain technology to build exclusive digital inheritance files for 687 certified municipal-level and above intangible porcelain crafts inheritors, recording complete production flow of handmade porcelain such as blank making, glazing and firing through video and 3D modeling; in cooperation with Internet enterprises including Tencent, Jingdezhen builds multi-modal shared dataset

integrating text, picture and short-video heritage resources, preliminarily realizing centralized digital storage of scattered whole-region heritage resources from museums, folk workshops and suburban ancient kiln sites.

3.2 Midstream: Intelligent Conservation and Immersive Digital Scene Development

In terms of physical relic protection, Jingdezhen Imperial Kiln Museum introduces AI matching algorithm and 3D printing auxiliary restoration technology: the intelligent system automatically matches fragmented porcelain pieces according to gene bank data, shortening traditional manual splicing cycle from several months to 3–7 working days and cutting restoration cost by nearly 40%; more than 500 environmental monitoring sensors are laid across major ancient kiln sites such as Hutian and Nan Kiln, combining drone aerial survey and manual regular inspection to realize 24-hour intelligent monitoring of soil humidity, temperature and corrosion conditions of ruins. In immersive scene construction, Taoyangli Historic District develops AR immersive project *Why Jingdezhen*, adopting spatial positioning technology to restore over 60 sets of ancient handmade porcelain production scenarios on original workshop sites; visitors can simulate pulling blank and glazing through interactive terminals, realizing situational experience of traditional craftsmanship. Multiple digital museum mini-programs are launched for offline relic online exhibition, breaking time and space restriction of physical museum visits.

3.3 Downstream: Digital Derivative Industry and Smart Cultural Tourism Development

Driven by digital heritage resources, Jingdezhen has initially developed diversified downstream industrial forms: relying on blockchain copyright confirmation system, local cultural enterprises issue limited blue-and-white porcelain digital collections and IP peripheral products, realizing standardized pricing and online transaction of digital heritage assets; the official smart tourism platform *Roam Jingdezhen* applies big data passenger flow analysis to optimize scenic route design and launch customized ceramic experience itineraries integrating offline handmade activities and online digital preview. Besides, a large number of inheritors release craftsmanship teaching short videos on Douyin and other platforms, developing paid online porcelain courses and expanding the commercial realization path of intangible heritage inheritance. Up to 2025, the annual comprehensive output value of Jingdezhen's ceramic digital cultural industry has exceeded 1.38 billion RMB, providing preliminary economic source for heritage feedback protection.

4. Existing Constraints Restricting Sustainable Protection under Current Digital Industrial Layout

Although Jingdezhen has made remarkable phased achievements in digital heritage industrial construction and initially built a basic digital industrial system covering data archiving, intelligent protection and cultural tourism operation, prominent bottlenecks and structural defects in industrial chain docking, resource sharing, content quality and profit feedback still hinder the high-quality and sustainable development of whole-region heritage protection. Most digital projects focus on superficial

display and technical stacking, failing to form deep integration between digital technology and ceramic cultural connotation. Meanwhile, the unbalanced development of upstream, midstream and downstream industrial links leads to disconnection between resource construction, content development and market operation, which restricts the transformation from digital heritage resources to sustainable protection momentum. The main restrictive factors are comprehensively reflected in four aspects of data resource management, digital content construction, industrial operation mechanism and supporting system guarantee.

4.1 Upstream: Isolated Data Resources and Ununified Collection Standards

Despite the completion of Ancient Ceramic Gene Bank and multiple institutional databases, digital heritage resources managed by museums, scenic spots, folk private kiln workshops and county-level cultural institutions are separated by data barriers without unified city-level sharing specification. Some small inheritor workshops and remote suburban ancient kiln relics lack fund and technical support to complete standardized digital collection, leading to incomplete whole-region heritage big data; repeated digital collection of the same porcelain resources by different institutions causes waste of human and financial cost and fails to form integrated whole-city heritage data pool supporting full industrial chain development.

4.2 Midstream: Disproportion between Technology Application and Cultural Content Excavation

Part of AR/VR immersive scenic projects overly pursue technological novelty but neglect in-depth excavation of Jingdezhen's unique porcelain historical connotation, resulting in superficial display content and poor long-term tourist attraction; most grassroots inheritor groups with small-scale workshops are restricted by insufficient special digital subsidy, unable to purchase scanning and modeling equipment, thus their unique folk craftsmanship cannot be digitally recorded and transformed into midstream digital content resources, forming a gap between official large-project resources and scattered folk heritage digitization.

4.3 Downstream: Low Added Value and Imperfect Industrial Profit Feedback Mechanism

Most downstream digital cultural products remain at primary souvenir and ordinary digital collection level with insufficient core IP development, low brand added value and unstable industrial profit margin; crucially, Jingdezhen has not issued explicit institutional clauses specifying fixed proportion of digital industrial revenue for heritage maintenance and inheritor allowance at present. Most operating income of cultural and creative enterprises flows into commercial operation instead of heritage protection fund, so the endogenous feedback mechanism of "industry feeds protection" has not been formally established, and whole-region heritage protection still highly relies on government fiscal appropriation.

4.4 Supporting System: Deficient Policy and Compound Talent Reserve

Jingdezhen lacks targeted local regulatory documents on digital heritage asset pricing, copyright protection and data transaction norms; meanwhile, the compound talent team mastering both Jingdezhen ceramic culture and digital development technology is seriously insufficient. Local colleges

including Jingdezhen Ceramic University have few cross-disciplinary courses combining ceramic art with big data and digital media, resulting in industrial chain midstream content development and downstream product design restricted by talent shortage.

5. Construction of Whole-Region Heritage Sustainable Protection Mode Based on Full Digital Industrial Chain

Targeting above practical deficiencies, this study constructs a four-dimensional closed-loop sustainable protection mode covering upstream unified big-data platform, midstream refined intelligent development, downstream diversified industrial activation and multi-dimensional supporting guarantee, following the full-length digital industrial chain logic of resource digitization – intelligent protection – industrial realization – feedback governance.

5.1 Upstream: Build City-Wide Unified Whole-Region Heritage Big Data Platform

Led by Jingdezhen Municipal Bureau of Culture, Radio, Film and Tourism, integrate existing fragmented databases of Imperial Kiln Museum, Taoyangli Management Committee and county-level cultural centers, formulate unified digital collection standard for tangible relics and intangible porcelain craftsmanship based on Ancient Ceramic Gene Bank's "8+X" framework. Launch biennial whole-city heritage digital general survey, supplement missing digital resources of suburban remote kiln sites and private inheritor workshops regularly; under standardized data authorization mechanism, open non-confidential heritage basic data to qualified cultural enterprises and university research institutions for free or low-cost access, effectively reduce repeated collection cost and provide complete data source for midstream content creation and downstream product development.

5.2 Midstream: Classified Intelligent Protection and In-Depth Digital Content Development

Carry out classified digital development according to heritage attribute: for precious unearthed porcelain relics and core ancient kiln ruins, focus on AI auxiliary restoration and all-weather environmental intelligent monitoring to realize scientific static protection; for handmade intangible craftsmanship and porcelain folk customs, avoid blind technical stacking and root immersive scene design into local historical stories and craft connotation. Set special municipal digital subsidy fund for grassroots inheritor groups to help them complete video recording and 3D modeling of unique craftsmanship, expand the coverage of folk heritage digital resources and enrich midstream digital content supply.

5.3 Downstream: Diversify Industrial Forms and Standardize Profit Feedback System

Break single product development mode and expand downstream industrial layout into four major categories: offline immersive experience camps, online paid craft courses, graded digital collection IP and customized virtual porcelain design products. Rely on existing blockchain copyright platform to strengthen whole-process IP management of Jingdezhen ceramic heritage and improve added value of digital commodities; formulate local supplementary provisions on the basis of *Jingdezhen Ceramic Culture Inheritance and Innovation Regulations*, stipulate 12%–15% of annual net profit of certified

ceramic digital enterprises shall be transferred into municipal special heritage protection fund, exclusively used for relic daily maintenance and outstanding inheritor allowance, realizing institutionalized industrial feedback closed loop.

5.4 Supporting Layer: Optimize Policy System and Compound Talent Cultivation

Supplement local laws and regulations concerning digital asset transaction, data security and heritage copyright; deepen school-enterprise cooperation between Jingdezhen Ceramic University, local digital tech firms and cultural institutions, set cross-major elective courses of ceramic + digital media + cultural industry, cultivate application-oriented compound talents for industrial chain all links; introduce high-end digital development talents through municipal talent introduction policy to solve technical bottlenecks of big data analysis and immersive content production. Meanwhile build regular communication mechanism among cultural, financial and market supervision departments to coordinate industrial policy adjustment dynamically.

5.5 Phased Implementation Suggestions for the Protection Mode

First, take Taoyangli Historic District and Imperial Kiln Site Park as pilot demonstration zones to implement the four-dimensional protection mode, summarize practical experience and then promote citywide step by step; second, deepen long-term strategic cooperation with large digital enterprises such as ByteDance and Tencent to introduce advanced technical resources and mature market operation channels; third, launch diversified public participation activities including online heritage digital collection and offline DIY digital porcelain experience to expand consumer market of downstream cultural products and consolidate industrial profit source for feedback protection.

6. Conclusion

The construction of full-length digital industrial chain fundamentally transforms Jingdezhen's traditional fragmented, finance-reliant whole-region cultural heritage protection mode and realizes the shift from passive post-remedial conservation to proactive predictive protection driven by digital technology and endogenous industrial economy. Traditional heritage protection mainly relies on government financial appropriation and temporary project investment, which is unstable and unsustainable, unable to cope with the long-term aging of relics and the crisis of intangible heritage inheritance. In contrast, the digital industrial chain-based protection mode takes cultural resource digitization as the foundation, intelligent technology as the means, industrial value realization as the core driving force, and institutional guarantee as the long-term support. The four-dimensional closed-loop sustainable protection mode constructed in this study targets existing resource fragmentation, inadequate industrial feedback and talent shortage pain points from upstream to supporting links, taking unified big-data integration as foundation, refined intelligent conservation as core, diversified industrialization as economic guarantee and institutional construction as long-term support, forming the scientific and complete sustainable development logic of "digital resource accumulation – scientific heritage protection – industrial value realization – profit reverse feeding

inheritance”.

From practical perspective, after the standardized and comprehensive implementation of this four-dimensional closed-loop protection mode, Jingdezhen can effectively reduce long-term fiscal pressure on heritage protection, activate massive dormant scattered folk ceramic heritage resources that have not been included in official protection systems, steadily improve grassroots inheritors' income level and social status through diversified industrial operation channels, and realize coordinated and balanced development of physical relic preservation, dynamic craft inheritance, cultural brand communication and urban cultural industry prosperity. Looking ahead, on the basis of continuously optimizing digital industrial chain layout, improving relevant supporting policies and improving the professional ability of industrial talents, relevant departments can carry out in-depth cross-border digital cultural cooperation with global porcelain-related museums, historical and cultural cities and art institutions relying on Jingdezhen's unique digital heritage resources. It can export China's innovative ceramic cultural heritage digital protection experience, and provide replicable and referable digital sustainable development paths for global traditional handicraft heritage cities. Future follow-up research can adopt long-term tracking empirical data and quantitative analysis methods to scientifically quantify the protection efficiency, inheritance effect and economic benefit improvement brought by digital industrialization, and further optimize the detailed implementation standards, profit distribution proportion and industrial supervision mechanism of the profit feedback system, so as to continuously improve the scientificity, operability and sustainability of the whole-region heritage protection mode.

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