



Mechanism Development for the Digital Living Transmission of Embroidery Intangible Cultural Heritage: A Case Study of Rizhao Embroidery

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Abstract

Digital technologies have opened up new pathways for the living transmission of intangible cultural heritage (ICH). However, digitalization practices for local traditional crafts generally place greater emphasis on storage and preservation than on transmission and inheritance, and sustainable operational mechanisms have yet to be established. To address the developmental challenges of digital transmission in traditional crafts, this study takes Rizhao embroidery as a case study and employs a case study approach to examine the structural constraints on its digital living transmission from three dimensions: knowledge, participation, and value, drawing on multiple sources of data. The findings reveal a closed-loop constraint in the digital transmission of Rizhao embroidery, characterized by discontinuities in knowledge transformation, the absence of sustained learning mechanisms, and insufficient value feedback and circulation. These three constraints are interrelated and mutually reinforce one another, thereby limiting the long-term transmission of ICH. Building on the essential principles of living ICH transmission, this study develops a three-dimensional operational mechanism and a five-stage transmission model comprising “recording, dissemination, learning, co-creation, and feedback,” thereby clarifying the systemic operational logic of digital living transmission. By moving beyond the conventional perspective of technology-enabled transmission, this study contributes to the theoretical framework for the digital transmission of local traditional crafts and provides a feasible reference model for the digital, living, and sustained transmission of local ICH.

Keywords

Intangible cultural heritage; Digital living transmission; Traditional crafts; Mechanism development

1. Introduction

In recent years, the rapid development of digital technologies has continuously transformed both the concepts and practices of cultural heritage preservation. From digital collection and digital presentation to digital dissemination, the digitalization of intangible cultural heritage (ICH) has continued to deepen. New technologies, including digital platforms, virtual

exhibitions, artificial intelligence, and immersive experiences, have gradually become important supports for ICH preservation. Against this background, how digital technologies can enhance the effectiveness of ICH dissemination, expand channels for public participation, and strengthen cultural influence has become an important issue of common concern to both academic researchers and practitioners. However, existing digitalization practices have focused predominantly on resource preservation, outcome presentation, and cultural dissemination, while the potential of digital technologies to promote skill transmission, knowledge continuity, and community participation has not yet been fully realized. Whether digitalization has genuinely promoted the living transmission of ICH, rather than merely expanded its reach of dissemination, has therefore become an important question that current research on ICH digitalization needs to address.

Unlike tangible cultural heritage, the core value of ICH does not lie in static preservation, but in its continuous practice and recreation by communities, groups, and bearers, through which its cultural vitality is maintained across generations (Huang et al., 2026). The Convention for the Safeguarding of the Intangible Cultural Heritage explicitly recognizes ICH as cultural traditions that are continuously practiced and recreated by relevant communities, groups, and individuals. Its vitality derives from continuous transmission rather than preservation alone. Accordingly, digital preservation cannot automatically be transformed into living transmission. If digital initiatives remain limited to the accumulation of images, videos, or database resources, without corresponding mechanisms for learning, participation, and value feedback, digital resources may fail to enter actual transmission practices. They may even produce a structural contradiction in which “digital preservation continues to expand while actual transmission continues to weaken.” The key to digital living transmission, therefore, lies not in increasing the quantity of digital resources, but in whether digital technologies can be embedded throughout the processes of knowledge transfer, stakeholder participation, and value creation, thereby establishing a sustainable transmission mechanism.

Traditional embroidery crafts particularly exemplify this tension. Embroidery techniques involve not only patterns, colors, and finished forms, but also extensive tacit knowledge concerning stitch techniques, material selection, craft experience, and aesthetic judgment. Such knowledge is highly dependent on embodied practice and master–apprentice interaction and is difficult to fully articulate through written descriptions or static images. In recent years, short-video platforms and social media have significantly increased public attention to traditional embroidery. However, platform-based traffic-oriented logics tend to favor visually striking content, which can easily reduce complex craft practices to fragmented and entertainment-oriented material, while process-based knowledge capable of supporting sustained learning and skill transmission remains relatively limited (Chen & Zhang, 2026). As a result, a clear disconnection has emerged between the popularity of dissemination and the depth of transmission. At the same time, although young people frequently use digital media, their participation often remains limited to browsing, liking, and short-term experiences. Relatively few users progress to sustained learning and co-creation, and a stable connection between digital dissemination and intergenerational transmission has yet to be established.

As a local craft within the Lu embroidery tradition, Rizhao embroidery has been shaped by multiple cultural influences, including coastal agrarian culture and the folk traditions of Jiaodong and Yimeng. It possesses distinctive technical characteristics, pattern narratives, and memories of family and folk customs that distinguish it from other embroidery traditions. In the context of local initiatives such as the “Shandong Handicrafts” program, the development of ICH workshops, and the integration of culture and tourism, Rizhao has already

accumulated a certain practical foundation for the preservation of embroidery. Nevertheless, Rizhao embroidery continues to face practical challenges, including fragmented documentation of techniques, discontinuous learning pathways, unstable youth participation, considerable operational pressure on workshops, and the absence of clear rules for digital innovation. These problems are not isolated from one another. Rather, they collectively indicate that effective connections have yet to be established among digital resource development, knowledge transmission, stakeholder participation, and industrial development, and that digitalization has not yet been effectively transformed into the capacity for living transmission.

Existing research has generated substantial findings concerning ICH digital preservation, digital resource development, productive preservation, youth participation, and the integration of culture and tourism, providing an important theoretical foundation and practical experience for the application of digital technologies to ICH preservation. Nevertheless, three issues warrant further investigation. First, existing studies have focused primarily on individual aspects such as digital resource development, digital presentation, and digital dissemination, while providing insufficient systematic explanations of how digital resources can subsequently be transformed into learning behaviors, social participation, and sustained transmission. Second, a considerable body of research has concentrated on the development of digital platforms, digital museums, and digital archives, while paying insufficient attention to the digital representation of tacit knowledge and its transformation into learnable knowledge in traditional craft-based ICH. Third, research on digital living transmission has largely focused on technological applications and practical approaches, while lacking an integrative analytical framework capable of explaining how knowledge flows, stakeholder participation, and value feedback can form a sustained cycle.

Based on these observations, this study argues that digital living transmission is not a natural extension of digital preservation, but rather a dynamic operational process involving knowledge production, stakeholder participation, and value circulation. Digital technologies can genuinely promote the living transmission of ICH only when they simultaneously facilitate the continuous accumulation of craft knowledge, sustained participation by diverse social actors, and the continuous circulation of cultural value back into the transmission system. Therefore, an approach focused solely on digital resource development or dissemination outcomes cannot adequately explain why digital practices can continue to function effectively, nor can it fully address the practical difficulties faced by local ICH in the process of digital transformation.

Accordingly, this study takes Rizhao embroidery as a case study and focuses on the development of a mechanism for digital living transmission. It addresses three interrelated research questions. First, what are the key structural constraints confronting the digital living transmission of Rizhao embroidery? Second, what are the internal relationships and operational logic among these constraints? Third, how can digital technologies establish a sustainable mechanism for living transmission through knowledge transfer, stakeholder participation, and value feedback? Following a problem-oriented approach combining data analysis and mechanism development, this study reviews relevant theories and previous research and draws on policy documents, publicly available local cases, and preliminary exploratory pre-interview materials to establish an analytical framework. It then proposes a mechanism model for digital living transmission, with the aim of enriching the theoretical interpretation of local ICH digitalization and providing an analytical framework that can inform the digital living transmission of traditional craft-based ICH.

2. Literature Review and Theoretical Foundations

2.1 Evolution of Research on the Living Transmission of ICH

The concept of ICH preservation has gradually evolved from “rescue-oriented preservation” toward “living transmission.” In contrast to tangible cultural heritage, which emphasizes physical preservation and the maintenance of authenticity, ICH places greater emphasis on the continuity of cultural practices. Its value derives from the continuous practice, recreation, and intergenerational transmission undertaken by communities, groups, and bearers in everyday life. The Convention for the Safeguarding of the Intangible Cultural Heritage explicitly recognizes ICH as cultural traditions formed and sustained through the continuous practice and recreation of relevant communities, groups, and individuals, with its vitality deriving from ongoing transmission rather than static preservation. As Tan and Li (2024) point out, this concept establishes an important characteristic distinguishing ICH preservation from the preservation of cultural resources in general. The object of preservation encompasses not only skills, knowledge, and forms of cultural expression, but also the social relationships, cultural spaces, and operational practices that sustain their development.

From the perspective of contemporary ICH preservation practices, Huang et al. (2026) emphasize that living transmission should remain people-centered and should establish a multi-actor network involving workshops, communities, and educational institutions to facilitate effective intergenerational continuity of traditional skills. With the gradual advancement of productive preservation, community participation, and the integration of culture and tourism, research on living transmission has increasingly shifted from the interpretation of macro-level concepts toward the examination of its internal operational mechanisms. On the one hand, scholars generally agree that ICH can achieve long-term continuity only when it is deeply embedded in contemporary production and everyday life and becomes part of stable social practices and cultural identities. On the other hand, it has increasingly been recognized that living transmission cannot rely solely on individual bearers, but also requires a collaborative network involving educational institutions, social organizations, market actors, and public cultural agencies. Consequently, living transmission has moved beyond the conventional understanding of one-to-one master-apprentice transmission and has come to be regarded as a social process involving continuous interaction and joint participation among multiple actors.

Overall, existing research has completed a theoretical shift from viewing ICH primarily as a “preservation object” to understanding it as a “preservation concept” centered on cultural vitality and social practice. However, existing studies have largely addressed why living transmission is necessary, while providing insufficient systematic explanations of the operational mechanisms on which living transmission depends, how different actors can establish sustained collaboration, and how digital technologies can be embedded within this dynamic process.

2.2 Development of Research on the Digital Preservation of ICH

The development of digital technologies has provided new technological pathways for ICH preservation and has made digital preservation an important area of ICH research in recent years. Early digitalization initiatives focused primarily on digital collection, digital archives, database development, and digital presentation, using technologies such as images, audio and video, and three-dimensional modeling to facilitate the long-term preservation and shared use of cultural resources. With the development of digital humanities, artificial intelligence, virtual reality, and related technologies, the application of digital technologies has gradually

expanded from resource preservation to digital presentation, digital dissemination, digital education, and digital cultural and creative development.

Addressing the existing shortcomings in the digitalization of traditional craft-based ICH, Zhai (2026) argues that digitalization should not simply remain at the level of archiving images of finished products, but should undertake process-oriented knowledge encoding of tacit craft knowledge, thereby shifting the focus from “preserving outcomes” to “preserving knowledge.” Industry standards issued by the Ministry of Culture and Tourism further clarify that the digitalization of traditional craft-based ICH should preserve not only visible outcomes but also complete information concerning the craft process. As generative artificial intelligence becomes increasingly involved in the ICH sector, Zhao et al. (2026) note that although digital creativity, cultural and creative product development, and open sharing of resources represent important directions for development, attention must also be paid to practical risks associated with AI, including cultural misinterpretation, symbolic appropriation, and potential harm to the rights and interests of ICH bearers.

From the perspective of Manovich's (2001) analysis of digital media and cultural archives, digital resources have long moved beyond their role as simple tools for static storage and have become important media interfaces through which the public can engage in cultural practices. Drawing on Jenkins's (2006) theory of convergence culture, ICH digitalization should not rely entirely on one-way institutional content delivery; participatory production by ordinary users also deserves attention, as digital media have created new pathways for the public to access and reinterpret local traditional cultures. Castells's (2010) research on network society further demonstrates that network environments can reduce spatial barriers to knowledge dissemination. The transmission of craft skills is no longer confined to face-to-face offline master-apprentice settings, as online spaces can also provide environments for knowledge interaction. However, from the perspective of Bandura's (1977) social learning theory, skill acquisition depends on observation, imitation, repeated practice, and feedback. Simply browsing digital media content cannot be directly transformed into actual mastery of skills.

Overall, research on digital preservation has gradually moved beyond an exclusive emphasis on digital storage toward a new stage characterized by digital utilization and digital enablement. Nevertheless, existing research continues to focus primarily on what digital technologies can “do,” while offering insufficient explanations of how digital resources can genuinely enter learning processes, promote social participation, and generate sustained momentum for transmission. In other words, digital preservation research has largely answered the question of “how to preserve,” but has not yet adequately addressed “how to sustain transmission.”

2.3 Further Development of Research on Digital Living Transmission

The integration of digital technologies with the concept of living transmission has made digital living transmission an increasingly important topic in ICH research in recent years. Existing studies generally suggest that digital technologies can not only improve the accessibility of cultural resources but also overcome the temporal and spatial limitations of traditional master-apprentice transmission, thereby creating new possibilities for public participation, educational dissemination, and cultural innovation. Consequently, digital living transmission has gradually expanded from digital resource development to areas such as digital education, digital communities, digital cultural and creative development, and digital governance.

With regard to youth engagement with and participation in ICH, Yang's (2026) study indicates that cultural identity among young people cannot be established simply through passive reception of information; rather, it develops gradually through sustained learning, experiential practice, and co-creation. Superficial browsing of short videos is difficult to translate directly into actual acquisition of craft skills. Initiatives such as incorporating ICH into school education, experiential learning programs, interaction within online communities, and community-based experiences have created diverse pathways for youth participation and have enriched the practical forms of digital living transmission.

However, existing research on digital living transmission still presents three areas requiring further development.

First, existing studies have largely examined individual aspects such as digital resource development, digital platform dissemination, educational practice, or industrial development. There remains a lack of an integrated analytical framework covering the entire process from knowledge recording and social dissemination to sustained learning, co-creation, and value feedback. Consequently, digitalization practices often exhibit the characteristics of “abundant resources but fragmented mechanisms.”

Second, although existing research generally recognizes the value of applying digital technologies, insufficient attention has been paid to the digital representation of tacit knowledge embedded in traditional crafts. Traditional crafts such as embroidery, pottery, and woodworking contain extensive operational knowledge formed through embodied experience and long-term practice. Such knowledge cannot be fully represented through images, videos, or textual descriptions alone, and its mechanisms of knowledge transformation have not yet been sufficiently examined.

Third, although previous studies have addressed youth participation, community collaboration, and industrial development, these elements have often been treated as relatively independent practical approaches. Insufficient attention has been paid to the systematic operational logic through which digital resources promote learning behavior, learning is transformed into co-creation, and co-creation subsequently generates value feedback. Consequently, research on digital living transmission has remained largely at the level of empirical discussions of “digital enablement,” without yet establishing a theoretical framework capable of explaining the sustained operational logic of digital transmission.

2.4 Literature Review and Theoretical Entry Point of This Study

A review of existing research shows that substantial progress has been made in the study of ICH digitalization and living transmission, providing an important theoretical foundation for this study. Nevertheless, whether in research on living transmission or digital preservation, attention has largely been directed toward specific individual aspects, while insufficient attention has been paid to the overall logic of digital living transmission as a continuously operating system. Existing studies have generally demonstrated that digital technologies can facilitate dissemination, improve presentation, and expand participation, but a unified theoretical explanation of how digital resources can continuously be transformed into knowledge accumulation, stakeholder participation, and cultural value circulation remains lacking.

In fact, digital living transmission is not simply an accumulation of digital preservation, digital dissemination, digital education, and other individual components. Rather, it is a dynamic process jointly driven by knowledge production, stakeholder participation, and value

creation. The sustained transmission of traditional craft-based ICH depends not only on the digital documentation of knowledge, but also on the continuous entry of learners and other participants into the transmission system, together with the formation of a sustained cycle through industrial feedback and social recognition. Strengthening any single component cannot substitute for the coordinated operation of the system as a whole.

Based on this understanding, this study proposes to move beyond the technology-centered analytical perspective prevalent in previous research and conceptualize digital living transmission as a dynamic mechanism jointly shaped by knowledge flows, stakeholder participation, and value feedback. Taking Rizhao embroidery as a case study, the study systematically examines the operational logic of digital living transmission.

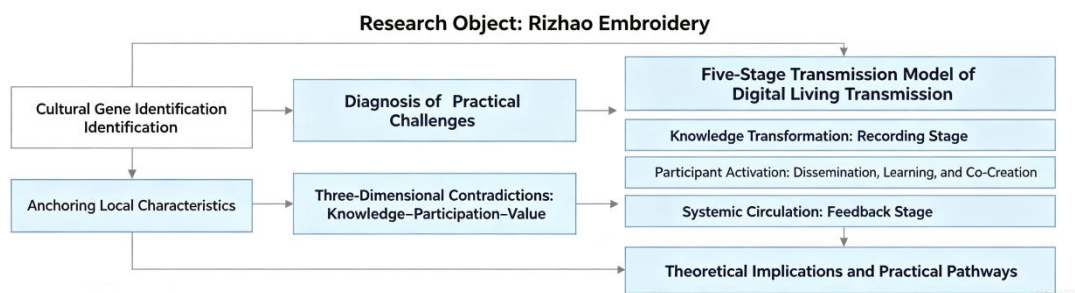


Figure 1. Analytical framework for the digital living transmission of Rizhao embroidery

3. Research Design

3.1 Research Approach

This study takes the digital living transmission of Rizhao embroidery as its research focus and employs a case study approach to examine the digitalization practices of traditional craft-based intangible cultural heritage (ICH) at the local level. Case studies emphasize the examination of complex social phenomena within their specific contexts. Their advantage lies in their ability to explain the interactions and operational logic among different factors through the integrated analysis of multiple sources of data. Digital living transmission involves not only the application of digital technologies, but also multiple dimensions including craft knowledge transfer, stakeholder participation, institutional support, and industrial development. It therefore exhibits clear systemic and contextual characteristics. Compared with large-sample statistical analysis, a case study approach is better suited to revealing the underlying logic through which mechanisms of digital living transmission are formed.

Rizhao embroidery was selected as the case for three main reasons. First, Rizhao embroidery exhibits typical characteristics of traditional craft-based ICH. Its transmission relies heavily on embodied practice, accumulated experience, and master–apprentice interaction, with a substantial proportion of tacit knowledge, making it a representative case for examining the digital living transmission of traditional crafts. Second, in recent years, Rizhao has continuously promoted the development of ICH workshops and the cultivation of the “Shandong Handicrafts” brand, establishing a relatively favorable practical foundation for digital preservation and productive preservation. This provides an appropriate real-world setting in which to examine digital living transmission. Third, compared with traditional embroidery forms such as Suzhou embroidery and Hunan embroidery, which have been more extensively studied, research on Rizhao embroidery remains relatively limited. It can therefore provide a relatively direct reflection of the practical challenges faced by local

traditional crafts in the process of digital transformation and has certain representative value for enriching research on the digital living transmission of local ICH.

In response to the three research questions proposed in the Introduction, this study follows a research approach characterized by “problem orientation, data analysis, and mechanism development.” First, it examines the practical context of digital living transmission and identifies the key factors constraining the digital living transmission of Rizhao embroidery. Second, it analyzes the internal relationships among different problems through cross-validation of multiple sources of data. Finally, based on the research findings, it theoretically synthesizes the operational mechanism of digital living transmission and proposes an analytical framework with potential applicability beyond the specific case.

3.2 Data Sources and Data Collection

To comprehensively examine the current state of digital living transmission of Rizhao embroidery, this study adopts a multi-source approach to data collection and cross-validation. The main sources of data consist of three categories: policy documents, local case materials, and preliminary exploratory interview materials. A standardized interview guide has been developed for this study; large-scale systematic field interviews and questionnaire-based data collection will be conducted in subsequent stages of the research.

First, policy documents. These include national-level policy documents such as the Law of the People's Republic of China on Intangible Cultural Heritage, the 14th Five-Year Plan for the Protection of Intangible Cultural Heritage, the National Cultural Digitalization Strategy, and the China Traditional Craft Revitalization Plan, as well as relevant policy documents issued by Shandong Province and Rizhao concerning ICH preservation, traditional craft revitalization, and the development of public cultural services. Policy documents are primarily used to examine the institutional context of digital living transmission and serve as an important basis for the analysis.

Second, local case materials. These mainly include publicly available reports by media outlets such as Xinhua News Agency and Wenlv China on the development of ICH workshops in Rizhao, practices associated with “Shandong Handicrafts,” and the productive preservation of traditional crafts, as well as local cultural publicity materials and publicly released information on ICH cases in Rizhao. These materials are used primarily to review the current development of digital preservation and living transmission of Rizhao embroidery and to further identify the characteristics of local practices.

Third, semi-structured preliminary exploratory interviews. Exploratory preliminary interviews were conducted around key issues including craft documentation, digital dissemination, learning practices, youth participation, workshop operation, and digital innovation. The interviewees included different types of stakeholders, such as ICH bearers and workshop managers, staff members of cultural and ICH preservation institutions, primary and secondary school and university teachers, young learners, cultural and creative enterprise operators, and community cultural organizers. Their perspectives were collected from multiple dimensions, including craft transmission, public governance, educational practice, market operation, and community participation, providing preliminary clues for identifying the practical difficulties confronting digital living transmission.

To enhance the credibility of the data analysis, this study follows the principle of source triangulation by cross-comparing policy documents, publicly available case materials, and preliminary interview data. When different sources consistently reflect the same issue, that

issue is regarded as having relatively high evidentiary credibility. Where substantial discrepancies exist among different sources, the relevant information is further examined in light of its specific context in order to minimize potential interpretive bias arising from reliance on a single source.

3.3 Data Analysis Method

This study employs Thematic Analysis to systematically organize and analyze the collected data. Thematic Analysis focuses on identifying themes that share common meanings within large bodies of textual data and subsequently examining the logical relationships among different themes. It is particularly suitable for research that seeks to explore the formation of mechanisms and explain complex social phenomena. The analysis proceeded in three stages.

The first stage involved open coding. Policy documents, case materials, and interview transcripts were read line by line to identify keywords and significant events reflecting the characteristics of digital living transmission, thereby generating initial codes. For example, statements such as “stitch techniques are difficult to demonstrate,” “I don’t know how to make the stitches,” and “only the finished product is available, not the process” were grouped under codes related to craft documentation. Statements such as “I came across a video,” “I don’t know where to learn,” and “I can’t find the course” were grouped under codes related to learning pathways. Statements such as “there is no further contact after the activity ends,” “nobody evaluates the work,” and “it is difficult to continue learning” were grouped under codes related to sustained participation.

The second stage involved theme development. On the basis of the initial codes, semantically related codes were clustered and progressively developed into thematic categories that reflected the major characteristics of digital living transmission. Through repeated comparison and refinement, several core themes were ultimately identified, including craft documentation, platform-based dissemination, learning transformation, collaborative participation, industrial feedback, and digital governance. The relationships among these themes were then further examined.

The third stage involved mechanism development. Based on the thematic analysis and relevant theories of digital living transmission, the interactive relationships among the identified themes were systematically synthesized. Particular attention was paid to explaining how digital resources enter learning processes, how learning promotes stakeholder participation, how stakeholder participation contributes to value creation, and how value feedback subsequently supports knowledge accumulation. This process helped reveal the underlying logic through which digital living transmission can operate continuously and provided an analytical foundation for the subsequent development of the transmission mechanism.

3.4 Ensuring Research Credibility

To enhance the credibility of the research findings, this study adopts corresponding measures in three areas: data sources, the analytical process, and validation of findings.

Regarding data sources, the study follows the principle of triangulation by combining policy documents, local case materials, and preliminary interview data. Conclusions are not based on any single source of information, thereby minimizing, to the extent possible, the influence of data bias on the research findings.

Regarding the analytical process, the study follows the principle of constant comparison. Statements concerning the same issue from different interviewees are repeatedly compared, with attention paid both to common perspectives and to representative differences in opinion.

Regarding validation of findings, the study emphasizes the mutual corroboration of theoretical interpretation and empirical evidence. Important judgments generated during the research process are examined through an integrated analysis of policy contexts, case practices, and interview materials, thereby avoiding inferences based solely on individual cases. During the process of mechanism development, particular attention is also paid to the relationships among different factors, ensuring that the findings not only respond to the practical problems of digital living transmission in Rizhao embroidery but also possess a certain degree of theoretical explanatory value and potential for broader application.

4. Research Findings

The integrated analysis of policy documents, case materials, and preliminary exploratory interview data indicates that the various practical problems emerging in the digital living transmission of Rizhao embroidery are not isolated phenomena. Rather, they constitute a set of structural constraints extending across the entire chain from knowledge preservation and stakeholder participation to value realization. To present the underlying structure of these constraints more clearly, this study categorizes and examines them across three analytical dimensions—knowledge, participation, and value, as shown in Table 1.

Table 1. Comparison of the three dimensions, core contradictions, and empirical manifestations of the digital living transmission of Rizhao embroidery

Analytical Dimension	Core Contradiction	Empirical Manifestations
Knowledge Dimension	Disconnection between digital documentation and knowledge transformation	Greater emphasis on displaying finished products than documenting craft processes; difficulty in digitizing tacit stitching techniques and embodied knowledge such as tactile experience; risks of cultural distortion in AI-generated patterns
Participation Dimension	Digital dissemination has not been transformed into a sustained learning mechanism	Young people tend to engage in superficial browsing, while systematic learners remain few; one-time experiential activities are common, but continuous learning pathways are lacking; online dissemination is disconnected from offline workshops and courses
Value Dimension	Value creation does not provide stable support for continued transmission	Unstable workshop income; continuing costs of teaching and digital documentation; unclear licensing and revenue-sharing arrangements; evaluation focused on traffic and sales rather than sustained transmission

The table adopts a three-level structure of “analytical dimension–core contradiction–empirical manifestation.” The analytical dimension provides the perspective from which the problem is examined; the core contradiction refers to the fundamental conflict at each level; and the empirical manifestations refer to the specific observable problems identified in the research materials.

From the perspective of the knowledge dimension, the fundamental problem is not the lack of digital resources such as images and short videos, but rather the fact that existing digitization efforts tend to focus on displaying finished products and have difficulty translating the tacit

knowledge embedded in embroidery techniques into a form that can be documented, transmitted, and learned. This has also generated related problems, such as AI-generated embroidery patterns becoming detached from their local cultural contexts. From the perspective of the participation dimension, the problem is not that the public lacks access to Rizhao embroidery, but that the attention generated by short videos and cultural-tourism experiences has not been supported by institutional pathways that can transform such attention into sustained craft learning. As a result, a disconnect has emerged between online dissemination and offline practice. From the perspective of the value dimension, the problem is likewise not a complete absence of attempts at cultural and creative product development or digital innovation, but the lack of supporting institutional arrangements and value feedback mechanisms. The efforts of workshops and ICH bearers are therefore difficult to translate into reasonable returns, while an evaluation system that places excessive emphasis on traffic and sales data further constrains the motivation for transmission.

The three dimensions do not exist independently; rather, they are interrelated and mutually constitutive. Shortcomings in knowledge documentation directly lead to insufficient learning materials. The absence of sustained participation pathways makes it difficult to expand the community of transmission participants. A limited participant base, in turn, constrains the market foundation for cultural and creative products and educational programs, further weakening value feedback. Insufficient value feedback then restricts investment in craft documentation and course development. This cyclical pattern of constraints also represents a common challenge faced by the digital transformation of local traditional crafts. The following sections examine each of the three dimensions in greater detail based on the research materials.

4.1 Constraints in the Knowledge Dimension

Traditional embroidery is a typical form of experiential knowledge. Its core value lies not only in the finished products themselves, but also in tacit knowledge concerning stitch techniques, material processing, craft procedures, and aesthetic judgment. Compared with explicit knowledge, such knowledge is highly dependent on embodied practice and accumulated experience and is strongly contextual and practice-oriented. It is difficult to represent it comprehensively through written descriptions or displays of finished products alone.

Interview data indicate that several ICH bearers believe that current digital documentation remains largely focused on the presentation of finished works, with insufficient attention to process-based knowledge that directly determines embroidery quality, such as the angle at which the needle is inserted, thread tension, and transitions between stitches. These aspects can often only be mastered through on-site demonstration and repeated practice. Learners also reported that even high-resolution images of finished embroidery available online cannot solve practical problems such as “not knowing how to make the first stitch.”

In addition, two types of bias can easily emerge in digital documentation practices. First, influenced by the traffic-oriented logic of short-video platforms, digital content tends to favor visually spectacular finished products while overlooking the processes of trial, error, and correction involved in skill acquisition. Second, AI-assisted pattern processing has rapidly become more widespread, but AI systems may generate artificial patterns that are detached from local folk-cultural contexts, creating a risk of misinterpreting the cultural characteristics of local embroidery (Chen & Zhang, 2026).

Further analysis reveals that digital resource development focuses more on “preserving outcomes” than on “preserving knowledge.” At present, a large proportion of digital resources exist in the form of images, short videos, or publicity materials, whose primary function is cultural dissemination rather than knowledge-based learning. As a result, although digital resources continue to increase in quantity, the supply of knowledge capable of supporting skill learning and sustained transmission remains insufficient. The disconnect between knowledge preservation and knowledge acquisition means that digital resources have not yet been effectively integrated into the transmission system, and this has become an important constraint on digital living transmission.

4.2 Constraints in the Participation Dimension

Digital platforms have expanded public access to traditional culture and created new spaces for the dissemination of local ICH. However, an expansion in the reach of dissemination does not necessarily lead to the formation of learning behaviors. Preliminary interviews indicate that most young interviewees first encountered Rizhao embroidery through short-video platforms, social media, or cultural and tourism activities, but relatively few subsequently entered a stage of sustained learning.

Many young interviewees noted that although platform content could stimulate their interest, it often lacked accessible pathways for further learning. For example, after watching embroidery videos, they did not know whether local experiential courses were available or whether further learning opportunities existed after an initial experience. Other interviewees observed that many ICH activities currently remain primarily one-off experiential events. After an activity ends, there is often little continued contact or learning feedback, making long-term participation difficult to establish.

Further comparison of different types of interview data suggests that the problem with youth participation is not a lack of interest, but rather the absence of institutional arrangements that can transform interest into learning. Current digital dissemination primarily serves a cultural publicity function, while course systems, workshop-based practice, community activities, and online platforms have yet to establish effective connections. The lack of a continuous participation pathway linking browsing, experiencing, learning, practicing, and co-creating leaves many potential learners at the initial stages of “knowing about ICH” and “experiencing ICH,” making it difficult for them to develop into stable participants or even new bearers.

At the same time, some schools have begun incorporating local ICH into curricula and practical activities. Students who have participated in a series of such courses generally demonstrate stronger cultural identification and a greater willingness to participate continuously. This suggests that young people's capacity for participation is not directly determined by digital dissemination, but gradually develops through sustained learning and repeated practice. Digital platforms can attract participants, but sustained learning mechanisms ultimately determine whether digital living transmission can achieve intergenerational continuity.

4.3 Constraints in the Value Dimension

Digital living transmission requires not only knowledge preservation and stakeholder participation, but also a value cycle capable of supporting long-term development. Field research indicates that Rizhao embroidery has undertaken active explorations in digital innovation, industrial development, and institutional support, but insufficient value feedback remains a significant problem overall.

First, ICH workshops perform multiple functions, including exhibition, teaching, production, and public cultural services, but their sources of stable income remain relatively limited. Some workshop managers reported that daily opening and operation, course organization, venue maintenance, and material procurement all require continuous investment, whereas existing revenues depend mainly on festival-related activities or sales of cultural and creative products, making it difficult to establish stable financial support. Due to considerable operational pressure, some bearers have had to devote more time and energy to commercial activities, leaving relatively limited time for curriculum development and digital resource production.

Second, digital innovation and collaboration still lack clear institutional standards. In recent years, an increasing number of cultural and creative enterprises have sought to apply traditional patterns to product development and digital design. However, participating enterprises commonly reported that there are no unified standards concerning the scope of pattern licensing, the boundaries of adaptation, revenue distribution, and attribution of creative outcomes, thereby increasing the costs of collaboration. At the same time, some ICH bearers are concerned that digital technologies may lead to the excessive commercialization of traditional patterns or even the misuse of their cultural meanings, making them relatively cautious toward digital innovation.

Finally, current evaluation systems for digitalization still rely primarily on indicators such as views, dissemination volume, and the number of activities. An excessive reliance on traffic and sales revenue as evaluation criteria may overlook cultural authenticity and actual transmission outcomes (Yan et al., 2026). The narrow orientation of evaluation encourages digital platforms to prioritize dissemination efficiency while paying comparatively less attention to sustained learning and long-term transmission, making it difficult to establish a virtuous cycle for digital living transmission.

4.4 Interrelationships Among the Constraints

The three dimensions discussed above are not independent problems. Rather, they form an interconnected and mutually reinforcing set of relationships within the process of digital living transmission.

Insufficient documentation of knowledge makes it difficult for digital resources to support sustained learning. The absence of sustained learning mechanisms, in turn, further reduces the possibility of young people entering the transmission system. Insufficient stakeholder participation weakens stable demand for workshop courses, digital resources, and community activities, thereby constraining value-creation capacity. Insufficient value feedback then further affects investment in digital resource updating, curriculum development, and craft documentation, gradually weakening the capacity for knowledge accumulation. This produces a cyclical structural constraint: knowledge is difficult to accumulate effectively, participation is difficult to deepen continuously, and value is difficult to circulate back into the system in a stable manner. These three dimensions interact with one another and collectively constrain the sustained operation of the digital living transmission system of Rizhao embroidery.

It should be noted that these constraints are not unique to Rizhao embroidery. Rather, they reflect problems that are commonly found in the digitalization practices of traditional craft-based ICH in many local contexts. Therefore, addressing the challenges of digital living transmission requires more than proposing solutions to individual problems. It also requires a reexamination of the relationships among knowledge preservation, stakeholder participation,

and value creation from the perspective of the overall operational system, followed by the development of a digital living transmission mechanism capable of sustaining a continuous cycle.

5. Discussion and Mechanism Development

In the digital preservation of local traditional crafts, problems are often attributed to a lack of technological tools. However, the structural contradictions identified in the case of Rizhao embroidery indicate that the core constraint on digital living transmission does not lie in the mere availability or absence of digital resources. Rather, it lies in the failure to establish an organic linkage among digital resources, stakeholder participation, and value circulation. Conventional digital preservation practices have largely focused on the storage and visualization of cultural resources, whereas the inherent requirements of living transmission point toward the continuous circulation of craft knowledge, deep participation by transmission actors, and the iterative generation of cultural value. Digital living transmission should therefore not be understood as the one-way embedding of digital technologies into traditional crafts, but as a dynamic operational process jointly driven by the coordinated interaction of knowledge production, stakeholder participation, and value creation.

To achieve systematic and effective digital documentation, material collection should not begin directly with the acquisition of digital resources. Instead, it is first necessary to identify and systematically organize the cultural genes of local embroidery. The cultural connotations of local embroidery can be conceptualized as four interconnected layers: formal genes, semantic genes, practice genes, and social genes.

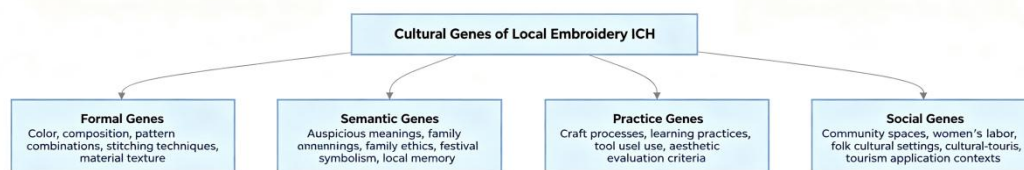


Figure 2. Four-dimensional framework for identifying the cultural genes of local embroidery ICH

This figure divides the cultural genes of local embroidery into four sub-dimensions. Formal genes correspond to the externally visible craft forms embodied in embroidery works; semantic genes convey the folk symbolism and local collective memory underlying the patterns; practice genes focus on experiential knowledge related to skill acquisition, operational procedures, and criteria for evaluating craftsmanship; and social genes reflect the folk contexts and social environments on which embroidery practices depend. The identification of cultural genes constitutes a prerequisite for digital documentation.

Cultural gene identification should be completed before the documentation stage. Its purpose is to anchor the distinctive local characteristics of Rizhao embroidery and mitigate the risks of detaching digital documentation from local cultural contexts and simplifying cultural meanings during the digitization process (Chen & Zhang, 2026). Only by clarifying these multiple layers of cultural meaning can digital documentation avoid becoming merely an archive of images of finished products and instead preserve a complete local cultural foundation for subsequent dissemination, learning, and co-creation. On the basis of this prerequisite of cultural gene identification, this study further develops the five-stage transmission model of “recording, dissemination, learning, co-creation, and feedback.”

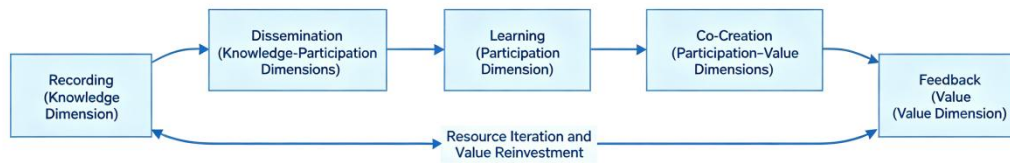


Figure 3. Five-stage transmission model of digital living transmission: “recording, dissemination, learning, co-creation, and feedback”

This model corresponds to the three-dimensional operational mechanism comprising the knowledge, participation, and value dimensions. Solid lines represent the progressive flow from one stage to the next, whereas dashed lines represent the feedback loops through which resources and value circulate back into the system. The recording stage incorporates the outcomes of cultural gene identification; dissemination expands cultural reach; learning then facilitates the development of transmission participants; co-creation enables cultural reproduction and reinterpretation; and feedback ultimately promotes resource iteration and value reinvestment, thereby sustaining the cyclical operation of the entire system.

5.1 The Core Essence of Living Transmission

A relatively common understanding in current ICH digitalization practices is to regard digital technologies primarily as tools for cultural preservation, using images, videos, databases, and other digital means to ensure the long-term retention of cultural resources. However, for traditional craft-based ICH, the completion of digital documentation does not in itself constitute living transmission. This is because the core value of ICH does not reside entirely in its visualized outcomes, but also in the experiential knowledge and cultural meanings continuously generated through craft practices.

Rizhao embroidery provides a clear example. Although an embroidery work can be fully presented through high-resolution images, images cannot adequately explain practical knowledge such as transitions between stitching techniques, control of hand pressure, material selection, and aesthetic judgment. If digitalization remains limited to the presentation of finished works, what is preserved is the outcome of the craft rather than the system of methods that enables the craft to be produced. Therefore, the key to digital living transmission is not simply to increase the quantity of digital resources, but to transform tacit knowledge into a knowledge system that can be learned, disseminated, and recreated.

From this perspective, digital living transmission is essentially a continuous process of knowledge production. Digital technologies are expected not only to perform a preservation function, but also to facilitate the organization, dissemination, and reproduction of knowledge, enabling traditional crafts to continuously generate new cultural meanings within changing social contexts. Digital resources are no longer merely static archives; they become important media connecting ICH bearers, learners, and the wider public. At the same time, it must be emphasized that digital technologies are only supporting means for transmission and cannot replace the actual practices of bearers and communities (Tan & Li, 2024).

Accordingly, the effectiveness of digital living transmission should not be evaluated solely in terms of the quantity of resources or the scale of dissemination. Greater attention should be paid to whether knowledge is understood, whether craft skills are learned, whether participants remain engaged, and whether cultural value is sustained.

5.2 Three-Dimensional Operational Mechanism

The emergence of digital living transmission cannot be achieved through any single type of factor in isolation. Rather, it is a systemic outcome produced through the coupling and coordinated interaction of the knowledge, participation, and value dimensions.

5.2.1 Knowledge transformation mechanism

The knowledge dimension addresses how traditional craft knowledge can be effectively documented, organized, and disseminated. Traditional crafts are characterized by a substantial amount of tacit knowledge. Many key skills depend on the embodied experience and long-term practical accumulation of ICH bearers and are difficult to fully articulate through conventional textual forms. Therefore, digital living transmission must first move beyond the model of “recording works” toward that of “recording knowledge,” with the identification of local cultural genes serving as a prerequisite for documentation.

This transformation means that digital resource development should not focus solely on images of finished products, but should systematically document the production process, material information, operating methods, cultural meanings, and transmission stories behind those products. For example, changes in stitching techniques, thread-color combinations, the origins of patterns, and the environments in which embroidery is produced should all become important components of digital resources. Only by shifting from recording outcomes to recording processes can digital resources genuinely become a knowledge foundation capable of supporting learning and transmission.

The knowledge dimension determines the starting point of digital living transmission. Without effective knowledge transformation, digital platforms can perform only a dissemination function and cannot genuinely enter the process of transmission.

5.2.2 Stakeholder participation mechanism

The participation dimension addresses the questions of who participates in transmission and how sustained participation can be achieved. ICH transmission is not a one-way process of information dissemination, but a process in which participants continuously enter, learn, and practice. Particularly among young people, cultural identification is not established simply through viewing cultural content, but gradually develops through experience, learning, and creation.

The case of Rizhao embroidery indicates that although digital dissemination has expanded public attention, a mechanism for transforming initial interest into sustained learning has yet to be established. Young people need not only cultural content but also clearly defined pathways for participation. For example, they may move from watching short videos to participating in experiential courses, then proceed to systematic learning, and ultimately engage in craft production and cultural dissemination, thereby forming a gradual process of participation.

Digital living transmission should therefore transform members of the public from passive viewers into active participants. Digital platforms should not function merely as display windows, but as interactive spaces connecting ICH bearers, learners, and cultural communities. Only through the establishment of stable participation mechanisms can ICH move beyond dependence on a limited number of individual bearers and achieve broader social continuity.

5.2.3 Value circulation mechanism

The value dimension addresses how digital living transmission can operate over the long term. ICH digitalization requires continuous investment in resource maintenance, curriculum development, platform operation, and talent cultivation. Without a stable value-feedback mechanism, digital resources may fall into a situation in which “construction is completed but maintenance is neglected.”

The value dimension emphasizes that digital living transmission requires not only cultural value, but also a comprehensive cycle involving economic, educational, and social value. In the process of industrial transformation, three types of cultural and creative development should be distinguished—traditional reconstruction, modern reinterpretation, and creative inspiration—while maintaining the boundaries of cultural preservation (Yan et al., 2026). On the one hand, digital resources can support educational programs, cultural and creative product development, cultural exhibitions, and other practical activities, thereby creating new sources of income for transmission actors. On the other hand, the resulting income can be reinvested in craft documentation, talent development, and platform construction, thereby promoting the continuous improvement of the transmission system.

The value dimension therefore does not simply refer to commercial development. Rather, it constitutes a feedback mechanism that supports the sustained operation of cultural transmission. Only when cultural value interacts positively with social and economic value can digital living transmission move beyond short-term project-based operation and achieve long-term development.

5.3 Construction of the Five-Stage Transmission Model

Based on an examination of the operational logic of the knowledge, participation, and value dimensions, this study further develops a five-stage transmission model comprising “recording, dissemination, learning, co-creation, and feedback.” The model is not a linear operational procedure, but a dynamic system formed through the interaction and coupling of the knowledge, participation, and value dimensions. Its stages are interconnected and collectively constitute a complete cycle of digital living transmission.

As the logical starting point of the entire system, the recording stage belongs primarily to the knowledge dimension and must be preceded by the identification of local embroidery cultural genes. By systematically documenting craft procedures, information about finished works, transmission stories, and the cultural contexts in which the craft exists, experiential craft knowledge can be digitally transformed into an organized knowledge base, laying a resource foundation for subsequent dissemination and practical learning.

Once knowledge resources have been systematically accumulated, the process moves into the dissemination stage. This stage serves as a bridge between the knowledge and participation dimensions. Digital media such as short videos, online courses, and virtual exhibitions can overcome geographical barriers and expand the social reach of traditional crafts. However, the primary purpose of dissemination should not be limited to increasing traffic and public attention. Its value lies in directing audiences toward appropriate entry points and creating opportunities for members of the public to become learners.

The transition from information reception to practical internalization is achieved through the learning stage, which is also crucial for translating the participation dimension into practice. Through tiered course design, hands-on experiences, and process-oriented practice and

feedback, ordinary audiences can gradually shift from passive viewers of cultural content to active craft learners, enabling the digital resources accumulated in the earlier stages to enter actual transmission practices.

When learners acquire a certain level of practical experience, they can enter the co-creation stage. This represents a core characteristic distinguishing digital living transmission from conventional preservation models and spans both the participation and value dimensions. Traditional crafts are not fixed collections of symbols; they are continuously evolving cultural practices. Through collaborative interaction among ICH bearers, young people, design practitioners, market actors, and communities, traditional patterns, craft techniques, and local cultural narratives can be connected to new application contexts, thereby enabling the reproduction and contemporary transformation of traditional culture.

The outcomes generated through craft practice and cultural creation ultimately converge in the feedback stage, which embodies the systemic support function of the value dimension. Learning outcomes, revenues generated through cultural and creative industries, and cultural identification at the social level collectively constitute forces that flow back into the system. These resources can support the updating of digital resources, the optimization of curricula, and the cultivation of a new generation of bearers, thereby enabling the entire transmission system to operate as a continuous cycle.

Overall, the model establishes a complete internal operational logic: recording consolidates the knowledge foundation of the system; dissemination expands the social reach of the culture; learning cultivates and develops transmission participants; co-creation enables the reproduction of cultural value; and feedback provides support for the continued operation of the entire system. These five stages are interconnected and collectively constitute a dynamic cycle for the digital living transmission of local traditional crafts.

5.4 Theoretical Significance and Practical Implications

The three-dimensional operational mechanism and five-stage transmission model developed in this study provide a new analytical perspective for understanding the digital living transmission of traditional craft-based ICH at the local level.

From a theoretical perspective, this study moves beyond the one-way logic of “technology enablement” commonly found in previous research on ICH digitalization and examines digital living transmission within an integrated system of knowledge flows, stakeholder participation, and value circulation. Digital technologies themselves are merely tools; their potential for transmission can only be realized when they are deeply embedded in the complete practical chain of ICH transmission, rather than being relied upon in isolation to achieve preservation objectives. At the same time, this study broadens the analytical scope of living transmission. Previous research has often focused primarily on individual ICH bearers, whereas this study argues that the transmission network consists of multiple actors, including ICH bearers, young learners, platform operators, market actors, and communities. This perspective is consistent with the increasing diversification of ICH transmission actors in digital environments. In addition, the proposed analytical framework addresses the relative lack of systematic analytical tools in existing research and provides a reference framework for examining the digital transformation of traditional crafts.

At the practical level, this analytical framework also has potential value for local practice. In the case of Rizhao embroidery, local digitalization should not focus exclusively on dissemination popularity or presentation effects. Instead, a complete transmission system

should be established around knowledge documentation, learning transformation, co-creation, and value feedback. This logic is not limited to Rizhao embroidery. It may also offer a useful reference for other local traditional craft-based ICH projects in China and provide ideas for developing digital living transmission practices in similar contexts.

6. Conclusion

Digital technologies have opened up new possibilities for the preservation and transmission of traditional craft-based intangible cultural heritage at the local level. However, technological digitalization alone cannot automatically resolve the practical challenges confronting ICH transmission. Taking Rizhao embroidery as a case study, this research combines policy documents, publicly available case materials, and preliminary exploratory interview data to examine the practical difficulties emerging during the digital transformation of traditional crafts and to identify the underlying operational mechanisms of digital living transmission.

The findings indicate that the core constraint on the digital living transmission of Rizhao embroidery is not an insufficient supply of digital resources, but the lack of an organic linkage among digital resources, stakeholder participation, and value feedback. From the knowledge dimension, embroidery contains substantial tacit knowledge that cannot be fully conveyed through images of finished products. Current digitalization practices generally emphasize the presentation of outcomes over process-based documentation, while also requiring attention to the risks of distortion of local cultural characteristics associated with traffic-oriented content production and inappropriate uses of AI. From the participation dimension, digital media have increased the social visibility of ICH but lack effective pathways for converting public attention into sustained participation. Young people's interest and attention are difficult to translate into continuous craft learning, and public participation cannot be effectively transformed into a force for transmission. From the value dimension, stable collaborative arrangements among ICH workshops, digital platforms, and market actors remain underdeveloped, while digital innovation has yet to generate effective revenue feedback capable of providing long-term support for the transmission system.

In response to these structural constraints, this study identifies a three-dimensional operational mechanism for digital living transmission and develops a five-stage transmission model comprising “recording, dissemination, learning, co-creation, and feedback.” The model emphasizes that digital living transmission is not equivalent to the simple digital archiving of traditional cultural resources. Rather, it is a dynamic cyclical system that takes the identification of local embroidery cultural genes as its prerequisite, knowledge transformation as its foundation, stakeholder participation as its driving force, and value feedback as its supporting condition. The recording stage transforms experiential craft knowledge into digital knowledge; the dissemination stage expands the social reach of the culture; the learning stage cultivates stable participants in the transmission process; co-creation facilitates the contemporary re-expression of traditional culture; and the feedback stage provides momentum for the continued operation of the entire system. These five stages are interconnected and collectively constitute the underlying logic of digital living transmission for local traditional crafts.

This study also generates several theoretical insights. Moving beyond an analytical perspective centered primarily on technological tools, examining ICH digitalization within an integrated system of knowledge flows, stakeholder participation, and value generation can enrich the theoretical trajectory of ICH digitalization from “resource preservation” toward “knowledge production.” At the same time, the study moves beyond an excessive focus on

individual ICH bearers and reveals a multi-actor collaborative transmission network involving bearers, learners, educational institutions, digital platforms, markets, and communities. By incorporating the identification of local cultural genes into the initial stage of digitalization, the study develops an interpretive framework adapted to local traditional crafts and addresses some of the limitations of single-dimensional analyses.

At the practical level, for Rizhao embroidery and similar local traditional crafts, digitalization should move beyond an exclusive pursuit of presentation popularity and dissemination traffic. Cultural gene identification should be conducted at an early stage, followed by systematic development of a knowledge system that fully documents craft processes and cultural narratives. Digital platforms should strengthen their capacity to convert audiences into learners and establish progressive pathways for practical participation. ICH workshops, educational institutions, and digital platforms should be encouraged to develop collaborative linkages. Authorization arrangements, revenue-feedback mechanisms, and diversified evaluation systems should also be improved so that cultural, educational, and industrial values can be considered together, ensuring that digital innovation serves cultural transmission itself rather than pursuing commercial returns alone.

7. Limitations and Future Research

The deeper integration of digital technologies with ICH transmission remains an important research direction in the revitalization of traditional culture. As emerging technologies such as artificial intelligence, digital twins, and virtual interaction continue to evolve, the digital living transmission of traditional crafts will encounter increasingly diverse practical contexts and research opportunities. Future research may further examine how to balance technological innovation with cultural authenticity. While safeguarding the cultural genes and core meanings of local ICH, researchers can explore appropriate ways for new technologies to participate in the reproduction of traditional culture and promote forms of digital innovation that are better adapted to traditional crafts.

In addition, digital living transmission of ICH is a long-term and dynamic process of social practice. Technological development, market conditions, youth cultural preferences, and local ICH policies are all subject to continuous change. Future studies may therefore conduct longitudinal research to dynamically examine the evolution of digital transmission systems and further refine the theoretical framework and practical approaches for the digital revitalization of traditional crafts.

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Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

Ethics Statement

The study was conducted in accordance with appropriate ethical standards. Participation was voluntary, and informed consent was obtained from all participants. Participant anonymity and confidentiality were maintained throughout the study.

Data Availability

The data supporting this study are available from the corresponding author upon reasonable request.

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