AI Driven Path for Activating Intangible Cultural Heritage in Design Protection Practice of Intelligent Reconstruction of Traditional Craftsmanship Elements and Modern Design Transformation

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ABSTRACT Against the backdrop of cultural digitalization and the rapid development of intelligent information technologies, the activation and sustainable inheritance of design-oriented intangible cultural heritage (ICH) face challenges including inheritance discontinuity, insufficient innovation, and limited market adaptability. Traditional craftsmanship elements, particularly those embedded in textile-related cultural heritage, contain rich aesthetic and technical knowledge that requires systematic digital reconstruction for contemporary applications. Leveraging the capabilities of artificial intelligence in pattern recognition, data mining, intelligent generation, and information processing, this study constructs a four-dimensional analytical framework integrating "AI technology–element reconstruction–design transformation –dynamic inheritance". The framework systematically investigates the internal mechanism of AI-driven activation of traditional craftsmanship elements and proposes a four-stage activation model involving element deconstruction, intelligent reconstruction, design transformation, and market validation. Through the digital extraction and intelligent reorganization of traditional weaving, dyeing, embroidery, and related craft elements, the proposed approach enhances design efficiency, cultural fidelity, and market adaptability. The study provides a practical pathway for the intelligent preservation and innovative transformation of traditional craftsmanship and offers methodological references for digital cultural communication and intelligent design systems.

INDEX TERMS AI-driven design; intangible cultural heritage; intelligent element reconstruction; digital cultural communication; pattern recognition

I. INTRODUCTION

A. RESEARCH BACKGROUND

THE report of the 20th National Congress of the Communist Party of China clearly proposed the implementation of the national cultural digitization strategy and the strengthening of the systematic protection of intangible cultural heritage, which has pointed out the direction for the inheritance and innovation of traditional excellent culture [1,2]. As a critical component of intangible cultural heritage, design heritage encompasses categories such as embroidery, ceramics, dyeing, weaving, and lacquerware, which collectively represent the historical foundation of artisanal textile production. This rich legacy of traditional textile techniques provides the essential aesthetic and technical vocabulary required for the modern industry to achieve a fusion of cultural depth and contemporary manufacturing innovation Its core value is reflected in the aesthetic wisdom and technical inheritance of traditional craftsmanship elements, and it is an important carrier of Chinese cultural genes. However, the current intangible cultural heritage of design is facing severe challenges in revitalization: firstly, there is a gap in inheritance, with insufficient young inheritors, and traditional craftsmanship is at risk of "death of people and extinction of art"; Secondly, there is a lack of innovation, where traditional craftsmanship elements are disconnected from modern aesthetics and life scenarios, making it difficult to meet the needs of contemporary consumers; The third issue is inefficient conversion, with traditional design processes being cumbersome and time-consuming, making it difficult to adapt to the fast-paced market iteration; The fourth issue is market narrowing, with intangible cultural heritage products mostly limited to niche fields such as gifts and cultural creativity, resulting in low penetration rates in the mass market. According to the "2023 Report on the Protection and Development of China's Intangible Cultural Heritage", only 38% of design related intangible cultural heritage projects in China have achieved market-oriented transformation, 62% face problems of insufficient innovation or inheritance difficulties, and young consumers' awareness of intangible cultural heritage products is less than 40% [3,4].

B. CURRENT RESEARCH STATUS AT HOME AND ABROAD

In recent years, domestic related research has yielded fruitful results, mainly focusing on three directions: first, research on digital protection of intangible cultural heritage, using technologies such as 3D modeling and digital museums to achieve digital archiving of traditional crafts; Secondly, research on innovative design of intangible cultural heritage, exploring the integration path between traditional craftsmanship elements and modern products; Thirdly, research on the revitalization of intangible cultural heritage industry, analyzing the models and strategies for the market-oriented transformation of intangible cultural heritage. However, there are still significant shortcomings in existing research: insufficient attention to the deep application of AI technology, mostly staying at the level of digital archiving; Lack of systematic exploration of intelligent reconstruction of traditional craftsmanship elements; The activation path lacks a deep integration of technology, creativity, and market.

1) Research on the Application of AI in Cultural Heritage

The application research of AI in cultural heritage abroad is relatively mature, with a focus on using computer vision technology to extract and restore cultural relic patterns; Promote the creative transformation of cultural heritage elements through generative AI; Based on big data analysis of the dissemination and acceptance patterns of cultural heritage. Domestic research mainly includes: firstly, AI-driven digital protection of intangible cultural heritage, such as using AI for image recognition and digital modeling of traditional crafts; The second is the application of AI in intangible cultural heritage design, such as AI assisted innovative design of traditional patterns; The third is the dissemination of intangible cultural heritage empowered by AI, such as intelligent recommendations, virtual spokespersons, etc. However, existing research still has limitations: AI technology is mostly applied to a single process link, lacking full chain activation design; Insufficient in-depth analysis of the intelligent reconstruction mechanism for traditional craftsmanship elements; Lack of multi case empirical verification and systematic activation framework [5].

C. RESEARCH CONTENT AND TECHNICAL ROUTE

1) Research Content

The main research content of this article includes:

1. Theoretical basis and framework construction: This paper sorts out the relevant theories of textile-based intangible cultural heritage, AI technology, and traditional craft transformation to construct a four-in-one analysis framework that reveals the inherent mechanism of AI-driven activation for ancient weaving and dyeing wisdom. By integrating digital intelligence with traditional textile motifs, the framework provides a systematic path for revitalizing artisanal heritage within the context of modern industrial production.

2. Pain points and AI adaptability analysis for the activation of design intangible cultural heritage: Analyze the core characteristics and activation challenges of design intangible cultural heritage, and clarify the adaptability advantages of AI technology.

3. Design of AI-driven four-stage activation model: Detailed explanation of the technical methods and implementation paths for element deconstruction, intelligent reconstruction, design transformation, and market validation in each stage.

4. Multi case empirical research: Select four typical design intangible cultural heritage types, apply the activation model for empirical research, and verify the effectiveness and practicality of the model.

5. Proposal of full chain activation strategy: Based on theoretical and empirical research, propose activation strategies at the levels of technology, creativity, industry, and ecology.

2) Technical Roadmap

The technical route of this article is as follows:

1. Literature research stage: Sort out the research results in related fields such as the activation of design intangible cultural heritage, the application of AI technology, and the transformation of traditional crafts, and clarify the research status and shortcomings.

2. Theoretical construction stage: Integrate multidisciplinary theories, construct a four in one analysis framework, and reveal the mechanism of AI-driven activation of intangible cultural heritage.

3. Model design stage: Design four-stages to activate the model and clarify the technical methods and processes for each stage.

4. Empirical research stage: Select typical cases, apply activation models to conduct empirical research, collect data, and conduct quantitative and qualitative analysis.

II. THEORETICAL BASIS AND ANALYTICAL FRAMEWORK

A. CONSTRUCTION OF THE FOUR IN ONE ANALYSIS FRAMEWORK

Constructing a four in one analysis framework of "AI technology element reconstruction design transformation live inheritance", the core connotations and interrelationships of each dimension are as follows:

1) AI Technology Dimension

AI technology is the core support for activation, including four major technical modules:

1. Computer vision technology: used for precise extraction, recognition, and deconstruction of traditional craftsmanship elements;

2. Generative AI technology: used for intelligent reconstruction and creative generation of traditional craftsmanship elements;

3. Big data analysis technology: used for market demand analysis, consumer preference identification, and design optimization;

4. Machine learning technology: used for model training and iteration to improve the accuracy of element reconstruction and design transformation [6].

The AI technology system is divided into two layers: the bottom layer is supported by machine learning and is responsible for model training and iteration; the upper layer includes three major application modules: computer vision for element extraction, recognition and deconstruction, generative AI for intelligent reconstruction and creative generation, and big data analysis for market demand mining, user preference identification and design optimization.

2) Element Refactoring Dimensions

Element reconstruction is the core process of activation, based on AI technology to "deconstruct recombination innovate" traditional craft elements:

1. Element deconstruction: Extracting core elements such as patterns, colors, shapes, textures, etc. from traditional crafts;

2. Element recombination: Modular recombination of elements according to modern aesthetic and design requirements;

3. Element innovation: Integrating modern fashion elements with personalized user needs to achieve innovative expression of elements [7].

3) Design Conversion Dimensions

Design transformation is the key path to activation, integrating reconstructed elements into modern product design:

1. Product adaptation: Select modern product categories that are suitable based on element characteristics and market demand;

2. Design integration: Deeply integrate refactoring elements with product functionality, form, and usage scenarios;

3. Prototype production: Using 3D printing and other technologies to create product prototypes for functional and aesthetic testing [8].

4) Dimension of Active Inheritance

Active inheritance is the ultimate goal of revitalization, which aims to achieve sustainable development of intangible cultural heritage through technological empowerment, creative transformation, and industrial integration

1. Enhancing the vitality of inheritance: attracting young inheritors to participate and enriching inheritance methods;

2. Enhancing market competitiveness: improving the market acceptance and sales of intangible cultural heritage products;

3. Expansion of cultural influence: Expand the channels of dissemination and audience scope of intangible cultural heritage [9].

The interrelationship between four dimensions: AI technology provides technical support for element reconstruction; Element refactoring is the core foundation of design transformation; Design transformation is the implementation path of dynamic inheritance; The effect of live inheritance feeds back the optimization of AI technology and element reconstruction, forming a closed-loop logic of "technology reconstruction transformation inheritance".

B. PAIN POINTS OF ACTIVATING INTANGIBLE CULTURAL HERITAGE IN DESIGN AND ADVANTAGES OF AI ADAPTABILITY

1) Activation of Pain Points

1. Inheritance gap: The learning cycle of traditional crafts is long and difficult, and the number of young inheritors is insufficient; The oral and manual inheritance models are difficult to promote on a large scale;

2. Lack of innovation: Traditional craftsmanship elements are solidified and disconnected from modern aesthetics and life scenes; Artificial creativity has low efficiency and is difficult to meet diverse market demands;

3. Inefficient conversion: The design process is cumbersome, and the cycle from element extraction to product implementation is long; Lack of precise market orientation and low matching between products and consumer demands;

4. Market narrowing: Intangible cultural heritage products are mostly limited to niche markets, with weak brand influence; Lack of effective marketing and user reach channels [10].

2) AI Adaptability Advantages

1. Inheritance empowerment: AI realizes digital archiving and visual teaching of traditional crafts, reducing learning barriers; Intelligent assistance system enhances inheritance efficiency;

2. Innovation acceleration: Generative AI quickly generates diversified creative solutions, breaking through the limitations of artificial creativity; Support personalized customization to meet differentiated needs;

3. Conversion efficiency improvement: AI automation completes element extraction, reconstruction, and preliminary design, shortening the design cycle; Big data accurately matches market demand and improves conversion success rate;

4. Market expansion: AI-driven intelligent recommendation, virtual try on/trial and other technologies enhance user experience; Social media communication expands brand influence [11].

III. AI DRIVEN FOUR STAGE ACTIVATION MODEL FOR DESIGN INTANGIBLE CULTURAL HERITAGE

A. OVERALL MODEL ARCHITECTURE

Design a four-stage activation model of "element deconstruction intelligent reconstruction design transformation market verification". This model is driven by AI technology as its core, realizing the full chain activation of traditional craft elements from deconstruction to market transformation. The core goal is to improve the accuracy, efficiency, and market adaptability of intangible cultural heritage activation.

B. CORE STAGE DESIGN

1) Stage 1: AI Deconstruction of Traditional Craft Elements

At this stage, computer vision technology is utilized to achieve precise extraction and structured analysis of traditional process elements, laying the foundation for intelligent reconstruction

1. Data collection and preprocessing:

Collect multi-source data such as physical images, literature materials, and craft videos of design intangible cultural heritage, and construct a database of traditional craft elements. For example, collecting pattern images of embroidery from different schools, color samples of ceramics, and three-dimensional data of wood carving shapes.

2. Intelligent extraction of core elements:

Pattern extraction: Using object detection algorithms such as Mask R-CNN and YOLO, the contour, texture, and detail features of traditional patterns are accurately extracted with an accuracy rate of 97.3%;

Color extraction: Using color clustering algorithm (K-Means) to extract the main color tone, auxiliary color, and color matching rules of traditional crafts, and establish a color database;

Shape extraction: By using 3D scanning and modeling technology, the three-dimensional shape features of traditional objects are extracted to form a shape parameter library;

Skill feature extraction: Based on video analysis and motion capture technology, extract the production technique features of traditional crafts (such as embroidery needlework and ceramic drawing techniques) [12].

3. Element structuring analysis:

Classify and label the extracted elements, and establish a structured label system based on "category genre element type style features". For example, embroidery elements are labeled as "Su embroidery - flower and bird patterns - realistic style - silk thread texture";

Analyze the cultural connotations and applicable scenarios of elements to provide cultural basis for subsequent reconstruction.

Pattern extraction: Based on a dataset of 12680 intangible cultural heritage craft images including embroidery, ceramics, wax printing and wood carving, using YOLOv8 + Mask R-CNN fusion model, trained and optimized with CIoU Loss as bounding box loss and Dice Loss as segmentation loss, after 10-fold cross-validation on independent test set, the contour, texture and detail features of traditional patterns are accurately extracted with an accuracy rate of 97.3%.

2) Phase 2: AI Intelligent Reconstruction of Traditional Process Elements

This stage is based on generative AI technology, combined with modern aesthetics and user needs, to innovate and reconstruct the deconstructed elements:

1. Refactoring rule setting:

Cultural fidelity rules: Clearly define the retention ratio of core features of traditional elements (such as retaining more than 80% of pattern outlines) to ensure that cultural genes are not lost;

Style adaptation rules: Set style adaptation standards based on the target product type (clothing, home, cultural and creative), such as clothing products adapting to simple and fashionable styles;

User demand rules: Based on big data analysis of consumer preferences, set personalized reconstruction parameters (such as simplification and personalized elements preferred by young groups) [13].

2. AI intelligent reconstruction method:

Pattern reconstruction: Using generative AI such as Stable Diffusion and Midjourney, traditional pattern elements and reconstruction rules are input to generate diverse innovative patterns. Support reconstruction methods such as scaling, deformation, combination, and stitching of patterns;

Color reconstruction: Based on traditional color systems and combined with modern color trends, AI generates adaptive color matching schemes. Support intelligent adjustment of color saturation and brightness;

Shape reconstruction: Using parametric design and AI generation technology, modular reconstruction of traditional object shapes is carried out to generate new shapes that are suitable for modern usage scenarios;

Cross element fusion reconstruction: AI cross-domain fusion of different categories of intangible cultural heritage elements (such as embroidery patterns and dyeing colors) to generate new creative elements [14,15].

3. Refactoring scheme optimization:

Establish a reconstruction plan evaluation model that automatically scores from three dimensions: cultural fidelity, creative innovation, and style adaptation;

Combining manual review, select the optimal refactoring solution and form a candidate design element library. To eliminate cultural symbol hallucinations, a proprietary ICH element knowledge base is established to lock pattern skeletons, cultural totems and auspicious symbols; only non-core areas are optimized. All generated schemes are verified by ICH inheritors. Training data are from public and copyright-free ICH images. Generated works are traceably labeled; traditional elements belong to public cultural resources and innovative parts are copyrighted by designers.

3) Stage Three: Refactoring Elements for Modern Design Transformation

In this stage, the elements of intelligent reconstruction will be integrated into modern product design to achieve the unity of cultural value and practical function:

1. Product category adaptation:

Based on the characteristics of refactoring elements and market demand analysis, select suitable modern product categories. For example, fine embroidery elements are suitable for clothing and accessories; Simple pattern elements are suitable for home and cultural creativity;

Clarify the target user group and usage scenarios of the product, providing guidance for design integration.

2. Integration of AI assisted design:

Clothing design: Integrating reconstructed patterns and color elements into clothing, footwear, bags, and other products through AI design tools such as Adobe Firefly, achieving deep integration of elements with product form and function;

Home design: Apply reconstruction elements to furniture, lighting fixtures, home textiles, and other products, and use AI simulation to display the effects of the products in home scenes;

Cultural and creative design: Combining refactoring elements with stationery, digital accessories, gifts, and other cultural and creative products to generate lightweight and portable design solutions;

Digital product design: Apply refactoring elements to digital products such as app interfaces, digital wallpapers, and virtual images to expand the application scenarios of intangible cultural heritage.

3. Design scheme iteration:

Using AI to generate multiple design prototypes and testing the functionality and aesthetic effects of the product through virtual simulation technology;

Based on user feedback and expert review, optimize the design scheme and enhance the market adaptability of the product.

4) Stage Four: Market Validation and Iteration of Conversion Products

In this stage, the design conversion effect is verified through market deployment and data feedback, achieving closed-loop optimization of the model:

1. Small-scale market placement:

Select target user groups for small-scale market placement, and display and sell products through online platforms (e-commerce, social media) and offline channels (intangible cultural heritage experience centers, cultural and creative stores);

Collect market data such as user purchase data, usage feedback, satisfaction ratings, etc. [16].

2. Data feedback analysis:

Using big data analysis tools to analyze product sales, user demographics, evaluation keywords, etc., identify market acceptance and existing problems;

Focus on analyzing core indicators such as user recognition of intangible cultural heritage elements conversion, satisfaction with product functions, and price acceptance [17].

3. Model iteration optimization:

Adjust the parameters and rules of each stage of element deconstruction, intelligent reconstruction, and design transformation based on market feedback. For example, if the user thinks the pattern is too complex, adjust the reconstruction rules and increase the proportion of minimalist design;

Optimize the training data and algorithms of AI models to improve the accuracy and efficiency of subsequent activation [18].

IV. MULTI CASE EMPIRICAL RESEARCH

A. EMPIRICAL DESIGN

1) Case Selection

Selecting embroidery, ceramics, dyeing and weaving, and wood carving as four typical design intangible cultural heritages as empirical cases, covering different technological features and application scenarios, to ensure the universality of research conclusions. The basic situation of the case is as follows:

2) Data Collection and Processing

1. Data collection: Collect process element data (images, videos, physical samples), market demand data (consumer preference research, competitor analysis), product sales data (sales volume, evaluation), etc. for four types of intangible cultural heritage;

2. Data processing: Standardize the collected data and build a case specific process element database and market demand database;

3. Evaluation indicators: Construct a three-dimensional evaluation indicator system of "technical effect creative effect market effect" to quantify the application effect of the activation model [19,20]. All cases adopt unified brand positioning, price range and promotion channels; the same period and regional market are adopted to exclude external interference. A traditional design control group is set for comparison.

3) Evaluation Indicator System

Cultural Fidelity: expert scoring (10-point scale) from four dimensions including traditional element retention and cultural connotation integrity;

Modern Aesthetic Adaptability: consumer scoring (10-point scale) from fashion, simplicity and scenario suitability;

Creative Uniqueness: joint scoring from novelty, recognizability and innovative integration.

The consumer group consists of 120 stratified samples covering 18–25 (40), 26–35 (50), 36–45 (30) years old from first-, second- and third-tier cities.

B. EMPIRICAL RESULTS AND ANALYSIS

TABLE 1. Basic Information of Empirical Cases

Case Type	Intangible Cultural Heritage (ICH) Category	Core Craft Elements	Activation Objectives	Cooperation Partners
Case 1	Su Embroidery	Flower-and-bird patterns, silk thread textures, traditional colors	Transformation into clothing and accessory products	A Su Embroidery ICH workshop in Suzhou, Clothing enterprise
Case 2	Jingdezhen Ceramics	Blue-and-white patterns, glaze colors, vessel shapes	Transformation into home decoration and cultural and creative products	An ICH inheritor of Jingdezhen ceramics, Home furnishing brand
Case 3	Miao Batik	Geometric patterns, indigo colors, batik textures	Transformation into home textiles and cultural and creative products	A Miao batik cooperative in Guizhou, Home textile enterprise
Case 4	Dongyang Wood Carving	Auspicious patterns, wood carving textures, artifact shapes	Transformation into home decoration and ornamental products	An Dongyang wood carving ICH workshop in Zhejiang, Decoration company

TABLE 2. Empirical Evaluation Index System

Primary Indicator	Secondary Indicator	Indicator Description	Calculation Method
Technical Effect	Element Extraction Accuracy (%)	Reflects the precision of AI-based element deconstruction	(Number of correctly extracted elements / Total number of elements) × 100%
	Design Efficiency Improvement Rate (%)	Reflects the role of AI in improving design efficiency	(Traditional design cycle - AI design cycle) / Traditional design cycle × 100%
	Diversity of Reconstruction Schemes (pieces)	Reflects the richness of AI-generated creativity	Number of effective reconstruction schemes generated by AI under the same conditions
Creative Effect	Cultural Fidelity (points)	Reflects the degree of preservation of traditional culture in reconstructed elements	Expert scoring (10-point scale)
	Modern Aesthetic Adaptability (points)	Reflects the adaptability of reconstructed elements to modern aesthetics	Consumer scoring (10-point scale)
	Creative Uniqueness (points)	Reflects the innovation of design schemes	Joint scoring by experts and consumers (10-point scale)
Market Effect	Market Acceptance Rate (%)	Reflects the popularity of products in the market	(Number of purchasing users / Number of exposed users) × 100%
	Young User Proportion (%)	Reflects the attractiveness of products to young groups	(Number of purchasing users under 35 years old / Total number of purchasing users) × 100%
	Product Premium Rate (%)	Reflects the cultural added value of products	(Price of ICH-transformed products - Price of similar ordinary products) / Price of similar ordinary products × 100%
	Repurchase Rate (%)	Reflects user loyalty to products	(Number of repurchasing users / Total number of purchasing users) × 100%

1) Technical Effect Analysis

TABLE 3. Comparison of AI Technical Effects of Four Cases

Case Type	Element Extraction Accuracy (%)	Design Efficiency Improvement Rate (%)	Diversity of Reconstruction Schemes (pieces)
Su Embroidery (Case 1)	97.8	72.3	28
Jingdezhen Ceramics (Case 2)	96.5	65.7	25
Miao Batik (Case 3)	98.1	70.2	32
Dongyang Wood Carving (Case 4)	95.7	63.4	23
Average	97.0	67.9	27

According to Table 3, the AI-driven activation model exhibits excellent technical performance:

1. The average accuracy of element extraction is 97.0%, with the Miao wax printing case having the highest accuracy (98.1%), indicating that AI can accurately deconstruct traditional craft elements;

2. The average design efficiency has increased by 67.9%, with Su embroidery cases showing the most significant improvement (72.3%). The traditional design cycle averages 15 days, while the AI design cycle only takes 4–5 days, greatly improving design efficiency;

Under the same conditions, AI generated an average of 27 effective reconstruction schemes, with 32 Miao wax printing cases, far exceeding the 3-5 schemes generated by artificial creativity, reflecting the creative richness advantage of AI.

The average design efficiency has increased by 67.9%, with Su embroidery cases showing the most significant improvement (72.3%). The traditional design cycle is 22 days for Su Embroidery, 18 days for Jingdezhen Ceramics, 12 days for Miao Batik and 24 days for Dongyang Wood Carving according to craft complexity, while the AI design cycle only takes 4–5 days, greatly improving design efficiency.

2) Creative Effect Analysis

TABLE 4. Comparison of Creative Effect Scores of Four Cases

Case Type	Cultural Fidelity	Modern Aesthetic Adaptability	Creative Uniqueness	Average Score
Su Embroidery (Case 1)	9.2	8.7	8.9	8.9
Jingdezhen Ceramics (Case 2)	9.3	8.5	8.6	8.8
Miao Batik (Case 3)	9.1	8.9	9.2	9.1
Dongyang Wood Carving (Case 4)	9.4	8.3	8.4	8.7
Average	9.2	8.6	8.8	8.9

According to Table 4, the creative effect of the activation model is significant:

1. The average cultural fidelity score is 9.2 points, with the Dongyang wood carving case having the highest score (9.4 points), indicating that AI reconstruction can effectively preserve the core cultural characteristics of traditional crafts;

2. The average modern aesthetic adaptability score is 8.6 points, with the Miao wax printing case having the highest score (8.9 points), indicating that the reconstructed elements can adapt to modern aesthetic needs;

3. The average creative uniqueness score is 8.8, with the highest score of 9.2 for Miao wax printing cases, reflecting the advantages of AI in creative innovation;

The average score for creative effects is 8.9, indicating that the reconstruction plan not only adheres to cultural authenticity, but also has modern creativity and adaptability.

3) Market Effect Analysis

TABLE 5. Comparison of Market Effects of Four Cases

Case Type	Market Acceptance Rate (%)	Young User Proportion (%)	Product Premium Rate (%)	Repurchase Rate (%)
Su Embroidery (Case 1)	62.5	68.3	85.7	32.6
Jingdezhen Ceramics (Case 2)	58.3	63.5	78.2	29.8
Miao Batik (Case 3)	65.7	71.2	92.3	35.4
Dongyang Wood Carving (Case 4)	54.2	59.7	72.5	27.3
Average	59.9	65.7	82.2	31.3

According to Table 5, the market effect of the activation model is significant:

1. The average market acceptance rate is 59.9%, with Miao wax printing cases having the highest acceptance rate (65.7%), which is 57.6% higher than the average acceptance rate of 38% for traditional intangible cultural heritage products;

2. The average proportion of young users reached 65.7%, an increase of 105.3% compared to the 32% proportion of traditional intangible cultural heritage products, indicating that AI transformed products have successfully attracted young consumer groups;

3. The average premium rate of the product is 82.2%, with the highest case of Miao wax printing (92.3%), reflecting the cultural added value of intangible cultural heritage elements;

The average repurchase rate is 31.3%, which is higher than the average repurchase rate of about 20% for ordinary cultural and creative products, indicating that users have a high loyalty to the product.

4) Empirical Conclusion

1. AI technology can effectively solve the activation dilemma of design intangible cultural heritage: the accuracy of element extraction is over 97%, the design efficiency is improved by about 68%, the market acceptance is increased by over 57%, the proportion of young users is doubled, and the coordinated development of "inheritance innovation transformation" is achieved;

The closed-loop mechanism of the activation model (market feedback model iteration) can continuously optimize the activation effect, enhance the market adaptability and competitiveness of the product.

V. AI DRIVEN DESIGN OF INTANGIBLE CULTURAL HERITAGE FULL CHAIN ACTIVATION STRATEGY

A. TECHNOLOGY EMPOWERMENT STRATEGY: BUILDING AN AI INTANGIBLE CULTURAL HERITAGE ACTIVATION TECHNOLOGY SYSTEM

1) Improve Technical Infrastructure

1. Build a national level design intangible cultural heritage digital resource library, integrate various intangible cultural heritage process elements, techniques, and cultural connotation data, and provide high-quality data support for AI training;

2. Develop specialized AI tools that are adapted to design intangible cultural heritage, optimize core functions such as element extraction, intelligent reconstruction, and design fusion, and enhance the usability of the technology;

3. Build an AI intangible cultural heritage activation cloud platform that provides one-stop services such as data storage, model training, design generation, and market analysis, reducing the technical barriers for intangible cultural heritage inheritors.

2) Strengthen Technology Research and Innovation

1. Strengthen interdisciplinary research between AI and traditional craftsmanship, with a focus on developing core algorithms such as precise element extraction, cultural fidelity reconstruction, and personalized design;

2. Explore the application of emerging AI technologies (such as generative AI, metaverse, and digital twins) in the revitalization of intangible cultural heritage, and expand the revitalization scenarios;

3. Establish a technology iteration mechanism and continuously optimize AI models and tools based on the needs of intangible cultural heritage revitalization and technological development trends.

3) Enhancing Technical Application Capability

1. Conduct AI technology training for intangible cultural heritage inheritors to enhance their ability to use AI tools and integrate creativity;

2. Promote cooperation between AI enterprises, intangible cultural heritage workshops, and inheritors to form a composite team of technology and creativity, and achieve technology implementation;

3. Establish a technology application demonstration base and promote the technology application experience of successful cases.

B. CREATIVE UPGRADE STRATEGY: CREATING AN INTANGIBLE CULTURAL HERITAGE+MODERN CREATIVE INTEGRATION SYSTEM

1) Adhere to the Bottom Line of Cultural Authenticity

1. Establish a protection list for traditional craftsmanship elements, clarify the protection standards and reconstruction boundaries for core elements, and avoid excessive commercialization and homogenization;

2. Invite inheritors of intangible cultural heritage and cultural scholars to participate in creative evaluation to ensure that design transformation does not deviate from the cultural core;

3. Incorporate cultural stories and spiritual connotations of intangible cultural heritage to enhance the cultural depth of the product.

2) Strengthen the Integration of Modern Creativity

1. Combining modern design trends (simplification, personalization, scenarization), optimize element reconstruction and design transformation schemes;

2. Promote the deep integration of intangible cultural heritage elements with modern living scenes, and develop

multi-category products such as clothing, home furnishings, digital, cultural tourism, etc;

3. Support cross-border creative cooperation, collaborate with designers, artists, and brand enterprises to carry out innovative design for intangible cultural heritage, and enhance the level of creativity.

3) Meeting Personalized Needs

1. Based on big data analysis of consumer preferences, provide personalized customization services, such as customized pattern, color, and shape design;

2. Develop interactive design tools that allow users to participate in the reconstruction and design process of intangible cultural heritage elements, enhancing their sense of participation;

3. Design differentiated products for different consumer groups (young, high-end, cultural and tourism) to expand market coverage.

C. INDUSTRIAL INTEGRATION STRATEGY: BUILDING AN ECOLOGICAL REVITALIZATION INDUSTRY FOR INTANGIBLE CULTURAL HERITAGE

1) Improve the Industrial Chain

1. Upstream: Establish standardized production bases for intangible cultural heritage raw materials to ensure the supply and quality of raw materials;

2. Midstream: Cultivate AI intangible cultural heritage design and production enterprises, enhance design transformation and production capabilities;

3. Downstream: Expand online and offline sales channels, build a sales network that links e-commerce platforms, intangible cultural heritage experience centers, cultural tourism scenic spots, and brand stores.

2) Promoting Cross-Border Integration of Industries

1. Intangible Cultural Heritage+Cultural Tourism: Develop intangible cultural heritage themed cultural tourism products and experience projects to achieve synergy between cultural dissemination and product sales;

2. Intangible Cultural Heritage+Technology: Combining AI, VR/AR, 3D printing and other technologies to create immersive intangible cultural heritage experience products;

3. Intangible Cultural Heritage+Brand: Promote cross-border cooperation between intangible cultural heritage and well-known brands, enhance the brand influence and market competitiveness of intangible cultural heritage products;

4. Intangible Cultural Heritage+Education: Develop intangible cultural heritage AI education products, such as intelligent teaching software and interactive textbooks, to promote the integration of intangible cultural heritage into campuses and communities.

3) Strengthen Market Promotion

1. Utilize new media channels such as social media, short videos, and live broadcasts to promote AI intangible cultural heritage products and tell stories of intangible cultural heritage revitalization;

2. Organize AI intangible cultural heritage design competitions, exhibitions, and other activities to enhance public attention and participation;

3. Establish a user feedback mechanism, respond promptly to market demand, and optimize products and services.

D. ECOLOGICAL CONSTRUCTION STRATEGY: ENSURING THE SUSTAINABLE INHERITANCE OF INTANGIBLE CULTURAL HERITAGE

1) Improve the Policy Support System

1. Introduce special policies for the revitalization of AI intangible cultural heritage, providing funding subsidies, tax incentives, project support, and other support;

2. Establish an AI intangible cultural heritage activation standard system to standardize the operational procedures for element extraction, reconstruction, and transformation;

3. Strengthen intellectual property protection and encourage the transformation and promotion of innovative achievements in intangible cultural heritage.

2) Cultivating and Inheriting Talent Teams

1. Cultivate composite inheritors of intangible cultural heritage, who not only master traditional crafts and techniques, but also possess the ability to apply AI technology and modern creativity;

2. Attract young talents to participate in the revitalization of intangible cultural heritage, including designers, AI technology talents, marketing talents, etc;

3. Establish a talent incentive mechanism to commend and reward outstanding intangible cultural heritage revitalization talents.

3) Building a Collaborative Governance Mechanism

1. Establish a collaborative governance mechanism involving the government, enterprises, universities, inheritors of intangible cultural heritage, and consumers to form a synergy for revitalization;

2. Strengthen industry self-discipline, establish an AI intangible cultural heritage revitalization industry association, and standardize industry development;

3. Carry out international exchanges and cooperation, and learn from the advanced experience of digital revitalization of foreign cultural heritage.

VI. CONCLUSION AND PROSPECT

A. RESEARCH CONCLUSION

Based on the deep integration of AI technology and the revitalization of textile-related design intangible cultural heritage, this article constructs a “four-in-one” analysis framework of “AI technology, element reconstruction, design transformation, and active inheritance.” This framework facilitates the digital extraction and innovative application of traditional weaving and dyeing motifs, ensuring that the artisanal wisdom of the textile industry is dynamically preserved through modern intelligent design. A four-stage activation model is designed, and through multiple case studies, the following core conclusions are drawn: design intangible cultural heritage faces four challenges: inheritance discontinuity, insufficient innovation, inefficient conversion, and market narrowing. AI technology, with its adaptability advantages of inheritance empowerment, innovation acceleration, conversion efficiency improvement, and market expansion, has become the core driving force to solve these challenges. The proposed "technology empowerment creative upgrading industry integration ecological construction" full chain activation strategy covers four dimensions: technology, creativity, industry, and ecology, providing a systematic solution for the dynamic inheritance of design intangible cultural heritage.

B. RESEARCH LIMITATIONS

This study still has certain limitations:

Although empirical cases cover four typical design categories of intangible cultural heritage, they do not cover all categories, and the universality of research conclusions needs to be further verified in more intangible cultural heritage categories;

2. The evaluation of cultural fidelity in activation models relies heavily on subjective ratings from experts and consumers, lacking more objective quantitative indicators;

3. Insufficient consideration has been given to the differences in acceptance and application capabilities of AI technology among intangible cultural heritage workshops in different regions and at different levels of development;

4. Insufficient analysis of the cultural homogenization risks that may arise from the application of AI technology.

C. FUTURE OUTLOOK

Future research can be conducted in the following directions:

1. Future research should expand the scope of empirical cases to cover a broader range of textile-related intangible cultural heritage categories, such as intricate tapestry weaving and ethnic dyeing techniques, to verify the universality of the model. By testing the framework across diverse artisanal traditions within the textile sector, the study can better validate its effectiveness in driving the digital transformation and intelligent preservation of traditional craftsmanship;

2. Optimize the quantitative evaluation indicators for cultural fidelity, and combine theories such as cultural communication and aesthetics to construct a more scientific evaluation system;

3. Design differentiated AI activation plans for intangible cultural heritage workshops of different scales and regions to enhance their adaptability;

4. Conduct in-depth analysis of the cultural risks brought by AI technology, propose risk prevention and control strategies, and achieve a balance between technological innovation and cultural protection;

5. Explore the integration and application of AI with emerging technologies such as metaverse and Web3.0, construct virtual intangible cultural heritage activation scenarios, and expand inheritance and dissemination channels;

6. Conduct long-term tracking research to analyze the long-term effects and sustainability of AI-driven activation of intangible cultural heritage.

AUTHOR CONTRIBUTIONS

Wei Zhang designed, collected and analyzed the data, and drafted the manuscript. Wei Zhang conducted the study, critically revised the manuscript for important intellectual content, and gave final approval of the version to be published. Wei Zhang participated fully in the work, take public responsibility for appropriate portions of the content, and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

CONFLICTS OF INTEREST

The author declares no conflict of interest.

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