

Research on the Innovative Design Process and Standardization of Heilongjiang's Ice and Snow Intangible Cultural Heritage Tourism Products from the Perspective of Cultural Gene Inheritance

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ABSTRACT Heilongjiang's ice and snow intangible cultural heritage carries distinctive regional cultural genes, yet its transformation into contemporary tourism products faces problems such as cultural distortion and lack of standardized design. From the perspective of cultural gene theory, this study systematically identifies and analyzes the core cultural elements of ice and snow intangible cultural heritage, establishes an innovative process from gene extraction to design translation, and constructs a standardized evaluation system covering cultural authenticity, experience quality, and production norms. By integrating cultural gene classification, genealogy construction, and modern expression strategies, the study forms a corresponding mechanism between process nodes and standard inspections. On the premise of maintaining cultural authenticity, the framework supports innovative development and scalable production of tourism products. The research provides theoretical support and practical paths for the living protection of regional ice and snow intangible cultural heritage resources and facilitates the creative application of heritage motifs in cultural tourism products, including textile-related design applications.

INDEX TERMS cultural gene inheritance, ice and snow intangible cultural heritage, tourism product design, design standardization, heritage motifs

I. INTRODUCTION

AS an important birthplace of China's ice and snow culture, Heilongjiang boasts rich ice and snow-themed intangible cultural heritage, such as the Oroqen birch bark craftsmanship [1], Hezhe fish skin craftsmanship, and Manchu ice sports. These ICH items carry unique cultural genes and ethnic memories, manifesting through traditional textile techniques and patterns that serve as vital carriers of regional cultural identity [2]. However, in tourism development practice, there are common problems such as the simple appropriation of cultural symbols, the lack of systematic methods in innovative design, and inconsistent product quality standards, leading to the loss of cultural value and insufficient market competitiveness [3]. Establishing a scientific identification mechanism and standardized textile design process from the perspective of cultural gene inheritance can maintain the core characteristics of ICH culture while effectively aligning traditional fabric artistry

with contemporary aesthetics and market demands to solve this dilemma [4].

II. IDENTIFICATION AND ANALYSIS OF CULTURAL GENES OF HEILONGJIANG'S ICE AND SNOW ICH

A. APPLICABILITY OF CULTURAL GENE THEORY IN ICE AND SNOW ICH RESEARCH

The concept of cultural gene (Meme) originates from Dawkins' cultural evolution theory. It refers to the smallest reproducible and transmissible unit in cultural information. Its introduction into the research on ice-snow intangible cultural heritage (ICH) provides a theoretical tool for the scientific identification of cultural elements [5]. Heilongjiang ice-snow ICH has taken shape against the backdrop of specific geographical and climatic conditions and ethnic lifestyles, and its cultural genes feature three attributes: environmental adaptability, ethnic distinctiveness and inheritance stability. The definition of "cultural gene" in this study is specified

as follows: a cultural element of Heilongjiang ice-snow ICH that possesses the three aforementioned characteristics, with the following three sub-attributes: (1) Identifiability: capable of being clearly recognized through material forms, technical norms or symbol systems; (2) Inheritability: retaining the stability of core characteristics in intergenerational transmission with a mutation rate of less than 15%; (3) Translatability: capable of being refined into design parameters and applied in contemporary product development [6]. For quantitative analysis, a three-dimensional index system is adopted, including “symbol retention rate” (the retention ratio of core visual symbols $\geq 85\%$), “craft restoration rate” (the compliance rate of key processes with traditional standards $\geq 80\%$) and “semantic recognition rate” (the accuracy rate of cultural interpretation by the target audience $\geq 70\%$). The hunting cultural genes of the Oroqen people are embodied in the functional design and decorative patterns of their birch bark artifacts, while the fishing and hunting cultural genes of the Hezhen people are condensed in the manufacturing processes and graphic language of fish skin costumes [7]. Transmitted intergenerationally through diverse forms such as material carriers, technical norms and ritual behaviors, these cultural genes constitute the “cultural DNA” of ice-snow ICH. The cultural gene theory offers a systematic analytical framework for identifying the core elements of ICH, analyzing cultural inheritance mechanisms and guiding innovative design practices, thus transforming abstract cultural values into operable design basis [8].

B. EXTRACTION METHODS OF CORE CULTURAL ELEMENTS OF ICE AND SNOW ICH

The extraction of cultural genes of ice and snow ICH requires the comprehensive application of multiple research methods. Field investigations are conducted to obtain first-hand data, going deep into the ethnic settlements of the Oroqen and Hezhe peoples, observing and recording the complete processes of traditional craftsmanship, the selection and use of tools and materials, and the morphological characteristics of finished products. In-depth interviews are conducted with inheritors to explore the implicit knowledge behind the craftsmanship, such as cultural concepts, aesthetic standards, and taboo norms. Historical document sorting is carried out to trace the historical evolution of cultural elements from local chronicles [9], ethnographies, and museum collections. On this basis, semiotic analysis is used to deconstruct the visual symbol system and extract the basic units of colors, patterns, and shapes; process flow decomposition is adopted to identify key nodes in technical norms; and semantic analysis is used to summarize the core expressions of cultural connotations. Finally, a three-dimensional element extraction system is formed, covering the material layer (materials, tools, and product forms), the behavioral layer (craftsmanship processes and usage methods), and the spiritual layer (cultural concepts and aesthetic ideas).

C. CLASSIFICATION AND GENEALOGY CONSTRUCTION OF CULTURAL GENES OF ICE AND SNOW ICH

According to the functional attributes and forms of expression of cultural genes, the cultural genes of Heilongjiang’s ice and snow ICH can be divided into four types. Firstly, material and technical genes, such as the seasonal selection for birch bark stripping and temperature control for fish skin tanning, which determine the basic quality of products. Secondly, shape and decoration genes, including typical pattern units such as cloud-thunder patterns, antler patterns, and fish scale patterns, as well as their combination rules, carrying the totem worship and natural concepts of ethnic groups. Thirdly, functional and ritual genes, reflected in the practical function settings of artifacts and the usage etiquette in specific scenarios, such as the wearing procedures of shaman costumes and the sacrificial norms of ice fishing and hunting. Fourthly, aesthetic and philosophical genes, reflecting the in-depth aesthetic concepts of ethnic groups such as color preferences, symmetry principles, and blank space awareness. On the basis of classification, a genealogical map of cultural genes of ice and snow ICH is constructed, marking the subordinate relationships, influence intensities, and inheritance paths among various genes, forming a hierarchical genetic map, which provides a clear cultural coordinate system for subsequent design translation (see Figure 1).

III. CONSTRUCTION OF INNOVATIVE DESIGN PROCESS BASED ON CULTURAL GENE INHERITANCE

A. TRANSLATION MECHANISM FROM CULTURAL GENES TO DESIGN LANGUAGE

After the systematic identification and genealogy construction of cultural genes, how to transform these cultural elements into operable design schemes has become a key link in innovative practice. The translation from cultural genes to design language is the core of innovative design, requiring the establishment of a systematic conversion mechanism. Firstly, gene decoding is carried out: the extracted cultural genes are encoded and classified according to four dimensions—form, color, material, and craftsmanship—to form a visual design element library. Secondly, semantic conversion is implemented: the original context and symbolic connotations of each cultural gene are analyzed, and its expression method in contemporary design—retention, deformation, or reconstruction—is determined. For example, the original semantics of antler patterns are strength and life, which can be translated into structural reinforcement elements or visual identification symbols of products [10]. Thirdly, form recombination is carried out: modern design methods such as modular design and parametric modeling are used to integrate traditional elements with contemporary modeling language to generate new forms with cultural recognition [11]. Fourthly, functional adaptation is performed: the presentation proportion, density, and combination mode of cultural elements are adjusted according to the

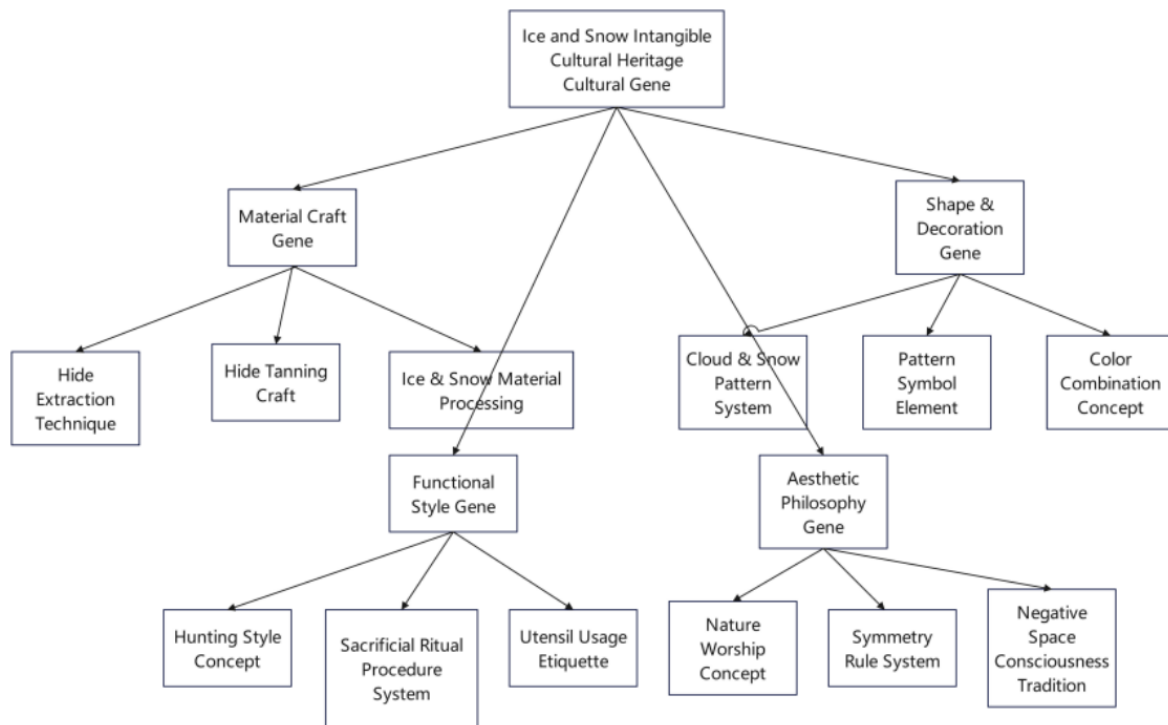


FIGURE 1. Genealogy of Cultural Genes of Heilongjiang's Ice and Snow ICH

usage scenarios and aesthetic needs of target users to achieve a balance between cultural nature and practicality [12]. The entire translation process needs to establish a dual-subject collaboration mechanism of “cultural consultants-designers” to ensure the cultural accuracy of the translation results (see Figure 2).

B. MODERN CREATIVE EXPRESSION STRATEGIES OF ICE AND SNOW ICH ELEMENTS

Modern creative expression needs to realize formal innovation on the premise of respecting cultural authenticity.

Strategy 1: Extractive expression of “retaining both form and spirit”—extracting the core characteristics and spiritual essence of traditional elements and processing them through simplification and geometrization to make them conform to contemporary aesthetics. For example, simplifying the complex decorations of shaman costumes into streamlined patterns while retaining their sense of movement and sacredness.

Strategy 2: Juxtapositional expression of “dialogue between ancient and modern times”—juxtaposing traditional and modern elements in the same product to form visual tension and cultural contrast, such as embedding birch bark craftsmanship badges on modern ice and snow sports equipment.

Strategy 3: Interactive expression of “digital empowerment”—using digital technologies such as AR and VR to present cultural elements in a dynamic and immersive way, such as developing augmented reality applications that show the entire process of fish skin production.

Strategy 4: Scenario-based expression of “cross-border integration”—implanting ice and snow ICH elements into multiple fields such as cultural and creative products, home furnishings, and fashion to expand cultural communication channels.

Each strategy should be flexibly selected according to product type, target market, and cultural sensitivity to avoid cultural dissolution caused by over-design. Taking the “Fish Leaping over Longjiang” series of products developed by Harbin Institute of Technology in cooperation with Hezhe inheritors in Jiamusi as an example, the practical path of translating cultural genes into design language is demonstrated. This project extracts three types of core cultural genes from traditional

Hezhe fish skin costumes: material and technical genes, shape and decoration genes, and aesthetic and philosophical genes. The design team adopted the “extractive expression” strategy to geometrically simplify the complex fish scale patterns on traditional fish skin costumes into streamlined pattern modules, retaining their dynamic sense of “stacking upward” and the cultural implication of “endless life”. In terms of product form, the “juxtapositional expression” was implemented to develop three products with different positioning. In the prototype verification stage, the initial design had a cultural recognition rate of only 68% due to excessive simplification of fish scale patterns. Inheritor You Cuiyu pointed out that “the core feature of ‘inter laced scales’ of fish scale patterns has been lost”. The design team adjusted the pattern modules according to feedback, adding serrated details on the edges of scales and light-

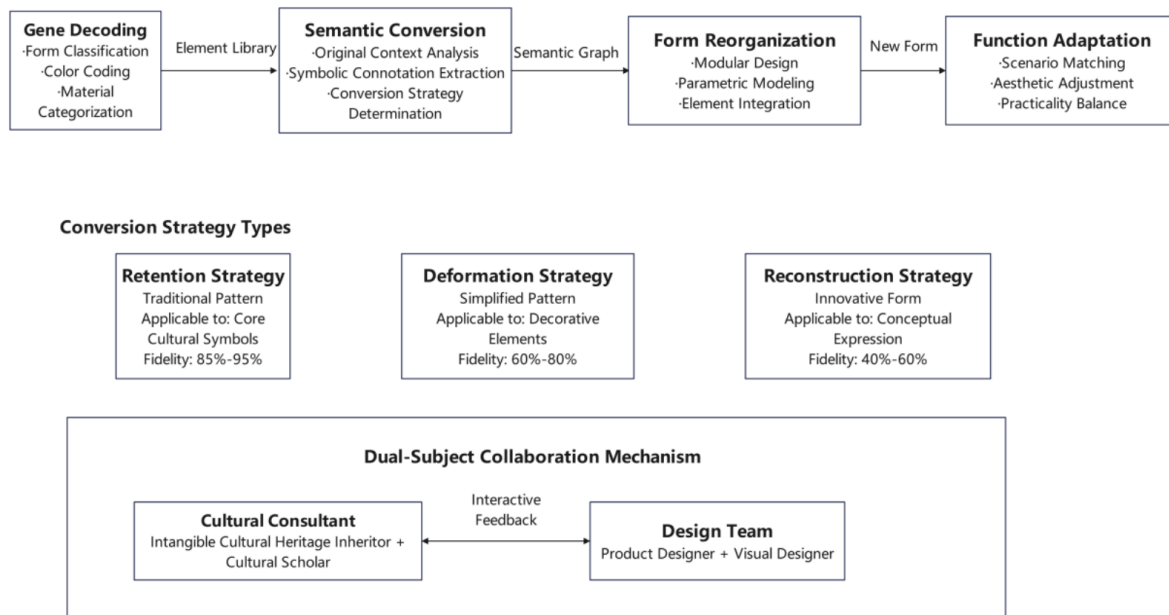


FIGURE 2. Translation Mechanism from Cultural Genes to Design Language

dark gradient processing. The secondary test showed that the cultural recognition rate increased to 87%, and the user cultural resonance reached 82 points. This series of products was first launched at the 2024 Harbin Ice and Snow World, with sales exceeding 1.5 million yuan in three months, becoming a benchmark case of Heilongjiang's ice and snow cultural and creative products [13].

C. DEVELOPMENT, VERIFICATION AND ITERATIVE OPTIMIZATION OF TOURISM PRODUCT PROTOTYPES

The development of product prototypes adopts an agile process of "rapid trial and error-continuous improvement". In the early stage, low-fidelity prototypes (hand-drawn sketches and 3D printed models) are produced according to the design scheme, and cultural consultants and potential users are invited to conduct the first round of evaluation, focusing on verifying the recognition and emotional resonance of cultural elements. In the middle stage, medium-fidelity prototypes (functional samples and digital simulations) are developed, and usability tests are conducted in small-scale markets to collect user feedback and purchase intention data, analyzing the balance between cultural nature and practicality. In the later stage, high-fidelity prototypes (finished products close to mass production standards) are completed, and multiple rounds of user experience tests and expert reviews are carried out to form the "Product Cultural Evaluation Report" and "Market Performance Analysis Report". After each round of verification, targeted optimization is carried out according to feedback data: if the cultural recognition rate is lower than 75%, the presentation method of core cultural symbols is adjusted; if the user satisfaction is lower than 80%, the product function and interactive design are improved. A prototype database is established to file the design parameters, test results, and improvement measures

of each version, forming a traceable development knowledge system to provide a reference paradigm for subsequent product development.

D. RISK IDENTIFICATION AND MITIGATION MECHANISM FOR CULTURAL GENE INHERITANCE

In the process of innovative design, the inheritance of cultural genes is confronted with multiple risks. A systematic identification and mitigation mechanism must be established to safeguard cultural authenticity. First is the risk of cultural dilution, which refers to the excessive simplification or abstraction of cultural elements in the pursuit of marketization and modernization, leading to the loss of core cultural information. A cultural concentration threshold shall be set, stipulating that each product must retain at least three recognizable cultural gene markers, and the cultural distinctiveness must be verified by inheritors to be no less than 80%. Second is the risk of symbolic misuse, manifested in the arbitrary application of sacred symbols with specific religious or ritual significance to commercial products, thus violating ethnic cultural taboos [14]. A Manual for the Standardized Use of Ice-Snow ICH Cultural Symbols shall be compiled, clearly listing prohibited symbols (such as patterns of Shaman artifacts and sacrificial totems) and applicable scenarios for restricted symbols. All design schemes must undergo dual review by ethnic cultural experts and inheritors. Third is the risk of craftsmanship degradation. Replacing traditional handcrafted techniques with industrialized production for cost reduction will impair the cultural value of products. A Catalogue of Core Craftsmanship Protection shall be formulated, explicitly stipulating that key processes such as birch bark stripping and fish skin tanning must comply with traditional craftsmanship standards. The appropriate

introduction of modern technologies in auxiliary processes is permitted, but the proportion of process composition shall be truthfully indicated in product specifications. Fourth is the risk of cultural appropriation. The random mixing of cultural elements from different ethnic groups may cause cultural confusion and identity conflicts. The principle of “one product, one cultural origin” shall be upheld. Each product shall clearly define its cultural attribution, avoiding the indiscriminate integration of cultural symbols from different ethnic groups such as the Oroqen, Hezhe, and

Manchu. A three-level risk early-warning mechanism shall be established: conducting risk assessment in the initial stage of design, implementing dynamic monitoring during the mid-term of development, and carrying out cultural compliance review before market launch. This ensures that innovative design proceeds within the safe boundaries of cultural inheritance.

IV. ESTABLISHMENT OF STANDARDIZED EVALUATION SYSTEM FOR ICE AND SNOW ICH TOURISM PRODUCTS

A. QUANTITATIVE EVALUATION INDICATORS FOR CULTURAL AUTHENTICITY DIMENSION

Cultural authenticity constitutes the core value of intangible cultural heritage (ICH) tourism products, making it imperative to construct a quantifiable evaluation index system. The first-level index is set as the Cultural Gene Retention Rate, under which three second-level indices are established:

1. Material Form Restoration Rate (weight: 35%): It assesses the consistency between a product's material, craftsmanship, and shape and their traditional prototypes, adopting the expert scoring method with a score range of 0 to 100 points. A score of 85 or above is rated as excellent.

2. Cultural Semantic Communication Rate (weight: 40%): It evaluates whether the cultural connotations and ethnic memories embodied in a product can be accurately interpreted by the target audience. Assessed through user interviews and semantic analysis, it requires that over 70% of the audience can identify the core cultural information.

3. Technical Norm Compliance Rate (weight: 25%): It measures the degree to which the product manufacturing process abides by traditional technological procedures and quality standards, and is evaluated by ICH inheritors based on craft archives.

A product can only be deemed to meet the basic requirements of cultural authenticity when its composite score of the three indices reaches 60 points or above. Specifically, a score of 60–77 points is rated as the basic qualified level, and such products can be launched only after being attached with a detailed cultural origin explanation; a score of 78 points or above is rated as the good level, and such products are eligible for priority recommendation to the market. Meanwhile, a Red Line for Cultural Taboos is established. A product will be directly judged as culturally inauthentic if it falls into any of the following circumstances:

1. Violating ethnic cultural taboos (e.g., the unauthorized use of exclusive symbols for Shaman sacrificial rituals);

2. Distorting historical facts as confirmed by cultural competent departments or ethnic affairs commissions at or above the provincial level;

3. Commercializing sacred symbols in a frivolous and entertaining way (e.g., using religious totems for vulgar marketing).

The judgment procedure shall be jointly conducted by a tripartite expert panel consisting of ICH inheritor representatives, cultural scholars and legal advisors to avoid subjective arbitrariness.

B. FORMULATION OF GRADING STANDARDS FOR TOURIST EXPERIENCE QUALITY

The grading standards for tourist experience quality are carried out from three levels: functional, emotional, and cognitive. At the functional level, basic experience indicators (product usability, safety, and durability) and value-added experience indicators (portability, aesthetics, and innovation) are set, using a 100-point scoring system: 60–75 points as qualified, 76–85 points as good, and 86 points or more as excellent. At the emotional level, the intensity of emotional reactions triggered by the product is evaluated, measuring the user's pleasure, sense of surprise, and cultural pride through an emotional scale, requiring excellent products to score more than 80 points in all three emotional dimensions. At the cognitive level, the educational function of the product on ice and snow ICH culture is examined, measuring the degree of users' mastery of relevant cultural knowledge and the improvement of interest after use, requiring excellent products to significantly enhance the cultural cognition of more than 85% of users. Based on the comprehensive evaluation results of the three levels, products are divided into four grades: five-star (comprehensive score 90–100), four-star (80–89), three-star (70–79), and two-star (60–69). Products with a score below 60 are not allowed to enter the market. The grading results are announced through official platforms to provide decision-making references for consumers and form a market survival-of-the-fittest mechanism.

C. STANDARDIZED OPERATION STANDARDS FOR PRODUCT PRODUCTION

The standardized production standards cover three links: raw material procurement, process execution, and quality inspection. Raw material procurement standards clearly specify the collection time of traditional materials such as birch bark and fish skin (birch bark collection period is May–June every year, and fish skin is preferably salmon skin caught in autumn), origin scope (limited to specific ecological areas in Heilongjiang), quality grades (divided into A, B, and C levels according to indicators such as thickness, toughness, and texture), and prohibit non-traditional alternative materials. Process execution standards formulate the “Ice and Snow ICH Craftsmanship Operation Manual”, which details the operation steps, tool use, parameter control, and quality control points of each process. For example, the soaking temperature for fish skin tanning should be

maintained at 15–18°C for 72 hours with a deviation not exceeding $\pm 5\%$. The master-apprentice inheritance system is introduced, stipulating that core processes must be completed by certified inheritors or apprentices directly guided by them. Quality inspection standards set three checkpoints: appearance inspection (no obvious defects), performance testing (meeting the corresponding use strength), and cultural review (confirmation of the accuracy of cultural elements by inheritors). A product quality traceability system is established, and each product is attached with a “cultural ID card” marking the producer, craftsmanship level, and cultural traceability (see Figure 3).

D. DYNAMIC ADJUSTMENT AND CONTINUOUS IMPROVEMENT MECHANISM OF THE STANDARDIZATION SYSTEM

A standardized evaluation system must possess dynamic adaptability to respond to changes in the market environment and the evolution of cultural cognition. An Annual Standard Review System shall be established, whereby a review committee composed of cultural scholars, inheritor representatives, design experts and market analysts conducts a comprehensive review of the current standard system in the fourth quarter of each year to determine the standard framework and core parameters for the next year. The review covers the rationality of weight allocation for cultural authenticity indicators, the alignment of experience quality grading standards with evolving consumer expectations, and the adaptability of production norms to the application requirements of new materials and technologies.

Three categories of data are collected to support standard adjustments:

1. Product market performance data: Tracking sales volume, repurchase rates and user reviews of products at all rating levels to identify deviations between the standards and market demands [15]. When a conflict arises between market demands and cultural authenticity standards, the principle of “Culture Priority, Limited Compromise” shall be applied: if market feedback calls for a reduction in the density of cultural symbols without involving core cultural genes, the weights of relevant indicators may be adjusted; if market demands touch upon cultural bottom lines, the cultural authenticity standards shall remain unchanged, and consumer cognition shall be guided through market education and product segmentation strategies to ensure that cultural inheritance is not compromised by commercial pressures.

2. Cultural inheritance monitoring data: Investigating the satisfaction of inheritor groups with the implementation effect of the current standards, and recording technical challenges and cultural conflicts encountered in the standard implementation process.

3. Industry benchmarking data: Referencing advanced standards and successful cases of ICH product development at home and abroad, and absorbing adaptable evaluation dimensions and operational norms.

After the annual framework is determined, standard adjustments shall follow the principle of “Continuous Improvement”. Partial optimizations such as minor weight adjustments and indicator refinement may be implemented on a quarterly basis, provided that such quarterly adjustments do not alter the core evaluation dimensions defined in the annual review, so as to ensure the continuity and comparability of annual data. Major changes such as framework restructuring and the addition or deletion of dimensions may only be fully rolled out after expert demonstration, industry hearings and pilot verification. A Standard Iteration Archive shall be established to fully record the background, basis, content and effect evaluation of each standard revision, forming a knowledge accumulation for the evolution of standards. Meanwhile, Standard Exception

Clauses shall be formulated: for products with special cultural value or innovative breakthroughs, the expert joint review procedure may be initiated to grant a certain degree of flexibility in compliance with the standards on the premise of not violating cultural bottom lines, so as to encourage pioneering exploration and differentiated innovation.

V. INTEGRATED OPERATION OF INNOVATIVE DESIGN PROCESS AND STANDARDIZED SYSTEM

A. DESIGN OF CORRESPONDING RELATIONSHIP BETWEEN PROCESS NODES AND STANDARD INSPECTIONS

A dynamic correspondence mechanism between the design process and evaluation criteria shall be established to achieve full-process quality control. Corresponding quality control measures are implemented at each stage as follows: At the cultural gene identification stage, a pre-assessment of cultural authenticity shall be conducted. A cultural consultant team shall review the completeness and accuracy of extraction results in accordance with the Specifications for Cultural Gene Extraction, ensuring that the coverage rate of identified cultural elements reaches over 90%. At the design translation stage, a checkpoint for translation accuracy verification shall be embedded. Design proposals shall be evaluated against the translation mechanism criteria, with a focus on verifying that the retention rate of core cultural symbols reaches 85% and that semantic communication is clear and unambiguous. At the prototype development stage, a three-round verification system shall be implemented, corresponding respectively to cultural review (evaluation by inheritors), market testing (user experience scoring) and compliance verification (against production norms). At the mass production preparation stage, a comprehensive certification procedure shall be initiated. Products must pass a synthetic evaluation across three dimensions—cultural authenticity, experience quality and production norms—and obtain a score of 78 or above to enter the market.

A standardized inspection form shall be allocated to each process checkpoint, specifying the inspection items, scoring criteria, responsible entities and time limit requirements. The setting of checkpoint time limits shall follow the



FIGURE 3. Standardized Evaluation System for Ice and Snow ICH Tourism Products

principle of “task complexity classification”: 10–15 working days for the cultural gene identification stage (involving field investigations and literature sorting); 7–10 working days for the design translation stage (requiring multiple rounds of proposal deduction); 5–7 working days for the prototype verification stage (including production and testing); 3–5 working days for the mass production preparation stage (focusing on document review). The time limit for each stage may be extended upon application based on the actual project situation, provided that a written explanation is submitted and approved by the consortium, so as to prevent rigid time limits from compromising design quality. A traceable quality archive shall be established for the entire process. (see Figure 4).

B. ORGANIZATIONAL MODEL AND GUARANTEE MECHANISM OF MULTI-SUBJECT COLLABORATION

Effective integrated operation requires the construction of an organizational structure for multi-stakeholder collaboration, adopting a three-tier model of core layer - support layer - extension layer. The core layer comprises intangible

cultural heritage inheritors, cultural scholars and product designers to form a Cultural Innovation Consortium, which is responsible for strategic decision-making and the control of key nodes. A hierarchical decision-making mechanism is established herein: matters of high cultural sensitivity involving the use of core cultural symbols and the translation of sacred ritual elements shall be subject to the unanimous approval of the three parties (inheritors, cultural scholars and designers); for technical issues such as formal innovation and material substitution, the principle of “two-thirds majority approval” shall be adopted to balance the solemnity of cultural protection and the flexibility of innovation.

The support layer includes craft technicians, quality inspectors and market researchers, who are responsible for specific implementation and technical support. The extension layer covers government cultural departments, tourism enterprises and university research institutions, which provide policy guidance, market channels and theoretical support. A communication mechanism of “regular consultation + dynamic coordination” is established, with collaborative promotion meetings held on a monthly basis and online

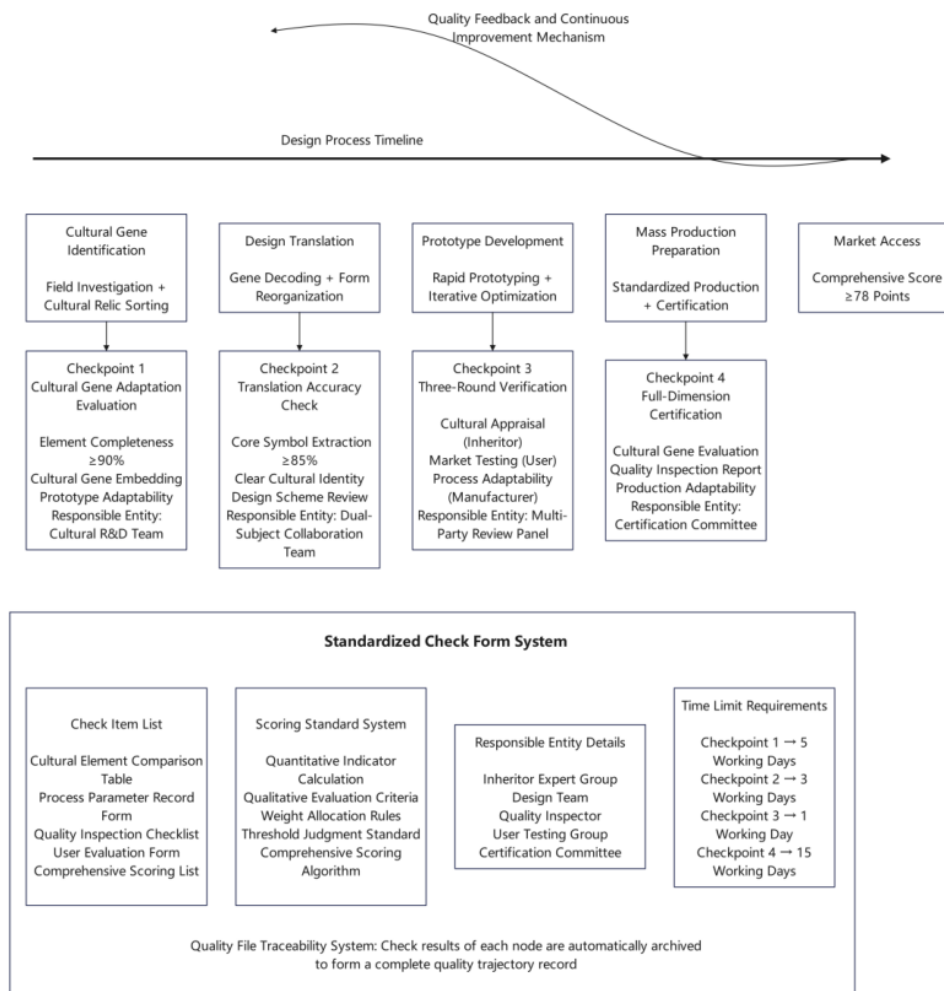


FIGURE 4. Corresponding Relationship Between Innovative Design Process and Standard Inspection

progress briefings conducted weekly. The safeguard mechanisms are as follows:

Funding guarantee: A Special Fund for the Innovation of Ice-Snow Intangible Cultural Heritage is set up, with funds allocated by project stage;

Talent guarantee: A dual-mentor training system for inheritors and designers is established, training 50 interdisciplinary talents annually;

Intellectual property guarantee: Apply for appearance patents and geographical indication protection for innovative products, and clearly define the profit distribution ratio among inheritors, designers and enterprises as 4:3:3.

C. COLLABORATIVE DEVELOPMENT STRATEGY OF REGIONAL ICE AND SNOW ICH PRODUCT SYSTEM

Taking the whole region of Heilongjiang as a unit, a differentiated and collaborative product system is constructed. **Spatial layout strategy:** Harbin focuses on high-end cultural and creative products integrating ice and snow art and Manchu culture; Yichun develops the Oroqen birch bark crafts series; Jiamusi focuses on Hezhe fish skin products

and folk experience projects; Mudanjiang develops Korean ice and snow folk tourism commodities. **Product hierarchy strategy:** forming a three-level product matrix of “cultural symbol category (refrigerator stickers, key chains, etc.)-functional and practical category (clothing, utensils, etc.)-experience service category (research courses, immersive performances, etc.)” to meet the needs of different consumption levels. **Brand collaboration strategy:** establishing the regional public brand of “Longjiang Ice and Snow ICH”, unifying the visual identification system and quality certification marks, and incorporating local products into the system as sub-brands to realize “brand sharing, quality mutual recognition, and channel co-construction”. **Marketing collaboration strategy:** building a unified online sales platform and an offline experience center network, integrating ICH resources from various places to launch high-quality routes of “ice and snow ICH cultural tour”, and conducting centralized display and promotion through festivals and international exhibitions. A product information database and market monitoring system are established, and the “Heilongjiang Ice and Snow ICH Product Development

Report” is released regularly to provide data support for the adjustment of industrial policies.

D. PROCESS MONITORING AND DATA-DRIVEN OPTIMIZATION BASED ON DIGITAL PLATFORMS

In the integrated operation system, the establishment of a digital management platform serves as a pivotal underpinning for achieving process visualization and the dynamic optimization of standards. By building an Ice-Snow ICH Product Lifecycle Management System, real-time monitoring and data collection are implemented for all links from cultural gene identification to product launch. The platform is equipped with functional modules as follows: a cultural gene database module, which inputs information on all identified cultural genes and their translation rules to form a searchable knowledge graph; a design process tracking module, which records the dwell time, revision times and problem feedback of each product at every process node and generates a visual progress dashboard; and an embedded intelligent early warning system, which automatically triggers an early warning mechanism when any indicator deviates from the standard threshold—for instance, pushing rectification suggestions to the responsible entity if the cultural recognition rate falls below 75%.

Meanwhile, the platform is configured with a unified data analysis engine, which conducts a comprehensive analysis

based on process data, user feedback data and market monitoring data from the data collection layer, and outputs two types of outcomes: the Process Efficiency Analysis Report for business optimization, which focuses on efficiency indicators such as node time consumption and revision frequency; and the Standard Adaptability Evaluation Report for standard iteration, which centers on quality indicators such as indicator weight and threshold rationality. The two reports share the same data source but focus on different analytical dimensions, avoiding repetitive data collection and processing, and providing guidance for the simplification and adjustment of design processes as well as the weight optimization of evaluation indicators. Blockchain technology is introduced to ensure the immutability of cultural traceability information. The “cultural ID” of each product is stored on the blockchain, allowing consumers to scan a QR code to check the complete development process and cultural certification information, thereby enhancing market trust. In addition, the digital platform is designed with open API interfaces to realize data interconnection with cultural and tourism departments, museums and university research platforms across the province, building a regionally collaborative digital ecosystem. This lays a technical foundation for the intelligent management and precision decision-making of Heilongjiang’s ice-snow ICH industry (see Figure 5).

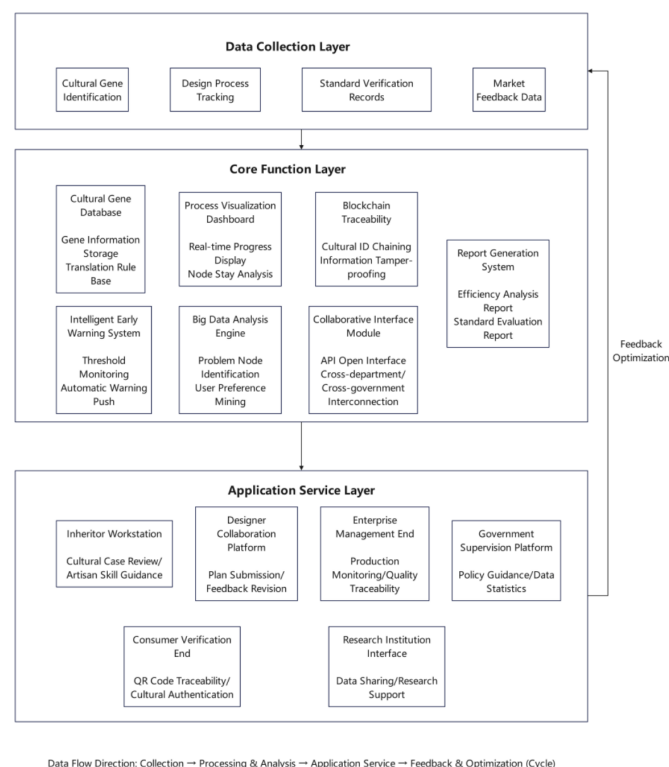


FIGURE 5. Architecture of Digital Management Platform for Ice and Snow Intangible Cultural Heritage Products

VI. CONCLUSION

As a unique carrier of frigid-region culture, the ice-snow intangible cultural heritage resources of Heilongjiang require that the development of their tourism products not only inherits the spiritual core of ice-snow culture but also adapts to the market demands of the modern ice-snow economy. By reconstructing the development logic of ice and snow ICH tourism products through cultural gene inheritance theory, this study establishes a comprehensive system spanning gene identification, textile design translation, and standardized evaluation to resolve the contradiction between heritage preservation and innovative industrial development. The research transforms abstract cultural values into operable design methods and evaluation standards, shifting ICH protection from passive rescue to active living inheritance. The integrated operation mechanism of processes and standards not only ensures the bottom line of cultural authenticity but also leaves space for innovative expression, realizing the organic connection between traditional craftsmanship and modern industry. The multi-subject collaboration model strengthens the core position of inheritors and promotes the integration and innovation of cross-border knowledge. The regional collaborative development strategy breaks the fragmented pattern of scattered development in various places and forms a recognizable brand matrix of “Longjiang Ice and Snow ICH”. Future research should deepen the application of digital technology in ICH communication and explore artificial intelligence-assisted design for the translation of textile cultural genes, driving Heilongjiang’s ice and snow ICH tourism products toward high-quality, large-scale, and internationalized industrial development.

AUTHOR CONTRIBUTIONS

Conceptualization – Yuan Yao and Peng Zhang; methodology – Yuan Yao and Peng Zhang; investigation – Yuan Yao and Peng Zhang; writing-original draft preparation – Yuan Yao and Peng Zhang. All authors have read and agreed to the published version of the manuscript.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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REFERENCES

- [1] H. Wang, “Research on the Communication Path of Heilongjiang “Three Skins” Crafts Intangible Cultural Heritage from the Perspective of Culture-Tourism Integration,” *Contemporary Research on Education and Teaching*, vol. 11, no. 5, pp. 120-124, 2025, doi: 10.3969/j.issn.2095-6517.2025.05.027.
- [2] Y. Yuan and Y. Lu, “Research on Culture-Tourism Integration Promoting Ethnic Minority Cultural Identity in Heilongjiang Province,” *Economic Research Guide*, no. 11, pp. 72-76, 2025, doi: 10.3969/j.issn.1673-291X.2025.11.015.
- [3] X. Xu, “Study on the Countermeasures for the Deep Integration of Culture and Tourism in Heilongjiang Province under the Background of High-quality Development,” *Tourism Management and Technology Economy*, vol. 5, no. 2, 2022, doi: 10.23977/TMTE.2022.050208.
- [4] W. Li and G. Ji, “Research on the Integrated Development of Intangible Cultural Heritage and Ice-Snow Cultural and Creative Product Design in Heilongjiang Province,” *Journal of Harbin University*, vol. 46, no. 1, pp. 116-119, 2025, doi: 10.3969/j.issn.1004-5856.2025.01.024.
- [5] Y. Qi, “Promoting Regional Archaeological Research and Inheriting Heilongjiang Historical and Cultural Genes,” *Endeavor*, no. 24, pp. 25-26, 2020, doi: 10.16634/j.cnki.cn23-1001/d.2020.24.009.
- [6] Y. Wang, “Digital Inheritance of Intangible Cultural Heritage Genes,” *Journal of Hengyang Normal University*, vol. 45, no. 4, pp. 49-54, 2024, doi: 10.13914/j.cnki.cn43-1453/z.2024.04.008.
- [7] S. Guo, F. Gao, J. Yao, et al., “Research on Inheritance, Protection and Innovative Development of Hezhe Ethnic Intangible Cultural Heritage,” *Journal of Social Science of Jiamusi University*, vol. 43, no. 8, pp. 136-139, 2025, doi: 10.3969/j.issn.1007-9882.2025.08.032.
- [8] G. Yang, “An Analysis of the Path of Empowering Art Derivatives Based on Red Cultural Genes Carried by Heilongjiang Region,” *Journal of Heilongjiang Institute of Teacher Development*, vol. 44, no. 1, pp. 144-146, 2025, doi: 10.3969/j.issn.2096-8531.2025.01.029.
- [9] Z. Nan and Z. Xiaojing, “A Visual Analytics Approach for National Intangible Cultural Heritage in Heilongjiang Province,” *Journal of Computational Methods in Sciences and Engineering*, vol. 23, no. 3, pp. 1625-1633, 2023, doi: 10.3233/JCM-226679.
- [10] C. Liu, “Inheritance and Innovation of Heilongjiang Anti-Japanese United Army Spirit in Tourism Cultural and Creative Products,” *Green Packaging*, no. 7, pp. 152-156, 2024, doi: 10.19362/j.cnki.cn10-1400/tb.2024.07.034.
- [11] Y. Sun, “Design of Encrypted Cultural and Creative Products for Ice and Snow Tourism in Heilongjiang Province under the Metaverse Concept,” *Art & Design Research*, vol. 5, no. 1, 2024, doi: 10.37420/J.ADR.2024.007.
- [12] L. Jia and Y. Gao, “Research on the Integrated Development Path of Heilongjiang Ice-Snow Sports Tourism Industry and Cultural Industry-Taking Ice-Snow Folk Culture Experience Projects as an Example,” *Science & Technology of Stationery & Sporting Goods*, no. 23, pp. 98-100, 2025, doi: 10.3969/j.issn.1006-8902.2025.23.034.
- [13] X. Dan, “The Asian Winter Games Empowers the Economy of Heilongjiang Province: Facilitating the Rise of the Ice and Snow Industry and the Diverse Development of the Economy,” *Journal of Literature and Art Studies*, vol. 15, no. 11, 2025, doi: 10.17265/2159-5836/2025.11.013.
- [14] F. Wang, “Legal Protection of Intangible Cultural Heritage and Heilongjiang Local Development,” *International Journal of Frontiers in Sociology*, vol. 4, no. 4, 2022, doi: 10.25236/IJFS.2022.040412.
- [15] G. Yang and L. Wan, “Research on High-Quality Development Strategies for Sino-Russia Ice and Snow Tourism in Heilongjiang Province Under the Context of New Quality Productive Forces,” *Journal of Tourism Management*, vol. 2, no. 3, 2025, doi: 10.62517/JTM.202513301.