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Article

A Framework for the Digital Transformation of Traditional Bamboo Weaving in Contemporary Interior Design

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Abstract: This study explores the digital transformation and spatial application of traditional bamboo weaving in contemporary interior design. It aims to develop a parametric modeling framework that translates traditional bamboo weaving techniques into computational design parameters, thereby enabling their effective integration into modern interior environments. A mixed-method research approach was adopted, including literature review, field investigation, expert interviews, and parametric modeling experiments. Field studies were conducted in three representative bamboo weaving regions Qingshen (Sichuan), Shengzhou (Zhejiang), and Gutian (Fujian) to collect quantitative technical data. including bamboo filament precision, weaving density, perforation rate, thermoforming temperature, and structural performance. These parameters were systematically translated into digital variables and implemented through parametric modeling using Rhino and Grasshopper. The results demonstrate that traditional bamboo weaving techniques can be effectively transformed into a parametric digital design model capable of generating adaptable patterns, structures, and spatial elements for interior applications. The proposed framework reconstructs the logic of weaving through computational algorithms and supports design implementations such as spatial partitions, lighting elements, decorative screens, and wall installations. By transforming experiential craft knowledge into a structured parametric system, this research contributes to the fields of digital heritage and computational design. It provides a practical methodological pathway for integrating traditional craftsmanship with contemporary interior design practices, thereby supporting the sustainable preservation and innovative development of bamboo weaving as an intangible cultural heritage.

Keywords: bamboo weaving, parametric modeling, computational design, intangible cultural heritage, interior space design

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1. Introduction

Traditional bamboo weaving is an important component of Chinese handicraft culture and represents a valuable form of intangible cultural heritage with deep historical and cultural significance. For centuries, bamboo weaving has played a vital role in daily life, material culture, and regional craft traditions across China. However, with the rapid development of industrial production and changes in contemporary lifestyles, many traditional bamboo weaving practices are facing challenges related to declining demand, aging craft communities, and limited adaptation to modern design contexts. As a result, exploring innovative approaches for integrating traditional bamboo weaving into contemporary design environments has become an important issue in both cultural heritage preservation and design research.

In recent years, digital technologies and computational design methods have provided new opportunities for the documentation, transformation, and reinterpretation of traditional craft knowledge. Among these approaches, parametric modeling has demonstrated particular potential in translating traditional structural logic into adjustable digital systems that can support design innovation. Within this context, this study investigates the digital transformation of traditional bamboo weaving and its application in contemporary interior space design. By combining field investigation, craft parameter extraction, and parametric modeling experiments, the research aims to develop a digital framework that bridges traditional craftsmanship and modern design practice, thereby promoting both cultural preservation and innovative spatial applications of bamboo weaving.

1.1. Research Background and Significance

Bamboo weaving is a traditional Chinese craft with a history of several thousand years and has been listed as a national Intangible Cultural Heritage in China. In recent years, policies promoting the revitalization of traditional culture have emphasized the importance of safeguarding and innovatively transforming traditional crafts. Contemporary studies on intangible cultural heritage indicate that many traditional crafts face challenges related to modernization and lifestyle changes, particularly the weakening connection between traditional craft practices and contemporary social needs [1]. As modern production systems and consumer habits evolve, traditional bamboo weaving has gradually lost its role in everyday life, resulting in declining market demand and increasing difficulties in skill transmission.

At the global level, sustainable design and bio-based materials have become important research directions in architecture and product design. Bamboo has attracted considerable attention due to its rapid renewability, high carbon sequestration capacity, and excellent mechanical properties. Recent research highlights bamboo as an important sustainable material with broad potential applications in furniture, architecture, and cultural product design [2]. Furthermore, the ecological advantages of bamboo materials align with the growing emphasis on circular economy principles and environmentally responsible design strategies in contemporary design practice. At the same time, contemporary design aesthetics increasingly value natural materials, simplicity, and craftsmanship, influenced by Eastern philosophy and minimalist design culture. Under this context, bamboo weaving has gradually attracted attention in international design discourse as a craft that integrates ecological sustainability with cultural identity [3].

For China, the contemporary transformation of bamboo weaving represents not only a strategy for protecting traditional culture but also an opportunity to integrate local cultural identity into global design innovation. Through modern design methods and digital technologies, traditional craft knowledge can be systematically reinterpreted and applied in contemporary spatial design. Digital technologies, including virtual reality documentation and computational modeling, have already demonstrated potential in preserving and transmitting traditional bamboo weaving knowledge in digital environments [4]. Recent research in digital heritage also emphasizes that parametric modeling and computational design methods can effectively translate traditional craft structures into reproducible digital systems, thereby supporting both cultural preservation and contemporary design innovation [5].

Furthermore, the revitalization of bamboo weaving also has economic and social implications. Recent studies on rural revitalization indicate that traditional craft industries can support local employment, empower craft communities, and promote sustainable cultural economies [6]. Therefore, the integration of bamboo weaving with contemporary design innovation may contribute not only to cultural preservation but also to sustainable regional development.

This study therefore situates bamboo weaving within an interdisciplinary framework that integrates design studies, materials science, anthropology, and digital technology. In particular, digital design tools such as parametric modeling and three-dimensional simulation provide new possibilities for transforming tacit craft knowledge into structured design systems applicable to modern interior environments.

1.2. Research Objectives

This research aims to explore the transformation and application of traditional bamboo weaving in modern interior spaces. This study has two main objectives:

First, The study and analyze the materials, design concepts, and weaving techniques of traditional bamboo weaving within local craft communities.

Second, The develop a framework for the digital transformation of traditional bamboo weaving by translating weaving structures and patterns into parametric digital models.

1.3. Research Assumption

This study is based on the assumption that traditional bamboo weaving techniques contain inherent structural logic and modular characteristics that can be translated into digital design parameters. By extracting technical variables such as weaving density, filament precision, and structural patterns, it is possible to construct parametric digital models that accurately represent traditional craftsmanship while enabling innovative spatial applications.

Through this approach, bamboo weaving can evolve from a purely handcrafted tradition into a digitally supported design system, facilitating both the preservation of cultural heritage and its sustainable integration into contemporary interior design.

1.4. Research Contributions

This research makes three primary contributions to the fields of digital heritage and computational design.

First, it establishes a parametric modeling framework for traditional bamboo weaving, translating craft parameters such as filament precision, weaving density, and perforation rate into computational variables.

Second, the study proposes a digital transformation pathway for intangible cultural heritage craftsmanship, converting tacit craft knowledge into explicit parametric design rules that can be reproduced and adapted in digital environments.

Third, the research demonstrates the practical application of digital bamboo weaving in contemporary interior spaces through several parametric design prototypes, including partitions, furniture, and decorative installations.

2. Parametric Modeling of Bamboo Weaving

This study aims to transform traditional bamboo weaving knowledge into a structured computational design system applicable to modern interior decoration through digital modeling of bamboo weaving art. The modeling process integrates traditional process analysis, parametric algorithm development, and digital simulation technology, constructing a complete system framework for the digital transformation of bamboo weaving techniques and providing technical support for the modern application of traditional bamboo weaving craftsmanship.

2.1. Parameter Extraction

The core is the quantitative extraction and analysis of key technical parameters of traditional bamboo weaving techniques. To this end, we conducted systematic field surveys and expert interviews in three representative bamboo weaving production areas: Qingshen County in Sichuan Province, Shengzhou City in Zhejiang Province, and Gutian City in Fujian Province. These three production areas correspond to three different bamboo weaving systems: planar weaving, three-dimensional structural weaving, and perforated weaving, basically covering the main types of traditional bamboo weaving techniques. Through on-site observation, practical recording, and precise technical measurements, we systematically collected and recorded key process parameters such as bamboo fiber precision, weaving density, perforation rate, forming temperature, and structural tension. These parameters collectively constitute the basic variables for digital modeling. The quantitative extraction of process parameters breaks the implicit "oral transmission" model of traditional bamboo weaving techniques, transforming difficult-to-quantify experiential knowledge into standardized, measurable data that can be directly used for computational modeling, laying a solid foundation for subsequent modeling work.

2.2. Parametric Algorithm Development

Based on the core process parameters extracted in the early stage, we constructed a complete parametric modeling framework for bamboo weaving using Rhino and Grasshopper as technical platforms. The core logic of this modeling process follows three core steps: "parameter mapping and process restoration and error correction," ensuring that the digital model can both reproduce the essence of traditional craftsmanship and meet the flexible needs of modern design. Specifically, the algorithm development process is divided into four main stages: First, parameter acquisition and import, which converts various technical data obtained from on-site surveys into digital variables that the algorithm can recognize and compute; second, basic texture algorithm programming, which transforms the warp and weft interlacing logic of traditional bamboo weaving into computational geometry algorithms that can simulate woven patterns, restoring the core features of bamboo weaving textures; third, parameter coupling and debugging, which achieves dynamic linkage of key variables such as weaving density, fiber diameter, and interlacing angle, ensuring that variable adjustments can affect the generated geometric shape in real time; and fourth, algorithm verification and optimization, which corrects algorithm deviations through comparison with traditional bamboo weaving objects and expert review, ensuring that the generated digital model is consistent with traditional craft principles and aesthetic standards. Through this parametric control system, various bamboo weaving structures can be automatically generated simply by adjusting relevant variables, while effectively preserving the structural consistency and traditional aesthetic characteristics of bamboo weaving.

2.3. Integration of Material Constraints

To ensure the actual producibility of the digital model and avoid the problem of "digitally feasible but practically unrealizable," we fully embed the material properties of bamboo and traditional process constraints into the parametric modeling system. Core physical parameters of bamboo, including its elastic modulus (10-12 GPa), bending radius limit, and deformation range, are incorporated into the algorithmic modeling process. These parameter constraints ensure that the geometry generated by the digital system remains within the physical performance limits of bamboo. Furthermore, we established a series of process constraints based on traditional bamboo weaving production practices, including minimum interlacing unit size, minimum structural load requirements, and heat-setting temperature parameters commonly used in bamboo forming processes. This avoids unrealistic modeling results from a process perspective. By embedding these constraints, the digital model accurately reflects actual production process requirements, effectively avoiding the excessive geometric degrees of freedom common in digital modeling aimed at purely aesthetic purposes, and achieving a seamless connection between "digital modeling" and "actual production."

In addition to the digital modeling of traditional pure bamboo weaving structures, this study also explores digital modeling methods for composite material systems combining bamboo with other materials (such as metals and glass). The modeling process follows a step-by-step workflow of "component modeling and precise assembly and material allocation": first, the bamboo weaving components and metal/glass components are modeled separately; then, precise positioning is used to assemble and connect the components; finally, different materials are assigned corresponding mechanical performance parameters to simulate their role in the overall structure. For example, bamboo fibers, as flexible structural elements, mainly serve decorative and auxiliary support functions; the metal frame, as a rigid structural element, mainly provides overall load-bearing support. The application of multi-material simulation technology enables the digital model to accurately represent bamboo hybrid structural systems commonly used in contemporary interior design, further expanding the modern application scenarios of bamboo weaving art.

2.4. Model Optimization

To ensure the practicality and efficiency of the digital model in the modern interior design workflow, we adopted a Layered Level of Detail (LOD) strategy to optimize the model. The geometric accuracy of the model is divided into three levels: high, medium, and low. The appropriate accuracy level is flexibly selected according to different design scenarios (such as scheme presentation, detail refinement, and construction implementation). To balance visual fidelity and computational efficiency, we focused on creating a low-rendering-density model. While preserving the basic characteristics of bamboo weaving texture and without affecting the visual effect, we significantly reduced the model's data volume, effectively improving the model's loading speed and computational performance. This ensures that the model can adapt to the workflow of mainstream design software and meet the high-efficiency requirements of actual design work.

3. Application of Digital Bamboo Weaving in Interior Space

3.1. Study of Weaving Techniques

The regional characteristics of traditional Chinese bamboo weaving are shaped by the combined influence of natural resource conditions, local cultural traditions, and established craft techniques. Based on the field investigations introduced in Section 2, this study focuses on three representative bamboo weaving regions Qingshen (Sichuan), Shengzhou (Zhejiang), and Gutian (Fujian). These regions represent three major craft systems: fine plain weaving, three-dimensional structural weaving, and sparrow-eye openwork weaving. Their structural characteristics, process parameters, and spatial applications differ significantly, providing a diversified technical foundation for the digital transformation of bamboo weaving techniques.

Qingshen bamboo weaving is characterized by fine plain weaving as its core technique. Extremely thin bamboo filaments are produced through traditional splitting and processing methods, allowing craftsmen to achieve very high weaving density and refined surface textures. The finished works display delicate patterns and smooth surfaces, often described as "painting through weaving." Because of its high precision and refined texture, Qingshen bamboo weaving is particularly suitable for interior applications that emphasize decorative quality and surface detail, such as decorative panels, wall surfaces, and artistic installations.

Traditional patterns in Qingshen bamboo weaving primarily depict landscapes, flowers and birds, as well as classical poetry and calligraphic motifs. Relying on extremely fine bamboo filaments, these patterns are capable of reproducing the artistic atmosphere of traditional Chinese ink painting and gongbi painting styles. Common motifs include fragments inspired by A Thousand Li of Rivers and Mountains, the "Four Gentlemen" (plum blossom, orchid, bamboo, and chrysanthemum), and lotus flowers with koi fish. The pattern lines are delicate and fluid, while the color palette is derived from the natural gradients of bamboo itself ranging from pale beige to light brown without requiring additional pigmentation. This approach reflects both the technical sophistication of the craft and the elegance of traditional literati aesthetics. In some classic designs, traditional auspicious motifs such as the hui pattern and cloud patterns are also incorporated as decorative borders (As shown in Figure 1).

Figure 1. Plain weave pattern from Qingshen, Sichuan.

Shengzhou bamboo weaving is distinguished by three-dimensional structural weaving. In contrast to the fine filaments used in Qingshen weaving, Shengzhou weaving employs relatively thicker bamboo strips that undergo heat treatment to improve flexibility before weaving. Diagonal and hexagonal patterns form the primary structural configurations. The resulting woven structures exhibit strong rigidity and geometric diversity, making them suitable for interior spatial elements requiring structural support, including partitions, furniture frames, and architectural panels.

Traditional patterns in Shengzhou bamboo weaving are primarily based on geometric and biomorphic motifs. The geometric patterns typically include diagonal grids, regular hexagons, octagonal lattice patterns, and square hui-grid structures. Through three-dimensional weaving techniques, these patterns create layered surface textures with subtle concave-convex variations, enhancing both structural stability and visual rhythm. The overall pattern composition appears orderly and monumental, closely aligning with the functional characteristics of three-dimensional woven structures (As shown in Figure 2).

Figure 2. Three-dimensional bamboo weaving from Shengzhou, Zhejiang.

Gutian bamboo weaving is well known for its sparrow-eye openwork weaving structure, characterized by a high perforation rate and relatively low weaving density. The openwork configuration allows for excellent ventilation and light transmission, producing distinctive light and shadow effects within interior environments. This type of weaving is therefore suitable for semi-transparent spatial elements such as decorative screens, ventilation panels, and lightweight interior partitions.

Traditional patterns in Gutian bamboo weaving are centered on the characteristic sparrow-eye motif, often combined with other openwork patterns. The sparrow-eye pattern is formed by two groups of diagonally interlaced bamboo filaments that create small square openings resembling bird eyes. These openings are arranged in a regular repeating structure and represent one of the most distinctive visual features of Gutian bamboo weaving. After weaving, the pattern produces a rhythmic openwork texture with alternating dense and sparse areas. When natural light passes through the woven surface, the perforated structure projects dynamic and rhythmic light shadow patterns in the surrounding space, enhancing both decorative expression and functional performance. In some traditional screen designs, the sparrow-eye pattern is further combined with auspicious motifs such as the Chinese character fu (symbolizing good fortune) and bat patterns, reflecting the regional folk culture embedded in Gutian bamboo weaving traditions (As shown in Figure 3).

Figure 3. Classic bamboo weaving pattern from Gutian.

The craft characteristics of these three regions exhibit systematic differences in terms of raw materials, structural patterns, and functional applications. A comparative overview is presented in Figure 4. These differences provide important references for parameter extraction in digital modeling and establish a technical foundation for the subsequent algorithmic transformation and spatial design applications of bamboo weaving.

Figure 4. Comparative Analysis of Bamboo Weaving Techniques in Three Representative Production Regions of China.

3.2. Digital Classification and Algorithmic Transformation

Based on the technical characteristics extracted from field investigations in the three major production regions, this study adopts structural logic and weaving patterns as the primary classification criteria to systematically categorize traditional bamboo weaving techniques into three types: plain weaving systems, twill weaving systems, and composite structural systems. Each weaving system exhibits distinctive structural characteristics and corresponds to a specific digital transformation pathway. By defining quantifiable parameters, these traditional craft systems can be translated into parametric algorithms, thereby providing a structured technological framework for digital modeling.

The plain weaving system represents the fundamental structure of traditional bamboo weaving. Its defining feature is the orthogonal interlacing of warp and weft bamboo strips, with evenly distributed intersection points forming a regular grid structure. This configuration ensures balanced stress distribution and high structural stability. The fine plain weaving of Qingshen bamboo weaving serves as a typical example. In the digital transformation process, key variables such as fiber spacing, weaving density, and orthogonal angle are defined. Through computational geometry algorithms, the fundamental logic of warp-weft interlacing can be reconstructed to generate standardized planar grid texture models. This system is particularly suitable for modeling two-dimensional spatial elements, such as decorative panels and interior screens.

The twill weaving system is characterized by diagonal interlacing, where the intersection angle between warp and weft deviates from 90°, producing dynamic diagonal textures and enhanced structural flexibility. This structure allows for simple curved surface formations. Typical examples include the twill and hexagonal weaving patterns of Shengzhou bamboo weaving. In digital transformation, additional parameters including interlacing angle, texture inclination, and surface curvature are introduced based on the parameters of plain weaving systems. Algorithmic modeling enables the reconstruction of diagonal interlacing logic and supports the generation of complex geometric forms and dynamic surface patterns. Consequently, this system is suitable for spatial elements requiring both structural functionality and aesthetic expression, such as curved partitions and surface-decorative panels.

The composite structural system represents an advanced form of traditional bamboo weaving. Its key characteristic lies in the integration of multiple patterns and densities within a single structure, combining weaving modes such as plain and twill weaving to create three-dimensional woven surfaces. This system provides both spatial adaptability and visual diversity and can be regarded as an advanced extension of three-dimensional weaving in Shengzhou and openwork weaving in Gutian. During digital transformation, the parameters from the previous two systems are integrated, while additional variables including pattern splicing ratios, local density adjustments, and three-dimensional spatial coordinates are introduced. Through the coupling of multiple algorithms, different weaving logics can be combined to generate complex woven structures. This system is particularly suitable for modeling large-scale three-dimensional decorative installations and composite spatial partitions.

The digital transformation of these three weaving systems is implemented using Rhino and Grasshopper as the primary technological platforms. Following the workflow of parameter extraction, variable definition, algorithm programming, and error correction, the empirical knowledge embedded in traditional weaving practices is translated into computable and adjustable parametric design rules. This process establishes a digital inheritance framework for intangible cultural heritage bamboo weaving techniques and facilitates the transformation of traditional craft knowledge into computational design systems (As shown in Figure 5).

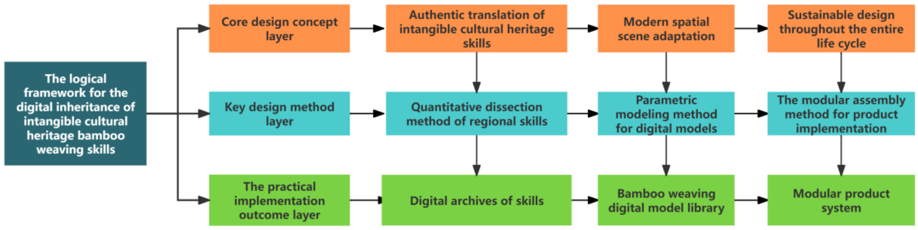

Figure 5. Digital Translation Logic Framework.

3.3. Guidelines for Creating Innovative Digital Models from Traditional Bamboo Weaving

The digital transformation of bamboo weaving techniques enables their integration into contemporary interior environments through parametric modeling and computational design. By translating traditional weaving parameters into adjustable digital variables, bamboo weaving structures can adapt to different spatial scales and functional requirements. Based on the digital modeling framework developed in this study, several parametric design prototypes were created and applied to three representative residential interior environments: the living room, the study, and the bedroom. These spaces represent common scenarios in which bamboo weaving elements can function simultaneously as structural and decorative components.

1) Living Room

As the central social space of the home, the living room requires a balance between spatial zoning, multifunctionality, and visual coherence. Bamboo weaving elements can serve both decorative and structural roles, defining spatial boundaries while contributing to furniture design. In this study, weaving techniques from the three representative regions were selectively integrated: the openwork Que-mu weaving from Gutian for spatial partitions, the three-dimensional structural weaving from Shengzhou for furniture support structures, and the fine plain weaving from Qingshen for detailed surface textures.

Two parametric design prototypes were developed for the living room: a bamboo woven folding partition and a multifunctional liftable bamboo coffee table. The folding partition adopts the Gutian openwork weaving system as its primary structure. In the modeling process, a standard panel geometry is first defined in Rhino, after which the openwork weaving algorithm generates hexagonal perforated units to form a semi-transparent woven surface. Reinforced cross-weaving structures are added along the edges to improve structural stability. Under natural lighting conditions, the hexagonal openings create dynamic diamond-shaped shadow patterns, producing spatial light effects that reflect the traditional Eastern aesthetic concept of the balance between solidity and emptiness.

The multifunctional liftable coffee table integrates techniques from all three regions. The tabletop employs the fine plain weaving of Qingshen bamboo weaving, creating a dense woven surface with refined texture. The supporting frame uses the three-dimensional structural weaving technique from Shengzhou, while the storage basket adopts the Gutian openwork pattern. Through parametric modeling in Grasshopper, the woven textures of the tabletop, frame, and storage basket are generated separately and then integrated with a hydraulic lifting mechanism to form the final furniture structure. The layered weaving textures create rich visual effects while maintaining practical functionality for everyday living activities (As shown in Figure 6).

Figure 6. Furniture in the living room area.

2) Study Room

The study represents a semi-enclosed space dedicated to reading and cultural activities. In this environment, bamboo weaving is applied to furniture and storage elements that combine functional utility with cultural expression. Two design prototypes were developed: a bamboo woven calligraphy display desk and a perforated bamboo bookshelf.

The calligraphy display desk combines the fine weaving technique of Qingshen with the nested structural framework derived from Shengzhou weaving. The woven tabletop incorporates selected calligraphic characters from the classical work Preface to the Orchid Pavilion (Lanting Xu). In the modeling process, the plain-weave algorithm first generates the base weaving pattern. A vector-based pattern embedding method is then used to translate the calligraphic strokes into bamboo strip paths, allowing the woven texture to reproduce the structure of the characters. The woven panel is integrated with a wooden base through a slot-based assembly structure to ensure stability.

The perforated bamboo bookshelf is derived from the Gutian openwork weaving system combined with reinforced structural edges inspired by Shengzhou weaving techniques. The shelves use hexagonal openwork patterns that allow light to pass through the structure, producing distinctive light and shadow effects on surrounding surfaces. Solid wood vertical supports are integrated with the woven panels through modular connections, ensuring both structural stability and visual coherence. This design integrates the natural aesthetic qualities of bamboo weaving with the functional requirements of book storage (As shown in Figure 7).

Figure 7. Study Furniture.

3) Bedroom

In the bedroom, bamboo weaving is primarily applied to furniture surfaces and lightweight spatial partitions. Compared with public areas such as the living room, the bedroom emphasizes a calm atmosphere and material warmth. Therefore, designs in this space focus on the delicate textures of Qingshen weaving combined with the lightweight structural characteristics of Shengzhou weaving.

Through parametric modeling, weaving density, pattern scale, and structural spacing can be adjusted according to bedroom dimensions and lighting conditions. This flexibility allows bamboo weaving elements to maintain visual harmony with surrounding furniture and architectural components while preserving their natural material character. The warm tones and natural textures of bamboo contribute to a comfortable and tranquil environment appropriate for private living spaces (As shown in Figure 8).

Figure 8. Bedroom Furniture.

Overall, the design prototypes developed in this study demonstrate that bamboo weaving can evolve from small-scale handicrafts into adaptable spatial design elements. By integrating the craft logic of different weaving traditions with parametric modeling methods, the proposed digital bamboo weaving framework enables flexible combinations of weaving techniques tailored to specific interior functions and spatial conditions. This approach provides a practical pathway for incorporating traditional bamboo weaving craftsmanship into contemporary interior design while supporting the dynamic preservation and innovative development of this intangible cultural heritage.

4. Conclusions

This study investigates the digital transformation and contemporary spatial application of traditional bamboo weaving as an item of intangible cultural heritage within modern interior design. Through a mixed-method research approach combining literature review, field investigation, expert interviews, and parametric modeling experiments, the research systematically explored the extraction of craft parameters, the construction of a digital modeling framework, and the development of interior design prototypes based on bamboo weaving techniques. The results demonstrate that traditional bamboo weaving knowledge can be effectively transformed from an experience-based craft practice into a structured computational design system, enabling its integration into contemporary interior environments.

From a theoretical perspective, this research establishes an interdisciplinary framework that integrates traditional craft studies, computational design, and interior design research. Through field investigations in three representative bamboo weaving regions Qingshen (Sichuan), Shengzhou (Zhejiang), and Gutian (Fujian) the study extracted key quantitative parameters such as bamboo filament precision, weaving density, perforation rate, and thermoforming temperature. These parameters clarified the structural logic and regional characteristics of three representative weaving systems: fine plain weaving, three-dimensional structural weaving, and openwork weaving. Based on this analysis, a parametric modeling framework was developed to translate traditional weaving logic into adjustable computational variables. Compared with previous studies that primarily focus on cultural documentation or visual representation, this research emphasizes the integration of craft structural logic, bamboo material characteristics, and parametric modeling methods, thereby contributing a methodological approach for the digital transformation of traditional craft systems within the broader field of digital heritage research.

From a practical perspective, the proposed digital modeling framework was implemented using Rhino and Grasshopper and applied to several residential interior design scenarios, including living rooms, studies, and bedrooms. A series of parametric bamboo weaving design prototypes were developed, demonstrating how traditional weaving techniques can be adapted to contemporary spatial requirements. The results indicate that bamboo weaving can evolve from small-scale handicrafts into flexible architectural and interior design elements through parametric control and modular design strategies. This transformation not only enhances the adaptability of bamboo weaving in modern spatial environments but also provides a practical pathway for integrating traditional craftsmanship with contemporary design practice.

Despite these contributions, several limitations remain. The field investigation focused primarily on three representative bamboo weaving regions, and future research could expand the geographic scope to include additional weaving traditions in order to enrich the parameter database. Moreover, the current modeling framework has limitations in simulating the complex material behavior of bamboo, particularly when combined with other structural materials. Future studies may integrate advanced computational approaches such as generative design, artificial intelligence, and finite element analysis to improve the simulation of bamboo material performance. In addition, further research should explore the connection between digital bamboo weaving models and real manufacturing processes, including CNC fabrication and digital weaving technologies. Such developments would support the large-scale application of bamboo weaving in architectural and interior design while promoting the sustainable preservation and innovative development of this important intangible cultural heritage.

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