DOI: 10.5152/forestist.2026.25164
Forestist 2026: 76: 1-16

IUC UNIVERSITY PRESS İSTANBUL

Original Article

Sustainable Development Strategies for National Intangible Cultural Heritage Bases: A Strengths, Weaknesses, Opportunities, and Threats–Analytical Hierarchy Process Approach to the Qingshen Bamboo Weaving Base

Lijuan Su[1], Yu Jiang[2], Qin Wang[3], Lin Zhu[4], Can Zhao[5], Enlong Xia[4], Ge Li[4]

[1]National Academy of Forestry and Grassland Administration, Beijing, China
[2]Institute for Political Studies, Universidade Católica Portuguesa, Lisboa, Portugal
[3]Chongqing Technology and Business University, Chongqing, China
[4]International Centre for Bamboo and Rattan, Beijing, China
[5]China Bamboo Industry Association, Beijing, China

What is already known on this topic?

- Traditional intangible cultural heritage (ICH) faces significant preservation challenges amid modern social transformation.
- Productive protection is a key mechanism to transform ICH skills into cultural products.
- SWOT-AHP frameworks are widely accepted tools for strategic evaluation in traditional industries.

ABSTRACT

Bamboo weaving, as a unique form of natural resource utilization and cultural exploration, is intricately linked to the livelihoods of millions worldwide. Qingshen bamboo weaving, recognized as national intangible cultural heritage in China, is the sole bamboo weaving–themed base among the latest batch of 99 national productive protection demonstration bases. This study employs a hybrid SWOT–AHP framework to empirically analyze the sustainable development pathway of the Qingshen Bamboo Weaving Base, identifying 18 key factors and calculating their relative importance through hierarchical judgment matrices. The findings reveal three primary conclusions. First, the base exhibits a predominant Strength-Opportunity (SO) strategic orientation: internal strengths (S' = 1.0012) and external opportunities (O' = 0.9530) substantially outweigh weaknesses (W' = −0.4859) and threats (T' = −0.5112), with strategic centroid *P*.(0.1288, 0.1105) situated in the first quadrant ((oid *P*(0.1288, 0.1105)) favorable window for growth-oriented strategy. Second, critical success factors exhibit significant divergence: national policy support (O_1) and strategic educational partnerships (O_3) emerge as paramount external drivers, while local employment enhancement and rural revitalization (S_3) constitute the most significant internal strength; conversely, inadequate product design capabilities (W_4) and intensified market competition (T_2) represent pressing constraints, revealing a systemic deficiency in translating cultural heritage into market competitiveness. Third, sustainable development necessitates a multidimensional integrated approach—a strategic transition from a resource-dependent model toward a design-driven, brand-oriented industrial ecosystem that synergizes policy support, design innovation, digital empowerment, and community engagement. This study provides valuable insights for preserving and sustainably developing intangible cultural heritage, offering a replicable analytical framework for similar cultural heritage bases worldwide.

Keywords: National Intangible Cultural Heritage Production Protection Demonstration Bases, sustainable development, SWOT–AHP analysis

Cite this article as:
Su, L., Jiang, Y., Wang, Q., Zhu, L., Zhao, C., Xia, E., & Li, G. (2026). Sustainable development strategies for national intangible cultural heritage bases: A strengths, weaknesses, opportunities, and threats–analytical hierarchy process approach to the Qingshen bamboo weaving base. *Forestist*, 76, 0164, doi: 10.5152/forestist.2026.25164.

Corresponding Author:
Lin Zhu
E-mail: lin-zhu@outlook.com

Received: November 22, 2025
Revision Requested: January 26, 2026
Last Revision Received: May 1, 2026
Accepted: June 11, 2026
Publication Date: August 14, 2026

Content of this journal is licensed under a Creative Commons Attribution-NonCommercial 4.0 International Licence.

Introduction

Intangible cultural heritage refers to human practices that are transmitted from generation to generation, encompassing oral traditions, performing arts, social customs, rituals, festivals, knowledge and practices, and skills related to the natural environment (as defined by UNESCO) (UNESCO, 2003; Melis & Chambers, 2021). Intangible cultural heritage represents a treasure of human civilization, embodying diverse traditional expressions, knowledge, and practices and serves as a repository of cultural wisdom and spiritual treasures passed through generations (Zhang et al., 2024). It plays a crucial role in maintaining community identity and social continuity while promoting cultural diversity (Lenzerini, 2011). The cultural exchanges and conflicts arising from the accelerated development of globalization pose unprecedented challenges and threats to intangible cultural heritage worldwide (Farah & Tremolada, 2015). Many traditional cultural heritages are significantly impacted, with some facing the risk of extinction (Dimitropoulos et al., 2018). In this context, the urgent question of how to protect, inherit, and effectively utilize these invaluable cultural resources has emerged as a critical issue that requires immediate attention globally (Xiang, 2011). Scholars worldwide have conducted in-depth research on intangible cultural heritage from various perspectives and levels, exploring its connotations, means of inheritance, social significance, protection strategies, and other related issues (Miyata, 2013). Through field investigations, literature analyses, interdisciplinary research, and other methodologies, researchers have gradually elucidated the importance and role of intangible cultural heritage in human society, proposing a series of feasible protection and inheritance programs (Monova-Zheleva et al., 2020).

What this study adds on this topic?

- Provides a micro-empirical analysis of China's only national-level bamboo-weaving productive protection base.
- Enhances the SWOT-AHP framework by introducing factor intensity scoring and a strategic centroid model.
- Proposes a multidimensional pathway integrating productive protection, rural revitalization, and green low-carbon goals.

Productive protection is one of the primary methods for safeguarding intangible cultural heritage in China (Kong & Hong, 2020). This approach involves transforming intangible cultural heritage and its resources into cultural products within production practices, with a focus on maintaining the authenticity, integrity, and inheritance of intangible cultural heritage (Zhu, 2013). This is achieved through the effective inheritance of intangible cultural heritage skills via production, circulation, sales, and other means (Ge et al., 2022). Currently, this protection method is applied primarily in the realms of traditional arts and skills. In March 2024, the Ministry of Culture and Tourism (MCT) identified a total of 99 enterprises and units as the "National Intangible Cultural Heritage Productive Protection Demonstration Bases 2023–2025" (MCT, 2024). These bases serve not only as practical platforms for the protection of intangible cultural heritage but also as vital vehicles for promoting the development of cultural industries and revitalizing local economies. Among these bases, the sole one themed around bamboo weaving is "Sichuan Qingshen County Yunhua Bamboo Travel Co., Ltd." (hereinafter referred to as the Qingshen Bamboo Weaving Base or the Base) (MCT, 2024), which serves as a typical case study for this research. As a key base for the production, education, and research of bamboo weaving, the Qingshen Bamboo Weaving Base has played an active and unique role in promoting the development of intangible cultural heritage, fostering rural revitalization, and advancing the bamboo industry. The Qingshen Bamboo Weaving Base has significantly contributed to social education in production and research by showcasing traditional techniques and enhancing the capacity to utilize natural resources. Furthermore, it facilitates the formation of specific brands and promotes synergistic effects among different value chains within the bamboo industry, thereby achieving sustainable development.

Bamboo is a widely distributed plant that is primarily found in the tropical and subtropical regions of Asia, Africa, and the Americas and covers an area of more than 50 million hectares (Mitch et al., 2010). Owing to its rapid growth, renewability, accessibility, and low cost, bamboo has become an essential resource for production and daily living in bamboo-rich areas (Dlamini et al., 2022). Bamboo weaving plays a significant role in the daily lives of people, particularly those residing in bamboo regions. It not only provides practical daily necessities such as baskets, barrels, tables, and chairs but also contributes to environmental protection, cultural inheritance, and economic development (Cai et al., 2024). The technical proficiency of bamboo weaving varies globally according to region, culture, and historical context; however, many regions possess rich traditions and skills in bamboo weaving (Chen et al., 2023). For example, bamboo weaving, with its extensive historical lineage, is recognized as one of the representative items on the national intangible cultural heritage list of China (MCT, 2025); Japanese bamboo weaving is characterized by meticulous and exquisite techniques and is often closely associated with traditional cultural practices such as tea ceremonies and flower arrangements (Tomita & Tomita, 1982). Numerous countries and regions, including Vietnam, Thailand, and the Philippines in Southeast Asia; Cameroon, Ghana, and Nigeria in Africa; and Colombia, Mexico, and Brazil in Latin America, also have rich bamboo-weaving traditions. The bamboo-weaving products from these regions often exhibit vibrant colors and diverse forms, reflecting local culture and lifestyles (Zhu, 2020).

In recent years, scholars have conducted extensive research focusing on three core directions: the productive protection of intangible cultural heritage (ICH), the development of the bamboo-weaving industry, and ICH sustainable development strategies. In terms of the productive protection of ICH, this approach entails transforming ICH resources into cultural products through production, circulation, sales, and other links, adhering to the principles of authenticity, integrity, and inheritability while promoting the effective inheritance of ICH techniques (Song et al., 2025). Regarding the development and cultural protection of the bamboo weaving industry, research has gradually shifted toward cross-border integration and technical innovation. For instance, the application of AI-assisted platforms and smart contracts has been explored to construct self-organizing cultural-ecological systems, fostering localized knowledge networks and intergenerational cooperation for intangible cultural heritage (Zhao et al., 2026). In terms of sustainable development strategies, the collaborative synergy between government, industry, academia, research, and users plays a pivotal role in cultural inheritance. Concurrently, the empowerment of traditional techniques through emerging technologies has become a key focal point; for instance, Jiang (2025) demonstrated that virtual reality (VR) experience systems effectively enhance the market sustainability of bamboo weaving products by fostering immersive consumer engagement and digital value co-creation. Additionally, the SWOT–AHP method has been widely applied in strategic analysis of traditional industries (Chen et al., 2025), offering a quantitative basis for evaluating the competitive position of cultural heritage.

However, a comprehensive review of existing achievements reveals three core research gaps in the field: first, most existing studies focus on macro-policy and theoretical discussions of ICH protection, with relatively few micro-empirical studies on national-level productive protection demonstration bases. In particular, there is a lack of specialized research targeting the only national-level bamboo weaving-themed base, resulting in insufficient case relevance. Second, the application of the SWOT–AHP method in the bamboo weaving and ICH fields mostly remains at the level of qualitative description or single weight calculation, rarely incorporating quantitative scoring of factor intensity and strategic positioning models for in-depth analysis, which

limits the analytical depth of the method. Third, existing research fails to systematically integrate and analyze productive protection, green low-carbon development, rural revitalization, and ICH inheritance, leading to inadequate comprehensiveness of research perspectives.

Building on over a decade of practical engagement in bamboo weaving ICH conservation, the research team has accumulated extensive hands-on experience through close collaboration with inheritors, forest farmers, and base operation teams. In addition to this practical foundation, the authors have conducted multiple bamboo-weaving-related research projects, yielding substantial academic outputs, including several published books and numerous papers. Leveraging this interdisciplinary expertise spanning bamboo weaving ICH protection, forest farmers' livelihoods, and rural revitalization, this study addresses the identified gaps. Focusing on the unique needs of China's only national-level bamboo weaving-themed productive protection demonstration base, the authors employ the SWOT-AHP method to construct a comprehensive evaluation framework, aiming to provide scientific support and practical paths for its sustainable development.

The marginal contributions of this study are mainly reflected in three aspects: (1) Innovation in research object: conducting micro-empirical research with the Qingshen Bamboo Weaving Base—the only national-level productive protection demonstration base themed on bamboo weaving—as the case, filling the gap in specialized research on typical bamboo weaving ICH bases and enhancing case representativeness and practical relevance. (2) Innovation in research method: on the basis of the SWOT–AHP combined model, introducing quantitative scoring of factor intensity and the strategic quadrilateral centroid positioning model. By quantifying the intensity of factor impacts and calculating strategic coordinates to clarify the development quadrant, this study significantly improves the scientific rigor and accuracy of strategic evaluation compared with traditional single SWOT analysis. (3) Innovation in research perspective: Conducting multi-dimensional integrated analysis of productive protection, rural revitalization, ICH inheritance, and green low-carbon development, breaking through the limitation of single-dimensional focus in previous studies. It not only aligns with the strategic orientation of the carbon peaking and carbon neutrality goals and rural revitalization but also provides a more comprehensive sustainable development idea for similar bases.

Material and Methods

Study Area

As the research site, the base is situated in Qingshen County, Meishan city, Sichuan Province, in the southwestern region of China. This locale is renowned for its bountiful natural resources and deep-seated historical and cultural legacy of bamboo utilization (Figure 1). The region's varied ecological conditions have fostered a rich tapestry of biodiversity and a wealth of bamboo resources (Wu et al., 2020). Moreover, the weaving of Qingshen bamboo, recognized as a national intangible cultural heritage, represents a traditional folk craft imbued with distinct local characteristics and enjoys widespread popularity (Meng et al., 2022).

The base, encompassing an area of 10 hectares, stands as the sole bamboo weaving facility within the current cohort of 99 national demonstration bases dedicated to the productive conservation of intangible cultural heritage in China. It is a multifunctional complex that combines industrial, educational, and research components. Leveraging its strategic geographical positioning and rich cultural heritage, the base is dedicated to advancing poverty alleviation initiatives and a sustainable green economy. It also aims to enhance community governance, implement capacity-building programs, and ensure the protection of natural resources and intangible cultural heritage. These objectives are pursued through the sustainable utilization and stewardship of bamboo-related products.

Research Design

The technical route is as follows (Figure 2):

This study was reviewed and approved by the Ethics Committee of International Centre for Bamboo and Rattan (approval number: 1632024011; date of approval: 24 October 2024).

This study used DeepSeek to edit grammar during the preparation of the manuscript. However, all content of the study has been reviewed and edited by the authors following the use of AI/LLM tools.

SWOT–Analytical Hierarchy Process Analysis Methodology

The SWOT matrix, a classic strategic planning tool initially conceptualized in the 1960s during discourses at business schools, is designed to identify internal strengths (S) and weaknesses (W), as well as external opportunities (O) and threats (T), thereby enabling a comprehensive assessment of an entity's competitive position and development potential (Dyson, 2004). This framework has been widely applied in ICH research to explore sustainable development pathways and in bamboo-related studies, such as the sustainable utilization of bamboo resources (Potters et al., 2013) and the development of the bamboo handicraft industry (Peng, 2018). However, most existing studies rely solely on qualitative SWOT analysis, which cannot quantify factor importance—a critical shortcoming for the Qingshen Bamboo Weaving Base (a system integrating ICH conservation, rural revitalization, and industrial development), where clear factor prioritization is needed to avoid subjective strategy-making.

The analytical hierarchy process (AHP) represents a hybrid decision-making approach that amalgamates qualitative and quantitative elements to address complex issues with multifaceted objectives (Saaty, 1990; Fan & Xue, 2018). This technique leverages the subjective judgments of decision-makers to ascertain the relative significance of various factors, thereby assigning weights to each factor within a decision-making framework. These weights are subsequently utilized to determine the prioritization of different schemes, making the AHP particularly efficacious for issues that are not readily solvable through purely quantitative means (Li et al., 2021).

The integration of SWOT–AHP is not arbitrary but driven by the specific research needs: SWOT ensures comprehensive identification of internal/external factors, while AHP quantifies their weights to solve qualitative SWOT's prioritization defect. Notably, few studies have applied this integration to bamboo weaving ICH bases, filling an application gap and ensuring that strategies are comprehensive and objective. The integration of SWOT–AHP analysis in this research endeavors not only to gauge the current and prospective contributions of the Base to sustainable development but also to catalyze the high-quality progression of analogous institutions/centers. This is achieved by delineating strategies, plans, and measures for the sustainable exploitation and stewardship of bamboo-derived natural resources; by fostering superior practices for the conservation of intangible cultural heritage; and by fostering a collective commitment toward the pursuit of sustainable development.

Data Collection

SWOT Factor Generation

In determining the scale of the expert panel, this study adheres to the methodological principles of the AHP: the method does not rely

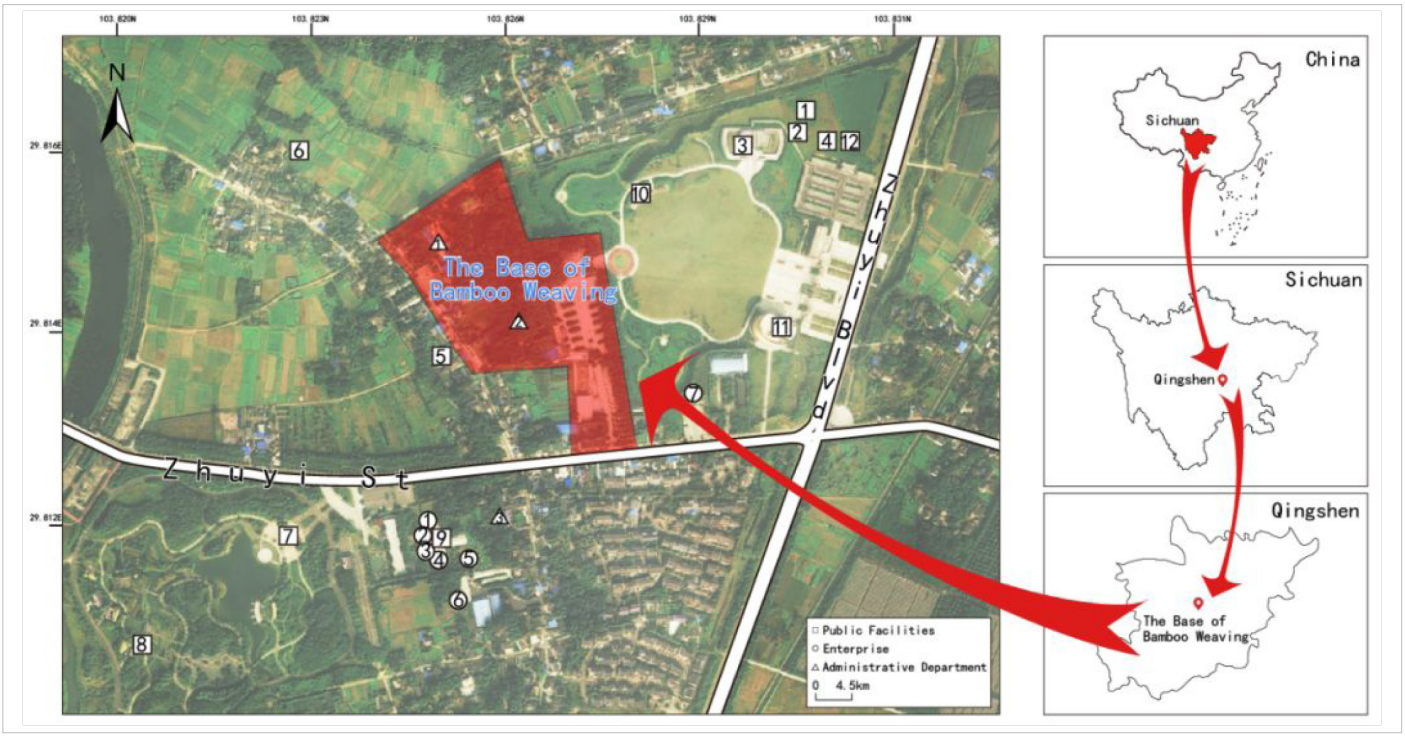

Figure 1.
Location of the Study Area. Chart explanatory notes: ☐1. Zhuli Fluorescent Museum; ☐2. Firefly Science Museum; ☐3. Panda Exhibit; ☐4. International Bamboo Art Square; ☐5. Zhuli Alley; ☐6. International Bamboo Art Resort; ☐7. Bamboo Cultural Square; ☐8. First Bamboo Forest Wetland Park in China; ☐9. Qingshen County Bamboo Industry Entrepreneurship and Innovation Incubator; ☐10. Qingshen International Bamboo Industry Exhibition Center; ☐11. International Bamboo Weaving Art Museum; ☐12. International Bamboo Art Center. △1. Women's Bamboo Weaving Studio of Qingshen; △2. Qingshen County Bamboo Weaving Association; △3. Qingshen County Bamboo Weaving Industrial Park Management Committee. ○1. Sichuan Yinzhuangyuan Bamboo Industry Co., Ltd.; ○2. Qingshen County Zhuangyuan Bamboo Art Factory; ○3. Nianlun Bamboo Workshop; ○4. Zhang Deming's Studio; ○5. Qingshen Bamboo Weaving Art and Culture Co., Ltd.; ○6. Qingshen Zhuliyuanzi Bamboo Art Theme Hotel; ○7. Qingshen Zhuyiju Bamboo and Wood Products Co., Ltd. Source: Google Maps, enlarged and highlighted by the author.

on large-sample statistics but emphasizes the representativeness and quality of expert judgments (Darko et al., 2019). Therefore, a stratified sampling approach was adopted, ultimately selecting fifteen experts with authoritative knowledge and extensive experience in bamboo weaving, intangible cultural heritage, and related interdisciplinary fields to form the analysis panel. All participants were informed of the purpose, process, and academic use of this study, and written informed consent was obtained from each expert prior to data collection. Among them, eight experts participated via electronic questionnaire, while seven experts took part in in-depth interviews.

The expert panel (Table 1) was composed as follows: five were researchers from national research institutions; one was a staff member from a provincial intangible cultural heritage protection-related unit; two were management personnel from national-level bamboo weaving training institutions; two were senior craftsmen from the bamboo weaving training base; and five were researchers from specialized interdisciplinary fields, including cultural heritage digitalization, bamboo material science and engineering, environmental economics and life cycle assessment, community development and intangible cultural heritage sociology, and cultural tourism and creative industry planning.

The panel of experts, all possessing specialized knowledge in bamboo weaving and related fields, was engaged in the identification of key factors for the sustainable development of the base. First, the authors systematically reviewed the literature and drew on commonly used analytical indicators in relevant studies (Li et al., 2021). The authors then conducted in-depth consultations with experts from multiple disciplinary backgrounds to collect candidate factors. Based on the principles of scientificity, independence, representativeness, and operability, the authors screened and refined these candidate factors to ensure their validity and relevance. Specifically, scientificity was ensured by grounding all candidate factors in established theories and prior empirical research; independence was maintained by eliminating overlapping or redundant indicators to avoid duplication; representativeness was achieved by selecting factors that comprehensively capture the economic, social, cultural, and environmental dimensions of bamboo weaving base development; and operability was addressed by prioritizing factors that can be measured or assessed using available data or expert judgment. Using the SWOT analytical framework, the authors finally identified a comprehensive set of 18 key factors, which were categorized into strengths, weaknesses, opportunities, and threats. Each factor was accompanied by a concise explanation to clarify its connotation and significance (Table 2).

Analytical Hierarchy Process Hierarchical Structure and Pairwise Comparison Methodology

In alignment with the SWOT analysis pertaining to the sustainable development of the bamboo weaving base, a hierarchical structure for the AHP was meticulously constructed. This structure delineates the

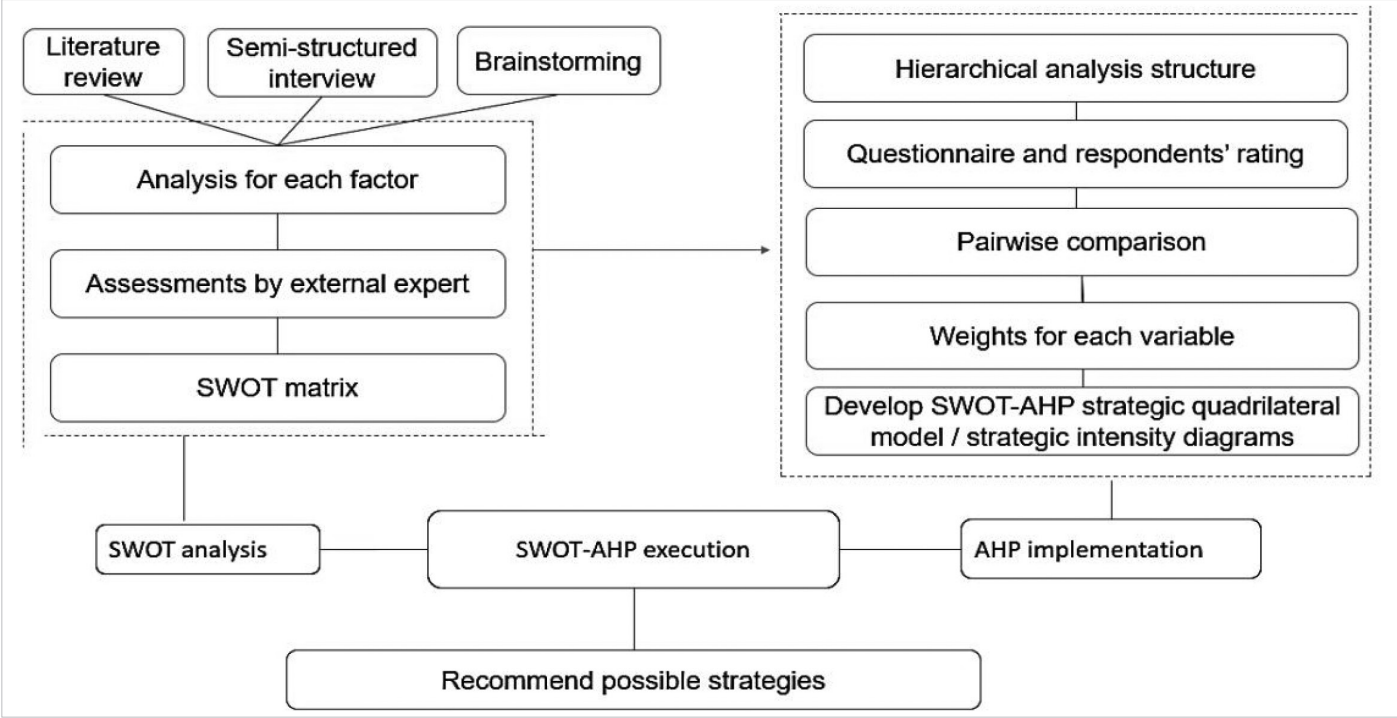

Figure 2.
Technical Route. Source: Author Composition.

sustainable development of the bamboo weaving base as the objective layer; encapsulates its strengths, weaknesses, opportunities, and threats within the criteria layer; and incorporates the 18 identified factors as the index layer (refer to Figure 3). The aforementioned panel of fifteen experts was then tasked with conducting pairwise comparisons among the factors within each layer, utilizing a numerical scale from 1 to 9 to articulate the relative significance of each factor (as presented in Table 3) (Kahraman, et al., 2007). The experts were instructed to articulate their judgments on the basis of their individual expertise and subjective assessments.

Table 1.
Expert Information

NO.	Work Experience (years)	Age, years	Sex	Institution Category	Position/Title
1	6	36	F	Research institution	Associate researcher
2	21	47	M	Research institution	Researcher
3	22	46	F	Research institution	Researcher
4	8	37	M	Provincial intangible cultural heritage protection-related unit	Staff
5	3	36	M	Research institution	Associate researcher
6	16	43	M	Research institution	Associate researcher
7	32	53	F	Bamboo Weaving Training Base	Senior Craftsman
8	15	33	F	Bamboo Weaving Training Base	Senior Craftsman
9	25	51	M	National level bamboo weaving training institution	Management staff
10	16	45	M	National level bamboo weaving training institution	Management staff
11	5	38	M	Cultural heritage digitalization research institutions	Researcher
12	8	39	F	Bamboo material science and engineering laboratories	Researcher
13	5	37	F	Environmental economics and life cycle assessment research centers	Researcher
14	10	41	F	Community development and intangible cultural heritage sociology scholars	Researcher
15	15	45	M	Cultural tourism and creative industry planning agencies	Researcher

Source: Author composition.

Table 2.
Summarized SWOT Factors

Goal	SWOT Groups	Factors
The Sustainability Development of the Qingshen Bamboo Weaving Base	Strengths (S)	Comprehensive infrastructure (S_1)
		Distinctive culture and science popularization tourism development model (S_2)
		Enhancement of employment and livelihood for local villagers, contributing to rural revitalization (S_3)
		Secured property rights and geographical indications (S_4)
		Full utilization of abundant local bamboo resources with distinctive characteristics (S_5)
		Robust training and education system, complemented by an experienced faculty (S_6)
	Weaknesses (W)	Imperative to bolster the management and operational team at the Base (W_1)
		Need for enhanced multilingual publicity and promotional capabilities (W_2)
		Necessity to elevate the application of high-tech equipment and craftsmanship (W_3)
		Requirement to improve product design and development capabilities (W_4)
	Opportunities (O)	National policy support for the advancement of bamboo weaving as an intangible cultural heritage (O_1)
		The enduring legacy of bamboo weaving culture, which continues to evolve and be reinvented (O_2)
		Strategic partnerships with educational institutions to foster bamboo weaving studies, engaging the younger demographic (O_3)
		The bamboo weaving industry's pivotal role in the green and sustainable economy, aligning with carbon peaking and neutrality goals (O_4)
	Threats (T)	Imperative to enhance the promotion and application of network and new media in the digital age (T_1)
		Intensified market competition due to the swift growth of the bamboo weaving industry in other regions (T_2)
		The adverse effects of the global economic downturn on the production and sales of bamboo weaving (T_3)
		The need to elevate public awareness and appreciation of bamboo weaving culture and products (T_4)

Source: Author composition.

In the initial entry of Table 4, the pairwise comparison indicates that Factor A is assigned a relative importance of 9 when juxtaposed with Factor B, whereas the reciprocal comparison yields a value of 2 for Factor B. This disparity underscores the heightened significance of Factor A in comparison with Factor B. In the subsequent row, the evaluation reveals that Factors C and D are deemed to possess equivalent levels of importance. In the third row, Factor E has a relative importance of 3 when contrasted with Factor F; conversely, the relative importance of Factor F in relation to Factor E is quantified as 5. Consequently, Factor F is perceived as being of greater importance, whereas Factor E is deemed to be of lesser importance.

Collection of Objective Operational Data

To complement the limitations of subjective expert judgments and provide empirical reference for the AHP weights, this study concurrently collected key operational data from the Qingshen Bamboo Weaving Base for the years 2022–2024. The data collection was conducted in 2024. To ensure both timeliness and completeness, three consecutive full years (2022–2024) were selected for trend analysis. The data were obtained from the base's internal statistical reports, publicly available information from local cultural and tourism authorities, and annual work summaries. Based on data availability, the authors matched quantitative proxy indicators to as many SWOT factors as possible (the specific indicators and annual values will be presented in detail in Table 5, Section 3.1). As an empirical study conducted in 2024, the most recent complete annual data accessible are precisely those from 2022 to 2024.

Implementing SWOT–Analytical Hierarchy Process

Judgement Matrix

The judgement matrices within the AHP framework are formulated by conducting a comparative analysis and assigning corresponding values to the factors within the criterion layer and the index layers. This process pertains to the dimensions of strengths, weaknesses, opportunities, and threats, as evaluated by the aforementioned expert scoring methodology (alternatively referred to as the expert consultation approach). To formalize the mathematical structure of this judgment matrix, the judgment matrix is defined via Equation (1) as follows:

$$A=\begin{bmatrix} 1 & a_{12} & \cdots & a_{1n} \\ a_{21} & 1 & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n1} & \cdots & 1 \end{bmatrix}=\begin{bmatrix} 1 & a_1/a_2 & a_1/a_3 & a_1/a_4 \\ a_2/a_1 & 1 & a_2/a_3 & a_2/a_4 \\ a_3/a_1 & a_3/a_2 & 1 & a_3/a_4 \\ a_4/a_1 & a_4/a_2 & a_4/a_3 & 1 \end{bmatrix} \quad (1)$$

where a_{ij} is the relative importance of the i-th indicator for the *j*-th indicator in that layer. Each expert will form 1 judgment matrix for the criterion layer and 4 judgment matrices for the index layer for S, W, O, and T, respectively.

Consistency Check

The consistency test is performed on each judgment matrix to check whether the matrix has serious logical errors. The consistency index (CI), random consistency index (RI), and consistency ratio (CR) are introduced. Equations (2) and (3) are used to calculate CI and CR, respectively:

$$CI=\frac{\lambda_{max}-n}{n-1} \quad (2)$$

$$CR=\frac{CI}{RI} \quad (3)$$

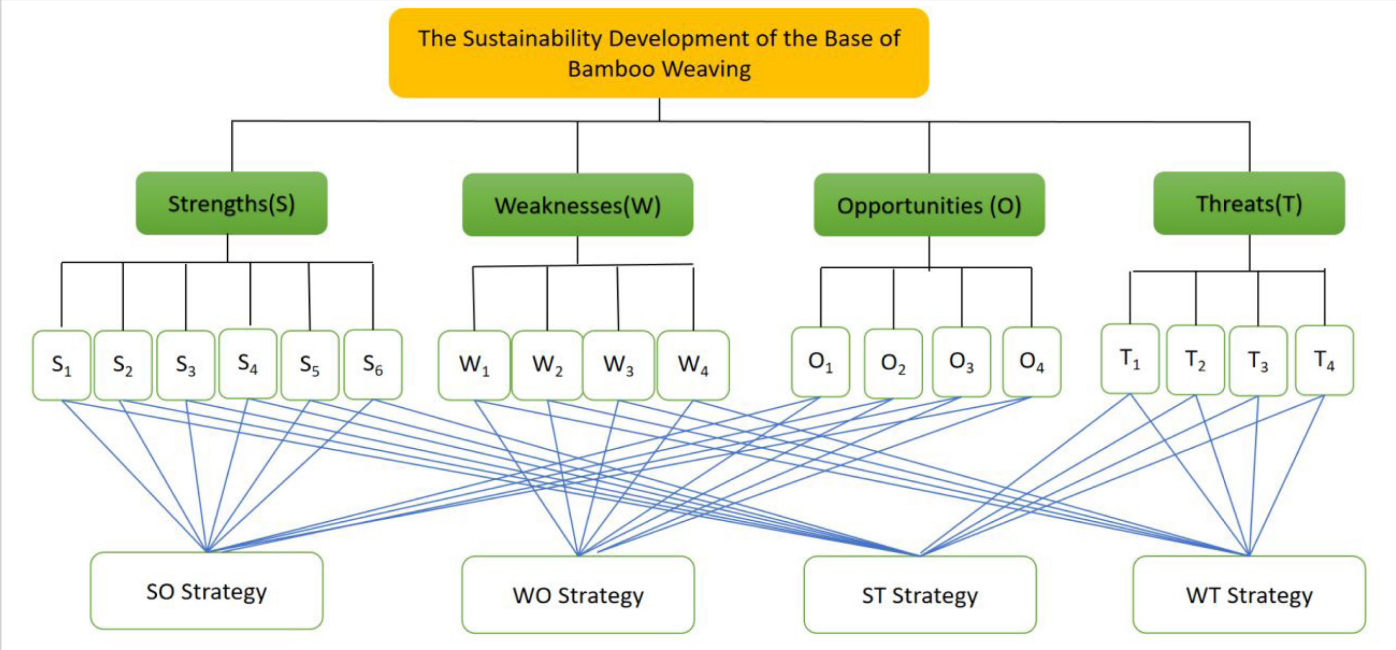

Figure 3.
Hierarchical Analysis Structure Graph. Source: Author Composition.

where λ_{max} is the maximum eigenvalue of this judgment matrix. There is perfect consistency when the CI = 0 and satisfactory consistency when the CI is close to 0. The RI is a fixed value related to *n*, which can be obtained by consulting the data (Table 6).

It is generally considered that when CR < 0.1, the degree of inconsistency of the matrix is within the tolerance range, and there is satisfactory consistency, passing the consistency test; otherwise, the judgment matrix should be readjusted. However, to minimize potential logical inconsistencies, the authors have raised the consistency check threshold to CR ≤ 0.08 in this study. For any judgment matrix with a CR exceeding 0.08, the authors have re-consulted the relevant experts to revise their judgments.

Calculation of the Index Weight

The geometrical mean ($\overline{W_i}$) of each row of the judgment matrix is calculated via the product square root method. The geometrical mean of each row is normalized to obtain the eigenvectors (W_i). These two steps are formalized via Equations (4) and (5):

$$\overline{W_i} = \left(\prod_{j=1}^{n} a_{ij} \right)^{\frac{1}{n}} i,j = 1,2,\cdots,n \quad (4)$$

$$W_i = \frac{\overline{W_i}}{\sum_{j=1}^{n} \overline{W_j}} i,j = 1,2,\cdots,n \quad (5)$$

where W_i is the ranking, i.e., weight, of the i-th factor of the layer derived from each judgment matrix. The weights for each factor were derived from each expert judgment matrix, and then average weights for the same factor were derived from 15 experts' judgment matrices, i.e., the intragroup weights, which represent the importance of each factor in

Table 3.
Scale for Pairwise Quantitative Comparisons of Alternatives

Intensity of Importance	Definition
1	Equal importance
3	Moderate importance of one over another
5	Essential or strong importance
7	Very strong importance
9	Extreme importance
2'4'6'8	Intermediate values between the two adjacent judgments

Source: Saaty (1990).

Table 4.
Sample Questionnaire for the Pairwise Comparison of Factors

Factors	The Relative Importance Of Left-hand Side Factors (1–9)	The Relative Importance of Right-hand Side Factors (1–9)	Factors
A	9	2	B
C	1	1	D
E	3	5	F

Source: Author composition.

Table 5.
Average Random Consistency Index

n	1	2	3	4	5	6	7	8	9
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45

Source: Saaty (1977).

Table 6.
Objective Operational Data Indicators and Annual Values

SWOT Group	Factor	Indicator	2024	2023	2022	Unit
S	S1	Total area of key infrastructure	99 680	66 600	58 500	m^2
	S2	Science education and study tour visits	63 500	18 000	13 500	Person-times
	S3	Directly employed villagers from surrounding communities	1240	1160	1060	Persons
		Annual per capita income increase for employed villagers	36000	18000	15000	RMB
	S4	Number of intellectual property rights (patents, standards, etc.)	45	43	38	Items
	S5	Local bamboo consumption	16 000	12 000	13 600	m^3
	S6	Number of certified/ICH inheritor instructors	116	112	108	Persons
		Total participants in various bamboo weaving trainings	3800	3500	3100	Persons
W	W1	Number of professional management and operational team members	15	13	11	Persons
	W2	Number of promotional personnel with foreign language proficiency	8	7	7	Persons
	W3	Number of digital design tools or equipment	15	10	9	Units
	W4	Number of new products developed	480	408	360	Items
		Number of design awards received	16	8	11	Items
O	O1	Amount of government support funds	550 000	380 000	350 000	RMB
	O2	Number of cultural activities held	80	60	54	Events
	O3	Number of partner educational institutions	17	15	12	Institutions
	O4	Estimated annual carbon sequestration from bamboo consumption	43 355	24 387	24 568	$t\,CO_2e$
T	T1	Number of new media reports	249	189	160	Teports
		Online sales as a percentage of total revenue	40	45	55	%
	T2	National market share of bamboo-woven products	8	10	10	%
	T3	Overseas order sales revenue	1 50 000 000	1 80 000 000	2 50 000 000	RMB
	T4	Awareness of bamboo weaving culture and products	10	15	18	%

Source: Raw data provided by Qingshen Bamboo Weaving Base, compiled and edited by the author.

its layer. The global weight of the index layer factor is its importance relative to the target layer, which is derived by the product of the intra-group weight and the intergroup weight of its criterion layer.

Calculation of the SWOT Strategic Quadrilateral

On the basis of the results of the weighting analysis, the total intensities of strength, weakness, opportunity, and threat (S', W', O', and T') are derived. These total intensities are calculated via Equations (6)–(9), as follows:

$$S' = \sum S_i \; i = 1,2,\cdots\cdots,n_S \tag{6}$$

$$W' = \sum W_i \; i = 1,2,\cdots\cdots,n_W \tag{7}$$

$$O' = \sum O_i \; i = 1,2,\cdots\cdots,n_O \tag{8}$$

$$T' = \sum T_i \; i = 1,2,\cdots\cdots,n_T \tag{9}$$

In the aforementioned formulae, n_S , n_W , n_O , and n_T represent the aggregate count of factors associated with strengths (S), weaknesses (W), opportunities (O), and threats (T), respectively. The variables S_i , W_i , O_i , and T_i denote the product of the global weight and the estimated strength. These constructs, S', W', O', and T', are utilized to delineate a strategic quadrilateral. The strategic centroid coordinates $P(x,y)$, the strategic orientation angle θ, the positive intensity U, the negative intensity V, and the strategic strength coefficient ` are subsequently calculated. These calculations correspond to Equations (10)–(14), as follows:

$$P(x,y) = P\left(\sum x_i / 4, \sum y_i / 4\right), \text{ where } \sum x_i = S' + W',\ \sum y_i = O' + T' \tag{10}$$

$$\theta = \arctan(y / x) \quad (0 \le \theta \le \pi) \tag{11}$$

$$U = S' * O' \tag{12}$$

$$V = W' * T' \tag{13}$$

$$` = U / (U + V) \tag{14}$$

Results

Trend Analysis Based on Objective Operational Data

This study collected key operational data of the Qingshen Bamboo Weaving Base from 2022 to 2024, covering 24 quantitative indicators (Table 5), to assist experts in their judgment and provide a realistic foundation to supplement subjective assessments. The three-year data

reveal distinct developmental trends across four dimensions: Strengths, Weaknesses, Opportunities, and Threats.

Regarding positive development trends, the base's infrastructure has been continuously improved, with the total area of key infrastructure increasing by 70.4% and science education and study tour visits growing nearly fourfold, significantly enhancing its carrying capacity. The impact on local development is evident: directly employed villagers from surrounding communities rose from 1060 to 1240 people, while their annual per capita income more than doubled to 36 000 RMB. Soft power construction has progressed steadily, with intellectual property rights increasing to 45 items, certified/ICH inheritor instructors reaching 116 people, and total participants in various bamboo weaving trainings growing to 3800 people. External resource acquisition capabilities have strengthened, with government support funds increasing to 550 000 RMB, cultural activities held reaching 80 events, and partner educational institutions expanding to 17 institutions. The estimated annual carbon sequestration from bamboo consumption increased from approximately 24 400 $t CO_2e$ in 2022–2023 to 43 355 $t CO_2e$ in 2024, reinforcing its contribution to green and low-carbon goals.

In the dimension of challenges, international promotion capacity building has lagged, with the number of promotional personnel possessing foreign language proficiency increasing by only one person. Market expansion presents a complex situation: online sales as a percentage of total revenue dropped from 55% to 40%, the national market share of bamboo woven products fell to 8%, overseas order sales revenue decreased year by year to 150 million RMB, and public awareness of bamboo weaving culture and products declined to 10%. These trends suggest that the expansion of brand influence has not yet been effectively converted into market competitiveness. Meanwhile, the number of new products developed continued to rise to 480 items, the number of design awards received grew to 16 items despite fluctuations, and digital design tools or equipment increased to 15 units, showing active reinforcement in management and innovation capabilities.

The aforementioned operational data outline the development profile of the base in recent years, highlighting improvements in hardware facilities, enhanced local development impact, and increased external resource acquisition capacity, while also identifying persistent challenges in international talent reserves and market expansion. These objective trends provide a traceable quantitative reference for experts to evaluate the importance of various factors in subsequent stages.

Judgment Matrix Construction and Consistency Check

Utilizing the i-th expert's assessments concerning the relative significance of the SWOT dimensions (strengths, weaknesses, opportunities, and threats), an intergroup judgment matrix was assembled and subjected to a consistency assessment. All matrix computation and consistency ratio (CR) calculation were performed via Microsoft Excel (Microsoft Corporation, USA). The outcomes of this evaluation are delineated in Table 7. Employing a similar methodology, the i-th expert's evaluations pertaining to the relative significance of each factor within the SWOT criterion layers were used to construct four intragroup judgment matrices. Four consistency assessments were subsequently executed (as detailed in Appendix 1, Appendix 2, Appendix 3, and Appendix 4). The findings indicate that, with a consistency ratio (CR) value of less than 0.1, all 50 judgment matrices successfully met the consistency criteria, thereby validating the reliability of the data for subsequent analysis.

Hierarchical Single-Factor Prioritization as Reflected in Weight Distributions

The hierarchical arrangement of single factors is depicted through the weight assigned to each factor's importance within a given layer relative to the factor in the immediately superior layer, as derived from the judgment matrices (refer to Table 8).

The weights of the factors were determined and subsequently ranked within the inter- and intragroup contexts of strengths (S), weaknesses (W), opportunities (O), and threats (T), as delineated in Table 9. Additionally, the global weight ranking for each factor in relation to the overarching goal was computed. This ranking information was then graphically represented for enhanced clarity and analysis (see Figure 4).

The analysis indicates that the impacts of various index-layer factors on SWOT dimensions differ significantly. For strengths, enhancing villagers' employment and livelihood and contributing to rural revitalization (S_3) represents the most important advantage for the sustainable development of the Qingshen Bamboo Weaving Base. Complete infrastructure (S_1) provides fundamental supporting conditions.

Regarding weaknesses, the most critical constraint is the need to improve product design and development capabilities (W_4). Strengthening the management and operational team (W_1) also represents a notable shortfall that limits long-term development.

For opportunities, national policy support for intangible cultural heritage development (O_1) and strategic partnerships with educational institutions to foster bamboo weaving studies and engage the younger demographic (O_3) serve as the most prominent external driving forces. Meanwhile, major threats include insufficient promotion and application of digital networks and new media (T_1) and intensified market competition from rapid industry growth in other regions (T_2), both of which require targeted responses to ensure sustainable development.

Analysis of the Intensity of Group and Factor Influences

A quantitative assessment of the 18 factors within the index layer was conducted by a panel of experts, with each factor receiving a score that reflects its relative significance. The scoring criteria ranged from −4 to 4, with the following values: −4, −3, −2, −1, 0, 1, 2, 3, and 4. Factors indicative of strengths and opportunities were allocated positive scores, whereas those signifying weaknesses and threats received negative scores. The impact intensity of a factor is directly proportional to the magnitude of the absolute value of its assigned score (see Table 10). The composite scores for the factors, as determined by the analysis, are hierarchically ranked in the following order: $S' = 1.0012 > O' = 0.9530 > W' = -0.4859 > T' = -0.5112$.

SWOT Strategic Quadrilateral

The four-quadrant coordinate system, with axes defined by the variables of advantage, disadvantage, opportunity, and threat, was utilized to plot the respective intensities of these factors. These intensities were then sequentially connected within the coordinate system to delineate a strategic quadrilateral, as depicted in Figure 5. The centroid of this strategic quadrilateral, denoted as $P(x, y)$, was calculated to be at the coordinates (0.1288, 0.1105), with the azimuth angle of the strategy type, denoted as θ, being 40.61 degrees.

Following the determination of the centroid coordinate P for the strategic quadrilateral, an analysis of the strategic strength coefficient is instrumental in ascertaining the entity's developmental strategy. The

Table 7.
Intergroup Judgement Matrix and Consistency Check

Expert No.	Judgement Matrix	λ_{max}	CI	CR	Consistency
1	$A_1=\begin{bmatrix} 1 & 7/3 & 7/2 & 3/2 \\ 3/7 & 1 & 4/5 & 1/2 \\ 2/7 & 5/4 & 1 & 3/7 \\ 2/3 & 2 & 7/3 & 1 \end{bmatrix}$	4.0378	0.0126	0.0140	Approved
2	$A_2=\begin{bmatrix} 1 & 9/5 & 6/5 & 1 \\ 5/9 & 1 & 7/5 & 3/5 \\ 5/6 & 5/7 & 1 & 5/3 \\ 1 & 5/3 & 3/5 & 1 \end{bmatrix}$	4.1851	0.0617	0.0686	approved
3	$A_3=\begin{bmatrix} 1 & 3 & 1 & 7/5 \\ 1/3 & 1 & 1/3 & 3/5 \\ 1 & 3 & 1 & 9/5 \\ 5/7 & 5/3 & 5/9 & 1 \end{bmatrix}$	4.0079	0.0026	0.0029	Approved
4	$A_4=\begin{bmatrix} 1 & 9/5 & 9/7 & 3 \\ 5/9 & 1 & 3/7 & 1 \\ 7/9 & 7/3 & 1 & 7/5 \\ 1/3 & 1 & 5/7 & 1 \end{bmatrix}$	4.0656	0.0219	0.0243	Approved
5	$A_5=\begin{bmatrix} 1 & 6/5 & 3/7 & 2/7 \\ 5/6 & 1 & 1/3 & 1/9 \\ 7/3 & 3 & 1 & 1 \\ 7/2 & 9 & 1 & 1 \end{bmatrix}$	4.1246	0.0415	0.0461	Approved
6	$A_6=\begin{bmatrix} 1 & 3/7 & 1/4 & 1/9 \\ 7/3 & 1 & 2/3 & 3/7 \\ 4 & 3/2 & 1 & 2/3 \\ 9 & 7/3 & 3/2 & 1 \end{bmatrix}$	4.0274	0.0091	0.0101	Approved
7	$A_7=\begin{bmatrix} 1 & 9/7 & 9/7 & 9/7 \\ 7/9 & 1 & 5/7 & 1 \\ 7/9 & 7/5 & 1 & 1 \\ 7/9 & 1 & 1 & 1 \end{bmatrix}$	4.0142	0.0047	0.0053	Approved
8	$A_8=\begin{bmatrix} 1 & 9/7 & 9/7 & 9/5 \\ 7/9 & 1 & 5/7 & 1 \\ 7/9 & 7/5 & 1 & 7/5 \\ 5/9 & 1 & 5/7 & 1 \end{bmatrix}$	4.0142	0.0047	0.0053	Approved
9	$A_9=\begin{bmatrix} 1 & 5/6 & 5/4 & 3/5 \\ 6/5 & 1 & 7/5 & 5/7 \\ 4/5 & 5/7 & 1 & 3/7 \\ 5/3 & 7/5 & 7/3 & 1 \end{bmatrix}$	4.0030	0.0010	0.0011	Approved

(*continued*)

Table 7.
Intergroup Judgement Matrix and Consistency Check (Continued)

Expert No.	Judgement Matrix	λ_{max}	CI	CR	Consistency
10	$A_{10}=\begin{bmatrix} 1 & 3 & 2 & 8/5 \\ 1/3 & 1 & 3/5 & 1 \\ 1/2 & 5/3 & 1 & 2 \\ 5/8 & 1 & 1/2 & 1 \end{bmatrix}$	4.0811	0.0270	0.0300	Approved
11	$A_{11}=\begin{bmatrix} 1 & 5/3 & 5/9 & 7/4 \\ 3/5 & 1 & 1/3 & 1 \\ 9/5 & 3 & 1 & 3 \\ 4/7 & 1 & 1/3 & 1 \end{bmatrix}$	4.0003	0.0001	0.0001	Approved
12	$A_{12}=\begin{bmatrix} 1 & 9/7 & 2 & 3 \\ 7/9 & 1 & 7/5 & 7/3 \\ 1/2 & 5/7 & 1 & 5/3 \\ 1/3 & 3/7 & 3/5 & 1 \end{bmatrix}$	4.0324	0.0108	0.0120	Approved
13	$A_{13}=\begin{bmatrix} 1 & 7/5 & 5/3 & 7 \\ 5/7 & 1 & 2 & 5 \\ 3/5 & 1/2 & 1 & 7/2 \\ 1/7 & 1/5 & 2/7 & 1 \end{bmatrix}$	4.0261	0.0087	0.0097	Approved
14	$A_{14}=\begin{bmatrix} 1 & 3 & 3/5 & 3 \\ 1/3 & 1 & 1/5 & 1 \\ 5/3 & 5 & 1 & 5/2 \\ 1/3 & 1 & 2/5 & 1 \end{bmatrix}$	4.0606	0.0202	0.0224	Approved
15	$A_{15}=\begin{bmatrix} 1 & 1/2 & 5/7 & 5/7 \\ 2 & 1 & 5/3 & 5/7 \\ 7/5 & 3/5 & 1 & 1 \\ 7/5 & 7/5 & 1 & 1 \end{bmatrix}$	4.0773	0.0258	0.0286	Approved

Source: Author composition.

strategic positive strength is quantified as U = 0.9541, the strategic negative strength is V = 0.2484, and the strategic strength coefficient is ρ = 0.7934. The coefficient ρ, which varies between 0 and 1, indicates the intensity of strategy implementation, with higher values suggesting greater intensity. The location of *p*(0.1288, 0.1105) in the first quadrant (refer to Figure 5) indicates that the bamboo weaving base possesses significant advantages and presents notable external opportunities.

Discussion

Applicability of SWOT–AHP and Comparison with Existing Research

The implementation of the hybrid SWOT–AHP model in this study provides a robust quantitative framework for assessing the sustainability of the bamboo weaving base, effectively bridging the gap between qualitative observation and strategic prioritization. As emphasized by Darko et al. (2019), the scientific rigor of AHP lies in its ability to systematize expert judgments while ensuring logical consistency through consistency ratios. This methodological approach aligns with the work of Kafle et al. (2023) in the timber bamboo sector of Nepal, where weight distribution was utilized to pinpoint commercialization breakthroughs in traditional resource industries. However, this study extends the existing literature by integrating "ICH attributes" as a core driver, forming an insightful dialogue with modern research on digital supply ecosystems (Sharma et al., 2024). While traditional supply chain studies often focus on raw material resilience, this research demonstrates that a comprehensive framework synchronizing policy support with digital infrastructure is required to transform a cultural craft into a sustainable industrial system capable of countering global market shocks.

Analysis of Critical Strategic Factors and Resource Synergy

The comprehensive ranking of the 18 factors reveals that the Qingshen base is currently in an "opportunity-driven" growth phase, with Opportunity factors (O factors) occupying the top four positions globally. O_1 (National policy support) and O_3 (Strategic partnerships) emerge as the paramount drivers, indicating that China's top-down policy inclination and academia-industry synergy are the most significant impetuses. This external favorability is synergized by internal

Table 8.
Aggregate Analysis of the Factor Weights in the Hierarchical Structure as Determined by Fifteen Experts

Factors	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6	Expert 7	Expert 8	Expert 9	Expert 10	Expert 11	Expert 12	Expert 13	Expert 14	Expert 15
S	0.4187	0.3003	0.3279	0.379	0.1398	0.0658	0.2995	0.3218	0.2134	0.4081	0.2528	0.3832	0.4259	0.3194	0.3194
W	0.144	0.2047	0.1164	0.1631	0.1007	0.1801	0.2142	0.2115	0.2512	0.1551	0.1498	0.2903	0.3184	0.1065	0.1065
O	0.14	0.2472	0.3492	0.2948	0.2679	0.2819	0.2534	0.2722	0.1688	0.2634	0.4494	0.2020	0.1972	0.4476	0.4476
T	0.2973	0.2477	0.2066	0.1631	0.4916	0.4722	0.2329	0.1945	0.3666	0.1734	0.1480	0.1244	0.0585	0.1266	0.1266
S1	0.1195	0.1213	0.2167	0.1666	0.2077	0.2318	0.177	0.1669	0.1652	0.2000	0.1753	0.2148	0.1726	0.1560	0.1170
S2	0.1337	0.142	0.0986	0.0947	0.0833	0.1424	0.1337	0.1334	0.2168	0.2145	0.1100	0.2443	0.2285	0.1220	0.1407
S3	0.1142	0.227	0.3054	0.2328	0.228	0.0787	0.2034	0.2029	0.143	0.1626	0.2246	0.1487	0.1031	0.2176	0.2379
S4	0.2948	0.1344	0.0716	0.1864	0.1011	0.249	0.1674	0.1766	0.18	0.1763	0.1627	0.1778	0.2285	0.1899	0.1193
S5	0.1755	0.1699	0.231	0.1223	0.106	0.227	0.1414	0.1334	0.1363	0.1363	0.1040	0.1102	0.1000	0.0936	0.1798
S6	0.1622	0.2054	0.0766	0.1972	0.2739	0.071	0.177	0.1868	0.1587	0.1102	0.2235	0.1042	0.1674	0.2209	0.2053
W1	0.2341	0.3422	0.3289	0.3065	0.3828	0.1497	0.264	0.2607	0.3925	0.2692	0.2695	0.2596	0.2462	0.4126	0.2595
W2	0.1356	0.2016	0.1062	0.1813	0.1712	0.1497	0.2186	0.2077	0.0591	0.185	0.3186	0.2107	0.1863	0.0879	0.2051
W3	0.3096	0.167	0.2889	0.2056	0.1728	0.3251	0.2204	0.2001	0.1388	0.2462	0.1425	0.1298	0.2002	0.1156	0.2279
W4	0.3208	0.2892	0.276	0.3065	0.2732	0.3754	0.2969	0.3315	0.4096	0.2996	0.2695	0.3998	0.3674	0.3839	0.3076
O1	0.2297	0.2712	0.2971	0.232	0.246	0.5577	0.2487	0.2414	0.3083	0.3098	0.2032	0.2442	0.2397	0.3097	0.3280
O2	0.2451	0.204	0.3736	0.2214	0.2165	0.2354	0.2147	0.2147	0.2901	0.2862	0.1719	0.1785	0.1495	0.3304	0.2730
O3	0.3875	0.2271	0.1196	0.2408	0.4071	0.1276	0.2487	0.2571	0.1737	0.2319	0.2504	0.3306	0.3252	0.1858	0.2319
O4	0.1378	0.2977	0.2097	0.3059	0.1303	0.0792	0.288	0.2869	0.2279	0.1721	0.3744	0.2467	0.2856	0.1741	0.1672
T1	0.2063	0.2829	0.2505	0.2194	0.3762	0.5	0.2188	0.2083	0.3172	0.1724	0.2287	0.2226	0.1898	0.2915	0.1614
T2	0.4177	0.2714	0.3525	0.2679	0.1761	0.2778	0.2926	0.2917	0.1199	0.238	0.2536	0.2859	0.2955	0.1936	0.2271
T3	0.1263	0.1911	0.2427	0.2934	0.305	0.0556	0.2796	0.2917	0.1689	0.2856	0.3186	0.2653	0.2955	0.2095	0.2923
T4	0.2496	0.2546	0.1543	0.2194	0.1428	0.1667	0.209	0.2083	0.394	0.3041	0.1990	0.2262	0.2191	0.3054	0.3192

Source: Author composition.

Table 9.
Ranking and Visualization of Factor Weights across SWOT Categories

Goal	SWOT Groups	Weight	Factors	Local Weight	Global Weight	Rank
The Sustainability Development of the Qingshen Bamboo Weaving Base	S	0.2874	S1	0.1739	0.0530	12
			S2	0.1492	0.0455	15
			S3	0.1887	0.0575	8
			S4	0.1744	0.0532	11
			S5	0.1444	0.0441	16
			S6	0.1693	0.0517	14
	W	0.1741	W1	0.2919	0.0528	13
			W2	0.1750	0.0316	18
			W3	0.2060	0.0373	17
			W4	0.3271	0.0592	6
	O	0.2539	O1	0.2844	0.0812	1
			O2	0.2403	0.0686	3
			O3	0.2497	0.0713	2
			O4	0.2256	0.0644	4
	T	0.2846	T1	0.2564	0.0586	7
			T2	0.2641	0.0604	5
			T3	0.2414	0.0552	9
			T4	0.2381	0.0545	10

Source: Author composition.

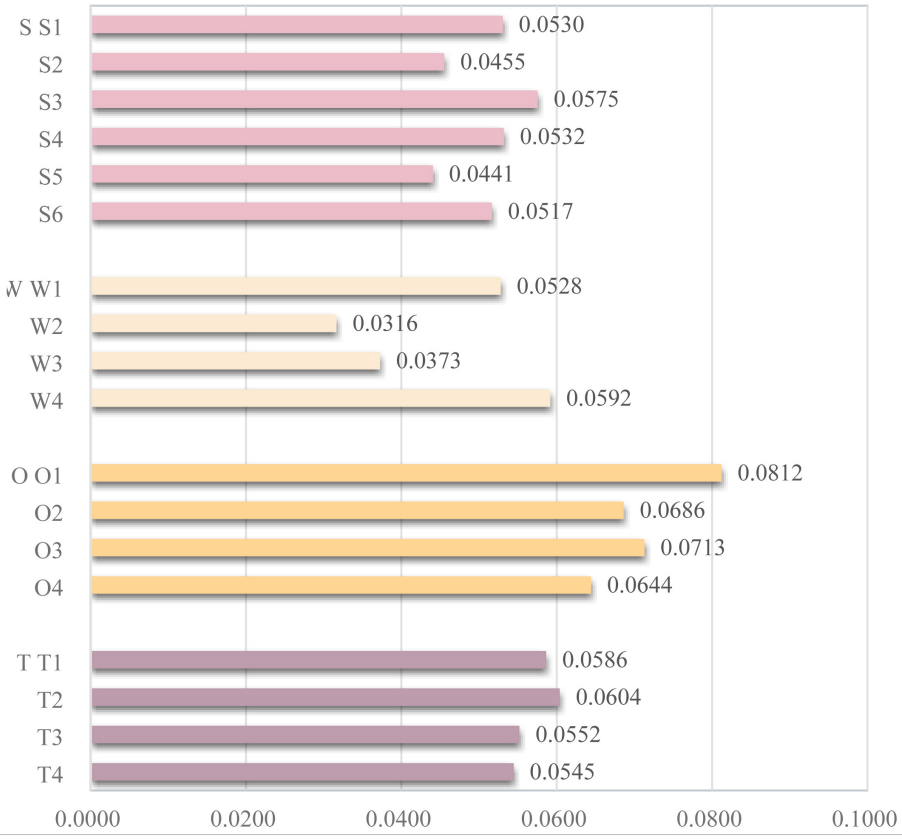

Figure 4.
Global Weights of All Factors. Source: Author Composition.

Table 10.
Intensities of the Groups and Factors

SWOT Groups	Factor	Global Weight of Factor	Estimated Strength	Factor Intensity	Total Intensity
S	S_1	0.0530	3	0.1590	S' = 1.0012
	S_2	0.0455	2	0.0910	
	S_3	0.0575	5	0.2875	
	S_4	0.0532	4	0.2128	
	S_5	0.0441	1	0.0441	
	S_6	0.0517	4	0.2068	
W	W_1	0.0528	−2	1.0012	W' = −0.4859
	W_2	0.0316	−1	-0.1056	
	W_3	0.0373	−3	-0.0316	
	W_4	0.0592	−4	-0.1119	
O	O_1	0.0812	5	-0.2368	O' = 0.9530
	O_2	0.0686	1	-0.4859	
	O_3	0.0713	4	0.4060	
	O_4	0.0644	3	0.0686	
T	T_1	0.0586	−2	0.2852	T' = −0.5112
	T_2	0.0604	−2	0.1932	
	T_3	0.0552	−1	0.9530	
	T_4	0.0545	−4	-0.1172	

Source: Author composition.

strengths, particularly the promotion of livelihoods and rural revitalization (S_3), which serves as the most significant positive factor. The base possesses a robust physical foundation to support this mission, boasting comprehensive infrastructure such as multifunctional conference rooms, practice rooms, and a showcase hall displaying achievements from domestic and international trainees. Logistical support is further guaranteed by well-equipped dormitories and a dining hall capable of accommodating 1,500 people, ensuring that the base can function as a high-capacity training hub. Furthermore, the presence of the China Bamboo Art City (Museum) and the bamboo garden (S_2) provides a unique cultural and scientific anchor that preserves a wealth of bamboo resources and art.

However, the internal and external constraints merit equal attention, as W4 (Product design and development capabilities) and T_2 (Intensified market competition) rank fifth and sixth respectively. The disparity between academic sustainable product design and professional artisanal practice remains a pivotal weakness, necessitated by a shift toward a "Policy-Design" integrated approach. To bridge this gap, the base must leverage national initiatives to foster innovation and creativity among producers. While the digital application factor T_1 remains a high-priority challenge, it should be viewed through the lens of "IT-enabled supply chains" (Kumar et al., 2015), where innovative strategies—including AI-driven design tools and new media technology—are employed to propagate scientific knowledge and cultural legacy. Management and operational teams (W_1) must also be augmented through educational and training programs to foster leadership and serve the public more effectively. The derived *p* value of P(0.1288, 0.1105) situated in the "strengthen type" quadrant confirms that the current period is a critical window. By capitalizing on internal infrastructure and policy dividends while utilizing IT and AI applications to mitigate the design gap, the base can differentiate itself from homogenized competition and achieve a transition into a branded, high-value industrial ecosystem.

Multidimensional Implications: Political, Practical, and Social

The findings of this study yield significant political, practical, and social implications. From a political perspective, the dominance of O_1 and O_3 indicates that policymakers should increasingly bind ICH protection with global carbon neutrality goals. Much like the technical logic used to ensure carbon neutrality in other sectors (Kumar et al., 2024),

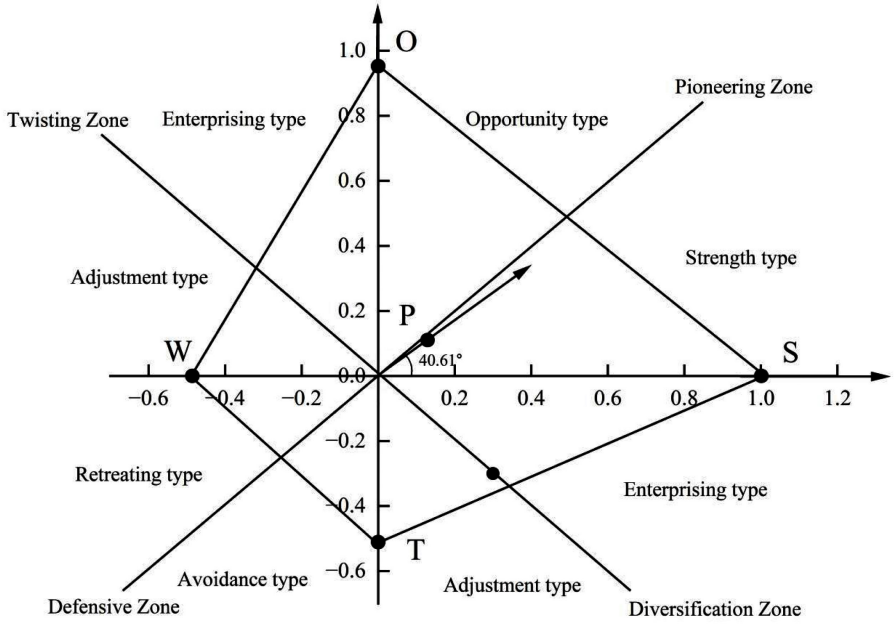

Figure 5.
SWOT Strategic Quadrilateral and Strategic Types. Source: Author Composition.

the bamboo industry—as a representative of the green economy—should seek dividends from international environmental policies to transform cultural heritage into a competitive advantage. Practically, for base managers, the prioritization of W_4 and T_2 suggests that design-driven differentiation is the only defense against market homogeneity. Establishing a strong brand identity that highlights product distinctiveness, combined with storytelling marketing that underscores artisanal skills, is crucial for fostering emotional connections with modern consumers and expanding market reach.

On a social level, this study confirms that sustainable industrial initiatives contribute significantly to the cognitive and economic well-being of local participants (Tomar et al., 2023). The improvement of livelihoods through S3 is not only an economic indicator but also a reshaping of cultural identity and social cohesion. By engaging in strategic partnerships with educational institutions (O_3) to offer workshops on sustainable design, the base serves the dual purposes of educating the public and cultivating a new generation of artisans. This interactive social structure, supported by the judicious utilization of local resources and Geographical Indication protection (S_4), ensures that the bamboo weaving base possesses a stronger endogenous growth momentum. This allows it to withstand external shocks, such as global economic downturns (T_3), more effectively than models reliant solely on government subsidies, ultimately ensuring long-term environmental, economic, and social sustainability.

Key Findings and Contributions

This study employs a hybrid SWOT–AHP framework to empirically analyze the sustainable development pathway of the Qingshen Bamboo Weaving Base, yielding three primary conclusions:

1. The base exhibits a predominant Strength-Opportunity (SO) strategic orientation. Quantitative analysis reveals that internal strengths ($S' = 1.0012$) and external opportunities ($O' = 0.9530$) substantially outweigh weaknesses ($W' = -0.4859$) and threats ($T' = -0.5112$) in influencing the sustainable development of the base. The strategic centroid $p(.1288, .1105)$, situated in the first quadrant, alongside a high strategic strength coefficient ($\rho = .7934$), empirically substantiates that the base is positioned within a strategic window to leverage internal capabilities for capitalizing on favorable external conditions.
2. Critical success factors and priority improvement areas exhibit significant divergence. National policy support (O1) and strategic educational partnerships (O3) emerge as the paramount external drivers, while local employment enhancement and rural revitalization (S3) constitute the most significant internal strength. Conversely, inadequate product design capabilities (W4) and intensified market competition (T2) represent the most pressing constraints on sustainable development, with digital promotion gaps (T1) also posing a significant challenge—collectively revealing a systemic deficiency in translating cultural heritage into market competitiveness.
3. The inheritance and sustainable development of bamboo weaving culture necessitate a multidimensional integrated approach. As a nationally recognized intangible cultural heritage in China, bamboo weaving embodies the convergence of traditional artistry and technological innovation throughout human history (Zheng & Zhu, 2021), serving as an indispensable craft integral to rural community life. Through sustainable education and skill dissemination, bamboo weaving has generated entrepreneurial and employment opportunities for rural inhabitants, catalyzing regional sustainable development.

The findings demonstrate that the base's sustainable development hinges on the synergistic coordination of policy support, design innovation, digital empowerment, and community engagement—a strategic transition from a resource-dependent model toward a design-driven, brand-oriented industrial ecosystem. This transformation not only stimulates cross-sectoral coordination and fosters emerging industries, but also aligns with global carbon neutrality goals.

Amidst global endeavors to identify effective conservation strategies for intangible cultural heritage, China's productive protection demonstration base model stands as a noteworthy exemplar. The contemporary era presents favorable opportunities for the inheritance and development of intangible cultural heritage such as bamboo weaving. This research is anticipated to provide valuable reference for bamboo weaving bases in China—and potentially worldwide—in charting sustainable development pathways attuned to local conditions.

Limitations and Future Research Directions

This study is not without its limitations. While the research framework and conclusions are robust, there is room for further improvement in expanding the research scope and enriching the analytical dimensions. Nevertheless, the analytical framework established in this study still provides valuable references for other similar bases and industries. Future research can be further expanded to address these limitations and deepen the related research. First, the authors will expand the data scope and construct a more diverse, multidisciplinary expert panel to further enhance the comprehensiveness and reliability of the research findings. Second, the authors will systematically collect historical data to conduct in-depth longitudinal comparative analysis, quantify the dynamic changes of relevant factors over time, and better reflect the evolutionary characteristics of the research object. Third, the authors will expand the research scope to include similar bases in multiple regions, apply the same SWOT–AHP analytical framework to carry out inter-regional benchmarking analysis, and thus enhance the external validity and generalizability of the research conclusions. In addition, subsequent studies will also delve into the impacts of industry-education-research collaboration, participant satisfaction levels, and the recognition of various stakeholders regarding the sustainable use of natural resources, so as to provide more comprehensive and targeted suggestions for the sustainable development of related fields.

Data Availability Statement: The data that support the findings of this study are available on request from the corresponding author.

Artificial Intelligence Usage Statement: This study used DeepSeek to edit grammar during the preparation of the manuscript..

Ethics Committee Approval: Ethical committee approval was received from the Ethics Committee of ICBR (Approval no: 1632024011, Date: October 24, 2024).

Informed Consent: Written informed consent was obtained from experts who participated in this study.

Peer review: Externally peer reviewed.

Acknowledgments: The authors thank to the instructors at the Base, Yunhua Chen, Lan Chen, and Baozhen Zhang, for their contributions to the foundational materials of the study.

Author Contributions: Concept – Q.W., G.L.; Design – L.Z.; Supervision – Q.W., G.L.; Resources – L.S.; Materials – C.Z., E.X.; Data Collection and/or Processing – Y.J.;

Analysis and/or Interpretation – Y.J.; Literature Search – L.S.; Writing Manuscript – L.S.; Critical Review – C.Z., E.X.; Other – L.Z.

Declaration of Interests: The authors declare that they have no competing interests.

Funding: This research was financially supported by the Fundamental Research Funds of ICBR (1632025011, 1632024010, and 1632022003).

References

Cai, Y. F., Huo, J. Q., Zhang, H. J., & Wang, L. J. (2024). Exploration of the innovative development path of bamboo weaving and fashion design in the background of intangible cultural heritage. *Frontiers in Art Research*, *6*(5), 14–23. [CrossRef]

Chen, H., Zhen, S., & Lian, C. (2023). Research on bamboo weaving pattern and its application in home design. *China Forest Products Industry*, *60*(9), 68–73. [CrossRef]

Chen, J., Li, N., Li, Y., Zhang, J., & Zhou, Z. (2025). Research on the application of Guangdong intangible cultural heritage in food packaging using SWOT-AHP analysis. *CyTA – Journal of Food*, *23*(1). [CrossRef]

Darko, A., Chan, A. P. C., Ameyaw, E. E., Owusu, E. K., Pärn, E., & Edwards, D. J. (2019). Review of application of analytic hierarchy process (AHP) in construction. *International Journal of Construction Management*, *19*(5), 436–452. [CrossRef]

Dimitropoulos, K., Tsalakanidou, F., Nikolopoulos, S., Kompatsiaris, I., Grammalidis, N., Manitsaris, S., Denby, B., Crevier-Buchman, L., Dupont, S., Charisis, V., Hadjileontiadis, L., Pozzi, F., Cotescu, M., Çiftçi, S., Katos, A., & Manitsaris, A. (2018). A multimodal approach for the safeguarding and transmission of intangible cultural heritage: the case of i-Treasures. *IEEE Intelligent Systems*, *33*(6), 3–16. [CrossRef]

Dlamini, L. C., Fakudze, S., Makombe, G. G., Muse, S., & Zhu, J. (2022). Bamboo as a valuable resource and its utilization in historical and modern-day China. *BioResources*, *17*(1), 1926–1938. [CrossRef]

Dyson, R. G. (2004). Strategic development and SWOT analysis at the University of Warwick. *European Journal of Operational Research*, *152*(3), 631–640. [CrossRef]

Farah, P. D., & Tremolada, R. (2015). *Global governance and intangible cultural heritage in the information society*. Chichester, UK: John Wiley & Sons, Ltd.

Ge, W., Xiao, H., & Fu, Y. (2022). A review of research on the productive safeguarding of intangible cultural heritage. *Comparative Study of Cultural Innovation*, *6*(32), 68–72.

Jiang, R. (2025). Research on the modern product transformation of traditional bamboo weaving craft from the perspective of sustainable design. *Social Sciences and Humanities*, *2*(2), 50–62. [CrossRef]

Kafle, A., Binfield, L., & Paudel, S. K. (2023). The commercialization of timber bamboo in Nepal: a SWOT-AHP analysis. *Advances in Bamboo Science*, *4*, 100036. [CrossRef]

Kahraman, C., Demirel, N. Ç., & Demirel, T. (2007). Prioritization of e-Government strategies using a SWOT-AHP analysis: the case of Turkey. *European Journal of Information Systems*, *16*(3), 284–298. [CrossRef]

Kumar, A., Mishra, S., Singh, N. K., Yadav, M., Padhiyar, H., Christian, J., & Kumar, R. (2024). Ensuring carbon neutrality via algae-based wastewater treatment systems: progress and future perspectives. *Journal of Environmental Management*, *360*, 121182. [CrossRef]

Kumar, R., Agrawal, R., & Sharma, V. (2015). IT enablement in sugar supply chain: an approach for farmers. *International Journal of Business Performance and Supply Chain Modelling*, *7*(4), 360–381. [CrossRef]

Lenzerini, F. (2011). Intangible cultural heritage: the living culture of peoples. *European Journal of International Law*, *22*(1), 101–120. [CrossRef]

Li, H., Chen, X., & Fang, Y. (2021). The development strategy of home-based exercise in China based on the SWOT-AHP model. *International Journal of Environmental Research and Public Health*, *18*(3), 1224. [CrossRef]

Ministry of Culture and Tourism (MCT) (2024). Notice of the Ministry of Culture and Tourism on the announcement of the list of national demonstration bases for productive protection of intangible cultural heritage from 2023 to 2025. Retrieved from https://zwgk.mct.gov.cn/zfxxgkml/fwzwhyc/202403/t20240328_951955.html

Ministry of Culture and Tourism (MCT) (n.d.). List of representative national intangible cultural heritage items. Retrieved from https://www.ihchina.cn/project.html?tid=7#sy_target1

Melis, C., & Chambers, D. (2021). The construction of intangible cultural heritage: A Foucauldian critique. *Annals of Tourism Research*, *89*, 103206. [CrossRef]

Meng, K., An, P., & Wang, M. (2022). Research on digital protection and development strategy of Qingshen bamboo weaving. *Furniture & Interior Design*, *29*(6), 7–12. [CrossRef]

Mitch, D., Harries, K. A., & Sharma, B. (2010). Characterization of splitting behavior of bamboo culms. *Journal of Materials in Civil Engineering*, *22*(11), 1195–1199. (doi:10.1061/(ASCE)MT.1943-5533.0000120)

Miyata, S. (2013). Intangible cultural heritage policy in Japan. In L. Arizpe & C. Amescua (Eds.). *Anthropological perspectives on intangible cultural heritage* (pp. 83–101). Berlin: Springer. [CrossRef]

Monova-Zheleva, M., Zhelev, Y., & Nikolova, E. (2020). Intangible cultural heritage presentation and preservation – Challenges and opportunities for museum specialists. *Digital Presentation and Preservation of Cultural and Scientific Heritage*, *10*, 233–240. [CrossRef]

Peng, X. Q. (2018). Study on development strategy analysis of new bamboo-slices products in Wanbei area. *Journal of Physics: Conference Series*, *1087*(4), 042049. [CrossRef]

Potters, G., Schutte, F., Van Goethem, D., De Nollin, S., Samson, R., & Gielis, J. (2013). Bamboo as a crop in Western Europe - A SWOT analysis. *Acta Horticulturae*, (1003), 89–95. [CrossRef]

Saaty, T. L. (1977). A scaling method for priorities in hierarchical structures. *Journal of Mathematical Psychology*, *15*(3), 234–281. [CrossRef]

Saaty, T. L. (1990). How to make a decision: the analytic hierarchy process. *European Journal of Operational Research*, *48*(1), 9–26. [CrossRef]

Sharma, K., Kumar, R., Kumar, A., Balabantaray, S., & Arora, M. (2024). A digital ecosystem for sustainable fruit supply chain in Uttarakhand: a comprehensive review. *Environment, Development and Sustainability*, *26*(5), 13217–13252. [CrossRef]

Song, J., Ding, K., Cheng, R., Luo, X., Liu, Y., Tian, Y., & Duan, Z. (2025). Revitalizing intangible heritage: sustainable tourism strategies for safeguarding Changsha's cultural memories. *Open Journal of Business and Management*, *13*(4), 2461–2474. [CrossRef]

Tomar, S., Sharma, N., & Kumar, R. (2024). Effect of organic food production and consumption on the affective and cognitive well-being of farmers: analysis using prism of NVivo, etic and emic approach. *Environmental Development and Sustainability*, *26*, 11027–11049. [CrossRef]

Tomita, J., & Tomita, N. (2023). *Japanese ikat weaving: The techniques of kasuri* (1st ed). Abingdon, UK: Routledge. [CrossRef]

UNESCO (2003). UNESCO intangible cultural heritage. Text of the convention for the safeguarding of the intangible cultural heritage. Retrieved from https://ich.unesco.org/en/convention

Wu, J. Y., Chen, H., Wu, Z. H., Fei, B. H., & Zhang, W. F. (2020). Bamboo weaving technology in Sichuan Province. *Journal of Bamboo Research*, *39*(1), 90–94. [CrossRef]

Xiang, H. (2011). On the protection, passing down and inheriting of intangible cultural heritage. *Heilongjiang National Series*, *5*, 137–142. [CrossRef]

Zhang, Y., Cheng, J., & Ma, S. (2024). An analysis of the inheritance and development of intangible cultural heritage. *Comparative Study of Cultural Innovation*, *8*(7), 188–191. [CrossRef]

Zhao, Y., An, N., & You, L. (2026). Weaving digital and traditional heritage: a lightweight ecosystem for willow weaving inheritance in Inner Mongolia. *Cogent Arts and Humanities*, *13*(1). [CrossRef]

Zheng, Y., & Zhu, J. (2021). The application of bamboo weaving in modern furniture. *BioResources*, *16*(3), 5024–5035. [CrossRef]

Zhu, H. (2020). *The innovation research and practice of contemporary bamboo weaving art based on the background of non-legacy culture* [Master's Thesis]. Hangzhou Normal University. [CrossRef]

Zhu, Y. (2013). Productive protection of intangible cultural heritage based on people's daily life needs: focusing on the protection of intangible cultural heritage of handicrafts. *Folklore Research*, *1*, 19–24. [CrossRef]