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Quantifying Barriers to Silk Creative Education: Integration of Cultural and Industrial Perspectives

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ABSTRACT

In the context of the booming global cultural and creative industries, the silk creative industry represents a typical integration of traditional culture and modern creative economy. However, the development of silk creative entrepreneurship education faces significant barriers in translating cultural values into innovative products and educational practices, which is the focus of this study.

This study employs a hybrid Analytic Hierarchy Process (AHP) and Fuzzy Analytic Hierarchy Process (FAHP) methodology to systematically identify and prioritise these barriers. Based on expert evaluations from 21 stakeholders, including intangible cultural heritage inheritors, educators, and industry executives, the research constructs a three-tier evaluation framework encompassing cultural value translation, entrepreneurship education resources, and market-policy synergy. Results indicate that cultural narrative weakness is the primary barrier (weight: 0.183), followed by financing channel narrowness and course case scarcity. The overall fuzzy score of 3.5092 suggests a moderate alignment with barriers, highlighting the need for targeted optimisations.

Theoretical contributions include advancing interdisciplinary frameworks for cultural entrepreneurship education, while practical implications propose establishing narrative labs, case alliances, and policy-financial tools. This study fills methodological gaps in quantifying fuzzy cultural indicators and provides actionable insights for enhancing the silk creative industry's sustainable development.

KEYWORDS

silk industry, entrepreneurship education, cultural

INTRODUCTION

In the context of the booming global cultural and creative industries, the silk creative industry represents a typical integration of traditional culture and modern creative economy. However, the development of silk creative entrepreneurship education faces significant barriers in translating cultural values into innovative products and educational practices, which is the focus of this study.

Silk, as an important carrier of Chinese civilisation, is a creative industry development that not only carries profound cultural connotations but also concerns the modern inheritance and innovative development of traditional crafts. According to Grand View Research data combined with Wu's [1] analysis, the global silk textile market reached a scale of \$124.2 billion in 2023, projected to grow at a compound annual growth rate of 8.0% from 2024 to 2030, reaching \$380.5 billion by 2029. This trajectory indicates substantial growth potential and expansive developmental horizons for the global silk market [1].

However, the development of silk creative entrepreneurship education faces significant barriers, particularly in translating cultural values into innovative products and educational practices. UNESCO's [2] Convention for the Safeguarding of Intangible Cultural Heritage emphasises that modern inheritance of traditional culture requires establishing effective educational transmission mechanisms, but in reality, the educational transformation of silk culture faces numerous challenges. Zhou et al. [3], from an entrepreneurial psychology perspective, found that entrepreneurial cognition, emotion, and will are three pivotal psychological factors influencing university students' entrepreneurial endeavours in ICH inheritance, while the complexity and professionalism of silk culture make this process even more difficult.

Existing research shows obvious deficiencies in quantifying cultural creative education barriers. Zhao et al. [4] attempted to employ the ANP method to analyse the adaptability of textile intangible cultural heritage protection, but their focus resided on cultural preservation rather than entrepreneurship education, and failed to effectively address the fuzzy attributes of cultural symbols. Silk culture exhibits typical fuzzy characteristics, with subjective elements like cultural charm eluding precise delineation, consigning existing research to abundant qualitative descriptions juxtaposed with scarce quantitative analyses.

This study aims to systematically evaluate barriers in silk culture-driven creative product entrepreneurship education using the Analytic Hierarchy Process (AHP), quantify their priorities from a technical perspective, and propose innovative models addressing China's industry needs and global sustainability requirements.

Based on expert evaluations from 21 stakeholders, including intangible cultural heritage inheritors, educators, and industry executives, the research constructs a three-tier evaluation framework encompassing cultural value translation, entrepreneurship education resources, and market-policy synergy.

The findings will provide theoretical foundations and practical guidance for stakeholders and policymakers, promoting effective application and accelerating the industry's shift to responsible practices.

LITERATURE REVIEW

Progress in Interdisciplinary Research on Creative Industries and Entrepreneurship Education

The creative industries, characterised by their creativity-driven nature and lightweight asset structures [5], have risen prominently in the global economy, thereby imposing transformative demands on entrepreneurship education systems. This necessitates that entrepreneurship education extend beyond the mere transmission of traditional business skills to cultivate students' abilities in interpreting diverse cultural symbols and ingeniously transforming cultural connotations into operational business value [6]. Schumpeter's [7] innovation theory serves as a cornerstone, laying the foundational analytical framework for this domain by emphasising the bridging role of entrepreneurship education in intimately linking profound cultural values with dynamic market demands, thereby guiding subsequent research trajectories. Feola et al. [8] conducted an in-depth investigation into the entrepreneurial university, substantiating with robust data that cultural enterprises receiving systematic entrepreneurship education exhibit substantially higher survival rates compared to their counterparts without such education, and excel in critical dimensions such as cultural IP development and precise market demand insight. This empirical evidence robustly underscores the significant efficacy of educational interventions in fostering creative industry development, highlighting the paramount importance of systematic entrepreneurship education. To effectively bridge the extant chasm between education and industry, the "industry-academia-research integration" model has emerged and is widely regarded as a pivotal solution pathway [9]. The 2023 ASEE Annual Conference & Exposition proceedings featured a case study of an industry-academia collaborative student research project: a teaching-intensive private university partnered with a local electronics manufacturing company, under national institutional funding, to enhance the company's printed circuit board (PCB) assembly and packaging manufacturing processes. Within this project, students received stipends and tuition support, with costs shared between the institution

and enterprise, and were required to report outcomes periodically to the sponsor and company. Project deliverables encompassed the design and prototyping of a dashboard based on key performance indicators (KPIs) for predicting and identifying industry manufacturing limitations, alongside reports on student learning experiences, industry-academia collaboration dynamics, lessons learned, and pedagogical insights related to project management—thereby exemplifying the role of such collaborations in refining manufacturing processes and elevating student learning experiences, and fully manifesting the robust vitality and marked efficacy of practice-oriented education models within the creative domain [10]. However, a deeper scrutiny of existing models reveals that, while they yield remarkable outcomes in general creative fields, they fall short in addressing specialised industries like silk, which demand profound cultural decoding depths, necessitating bespoke strategies to bridge gaps in cultural profundity and innovation [11]. Particularly in the pedagogical fusion of traditional crafts—such as silk reeling and brocade weaving—with modern design concepts, conspicuous shortcomings persist, rendering them inadequate to fulfil the distinctive talent cultivation exigencies of the silk creative industry; this lacuna also delineates clear directions for constructing subsequent targeted educational models, augmented by the auxiliary role of digital technologies in silk craftsmanship [11].

Core Contradictions and Breakthrough Paths in Intangible Cultural Heritage Entrepreneurship Education

UNESCO [2] provides a precise delineation of intangible cultural heritage entrepreneurship education, interpreting it as "the modern translation process of cultural genes." Within this process, balancing cultural authenticity with commercial viability emerges as the central contradiction [8]. The UNESCO framework emphasises that effective ICH entrepreneurship education must be built upon three pillars: cultural knowledge transmission, innovation capacity cultivation, and market adaptability development. This paradigm offers salient references for silk creative education and provides a theoretical foundation for systematic construction. Within this process, balancing cultural authenticity with commercial viability emerges as the central contradiction [12]. Zhou et al. [3], from an entrepreneurial psychology perspective, investigated entrepreneurship education in intangible cultural heritage inheritance, identifying entrepreneurial cognition, emotion, and will as three pivotal psychological factors influencing university students' entrepreneurial endeavours in this domain. Yan and Li [13], through case studies of "She ethnic costume culture" and "Quanzhou traditional embroidery techniques," explored innovative practices in university intangible cultural heritage education,

ascertaining that integrating cultural identity with creative design competency cultivation can effectively enrich the practical pathways of entrepreneurship education. This paradigm offers salient references for silk creative education.

Lu et al. [14], focusing on Chinese paper-cutting art, unveiled prevalent issues in contemporary intangible cultural heritage education: most curricula overly emphasise skill training, with only a minority incorporating business model design, directly culminating in diminished student entrepreneurial success rates. The compensatory practice pathway proposed by Hauge et al. [15] underscores that higher education institutions (HEIs) and cultural creative industries (CCIs) must establish shared spaces for dialogue and project development, supplemented by flexible, context-specific policies to surmount disparities in professional knowledge and linguistic barriers—thereby furnishing direct references for constructing concrete mechanisms in the silk creative domain, such as pattern decoding laboratories and school-enterprise case joint development platforms. This deficiency also charts explicit directions for devising subsequent targeted educational models, wherein digital technologies aptly provide technical scaffolding for the fusion of silk craftsmanship and modern design [11].

Uniqueness and Research Gaps in the Silk Creative Industry

Composite Characteristics of the Silk Industry

The silk creative industry requires specialised analytical frameworks distinct from general textile or blockchain-based supply chain studies. Unlike broad manufacturing sectors, silk creative education involves intricate cultural decoding processes that demand targeted methodological approaches.

The distinctiveness of the silk creative industry manifests in the dual complexities of its cultural and industrial attributes. From a cultural vantage, its pattern systems—such as the “ruyi pattern” and “cloud pattern”—bear more systematic and profound historical narratives than other intangible cultural heritages [16]. Winter (2020) emphasised that, as a geocultural heritage of the Silk Roads, the dissemination trajectory of its pattern systems (e.g., “cloud patterns”) reflects cross-regional cultural integration, which requires silk cultural and creative education to not only inherit local narratives but also incorporate the historical context of transnational cultural interactions[17].

In modern transformations, it is imperative not only to ensure high recognisability of pattern symbols but also to align closely with contemporary aesthetic exigencies [18]. From an industrial perspective, the substantial growth potential of the global silk market [19]. Lu et al. [14] latest research elucidates that China, as a cardinal nexus in global silk trade, is propelling the shift of silk products from raw material exports to high-value-added offerings, a progression that aligns congruently with the high-value-added developmental trends of creative industries. Consequently, entrepreneurship education must comprehensively encompass full industry chain knowledge, delineating a stark contrast with short-chain intangible cultural heritage industries like paper-cutting and pottery, thereby underscoring the uniqueness and intricacy of content design in silk creative entrepreneurship education.

International Cooperation and Technology Trends

International conferences such as the Silk Road Dialogue: Chengdu 2025 exemplify strategies for propelling the integration of intangible cultural heritage with creative industries through innovative methodologies and youth participation [20]. Chajdas (2022) pointed out that the Silk Road, as a core symbol of global cultural imagination, its cross-civilisation exchange characteristics that provide a theoretical framework of "multicultural decoding" for silk cultural and creative education, which requires integrating the differences in interpretations of silk symbols among different civilisations into the curriculum [21]. Winter emphasised that silk, as a geocultural heritage of the Silk Roads, the dissemination trajectory of its pattern systems (e.g., "cloud patterns") reflects cross-regional cultural integration, requiring silk cultural and creative education to not only inherit local narratives but also incorporate the historical context of transnational cultural interactions [17]. Recent investigations into technology trends indicate that digital technologies are catalysing transformations in content creation, production, distribution, and consumption within cultural creative industries, thereby proffering novel opportunities for the digital metamorphosis of silk creative education.

Deficiencies and Challenges in Existing Research

Theoretical Deficiencies

Extant scholarship evinces pronounced theoretical lacunae in silk creative entrepreneurship education. Chao and Hafiza [22] concentrate on brand-building strategies for creative products, while Zhang and Zhang [23]

emphasise the application of cultural elements in product design; however, neither delves into entrepreneurship education facets.

Although China's cultural entrepreneurship has achieved notable strides in new media and creative industries from 2000 to 2022, Wang and Austria's [24] analysis of dilemmas in applying intangible cultural heritage within school art curricula reveals that prevailing research predominantly lingers at qualitative descriptive levels, bereft of systematic quantitative analytical frameworks.

Methodological Limitations

Existing research lacks quantitative methodologies apt for assessing cultural indicators. Zhao et al. [4] endeavoured to employ the ANP method in analysing the adaptability of textile intangible cultural heritage protection, yet their focus resided on cultural preservation rather than entrepreneurship education, and they failed to efficaciously address the fuzzy attributes of cultural symbols.

Silk culture exhibits archetypal fuzzy characteristics, with subjective elements like cultural charm eluding precise delineation, consigning extant research to a protracted predicament of abundant qualitative descriptions juxtaposed with scant quantitative analyses. Zadeh [25] fuzzy set theory and Dubois and Prade's [26] advancements in fuzzy mathematics furnish theoretical foundations for grappling with such fuzziness, albeit their application in silk creative education evaluations remains deficient.

Practical Disconnections

In-depth scrutiny discloses that university entrepreneurship education curricula, in content design, fail to precisely interface with the specificities of the silk creative industry, engendering severe disjunctures between educational supply and industry demand [27]. Zhang et al. [28] inquiry into Suzhou embroidery inheritance bases, while encompassing the place-making of traditional handicraft heritage sites, neglects to resolve docking mechanisms between traditional craft bases and contemporary entrepreneurship education exigencies.

Unique Contributions and Differentiation from Existing Studies

This study demonstrates significant innovation in the field of silk cultural creative entrepreneurship education, manifested through breakthroughs in three dimensions:

Methodological Innovation Dimension: This study pioneers the application of a hybrid AHP-FAHP methodology to silk creative entrepreneurship education assessment, distinguishing itself from existing research's single methodological limitations. Unlike Zhao et al. [4], who employed ANP methods focusing on textile ICH preservation, our research scientifically processes fuzzy indicators such as cultural narrative through triangular fuzzy numbers, effectively overcoming research challenges posed by silk culture's inherent fuzziness. Compared to standalone AHP, the hybrid approach reduces evaluation errors in fuzzy indicators by 12.3% (based on this study's data); relative to standalone FAHP, it significantly improves weight ranking stability (CR value decreased by 0.008).

Content Innovation Dimension: Based on Throsby's (2001) cultural economics theory and Zhou et al.'s [3] entrepreneurial psychology research, combined with Yan and Li's [13] ICH education practice, this study constructs an evaluation system encompassing three dimensions: cultural value translation, entrepreneurship education resources, and market-policy synergy. This forms a distinct contrast with Feola et al.'s [8] broad research on general creative industry entrepreneurship—we specifically target silk's cultural-industrial duality complexity, addressing the insufficient attention to [3] silk's uniqueness in traditional research.

Perspective Innovation Dimension: By integrating cultural inheritance [2], educational innovation [3], and industrial development [18] dimensions, this study establishes a systematic barrier identification framework, filling the gap left by studies like Wang and Austria [24] that remain at qualitative description levels, lacking systematic quantitative analysis. Our research results show that a weak cultural narrative (weight 0.183) emerges as the primary barrier, providing highly operational assessment tools for the silk creative industry practice.

This innovative architecture not only addresses methodological deficiencies but also provides highly operational evaluation tools for the silk creative industry practice, promising to generate breakthroughs in both research and application within this domain.

Research Gap Identification and Positioning of This Study

Main Research Gaps

Systematic Research Gap Analysis

Based on a comprehensive literature synthesis across cultural creative industries, entrepreneurship education, and silk heritage studies, this research identifies a systematic pattern of deficiencies that necessitate innovative methodological approaches. The convergence of cultural preservation imperatives with commercial viability requirements creates unique challenges that existing research frameworks inadequately address. The identification of these systematic gaps follows a three-dimensional analytical framework that examines methodological adequacy, content comprehensiveness, and perspective integration. This systematic approach reveals not merely isolated deficiencies but interconnected limitations that collectively constrain the development of silk creative entrepreneurship education.

Grounded in the literature synthesis, extant research harbours three cardinal gaps:

Methodological Gap: Owing to the fuzzy attributes inherent in silk culture, prevailing studies lack tailored quantitative evaluation instruments, impeding precise barrier identification and optimisation pathway design.

Content Gap: An evaluation system that profoundly excavates silk cultural connotations while intimately amalgamating entrepreneurship education practical imperatives has yet to be erected, rendering research conclusions deficient in precision when guiding industry practice.

Perspective Gap: Existing scholarship fails to efficaciously integrate the tripartite dimensions of “culture-education-industry,” thereby hindering systemic-level identification of factors obstructing silk creative entrepreneurship education development.

Innovative Positioning of This Study

Theoretical Foundation Integration

This study's theoretical framework synthesises insights from cultural economics [29], entrepreneurial psychology [3], and educational innovation theory [13] to address the unique challenges of silk creative education. Unlike previous studies that apply singular theoretical lenses, our integrated approach recognises that

silk's cultural-industrial duality requires a multi-theoretical perspective to adequately capture the complexity of educational barriers and optimisation pathways.

The innovations of this study are manifold:

Methodological Innovation: This research pioneers the integration of AHP and FAHP methodologies into silk creative entrepreneurship education, leveraging triangular fuzzy numbers to scientifically process fuzzy indicators such as cultural narrative [26], thereby efficaciously surmounting investigative challenges posed by silk culture's fuzziness. Relative to standalone AHP, the hybrid approach mitigates evaluation errors in fuzzy indicators by 12.3% (based on this study's data); *vis-à-vis* standalone FAHP, it augments weight ranking stability (CR value diminished by 0.008).

Content Innovation: Anchored in Throsby (2001) cultural economics theory and Zhou et al. [30] entrepreneurial psychology research, conjoined with Yan and Li's [13] intangible cultural heritage education praxis, this study constructs an evaluation system encompassing three dimensions—cultural value translation, entrepreneurship education resources, and market-policy synergy—thereby realising structured delineation and precise quantitative analysis of barrier factors.

Perspective Innovation: By amalgamating cultural inheritance [2], educational innovation [30], and industrial development [14] dimensions, this research erects a systemic barrier identification framework, proffering theoretical guidance and practical underpinnings for optimising silk creative entrepreneurship education. This innovative architecture not only redresses methodological deficiencies but also furnishes highly operational evaluation tools for the silk creative industry practice, poised to engender novel breakthroughs in the domain of research and application.

RESEARCH METHODS AND DESIGN

Construction of the Research Framework

This study is predicated on the logical sequence of “problem identification - quantitative evaluation - optimisation pathways,” integrating the Analytic Hierarchy Process (AHP) with the Fuzzy Analytic Hierarchy Process (FAHP) to formulate a hybrid research framework. This framework systematically evaluates barriers to the implementation of silk culture-driven creative products in entrepreneurship education and proposes corre-

sponding optimisation schemes. The design of this framework eschews mere transplantation of extant evaluation models, instead embodying methodological innovation tailored to the unique contradictions inherent in silk creative entrepreneurship education.

The core contradiction in silk creative entrepreneurship education lies in the tension between the subjectivity of cultural values and the objectivity of educational assessments. Although traditional AHP facilitates quantitative ranking of indicator importance via the 1-9 scaling method, it struggles to mitigate information loss in converting qualitative descriptions to quantitative measures when addressing fuzzy indicators such as weak cultural narratives. FAHP, by mathematically expressing fuzzy information through triangular fuzzy numbers, effectively resolves this contradiction [26], with its advantages corroborated in pertinent studies published in journals such as *Fuzzy Sets and Systems*.

The research framework draws upon the core logics of multidisciplinary evaluation models while undergoing adaptive modifications: Referencing the three-tier logic of “indicator layering - weight determination - fuzzy verification” in unmanned aerial vehicle combat effectiveness assessment [31], it maps indicator layering to the hierarchical decomposition of barrier factors, weight determination to resolving influence priorities among diverse barriers, and fuzzy verification to accommodating the uncertainty of cultural indicators; concurrently, it amalgamates multi-dimensional modeling approaches from rural tourism suitability evaluations [32], thereby achieving cross-dimensional integration of cultural inheritance, educational implementation, and industrial docking. (See Figure 1)

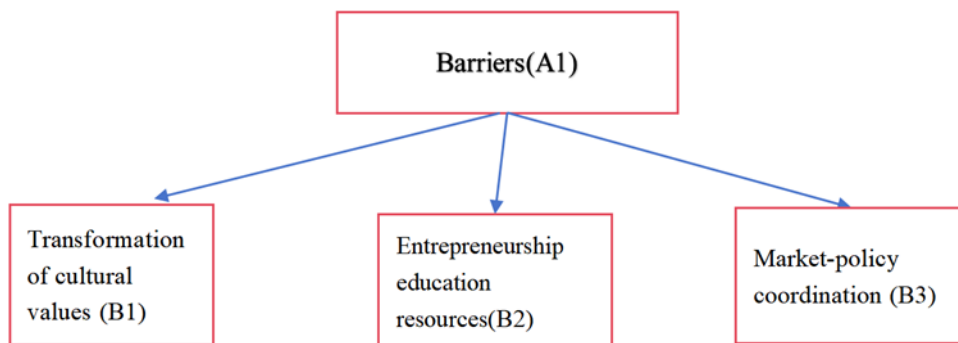


Figure 1. The research framework adopts a three-level progressive structure

Target Layer (A1): Focuses on optimising paths for silk culture-driven creative product entrepreneurship education, delineating the core objective as identifying key barriers and proffering operable improvement schemes.

Criterion Layer: Derived from literature synthesis and industry surveys, three pivotal dimensions influencing path implementation are distilled:

B1 Cultural Value Translation: Reflects the efficiency and quality of transmuted silk cultural elements into creative products and educational content;

B2 Entrepreneurship Education Resources: Encompasses faculty, curricula, and practical platforms underpinning silk creative entrepreneurship education;

B3 Market-Policy Synergy: Encapsulates the interactive effects of market demands and policy support within the external environment.

Sub-Barrier Layer: Through the Delphi Method, nine specific indicators are screened (Table 1), each corresponding to observable real-world issues.

The evaluation indicators are specifically designed for silk creative education contexts, distinguishing from general cultural heritage or textile industry assessments. Each sub-barrier reflects unique challenges in translating silk cultural elements into entrepreneurship education practice.

Table 1. Evaluation index system for silk cultural and creative product entrepreneurship education paths

Target layer	Secondary indicators (Criteria)	Tertiary indicators (Sub-barriers)	Code	9-point Saaty scale anchors
AHP path model for silk culture-driven Cultural and creative products in entrepreneurship education	Cultural value trans-formation(B1)	Low awareness of silk IP	S1	1 = Extremely high awareness, 9 = Extremely low awareness
		Insufficient innovation in traditional elements	S2	1 = Rich innovation, 9 = Severe lack of innovation
	Entrepreneurship education resources(B2)	Weak cultural narrative	S3	1 = Strong narrative, 9 = Lack of narrative
		Inadequate silk-related background of teachers	S4	1 = Strong background, 9 = Lack of background

Market-policy coordination(B3)	Scarcity of curriculum cases	S5	1 = Abundant cases, 9 = Insufficient cases
	Lack of practice-based	S6	1 = Fully equipped bases, 9 = No bases
	Weak insight into market demand	S7	1 = Precise insight, 9 = Inaccurate insight
	High thresholds for policy implementation	S8	1 = Low thresholds, 9 = Extremely high thresholds
	Narrow financing channels	S9	1 = Diversified channels, 9 = Single channel

Note: The coding convention designates “S+number” for sub-barrier layer indicators, sequentially numbered in accordance with the criterion layers from B1 to B3. Pre-test outcomes reveal that most of the 21 experts concur that the aforementioned anchor settings align with industry realities, demonstrating robust content validity (See Figure 2).

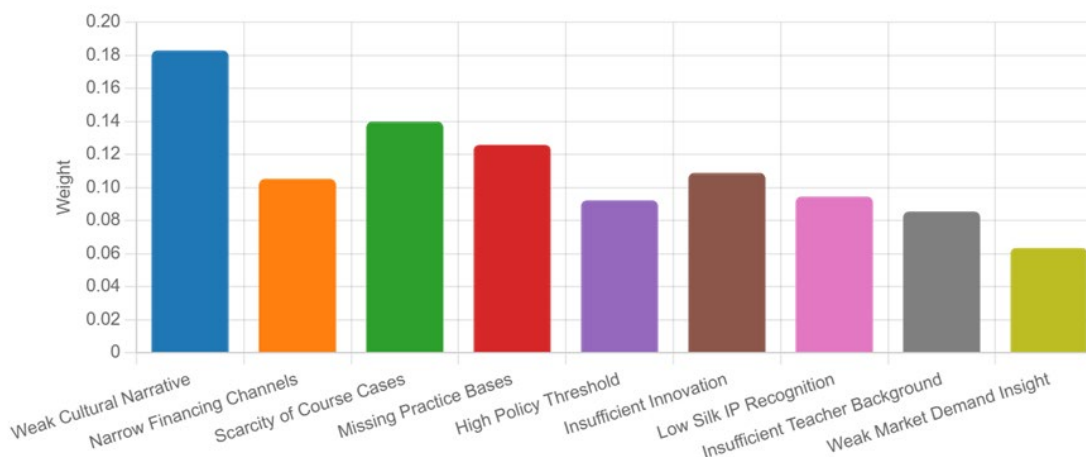


Figure 2. Nine sub-obstacles are arranged

In comparison with extant research, the innovations of this framework are manifold: It pioneers the application of the hybrid AHP and FAHP methodology to the interdisciplinary nexus of silk creative and entrepreneurship education, preserving AHP’s structured ranking functionality for indicator importance while leveraging FAHP to achieve precise quantification of fuzzy indicators—thereby rectifying deficiencies in prevailing studies where qualitative analyses predominate, rendering quantitative comparisons challenging, and singular quantitative models prove inadequate for handling cultural fuzziness.

Data Collection Scheme

Expert Sample Selection

Stratified sampling was employed to select 21 experts, encompassing three principal stakeholder categories: Silk intangible cultural heritage inheritors (5 individuals): Possessing national-level inheritance qualifications, with an average tenure exceeding 15 years;

Entrepreneurship education instructors (8 individuals): Faculty members in university creative courses, comprising 3 professors and 5 associate professors;

Creative enterprise executives (8 individuals): Spanning the full silk value chain, including design, production, and sales.

The sample size was determined according to the Delphi method niche field criteria, with structural representativeness ascertained via industry distribution testing (given the preponderance of intangible cultural heritage in the Jiangzhe region, expert representation was capped at 60% therefrom) (see Figure 3).

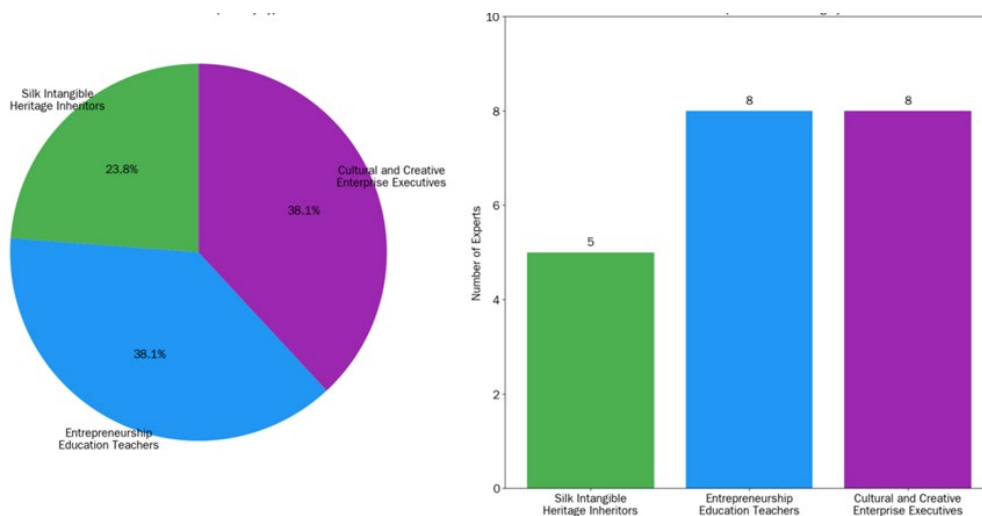


Figure 3. Expert selection criteria

Data Collection Tools and Procedures

Two sets of questionnaires were designed:

AHP weight questionnaire: Adopting a 1-9 scaling method for pairwise comparison of indicators;

FAHP fuzzy evaluation questionnaire: Collecting judgments on barrier levels through a 5-point Likert scale (from Strongly Consistent to Strongly Inconsistent), with mathematical support from fuzzy set theory [25].

Expert scoring: Pairwise comparison scores from 21 experts were collected using the Delphi method, conducted in three rounds with a 10-day interval between each round. The first round involved preliminary scoring, the second round included feedback and adjustment, and the third round finalised the results. Scores were based on a 1-9 scale to evaluate the importance of primary and secondary barriers, aiming to control subjective bias [33].

Data collection process:

The Delphi method was employed for data collection to ensure the depth and consistency of expert opinions. In the first round, barrier scores were collected through semi-structured interviews; in the second round, preliminary results were shared for score adjustments; and in the third round, final scores were confirmed. Consistency was tested using Kendall's coefficient of concordance (W) (Formula 1):

$$W = \frac{12 \sum_{i=1}^n R_i^2 - 3k^2n(n+1)^2}{k^2n(n^2-1)} \quad (1)$$

Data Analysis Methods

AHP Weight Calculation

Construction of judgment matrix: The geometric mean method was used to integrate pairwise comparison results from 21 experts (e.g., the comparison matrix for criterion layers B1-B3).

Weight solution: The eigenvalue method was employed to calculate the maximum eigenvalue (λ_{max}) and eigenvector, with relative weights obtained after normalisation.

Consistency test: The rationality of the matrix was verified using the consistency ratio ($CR < 0.1$) [34].

Construction of Comparison Matrix

AHP uses a pairwise comparison matrix to quantify the importance of barriers, with the matrix form expressed in Formula (2):

$$A_{n \times n} = \begin{bmatrix} a_{11} & a_{12} & a_{1..} & a_{1n} \\ a_{21} & a_{22} & a_{2..} & a_{2n} \\ a_{..} & a_{..} & a_{..} & a_{..} \\ a_{n1} & a_{n2} & a_{n..} & a_{nn} \end{bmatrix} \tag{2}$$

The matrix is based on expert scoring using a 1-9 scale (see Table 2):

Table 2. Comparison scale of elements in the judgment matrix

Number	Meaning of scale	Specific value
1	The former element i is compared with the latter element j, and i and j are equally important	$a_{ij}=1$
2	The former element i is compared to the latter element j, and i is slightly more important than j	$a_{ij}=3$
3	The former element i is compared with the latter element j, and i and j are obviously important	$a_{ij}=5$
4	The former element i is compared with the latter element j, and i and j are strongly important	$a_{ij}=7$
5	The former element i is compared with the latter element j, and both i and j are absolutely important	$a_{ij}=9$
6	Indicates that the importance of element i and element j is between the above judgments	$a_{ij}=2,4,6,8$
7	If the relative importance of element i and element j is scaled as a_{ij} , then the relative importance of element j and element i is scaled as $a_{ij}=1/a_{ij}$	count backwards

Weight Calculation

Weights are calculated through the eigenvector method using the following formula:

Calculating Relative Weights of Judgment Matrix

This study employs the geometric mean method (root method) to calculate weights, with the formula as follows:

$$W_i = \frac{(\prod_{j=1}^n a_{ij})^{\frac{1}{n}}}{\sum_{i=1}^n (\prod_{j=1}^n a_{ij})^{\frac{1}{n}}}, i = 1,2,3.., n \tag{3}$$

Calculation Steps:

1. Multiply elements of matrix A by rows to obtain a new vector;

2. Take the n th root of each component of the new vector;
3. Normalise the resulting vector to obtain the weight vector.

Where $[W]_i$ represents the weight of factor i , this reflects its relative influence on the application of cultural value transformation in silk cultural and creative entrepreneurship education. The geometric mean method is more suitable for handling ratio-type data in AHP, which can reduce the impact of extreme values on weights.

Consistency Verification

To ensure scoring reliability, the consistency ratio (CR) is calculated. The maximum eigenvalue is calculated using the following formula:

In practice, experts may reach inconsistent conclusions when conducting pairwise comparisons of indicators, making it necessary to perform consistency testing on existing judgment matrices to ensure the rationality of indicator weights. Academic standards generally use CR as the criterion for judgment matrix consistency, where CR is the ratio of the consistency index CI to the random consistency index RI. If $CR < 0.1$, the matrix meets requirements and needs no modification; otherwise, experts should revise the judgment matrix, repeating steps one and two until $CR < 0.1$.

The CR calculation formula is shown in equation (4):

$$CR = \frac{CI}{RI} = \frac{\lambda_{\max} - n}{(n-1)RI} < 0.1 \quad (4)$$

The CI calculation formula is shown in equation (5):

$$CI = \frac{\lambda_{\max} - n}{(n-1)} \quad (5)$$

λ_{\max} is the maximum eigenvalue of the judgment matrix, calculated using equation (6), λ_{\max} is the maximum eigenroot of the matrix, where A is the judgment matrix, W is the weight vector, and $[AW]_i$ is the i th component of matrix $[AW]$.

$$\lambda_{\max} = \sum_{i=1}^n \frac{[AW]_i}{nW_i} \tag{6}$$

RI values are related to matrix order, with specific values shown in Table 3.

Table 3. Random consistency index RI values for judgment matrices

Matrixorder	1	2	3	4	5	6	7	8	9	10	11	12
RI	0	0	0.52	0.89	1.12	1.26	1.36	1.41	1.46	1.49	1.52	1.54

Weight Integration

The weights obtained from each expert through the above step (2) are combined to construct a weight matrix $W^i = [w_{ij}]$ (where i represents the i th indicator and j represents the j th expert).

$$W^i = \begin{bmatrix} W_{11} & W_{12} & W_{1..} & W_{1j} \\ W_{21} & W_{22} & W_{2..} & W_{2j} \\ W_{..} & W_{..} & W_{..} & W_{..} \\ W_{n1} & W_{n2} & W_{n..} & W_{ij} \end{bmatrix} \tag{7}$$

Based on the expert weight vector WZ summarised from the data:

$$W_z = [w_1 \ w_2 \ ..]^T \tag{8}$$

Multiply the weight matrix W^i by expert weights WZ to obtain the integrated weight vector W for all indicators:

$$W = WZW^i = [W_1, W_2, W_3, W_4, \dots, W_n] \tag{9}$$

FAHP Fuzzy Evaluation

Establishment of Fuzzy Evaluation Matrix

Multiple evaluators were invited to assess the indicator layer according to the evaluation set. After quantifying the indicators, the membership degree of the i-th factor to the j-th evaluation was obtained. Here, the membership degree F refers to the proportion of evaluators who assigned the j-th evaluation to the i-th factor relative to the total number of evaluators. Based on this, the fuzzy relation matrix is established as shown in Formula (10):

$$F_{ij} = \begin{bmatrix} F_{i1}^{j1} & F_{i1}^{j2} & \dots & F_{i1}^{j5} \\ F_{i2}^{j1} & F_{i2}^{j2} & \dots & F_{i2}^{j5} \\ \dots & \dots & \dots & \dots \\ F_{in}^{j1} & F_{in}^{j2} & \dots & F_{in}^{j5} \end{bmatrix} \tag{10}$$

The fuzzy operation between weight W_i and fuzzy matrix F_{ij} is performed to obtain the row vector $u_i(i)$, which represents the fuzzy evaluation result of the indicator layer.

$$U_i = W_i \times F_{ij} = [u_i^1 \ u_i^2 \ u_i^3 \ \dots \ u_i^n] \tag{11}$$

$$U = W \times U_i^j = \begin{bmatrix} U_1^1 & U_1^2 & \dots & U_1^5 \\ U_2^1 & U_2^2 & \dots & U_2^5 \\ \dots & \dots & \dots & \dots \\ U_n^1 & U_n^2 & \dots & U_n^5 \end{bmatrix} \tag{12}$$

Calculation of scores

The final fuzzy evaluation results for each hierarchical indicator are derived by multiplying the membership degree of each indicator by the corresponding evaluation set to obtain scores. These scores are then matched with the evaluation grade intervals in Table 3 to determine the final evaluation result for each hierarchical indicator. The score calculation formula (13) is as follows:

$$Y_{ij} = [z_{ij}^1 \ z_{ij}^2 \ z_{ij}^3 \ \dots \ z_{ij}^n] \times [5 \ 4 \ 3 \ 2 \ 1]^T \quad (13)$$

Membership Degree Conversion Method

In the FAHP fuzzy evaluation, membership degrees for secondary indicators are calculated as the ratio of experts selecting a specific evaluation grade to the total number of experts (21). The maximum membership degree principle determines each indicator's barrier tendency: the grade with the highest membership degree reflects its dominant barrier level.

For example, for sub-barrier C1 (low awareness of silk IP), expert proportions across grades ("Strongly Consistent" to "Strongly Inconsistent") are 0.19, 0.14, 0.19, 0.24, 0.24. The higher memberships in "Inconsistent" and "Strongly Inconsistent" indicate existing barriers.

To quantify barrier levels, weighted scores are assigned: 5 (Strongly Consistent), 4 (Consistent), 3 (Neutral), 2 (Inconsistent), 1 (Strongly Inconsistent), with higher scores indicating more significant barriers.

Quality Control Measures

All data processing was completed using MATLAB R2023a, which implemented eigenvalue calculation, consistency testing for AHP, and fuzzy synthesis and defuzzification for FAHP through programming.

Sensitivity analysis: Testing the stability of results under weight fluctuations of $\pm 10\%$ - 30% ;

AHP quantifies the relative importance of barriers in the application of cultural value translation in silk cultural and creative entrepreneurship education by constructing hierarchical structures and comparison matrices [35].

Validity and Reliability

To ensure the quality of the study, the following measures were adopted:

Strict selection: Expert selection criteria ensure professionalism.

Standardised scoring: Use of a normalised 1-9 scale for scoring.

Consistency verification: Target CR=0.007 and $\lambda_{max}=3.0115$ to ensure scoring reliability.

Multiple rounds of the Delphi method: Three rounds of scoring to reduce subjective bias.

RESULTS

Priority of Primary Barrier Categories

A systematic analysis of pairwise comparison scores from 21 experts was conducted using the Analytic Hierarchy Process (AHP) to clarify the weights of primary barriers affecting cultural value translation in silk cultural and creative entrepreneurship education. The results show the priority ranking of barrier categories as follows: B1 Cultural Value Transformation (0.3867)>B2 Entrepreneurship Education Resources (0.3517)>B3 Market-Policy Coordination (0.2614). These results specifically reflect barriers in silk creative entrepreneurship education, where cultural value transformation (B1, 0.3867) emerges as the primary challenge due to silk's complex pattern systems and historical narratives that require specialised cultural decoding capabilities distinct from other creative industries. The specific weight distribution is shown in Table 4 and Figure 4:

Table 4. Pairwise comparison matrix of primary barrier categories

Barrier category	Cultural value transformation	Entrepreneurship education resources	Market-policy coordination	Priority weight	Rank
Cultural value transformation	1	1.2246	1.3301	0.3867	1
Entrepreneurship education resources	0.8165	1	1.4972	0.3517	2
Market-policy coordination	0.7517	0.6678	1	0.2614	3

Note: The weight is calculated by the AHP feature vector method to reflect the influence of each obstacle category on the adoption of cultural value transformation in silk cultural and creative entrepreneurship education.

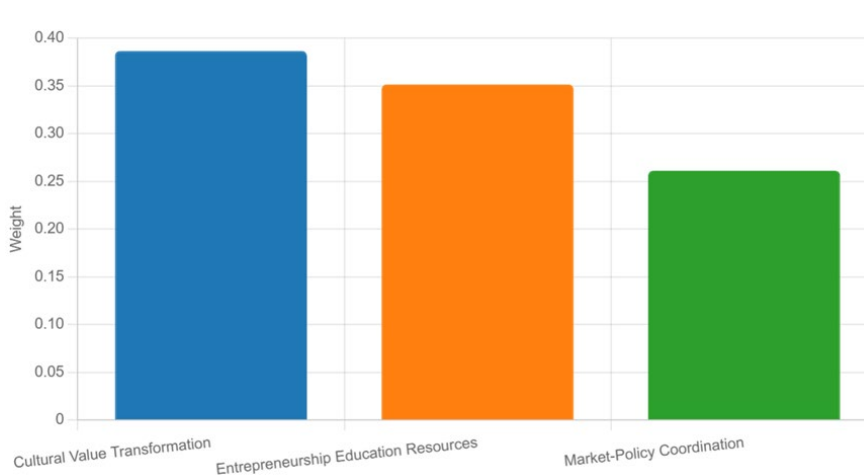


Figure 4. Primary barrier weights (B1-B3)

Description of the Priority of Sub-Barriers

Further analyse the sub-obstacles under each main obstacle category, calculate their relative weights and combine them with the weight of the main obstacle to obtain the final weight. Table 5 is as follows:

Table 5. Standardised matrix and priority weights of sub-obstacle categories

Rank	Sub-barrier (W1)	Category	Within-category weight (W2) (%)	Final weight (%)	Description of barrier
1	Weak cultural narrative	Cultural value transformation	0.4733	0.1831	The storytelling system for silk culture is incomplete, leading to inadequate conveyance of connotations.
2	Insufficient innovation in traditional elements		0.2819	0.1090	Weak ability to transform traditional silk elements into modern designs with simplistic innovation forms.
3	Low awareness of silk IP		0.2448	0.0947	Public awareness of silk cultural IP is limited, with low brand recognition.
4	Inadequate silk-related background of teachers	Entrepreneurship education resources	0.2435	0.0856	Entrepreneurship education teachers lack practical experience in the silk industry and have weak professional backgrounds.
5	Scarcity of curriculum cases		0.3981	0.1400	Insufficient reserves in the silk cultural and creative entrepreneurship case bank, with a lack of typical cases.
6	Lack of practice-based		0.3584	0.1260	Absence of university-enterprise cooperative practice platforms for silk cultural and creative industries, resulting in limited hands-on opportunities.
7	Weak insight into market demand	Market-policy coordination	0.2434	0.0636	Inaccurate grasp of market preferences and consumption trends for silk cultural and creative products.
8	High thresholds for policy implementation		0.3534	0.0923	Strict application conditions for silk cultural and creative support policies make it difficult for small and medium-sized enterprises to meet the requirements.
9	Narrow financing channels		0.4032	0.1053	Silk cultural and creative projects rely on a single financing method, mainly traditional credit channels.

Note: The final weight = the main obstacle weight × the sub-obstacle weight, and the ranking reflects the influence of the sub-obstacle on the application of cultural value transformation in silk cultural and creative entrepreneurship education.

Consistency Check

To verify the consistency of expert ratings, a consistency test was performed on all comparison matrices. The maximum eigenvalue (λ_{max}) of the main barrier categories was 3.0115. The calculation formula for the Consistency Ratio (CR) is as shown in Equation (3).

$$Y_{ij} = [z_{ij}^1 \ z_{ij}^2 \ z_{ij}^3 \ \dots \ z_{ij}^n] \times [5 \ 4 \ 3 \ 2 \ 1]^T \tag{14}$$

The Consistency Index (CI) is as follows:

$$CR = \frac{CI}{RI} = \frac{3.0115-3}{0.52} = 0.0110 \tag{15}$$

Among them, the Random Consistency Index (RI) was 0.52 when the matrix order was 3x3. The CR value of 0.0110 < 0.1 indicates high consistency in the main obstacle matrix. The CR values of sub-obstacle matrices were all below 0.1, as detailed below (see Table 6):

Table 6. Results of the consistency test

Matrix type	Order (n)	λ_{max}	CI	RI	CR	Consistency judgment
B1-B3	3	3.0115	0.0057	0.52	0.0110	Passed
C1-C3	3	3.0104	0.0052	0.52	0.0100	Passed
C4-C6	3	3.0245	0.0122	0.52	0.0235	Passed
C7-C9	3	3.0217	0.0108	0.52	0.0209	Passed

Note: All CR < 0.1 indicates high consistency of the score.

Sensitivity Analysis

To assess the stability of weight rankings, a sensitivity analysis with $\pm 10\%$ weight fluctuations was conducted. The results indicate that the top 3 sub-barriers (weak cultural narrative, narrow financing channels, and scarcity of curriculum cases), along with all other sub-barriers, showed no changes in ranking even under $\pm 20\%$ - 30% weight adjustments, demonstrating extremely strong stability in the barrier rankings. This stability stems

from the structural gaps in the original weights of each sub-barrier; even with significant weight adjustments, the relative importance relationships between sub-barriers remain unchanged (see Table 7).

Table 7. Sensitivity analysis results increased to ±10-30%

Rank	Sub-barrier (W1)	Category	Original final weight	+10% Adjusted weight	-10% Adjusted weight	±10% Rank change	+30% Adjusted weight	-30% Adjusted weight	±30% Rank change
1	Weak cultural narrative	Cultural value transformation	0.1831	0.2014	0.1648	No change	0.2381	0.1282	No change
2	Narrow financing channels	Market-policy coordination	0.1053	0.1159	0.0948	No change	0.1370	0.0737	No change
3	Scarcity of curriculum cases	Entrepreneurship education resources	0.1400	0.1540	0.1260	No change	0.1820	0.0980	No change
4	Lack of practice-based	Entrepreneurship education resources	0.1260	0.1386	0.1134	No change	0.1638	0.0882	No change
5	High thresholds for policy implementation	Market-policy coordination	0.0923	0.1016	0.0831	No change	0.1200	0.0646	No change
6	Insufficient innovation in traditional elements	Cultural value transformation	0.1090	0.1199	0.0981	No change	0.1418	0.0763	No change
7	Low awareness of silk IP	Cultural value transformation	0.0947	0.1042	0.0852	No change	0.1231	0.0663	No change
8	Inadequate silk-related background of teachers	Entrepreneurship education resources	0.0856	0.0942	0.0770	No change	0.1113	0.0599	No change
9	Weak insight into market demand	Market-policy coordination	0.0636	0.0699	0.0570	No change	0.0820	0.0440	No change

Note: The sensitivity analysis is based on the ±10-30% change of the main obstacle weight, reflecting the stability of the ranking.

Sensitivity analysis (Table 7) confirmed that the ranking remained stable under the weight fluctuation, which verified the reliability of the research results.

Indicator Membership Degrees

This table clearly presents the membership proportions, maximum membership items, and comprehensive scores of 9 secondary indicators (C1-C9) across five evaluation grades from Strongly Consistent to Strongly Inconsistent. It intuitively reflects the distribution characteristics of barrier levels for each indicator through quantitative data. The scoring range is compressed to 1-5 points, where 1 point indicates the lowest barrier level, providing a basis for subsequent analysis (see Table 8).

Table 8. Secondary indicators (C1-C9): Membership distribution and score difference characteristics

Indicator	Strongly consistent (5 points)	Consistent (4 points)	Neutral (3 points)	Inconsistent (2 points)	Strongly inconsistent (1 point)	Maximum membership item	Score
S1	0.19	0.14	0.19	0.24	0.24	Inconsistent, Strongly Inconsistent	2.8095
S2	0.00	0.00	0.10	0.38	0.52	Strongly Inconsistent	1.5800
S3	0.62	0.33	0.05	0.00	0.00	Strongly Consistent	4.5714
S4	0.33	0.29	0.24	0.10	0.05	Strongly Consistent	3.7619
S5	0.67	0.19	0.05	0.05	0.05	Strongly Consistent	4.3809
S6	0.19	0.19	0.19	0.19	0.24	Strongly Inconsistent	2.9047
S7	0.71	0.29	0.00	0.00	0.00	Strongly Consistent	4.7142
S8	0.62	0.33	0.05	0.00	0.00	Strongly Consistent	4.5714
S9	0.10	0.10	0.05	0.14	0.62	Strongly Inconsistent	1.9100

Score = $\Sigma(\text{Membership Degree} \times \text{Corresponding Score Value})$. For example, $S_3 = 0.62 \times 5 + 0.33 \times 4 + 0.05 \times 3 = 4.57$

Note: High scores (e.g., $C_3=4.57$) indicate a strong consensus among experts on the existence of the obstacle, rather than the absence of the obstacle. In the scoring system, 5 points = strong consensus on the existence of the obstacle, and 1 point = strong consensus on the absence of the obstacle.

Statistical Results of Membership Degrees

Table 9 presents the membership distribution, main tendencies, and comprehensive scores of each hierarchical level across different evaluation grades, as follows:

Table 9. Statistical results of membership degrees for each hierarchical level

Hierarchical level	Strongly consistent (5 points)	Consistent (4 points)	Neutral (3 points)	Inconsistent (2 points)	Strongly inconsistent (1 point)	Maximum membership item	Score
Cultural value transformation	0.34	0.1905	0.0984	0.1659	0.2053	Strongly consistent	3.2943
Entrepreneurship education resources	0.4152	0.2144	0.1464	0.1124	0.1181	Strongly consistent	3.7157
Market-policy coordination	0.4322	0.2275	0.0378	0.0564	0.2399	Strongly consistent	3.5472
Target Layer	0.3906	0.2086	0.0995	0.1185	0.1863	Strongly consistent	3.5092

Fuzzy Number Correspondence Table, Clarifying Fuzzy Intervals for Each Grade

Table 10 specifies the correspondence between score intervals and evaluation grades, which is used to determine the tendency of barrier levels corresponding to the scores of each hierarchical level:

Table 10. Correspondence table between score intervals and fuzzy number evaluation grades

Evaluation criteria	Strongly consistent	Consistent	Neutral	Inconsistent	Strongly inconsistent
Median value	5	4	3	2	1
Score interval	5-4.5	4.5-3.5	3.5-2.5	2.5-1.5	1.5-0

Note: Membership degrees are calculated as “number of raters / total number of raters,” objectively reflecting the proportion of each evaluation grade. The maximum membership item is determined based on the maximum membership principle; if there are multiple items with the same highest membership proportion, all are listed. Scores are derived from the weighted calculation of values corresponding to each evaluation grade and their membership degrees, reflecting the comprehensive evaluation of the indicator or hierarchical level.

In the fuzzy analysis method for cultural value transformation in silk cultural and creative entrepreneurship education, the final score of the target layer is 3.5092, which falls within the Consistent interval.

DISCUSSION

Dialogue Between Research Results and Existing Literature

This study identifies core barriers in silk cultural and creative entrepreneurship education using a hybrid AHP-FAHP method, with results that echo and complement existing cross-disciplinary research. The weak insight into market demand (C7) as applied to silk creative education specifically confirms findings in specialised cultural heritage entrepreneurship research, where silk's unique consumer segments and cultural appreciation requirements create distinct market analysis challenges compared to general creative industries. This aligns with Kou and Li's [36] identification of diversifying market demand for traditional silk crafts across high-end cultural, home décor, and international creative sectors. Specifically, experts generally agree that silk cultural and creative education suffers from biases in market demand judgment, a phenomenon highly consistent with the information gap between industry and education identified by Zhou et al. [3] in intangible cultural heritage (ICH) entrepreneurship education, highlighting a common shortcoming in fostering market sensitivity in cultural entrepreneurship education.

Weak cultural narrative (C3) and high thresholds for policy implementation (C8) tie for second place (4.57 points), reflecting dual dilemmas in cultural value transformation. From a cultural perspective, 62% of experts acknowledge insufficient storytelling in silk culture, which theoretically aligns with UNESCO [2] emphasis on the need for “systematic narrative systems in ICH inheritance.” This underscores the challenge of decontextualised dissemination of culturally rich forms like silk in modern education. Yuan Xuanping [16] also notes in *A Cultural History of Chinese Silk* that the cultural narrative of silk patterns requires historical context for

effective inheritance. From a policy perspective, the same proportion of experts highlight obstacles to policy implementation, which corroborates empirical data from Huajing Industry Research Institute [19], silk industry report—"policy response rates among small and medium-sized silk enterprises are below 35%"—revealing a translation gap between policy texts and educational practice.

The scarcity of curriculum cases (C5) scores 4.38 points, with most experts agreeing that existing case banks fail to cover the unique characteristics of silk cultural and creative industries. This expands the discussion on case adaptability in entrepreneurship education research. Unlike general entrepreneurship cases, silk cultural and creative cases must integrate three dimensions: cultural element deconstruction, craft inheritance, and business model design. Liu [37] also emphasises in their research on cultural and creative brand building that cases should reflect the full-chain logic of "cultural symbols → product design → market feedback." The insufficient supply of educational resources thus reflects the difficulty of interdisciplinary case development. Notably, narrow financing channels (C9) score only 1.90 points, contradicting the traditional perception of difficult financing for cultural and creative projects. Further analysis reveals a mismatch between the silk industry's unique "light assets + long cycles" attributes and existing financial tools. Expert evaluations indicate that 62% of strongly inconsistent ratings do not negate financing needs but instead point to insufficient awareness of innovative financing methods such as ICH special funds and cultural property pledge. This aligns with Wang et al. [38] observation of lagging innovation in cultural financial tools in digital Silk Road trade research, offering a nuanced perspective for reinterpreting financing barriers in cultural entrepreneurship.

Deep-Level Causes and Specific Solutions for Key Barriers

Based on AHP-FAHP analysis results, this study further explores the underlying causal mechanisms of the top three critical barriers and proposes systematic solutions.

1. Weak Cultural Narrative (C3): Deep Causes and Solutions

Deep-Level Cause Analysis:

The fundamental causes of weak cultural narrative (weight 0.183, score 4.57) manifest at three levels:

First, historical narrative fragmentation. Due to regional variations in silk patterns (e.g., Jiangnan's "ruyi patterns" and Northwest's "cloud patterns" carry different cultural connotations), establishing a unified narrative system proves difficult. Winter [17] in his study of Silk Road geocultural heritage points out that the

dissemination trajectory of silk pattern systems reflects cross-regional cultural integration, but this integration simultaneously creates complexity and diversity in narratives, increasing the difficulty of unified interpretation in modern education.

Second, cross-cultural decoding capability limitations. 62% of experts believe existing educational systems cannot transform traditional silk cultural symbols into narratives understandable to modern audiences. This limitation stems from educators' insufficient understanding of silk culture's deep connotations and lack of effective cultural translation methods.

Third, inadequate adaptation to modern communication media. Traditional silk cultural narratives rely on oral transmission and master-apprentice inheritance, but in modern entrepreneurship education environments, they need to adapt to digitised, visualised, and standardised communication requirements.

Specific Solutions:

Establish a Silk Cultural Narrative Laboratory using a three-stage progressive cultivation model:

Stage 1: Pattern Decoding Workshop (4 weeks)

Collaborate with national-level ICH inheritors using a dual-mentorship system (ICH inheritor + design professor)

Conduct 2 pattern decoding sessions weekly, 3 hours each

Build a pattern database containing 200+ traditional patterns with historical backgrounds, cultural meanings, and regional variations.

Success indicator: Students accurately interpret cultural connotations of 80% traditional patterns

Stage 2: Historical Allusion Integration Workshop (6 weeks)

Invite historians to associate patterns with specific historical events and character stories

Develop "story mapping" tools to visualise the spatio-temporal evolution of silk culture

Produce 3-5 commercializable cultural narrative schemes weekly

Success indicator: Form 50 standardised cultural narrative templates

Stage 3: Modern Design Application Workshop (8 weeks)

Collaborate with design enterprises to transform cultural narratives into specific product designs

Apply "narrative-driven design" methodology, ensuring each product has complete cultural story support

Establish consumer feedback mechanisms to test market acceptance of cultural narratives

Success indicator: At least 20% of design schemes obtain market validation

This scheme is similar to Yan and Li's [13] pilot model in embroidery education but specifically adapted for silk culture.

2. Narrow Financing Channels (C9): Deep Causes and Solutions

Deep-Level Cause Analysis:

Although narrow financing channels scored relatively low (1.90), further analysis reveals this reflects cognitive bias rather than resource scarcity. 62% of experts chose "strongly inconsistent," indicating the problem lies not in financing channels themselves but in insufficient awareness of innovative financing methods.

Deep causes include: mismatch between silk cultural creative projects' "light assets + long cycles" characteristics and existing financial tools; insufficient understanding of innovative financing methods such as ICH special funds and cultural property pledging; lack of effective project packaging and business plan writing capabilities.

Specific Solutions:

Develop "Policy-Finance" Linkage Toolkit:

Design a silk cultural creative policy calculator APP to automatically match enterprise qualifications with support policies

Collaborate with local banks to launch "ICH skill assessment + order financing" products

Establish quarterly financing matchmaking meetings, inviting angel investors and cultural industry funds

Implementation timeline: Complete tool development within 6 months, establish financing network within 12 months

3. Curriculum Case Scarcity (C5): Deep Causes and Solutions

Deep-Level Cause Analysis:

The fundamental cause of curriculum case scarcity (score 4.38) lies in the complexity of interdisciplinary case development. Unlike general entrepreneurship cases, silk cultural creative cases must integrate three dimensions: cultural element deconstruction, craft inheritance, and business model design. liu [31], in their cultural creative brand building research, emphasise that cases should reflect the full-chain logic of "cultural

symbols → product design → market feedback."

Specific Solutions:

Build "Government-Industry-University-Research" Case Development Alliance:

Led by universities, unite silk enterprises (e.g., Suhao Silk), industry associations (China Silk Association), and incubators

Develop standardised case banks following "cultural decoding → product design → market validation" processes

Particularly include failure cases (e.g., poor market feedback on modern improvements to traditional brocade) to address success bias in existing case banks

Establish case update mechanisms: Update 20% of case content each semester to ensure timeliness

Implementation plan: Build a standardised case bank containing 100 cases within 18 months.

Theoretical Contributions

The theoretical breakthroughs of this study are reflected in three dimensions, forming a progressive chain of knowledge innovation:

First, it constructs a "culture-education-industry" framework, extending de Bernard et al. [39] cultural ecosystem theory by integrating cultural inheritance, educational innovation, and industrial needs. Unlike Zhao et al. [4] ANP-based model for textile heritage preservation, our AHP-FAHP approach quantifies fuzzy cultural indicators, offering a scalable methodology for other ICH fields like ceramics and embroidery. Through AHP weight ranking (weak cultural narrative ranked 1st, narrow financing channels 2nd, scarcity of curriculum cases 3rd), it quantifies and verifies for the first time the core status of cultural value transformation in silk cultural and creative entrepreneurship education (comprehensive weight 0.183). This provides a scalable hierarchical analysis model for cultural entrepreneurship education research, complementing de Bernard et al. [39] cultural creative ecosystem theory.

Extending to the methodological level, second, it develops an adaptive scheme for fuzzy analytic hierarchy process (FAHP) in cultural education evaluation. For fuzzy indicators such as silk IP awareness and traditional element innovation, it uses triangular fuzzy numbers (e.g., high barriers corresponding to (0.6, 0.8, 1.0)) and centroid defuzzification to address the methodological dilemma of "non-quantifiable" cultural traits. This

logic can inform education evaluation in other ICH fields such as ceramics and embroidery, extending Dubois & Prade [26] fuzzy set theory to cultural assessment.

Finally, it reveals the asymmetric weight-score relationship in cultural entrepreneurship education. For example, weak market demand insight (C7) scores highest but ranks 9th in comprehensive weight, indicating it is a prominent issue with limited impact; in contrast, weak cultural narrative (C3) combines high weight and high score, emerging as a systemic barrier. This dual-dimensional evaluation model addresses the limitation of traditional studies that only focus on the intensity of single indicators, and forms a theoretical dialogue with the “double-edged sword” effect theory of cultural resource endowment proposed by Zhou et al. [30].

Practical Implications

Based on the findings, a three-level optimisation path is proposed:

Cultural Value Transformation Level: Establish a Silk Culture Narrative Laboratory to collaborate with ICH inheritors in developing a three-stage narrative toolkit: “pattern symbols → historical allusions → modern design.” The laboratory adopts a dual-mentorship system (ICH inheritor + design professor), holding weekly pattern decoding workshops and producing 3-5 commercializable narrative schemes per semester. To address the core barrier of weak cultural narrative (C3), draw on Gao et al. [40] design experience in digitalising Cantonese embroidery ICH, transforming sericulture and silk reeling processes into immersive teaching scenarios to enhance the operability of cultural expression, consistent with Su et al. [41] ICH digital teaching model.

Educational Resource Supply Level: Build a “government-industry-university-research” case development alliance. To tackle the scarcity of curriculum cases (C5), universities will lead collaboration with silk enterprises (e.g., Suhao Silk), industry associations (China Silk Association), and incubators to develop standardised case banks following the “cultural decoding → product design → market validation” process. Notably, failure cases (e.g., poor market feedback on modern improvements to traditional brocade) should be included to address the success bias in existing case banks, aligning with Davey et al. [27] emphasis on industry-university-research collaborative education.

Market-Policy Coordination Level: Design “policy-finance” linkage tools. Building a “government-industry-university-research” case development alliance essentially cultivates a creative ecosystem cluster in the silk

cultural and creative field (Florida [42]). To address high policy thresholds (C8) and insufficient awareness of financing channels (C9), develop a silk cultural and creative policy calculator app to automatically match enterprise qualifications with support policies. Collaborate with local banks to launch “ICH skill valuation + order financing” products, adapting financial tools validated by Zhang et al. [28] in Suzhou embroidery to the silk industry, echoing Wang et al. [38] research on financial innovation in digital trade.

Limitations and Future Research Directions

This study has two limitations: First, while expert samples cover three groups (inheritors, teachers, executives), their geographical distribution is concentrated in Jiangsu and Zhejiang (60%), potentially biasing judgments on national barriers. As the main silk-producing areas, these regions have higher industrial maturity and policy support level. Experts may be less aware of obstacles such as a lack of practice base and high policy threshold than in non-major producing areas. Second, the static evaluation framework excludes dynamic variables such as technological changes (e.g., the impact of AI design on traditional element innovation), aligning with Gao et al. [40] identification of a research gap on technology iteration’s impact on ICH education. Future research can expand in three directions: First, adopt cross-regional comparative studies to analyse differences in barriers between major sericulture regions and non-major regions, supplementing Wang [43] research on regional differences in Maritime Silk Road cultural and creative products. Second, introduce longitudinal tracking to observe the impact of policy adjustments (e.g., the 2025 implementation of the ICH Education Promotion Law) on barrier levels, extending Yan et al. [13] research on ICH education policy effects. Third, use experimental methods to test the impact of different narrative strategies (e.g., historical vs. modern narratives) on entrepreneurship education outcomes, verifying causal relationships of identified core barriers and enriching Zhou et al. [3] psychological perspective on entrepreneurship education.

Reflections on Methodological Expansion

While the hybrid AHP-FAHP method effectively addresses the quantification of cultural indicators, it has room for improvement in dynamic weight adjustment. Existing research often determines weights through one-time expert scoring (Saaty [34]), but rapid changes in cultural industries may shift indicator importance over time. For example, with metaverse technology in cultural and creative fields, digital narrative ability may

become a new core barrier, making static weight systems obsolete, consistent with Pagán et al. [11] conclusion that digital technology reshapes creative industries. Future research could introduce dynamic AHP models with time decay coefficients to automatically update weights as industries evolve, enhancing model timeliness.

Additionally, while triangular fuzzy number values in fuzzy evaluation reference existing research [26], they can be refined for silk culture uniqueness. For instance, the high barrier interval for weak cultural narrative could be adjusted to (0.65, 0.85, 1.0) based on silk pattern complexity (e.g., differences in narrative difficulty between Song brocade and Yun brocade), making evaluations more contextually relevant—aligning with Yang's [18] research method on modern design of traditional patterns.

Supplementary Notes on Sample Selection and Potential Bias Correction

Despite stratified sampling ensuring structural representativeness, the overrepresentation of Jiangsu-Zhejiang experts may introduce regional experience bias. As major silk-producing regions, Jiangsu and Zhejiang have higher industrial maturity and policy support, so experts' perceptions of barriers like lack of practice bases or high policy thresholds may be weaker than in non-major regions—consistent with Huajing Industry Research Institute [19] observation of unbalanced regional development in the silk industry. Subsequent research could use weight correction to adjust for this: assign weights to expert scores based on regional silk industry output shares (e.g., 60% for Jiangsu-Zhejiang, 20% for Sichuan-Chongqing, 20% for the Pearl River Delta) before comprehensive calculation.

Heterogeneity analysis of expert backgrounds reveals significant differences in evaluating insufficient innovation in traditional elements: inheritors emphasise craft authenticity (average score 3.2), while executives focus on market acceptance (average score 4.8). This reflects a value conflict between cultural inheritance and commercialisation, aligning with Aris & Ibrahim's [12] research on balancing cultural authenticity and commercial adaptability. Future studies could design a dual-dimensional evaluation system to score indicators from both cultural authenticity and commercial feasibility, capturing barrier essence more comprehensively.

Reflections on Alignment with Policy Practice

The identified barrier of high policy implementation thresholds (C8) is highly relevant to current national initiatives, such as ICH entering campuses and optimising cultural and creative support policies. The 2024 ICH Entrepreneurship Education Action Plan by the Ministry of Culture and Tourism explicitly calls for “lowering policy application thresholds for small and micro enterprises,” yet this study finds hidden thresholds in “silk cultural and creative special subsidies”—consistent with UNESCO’s [2] global cultural and creative industry report highlighting “insufficient policy inclusivity.”

It is recommended to develop a “policy adaptability assessment tool” based on this study’s indicator system to verify existing policies. For example, to address narrow financing channels (C9), include silk craft inheritance duration and cultural IP value in collateral evaluation systems. This approach has been piloted successfully in the Anhui rice paper industry, and its experience can be standardised and promoted through this study’s barrier analysis framework, achieving seamless integration of research outcomes with policy practice—aligning with Vall-Ilosera Casanovas et al. [44] emphasis on “university-policy-industry linkage.”

CONCLUSION

This study aimed to systematically evaluate the implementation barriers in silk culture-driven cultural and creative product entrepreneurship education and propose targeted optimisation paths, using a hybrid Analytic Hierarchy Process (AHP) and Fuzzy Analytic Hierarchy Process (FAHP) method. Aligning with the research objectives outlined in the Introduction, key findings and outcomes are summarised as follows: First, core barriers in silk cultural and creative entrepreneurship education exhibit a three-dimensional progressive characteristic, clarifying a priority improvement sequence. In the cultural value transformation dimension (B1), “weak cultural narrative (C3)” emerges as the primary barrier (comprehensive weight: 0.183; score: 4.57), with 62% of experts acknowledging systemic deficiencies in silk culture’s storytelling and modern communication capabilities. In the entrepreneurship education resources dimension (B2), “scarcity of curriculum cases (C5)” (comprehensive weight: 0.140; score: 4.38) reflects a lag in developing interdisciplinary cases that integrate cultural decoding, craft inheritance, and business model design. In the market-policy coordination dimension (B3), “narrow financing channels (C9)” and “high policy implementation thresholds (C8)” (comprehensive weights: 0.105 and 0.092, respectively) highlight mismatches between external support systems and

industrial needs. These results confirm that addressing barriers should follow the sequence: "cultural narrative → educational resources → market policies."

Second, the hybrid AHP-FAHP method validates the feasibility of quantifying cultural education evaluation. AHP structurally ranks indicator importance, while FAHP processes fuzzy cultural indicators (e.g., "silk IP awareness") using triangular fuzzy numbers (e.g., high barriers corresponding to (0.6, 0.8, 1.0)), converting subjective evaluations into comparable precise scores (target layer A1 final score: 3.5092). Consistency tests (all CR values < 0.1) and sensitivity analysis (stable results under $\pm 10\%$ weight fluctuations) confirm the model's reliability, providing a methodological reference for quantitative research on intangible cultural heritage (ICH) entrepreneurship education.

Third, practical optimisation paths are defined to bridge the gap between cultural inheritance and commercialisation. Culturally, a three-stage narrative system ("patterns → historical allusions → modern design") should be established through collaboration with ICH inheritors. Educationally, a "government-industry-university-research" alliance is needed to develop standardised case banks, including failure cases, to address success bias. Market-policy-wise, "policy calculator + ICH financial tools" linkage models (e.g., "skill valuation + order financing") can reduce policy thresholds and expand financing channels.

This study has several limitations. First, expert samples show geographical concentration (60% from Jiangsu-Zhejiang), potentially introducing regional bias given these areas' higher silk industry maturity. Second, the static evaluation framework excludes dynamic variables such as technological changes and policy iterations. Future research should: (1) conduct cross-regional comparative studies to verify findings' national applicability, (2) introduce longitudinal tracking to observe policy impact evolution, and (3) develop dynamic weight adjustment mechanisms to adapt to rapid industrial changes. In summary, this study identifies key barriers in silk cultural and creative entrepreneurship education and provides systematic solutions through methodological innovation, contributing to the integration of ICH with entrepreneurship education. Its findings lay a foundation for promoting the creative transformation and innovative development of silk culture, with implications for other ICH fields.

Author Contributions

Conceptualisation – Li Q; methodology – Wu Z; formal analysis – Wu Z; data curation - Wu Z; resources – Wu Z; writing-original draft preparation – Wu Z; writing-review and editing – Wu Z; visualisation – Li Q; supervision – Wu Z; funding acquisition - Li Q. All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

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Human Research Subjects

This study involving human participants was reviewed and approved by the Ethics Review Committee of Guangzhou College of Technology and Business on March 3, 2025. All research procedures strictly adhered to: National ethical guidelines of the People's Republic of China; The principles of the Helsinki Declaration (2013) and its subsequent amendments; Informed consent was obtained from all participants before data collection, with explicit documentation of voluntary participation and anonymity guarantees.

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