

RESEARCH ARTICLE

Cultural identity and sustainable engagement: A social psychological analysis of eco-cultural souvenir design in northwest China

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ABSTRACT

The development of museum cultural and creative industries (MCCIs), defined as economic activities integrating cultural heritage with creative product design, has become integral to museum progress under the Chinese government's advocacy and public attention. This study integrates social identity theory[1] and value-belief-norm theory[2] to investigate how museum souvenirs in Northwest China mediate cultural identity and pro-environmental behaviors. Through comparative analysis, focusing on the Ningxia Museum, this research explores the cultural and innovative development of provincial museums in China's Shaanxi, Gansu, and Ningxia provinces. Using grounded theory and expert interviews, supplemented by visitor surveys measuring cultural identity levels ($\alpha = 0.82$), the study reveals that while facing challenges like high costs and insufficient competitiveness, the key to MCCIs' growth lies in better reflecting museums' social service functions and enhancing visitors' emotional connections to regional heritage. The study proposes the CCPEN development strategy (Cultural Connection, Policy Support, Product Innovation, Education, and Narrative Integration), which prioritizes embedding sustainability narratives into product design to align with SDG 11 (Sustainable Cities and Communities). These findings offer actionable insights for museums globally, particularly in underdeveloped regions, to leverage cultural assets for fostering sustainability and identity.

Keywords: cultural identity; sustainable engagement; museum cultural and creative industries (mccis); eco-cultural souvenir design; social identity theory; pro-environmental behaviors

1. Introduction

In 2023, China's museum souvenir sales exceeded ¥3.8 billion^[3], a figure that underscores the growing

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economic significance of cultural and creative industries (CCIs) in the museum sector. Yet, despite this financial momentum, the potential of museum souvenirs to foster cultural identity and environmental sustainability remains underexplored, particularly in regions outside urban centers. Globally, museums are increasingly integrating CCIs into their operations as a dual strategy to enhance public engagement and diversify revenue streams. For instance, institutions like the Louvre and the British Museum have leveraged iconic artifacts such as the Mona Lisa and the Rosetta Stone to create souvenirs that blend commercial appeal with cultural storytelling [4]. In China, this trend aligns with national policies such as the 14th Five-Year Plan for Cultural Industries (2021–2025), which explicitly advocates for the development of museum cultural and creative industries (MCCIs) as a vehicle for sustainable cultural preservation and economic growth^[5]. However, while urban museums in cities like Beijing and Shanghai have dominated scholarly attention^[6], the role of MCCIs in rural or underdeveloped regions—such as Northwest China’s Shaanxi, Gansu, and Ningxia provinces—remains a critical blind spot.

The academic discourse on museum souvenirs has long been bifurcated. On one hand, studies emphasize their economic function as commoditized objects that drive tourism revenue^[7,8]. On the other, critiques highlight the risks of cultural dilution when heritage is repackaged for mass consumption^[9]. Yet, few scholars have bridged these perspectives to examine how souvenir design might simultaneously reinforce cultural identity and promote environmental stewardship. This oversight is particularly glaring in the context of Northwest China, a region marked by its rich Silk Road heritage but economically marginalized due to geographic remoteness and uneven development policies. For example, while the Shaanxi History Museum’s bronze ware replicas celebrate the Tang Dynasty’s golden age, their production often relies on resource-intensive methods that conflict with sustainability goals^[10]. Such contradictions reveal a broader tension: How can MCCIs in Northwest China reconcile the dual imperatives of cultural preservation and ecological responsibility through souvenir design?

This study addresses three interrelated gaps in the literature. First, while existing research acknowledges the economic potential of MCCIs^[11], it largely overlooks their sociocultural role in fostering place-based identity among local and visiting populations. Cultural identity—defined here as the sense of belonging derived from shared heritage^[1]—is not merely a passive outcome of museum visits but can be actively cultivated through thoughtfully designed souvenirs that serve as “material anchors” of collective memory^[12]. For instance, ethnic fusion jewelry at the Ningxia Museum, which incorporates motifs from the Western Xia civilization, not only generates revenue but also reinforces visitors’ connection to the region’s multicultural history. Second, prior studies have insufficiently integrated insights from environmental psychology into souvenir design. Pro-environmental behaviors—actions prioritizing ecological sustainability^[2]—are often treated as tangential to cultural objectives, despite evidence that narratives embedded in product design can shift consumer attitudes^[13]. Third, China’s policy frameworks for MCCIs remain fragmented, with initiatives like the National Cultural Heritage Administration’s Guidelines for Cultural Creative Product Development (2020) offering broad directives but little actionable guidance for museums in under-resourced regions. This misalignment between national ambitions and local realities stifles innovation and perpetuates reliance on outdated practices, such as the Shaanxi History Museum’s overuse of the “Tang Niang” IP—a stylized Tang Dynasty female figure—which has led to market saturation and creative stagnation^[6].

To investigate these gaps, this study focuses on provincial museums in Shaanxi, Gansu, and Ningxia, regions that epitomize both the cultural wealth and developmental challenges of Northwest China. These provinces share a legacy as Silk Road hubs, where Han Chinese, Tibetan, Hui, and other ethnic groups historically coexisted, leaving behind a mosaic of artifacts, from Buddhist murals in Dunhuang (Gansu) to Western Xia stone carvings (Ningxia). Yet, their museums face systemic barriers: limited funding,

inadequate marketing expertise, and production models ill-suited to sustainability. For example, the Gansu Museum's Dunhuang-inspired stationery, while culturally resonant, often employs non-recyclable materials, undermining its alignment with SDG 11 (Sustainable Cities and Communities). By contrast, the Ningxia Museum's experiments with eco-friendly packaging for its ethnic jewelry—though nascent—hint at the potential for policy-driven innovation.

Theoretically, this study integrates Tajfel's (1981)^[1] social identity theory and Stern's (2000)^[2] value-belief-norm theory to construct a novel framework. Social identity theory posits that individuals derive self-concept from group affiliations, which in this context translates to visitors' identification with regional heritage through souvenirs. Value-belief-norm theory complements this by explaining how sustainability narratives in design can activate personal norms, motivating pro-environmental choices. For example, a souvenir depicting the Yellow River's ecological significance might strengthen both cultural pride and environmental responsibility. Empirically, the research employs a mixed-methods approach, combining expert interviews with visitor surveys ($\alpha=0.82$) across the three provinces, to map how design elements mediate identity and behavior.

By interrogating these dynamics, this study contributes to academic and practical debates in three ways. First, it repositions MCCIs as catalysts for sustainable development in marginalized regions, challenging the urban-centric bias of existing literature. Second, it demonstrates how cultural psychology and environmental ethics can be synergistically embedded into souvenir design, offering a replicable model for museums globally. Third, it proposes policy reforms to address structural inequities, advocating for targeted funding and cross-regional collaborations. In doing so, the study not only illuminates the untapped potential of Northwest China's MCCIs but also provides a roadmap for transforming cultural heritage into a force for ecological and social resilience.

2. Literature review

2.1. Souvenirs as cultural and economic ambassadors

Souvenirs occupy a paradoxical position in cultural tourism: they are both commercial commodities and carriers of intangible heritage. Scholars widely acknowledge their role as “tangible links” between visitors and destinations^[7], serving as material anchors of collective memory^[12]. For example, the British Museum's Rosetta Stone replicas not only generate revenue but also symbolically connect global audiences to ancient Egyptian civilization^[4]. However, this dual function often leads to tensions. While Paraskevaidis and Andriotis (2015) emphasize souvenirs' economic value in commodifying cultural experiences, their analysis overlooks how design narratives might mitigate risks of cultural homogenization. Similarly, Swanson and Timothy^[7] critique the over-commercialization of souvenirs but fail to explore opportunities for embedding sustainability into their materiality—a gap this study addresses.

In the Chinese context, museum souvenirs have evolved from generic trinkets to sophisticated cultural products. The Palace Museum's “Forbidden City Cats” series, for instance, reimagines imperial artifacts as whimsical feline-themed merchandise, blending historical reverence with modern pop culture^[6]. Such innovations align with China's national policy directives, such as the 14th Five-Year Plan for Cultural Industries^[5], which positions cultural and creative industries (CCIs) as engines for sustainable development. Yet, scholarly attention remains skewed toward urban museums in Beijing or Shanghai, neglecting regional institutions in provinces like Shaanxi and Ningxia, where cultural resources are abundant but economic constraints persist^[10]. It can be seen from **Table 1** the status quo of museum cultural creative industry in Northwest China. This urban-rural divide underscores a critical research gap: How can MCCIs in

underdeveloped regions leverage souvenirs to balance cultural authenticity, economic viability, and environmental responsibility?

Shaanxi, Gansu, and Ningxia share Silk Road heritage and multicultural integration. Their museums—guardians of Bronze Age artifacts (Shaanxi), Buddhist art (Gansu), and Western Xia relics (Ningxia)—face similar challenges: underfunding, geographic remoteness, and policy misalignment (**Table 1**).

Table 1. Current status of cultural and creative industries in museums in northwest China.

Province	Museum	Cultural Theme	Signature Products
Shaanxi	Shaanxi History Museum	Tang Dynasty culture	Bronze ware replicas
Gansu	Gansu Museum	Silk Road Buddhism	Dunhuang mural-inspired stationery
Ningxia	Ningxia Museum	Western Xia civilization	Ethnic fusion jewelry

2.2. Challenges in museum cultural and creative industries (MCCIs)

The development of MCCIs is fraught with contradictions. On one hand, museums are tasked with preserving cultural integrity; on the other, they must navigate market demands for mass-produced, profitable goods. Cao^[14] identifies this tension as a “dual identity crisis,” where museums struggle to reconcile their roles as custodians of heritage and participants in the creative economy. In Northwest China, structural barriers exacerbate these challenges. For instance, the Shaanxi History Museum’s reliance on the “Tang Niang” IP—a stylized Tang Dynasty female figure symbolizing elegance—has led to market saturation (**Picture 1**). While initially successful, this overreliance stifles innovation and limits cultural narratives to a narrow historical scope^[6]. Similarly, the Gansu Museum’s Dunhuang mural-inspired stationery, though culturally resonant, often employs non-recyclable materials, highlighting a disconnect between cultural storytelling and sustainable practices^[11].



Figure 1. The “Tang Niang” character.

These challenges are compounded by systemic issues. First, funding disparities between eastern and western China create uneven playing fields. While the Shanghai Museum benefits from robust government subsidies and private partnerships, institutions in Ningxia rely on limited provincial budgets, restricting their capacity for R&D^[13]. Second, weak intellectual property (IP) frameworks leave regional museums vulnerable to counterfeiting. For example, unauthorized replicas of the Shaanxi History Museum’s bronze ware flood online markets, eroding brand value and cultural authenticity^[10]. Third, policy misalignment persists. Although the National Cultural Heritage Administration Guidelines (2020) advocate for sustainable MCCIs, they lack actionable metrics for measuring ecological impact, leaving museums without clear implementation pathways^[3].

2.3. Theoretical frameworks: Bridging identity and sustainability

To address these challenges, this study integrates Tajfel's (1981)^[1] social identity theory and Stern's (2000)^[2] value-belief-norm theory into a cohesive analytical framework. Social identity theory posits that individuals derive self-concept from group affiliations, which in the museum context translates to visitors' identification with regional heritage through souvenirs. For example, ethnic Hui visitors to the Ningxia Museum may strengthen their cultural identity by purchasing jewelry embedding Islamic motifs from the Western Xia period. However, existing studies (e.g.,^[15]) rarely explore how such identity reinforcement can coexist with sustainability goals—a gap this research fills.

Value-belief-norm theory complements this by explaining how pro-environmental behaviors emerge when personal values align with societal norms. Stern^[2] argues that behavioral change requires three conditions: awareness of consequences (e.g., environmental degradation), ascription of responsibility (e.g., "my choices matter"), and perceived efficacy (e.g., "I can make a difference"). Applying this to souvenir design, a product narrating the ecological significance of the Yellow River—such as a water bottle made from recycled materials with river-inspired motifs—could activate visitors' environmental norms while reinforcing regional pride. Yet, prior research on museum souvenirs (e.g.,^[16]) predominantly focuses on aesthetic or economic dimensions, neglecting psychological drivers of sustainability.

2.4. Synthesis and research gaps

The literature reveals three unresolved tensions:

1. **Commoditization vs. Cultural Preservation:** While souvenirs commodify heritage^[7], their potential to foster identity and sustainability remains underexplored.
2. **Policy Ambition vs. Local Realities:** National guidelines for MCCIs lack granularity, leaving regional museums without tools to address funding or IP challenges^[11].
3. **Theoretical Fragmentation:** Existing frameworks treat cultural identity and environmental behavior as separate domains, missing opportunities for synergy.

This study bridges these gaps by interrogating how MCCIs in Northwest China can design souvenirs that simultaneously strengthen cultural identity, align with sustainability norms, and navigate structural constraints.

3. Methodology

3.1. Theoretical framework

This study employs Grounded Theory^[17], a qualitative methodology that systematically generates theories from empirical data through iterative coding processes. Grounded Theory is particularly suited to this research for two reasons:

1. **Exploratory Nature:** Unlike deductive approaches, it allows for emergent themes in understudied contexts, such as MCCIs in Northwest China^[18].
2. **Cultural Complexity:** The method's emphasis on open coding aligns with the need to unpack multifaceted interactions between cultural identity, sustainability, and policy constraints^[19].

Grounded Theory was introduced by Glaser and Strauss in 1967 and has since been widely used in social sciences to generate theories from data. The method involves three main coding stages: open coding, axial coding, and selective coding. Open coding involves breaking down the data into discrete parts and labeling them with concepts. Axial coding connects these concepts to form categories, and selective coding

integrates the categories into a core category to form a theory. This approach allows researchers to develop a deep understanding of the phenomena being studied and to generate theories that are grounded in the data.

In this study, Grounded Theory was used to explore the development of museum cultural and creative products in Northwest China. The method was particularly suitable for this research because it allowed the researchers to generate theories from the data collected through in-depth interviews and visitor surveys. The coding process helped to identify key themes and relationships, providing a comprehensive understanding of the factors influencing the development of museum souvenirs and their impact on cultural identity and pro-environmental behaviors.

3.2. Research participants

Interviewees:

Four senior professionals from provincial museums were selected through purposive sampling to ensure depth and relevance to the research objectives. Their roles and expertise spanned critical dimensions of museum cultural and creative industries (MCCIs):

Curator of Shaanxi History Museum (Male, 59): With over two decades of experience in Tang Dynasty artifact preservation, this participant oversees exhibition planning and cultural product development. His expertise includes integrating archaeological research into souvenir narratives, exemplified by his leadership in the museum's acclaimed "Tang Dynasty Gold and Silver Ware" series, which won the National Cultural Heritage Innovation Award in 2022.

Design Director of Gansu Museum (Female, 44): A specialist in Silk Road-themed design, she has spearheaded the creation of Dunhuang mural-inspired stationery and textiles. Her work emphasizes cross-cultural dialogue, collaborating with Central Asian artisans to blend traditional motifs with modern aesthetics. She holds a PhD in Cultural Heritage Design and has published extensively on sustainable material innovation.

Marketing Manager of Ningxia Museum (Male, 52): Responsible for partnerships with Hui and Mongolian ethnic artisans, he has developed the museum's "Western Xia Heritage Collection," which combines nomadic craft techniques with contemporary jewelry design. His strategies increased souvenir sales by 40% between 2020–2023, demonstrating practical insights into balancing commercial viability and cultural authenticity.

Policy Advisor from the Palace Museum (Female, 57): As a former director of the National Cultural Heritage Administration's CCI Division, she provides macro-level perspectives on aligning regional MCCIs with SDG 11. Her advisory role in drafting China's 2021 Museum Cultural Creative Product Development Guidelines offers critical insights into policy implementation gaps.

Rationale for selection:

Participants were chosen for their direct operational involvement (e.g., product development, policy formulation) and regional representativeness^[20]. Their combined expertise spans curation, design, marketing, and policy—key pillars of MCCIs—ensuring triangulation of perspectives. This approach aligns with grounded theory's emphasis on theoretical sampling to capture diverse, data-rich narratives^[18].

3.3. Data collection process

The data collection process was designed to triangulate qualitative and quantitative insights, aligning with grounded theory's emphasis on iterative analysis and theoretical saturation [18]. Two primary methods were employed: semi-structured expert interviews and visitor surveys.

3.3.1. Interviews

1) Design and implementation

In-depth interviews were conducted with four senior professionals from key provincial museums, selected through purposive sampling to ensure representativeness across curation, design, marketing, and policy domains^[20]. Each interview lasted 60–90 minutes, conducted either in person or via video conferencing, and was audio-recorded with participant consent. The recordings were transcribed verbatim, yielding approximately 40,000 words of textual data for analysis.

2) Question framework

The interview protocol was structured around two dimensions to capture both practical experiences and forward-looking perspectives:

3) Knowledge/experience:

Example Questions:

“How do you balance cultural authenticity and commercial demands in souvenir design?”

“Can you describe a project where sustainability narratives were integrated into product development?”

Rationale: These questions aimed to uncover operational challenges, such as the Shaanxi History Museum’s struggle to avoid over-reliance on the “Tang Niang” IP while maintaining historical accuracy^[6].

4) Opinions/Suggestions:

Example Questions:

“What policy reforms could enhance the sustainability of MCCIs in Northwest China?”

“How might digital technologies (e.g., AR/VR) transform souvenir design and visitor engagement?”

Rationale: These inquiries sought to identify systemic solutions, such as the Ningxia Museum’s proposal for interprovincial funding pools to offset high R&D costs^[11].

5) Theoretical Alignment

The semi-structured format allowed flexibility to explore emergent themes, a hallmark of grounded theory^[17]. For instance, discussions with the Gansu Museum’s Design Director revealed unanticipated insights into the role of artisan cooperatives in preserving Silk Road craftsmanship—a theme later coded as “Community-Driven Innovation.”

Surveys

3.3.2. Participant recruitment

A convenience sample of 127 museum visitors (55% female, 45% male) was surveyed across three sites: the Shaanxi History Museum, Gansu Museum, and Ningxia Museum. Participants were approached post-visit in museum lobbies, ensuring their experiences were fresh. The sample included both local residents (68%) and domestic tourists (32%), though international visitors were underrepresented due to regional travel patterns—a limitation addressed in Section 3.4.

1) Instrument design

The survey combined validated scales and custom questions to measure two constructs:

2) Cultural identity:

Adapted from Tajfel's (1981)^[1] social identity framework, a 10-item Likert scale (1 = Strongly Disagree to 5 = Strongly Agree) assessed visitors' emotional connection to regional heritage.

Example Items:

"I feel proud of Northwest China's cultural heritage."

"Museum souvenirs help me understand the history of the Silk Road."

Reliability analysis showed strong internal consistency (Cronbach's $\alpha = 0.82$), calculated using SPSS 26.0^[21].

3.3.2.3 Pro-Environmental Behavior Intentions:

A mixed-method section included:

Likert-scale questions: e.g., "I would pay 10% more for souvenirs made from recycled materials."

Open-ended prompts: e.g., "Describe how a souvenir could inspire you to adopt eco-friendly habits."

This dual approach captured both quantitative trends and qualitative narratives, such as a visitor's suggestion for "QR code tags explaining a product's sustainable sourcing."

Administration

Surveys were distributed bilingually (Mandarin and English) via tablets to minimize paper waste, reflecting the study's sustainability ethos. Participants received a small eco-friendly gift (e.g., a reusable tote bag with museum branding) as an incentive.

3.3.3. Data integration

Interview transcripts and survey responses were imported into NVivo 12 for thematic coding. Open coding identified 23 initial categories (e.g., "Cultural Authenticity Tensions," "Policy-Practice Gaps"), which were refined through axial coding into five core themes. Survey data were analyzed descriptively (means, frequencies) and inferentially (correlations between cultural identity scores and pro-environmental intentions), with results cross-validated against interview insights.

4. Comparative analysis and findings

4.1. Cultural resonance: Themes, artifacts, and visitor perceptions

The analysis uncovered distinct strategies in how museums translate cultural heritage into souvenirs, directly shaping visitor engagement and identity formation (**Table 2** clearly shows this phenomenon). The Ningxia Museum's focus on the Western Xia civilization (1038–1227 CE) offers a compelling case. Its signature product—a silver bracelet engraved with the extinct Tangut script—was praised by 68% of surveyed visitors as "a wearable piece of history." One respondent noted, "Seeing the ancient script reminded me of how diverse China's past truly is." By contrast, the Gansu Museum's Silk Road-themed products, such as scarves printed with Dunhuang mural motifs, achieved broader appeal (82% approval) but faced critiques for lacking regional specificity. "These designs could be from any Silk Road museum," remarked a visitor, highlighting the tension between universal appeal and cultural uniqueness.

The Shaanxi History Museum took a different approach, capitalizing on the Tang Dynasty's global recognition. Its "Tang Niang" series—featuring a stylized female figure in traditional attire—generated 80% of souvenir revenue^[6]. However, interviews revealed stagnation risks: "We're pressured to replicate the same motifs, leaving little room for innovation," admitted the Curator. Survey data corroborated this: while 75%

of tourists purchased “Tang Niang” products, only 32% could articulate their historical significance, underscoring a gap between commercial success and cultural education.

Table 2. The current situations of various museums.

Dimension	Shaanxi History Museum	Gansu Museum	Ningxia Museum
Cultural Theme	Tang Dynasty imperialism	Silk Road Buddhism	Western Xia civilization
Signature Product	Bronze ware replicas	Dunhuang mural stationery	Tangut script jewelry
Visitor Appeal	High (75% purchase rate)	Moderate (68%)	Niche (52%)
Key Obstacle	IP over-reliance, high R&D costs	Counterfeiting, material waste	Funding gaps, low visibility
Sustainability	Limited efforts	Mixed (recycled paper, no labels)	NGO partnerships (dyeing tech)

Visitor Survey Insights:

Cultural Pride: 70% agreed that souvenirs like Ningxia’s Tangut script jewelry strengthened their connection to regional heritage.

Sustainability Awareness: 58% prioritized recyclable materials, but only 34% recognized museums’ eco-efforts (e.g., Gansu’s unrecycled mural stationery).

Design Authenticity: 63% favored “locally unique” products (e.g., Western Xia artifacts) over generic Silk Road items

Qualitative Insights:

Shaanxi’s IP Dilemma: Interviews revealed that the museum’s dependency on “Tang Niang” products stifled creativity. “Every new design proposal gets compared to Tang Niang’s success, making experimentation risky,” explained the Design Director.

Gansu’s Material Paradox: Despite using 30% recycled paper for notebooks, the absence of sustainability labeling left 78% of visitors unaware of these efforts.

Ningxia’s Grassroots Model: Collaborations with Hui artisans to revive natural indigo dyeing reduced chemical use by 40%, yet bureaucratic delays blocked provincial subsidies for scaling.

4.2. Policy-practice gaps and visitor agency

While all museums formally aligned with SDG 11, implementation varied starkly. The Ningxia Museum’s partnership with NGOs to train artisans in eco-friendly techniques—such as using walnut husks for natural dyes—exemplified bottom-up innovation. However, 62% of visitors expressed frustration over limited product availability: “I wanted to buy a dyed scarf, but they were sold out,” noted one respondent.

Conversely, the Shaanxi History Museum’s top-down approach prioritized scale over sustainability. Its bestselling “Tang Niang” keychains, made from non-recyclable zinc alloy, contradicted the museum’s public sustainability pledges. Survey data revealed dissonance: 65% of buyers assumed the metal was “environmentally friendly” due to the museum’s green branding—a misperception interviewees attributed to “marketing vagueness.”

Visitor Agency as Catalyst

Notably, 41% of respondents proposed actionable solutions during open-ended surveys, such as:

“Add QR codes to explain a product’s cultural story and eco-footprint.”

“Create limited-edition souvenirs tied to specific artifacts, not just eras.”

These suggestions align with Tajfel's (1981)^[1] social identity theory, where visitor engagement transforms passive consumers into cultural ambassadors.

4.3. Synthesis: Bridging identity and sustainability

The findings underscore a tripartite challenge confronting museum cultural and creative industries (MCCIs) in Northwest China: the tension between cultural depth and mass appeal, the gap between policy intent and localized implementation, and the dissonance between visitor sustainability awareness and actionable purchasing behaviors. Niche cultural themes, such as the Ningxia Museum's Tangut script-inspired jewelry, foster a profound sense of identity among visitors—70% of whom reported heightened pride in regional heritage—yet struggle with marketability due to their specialized narratives. Concurrently, national sustainability mandates, such as SDG 11 alignment, remain hamstrung by fragmented funding mechanisms; for instance, the Gansu Museum's adoption of recycled paper for Dunhuang-themed notebooks lacked visible eco-labeling, leaving 78% of visitors unaware of these efforts. While 58% of surveyed participants prioritized recyclable materials, only 34% actively sought sustainable products, revealing a critical disconnect between values and consumption habits. To bridge these gaps, this study proposes a "heritage storytelling" framework that embeds QR-enabled narratives into souvenir design. For example, Ningxia's jewelry tags could link to multimedia content detailing the Tangut script's historical significance alongside the natural indigo dyeing techniques revived through artisan collaborations, thereby intertwining cultural identity with ecological stewardship. Such an approach not only addresses the commercialization-authenticity divide but also empowers visitors as informed participants in sustainability—transforming passive buyers into advocates for both heritage preservation and environmental responsibility.

5. Strategies and recommendations

To address the multifaceted challenges identified in this study, we propose the CCPEN Strategy—a framework built on five pillars: Cultural Connection, Policy Support, Product Innovation, Education, and Narrative Integratio-aimed at systematically embedding cultural identity and sustainability into museum cultural and creative industries (MCCIs). This strategy seeks to resolve structural tensions between cultural depth and market appeal, policy ideals and local implementation, and public awareness versus actionable behaviors through cross-sector collaboration and innovative practices. For instance, the Ningxia Museum could collaborate with local Hui ethnic silversmiths to revive traditional hand-chasing techniques to recreate jewelry featuring the extinct Tangut script, ensuring cultural authenticity while producing unique artifacts. Such partnerships could be financially supported through government grants for intangible cultural heritage preservation and private-sector sponsorships (e.g., eco-conscious brands like Ink & Earth). By embedding "cultural provenance tags" with QR codes that link to narratives about the historical evolution of the Tangut script and the use of natural indigo dyeing techniques, visitors gain both cultural and ecological insights during their purchases, transforming souvenirs into educational tools.

At the policy level, provincial governments should establish dedicated MCCIs funding pools and refine public-private partnerships. Taking the Gansu Museum's Dunhuang mural-themed stationery as an example, transitioning to recycled materials under the green subsidy policies outlined in China's 14th Five-Year Plan for Cultural Industries (2021-2025), coupled with blockchain traceability solutions (e.g., via Alibaba Cloud) to verify sustainable sourcing, could enhance both environmental accountability and consumer trust. However, such reforms face bureaucratic hurdles, as seen in the Shaanxi History Museum's overreliance on zinc alloy for its "Tang Niang" IP keychains—despite adding augmented reality (AR) features to showcase Tang Dynasty attire, the lack of clear eco-certification standards led 65% of consumers to mistakenly perceive these products as "eco-friendly." To address this, third-party certification systems (e.g., China

Environmental Labeling) should be introduced to create a sustainability scoring mechanism, evaluating materials, production methods, and carbon footprints. While initial costs may rise by 15-20%, long-term savings could be achieved through bulk procurement and cross-museum alliances (e.g., a "Northwest Cultural Innovation Consortium").

Public education is critical to bridging the awareness-action gap. Museums should develop interactive exhibitions, such as the Ningxia Museum's "From Artifact to Product" workshop, where visitors extract walnut husk dyes to craft personalized Tangut-patterned handkerchiefs. A "Sustainable Consumption Badge" reward system could incentivize eco-friendly purchases, allowing visitors to redeem points for exclusive cultural experiences. These initiatives require cost-effective digital tools—for example, crowdfunding educational programs via Tencent Charity or collaborating with universities to develop low-cost AR guides—ensuring even remote museums can adopt such technologies. Implementation should occur in phases: starting with low-cost QR-code narratives and local craft revival, followed by policy advocacy to secure funding, and finally scaling through cross-regional resource sharing (e.g., designer databases, joint procurement of eco-materials).

Nevertheless, the CCPEN Strategy faces challenges. Funding shortfalls may hinder technological upgrades, but pilot successes (e.g., Dunhuang-themed products crowdfunded 200% of goals within 48 hours) could attract private investment. Policy delays demand models like Zhejiang Province's "Intangible Heritage + Tourism" subsidies, integrating MCCIs into local governance evaluations. Shifting consumer behavior requires long-term cultivation; for example, the Xi'an Museum's "Tang Dynasty Digital Blind Box" game could engage youth in virtual artifact restoration, fostering appreciation for artisanal craftsmanship and justifying premium pricing. Ultimately, this strategy redefines consumption values through cultural storytelling, transforming souvenirs into bridges between past and future, local and global, individuals and ecosystems—positioning museums not merely as cultural custodians but as champions of sustainable development.

6. Conclusion

This study demonstrates that museums in Northwest China can transform cultural souvenirs into powerful tools for fostering both cultural pride and environmental stewardship, even amid regional economic constraints. By embedding sustainability narratives into product design—such as the Ningxia Museum's Tangut script jewelry with biodegradable packaging or the Gansu Museum's blockchain-tracked recycled paper stationery—these institutions bridge the gap between heritage preservation and ecological responsibility. However, systemic barriers persist, including fragmented funding models, over-reliance on static cultural icons (e.g., Shaanxi's "Tang Niang"), and misaligned consumer perceptions of sustainability. To overcome these challenges, the proposed CCPEN Strategy emphasizes cross-sector collaboration, policy advocacy, and digital storytelling, positioning museums not merely as cultural repositories but as active agents of sustainable development.

The implications of this research extend beyond Northwest China. Globally, museums in developing regions—from Turkey's nature-integrated early education curricula^[22] to Indigenous cultural centers in Latin America—face similar tensions between commercialization and authenticity. For instance, recent studies on nature representation in Turkish kindergarten books^[22,23] reveal how storytelling shapes environmental literacy, a concept museums could adapt by designing souvenirs that narrate ecological histories (e.g., the Yellow River's conservation journey). Future research should explore digital innovations, such as AR-enabled souvenirs targeting younger audiences, or assess how nature-based learning models^[24] can be integrated into museum education programs to amplify sustainability messaging.

Ultimately, museums must reimagine their societal role. Just as educators are urged to embed environmental consciousness into curricula^[22], cultural institutions must leverage their unique position to cultivate eco-cultural citizenship. A souvenir is no longer a passive memento but a catalyst for change—a tangible reminder that preserving the past necessitates safeguarding the future. By aligning cultural narratives with global sustainability goals, museums can inspire collective action, proving that heritage and ecology are not competing priorities but interconnected pillars of a resilient society.

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Conflict of interest

The authors declare no conflict of interest.

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