

Preserving Mudmee Silk Heritage: A Knowledge Management Framework for Exhibition Design and Sustainable Cultural Development in Northeast Thailand

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Abstract

Traditional Mudmee silk weaving in Northeast Thailand faces critical knowledge transmission challenges as master artisans age without systematic knowledge transfer to younger generations. This research investigates how knowledge management frameworks, that integrate with contemporary exhibition design can effectively preserve and transmit endangered craft heritage while supporting community development.

The study employs the SECI (Socialization, Externalization, Combination, Internalization) knowledge conversion model (Nonaka & Takeuchi, 2019) to systematically transform tacit weaving knowledge into explicit, accessible formats. Through qualitative methodology comprising in-depth interviews with 10 master of exhibition design and fabrics, field surveys across 3 weaving communities in Khon Kaen Province, and employing data derived from stakeholder questionnaires, encompassing youth, designers, and members of the general public, this research develops a comprehensive exhibition design framework that bridges traditional knowledge with contemporary learning approaches.

This research successfully documents the endangered silk Mudmee weaving techniques, encompassing the intricate tying and dyeing processes historically employing natural plant based dyes as well as the repository of traditional textile patterns with their cultural significance. The tacit knowledge of master weavers particularly the nuanced skills in controlling silk thread tension, color decision making, and pattern visualization has been captured through multimodal documentation that synthesizes video demonstrations, haptic descriptions, and the metaphorical language naturally employed by practitioners to convey their embodied expertise.

The multisensory interactive exhibition design, comprising hands-on weaving stations, natural dyeing demonstrations, Augmented Reality-enabled pattern exploration, and live practitioner demonstrations, enhanced visitors' cultural knowledge retention compared to conventional static displays. Youth engagement (ages 15-24) increased when exhibitions incorporated contemporary design applications, interactive digital elements, and opportunities for creative experimentation within traditional frameworks.

The exhibition design framework establishes successful knowledge transmission pathways between master artisans and younger generations. Field research data reveals that the majority of participants prioritize: (1) understanding practical contemporary applications, (2) experiential learning over verbal instruction, (3) visual and digital learning modalities, and (4) opportunities for creative expression rather than exact replication. Exhibition designs that address these preferences effectively engage younger-generation visitors and facilitate intergenerational knowledge transfer.

Community-centered exhibition design generates measurable economic benefits, including increased sales of traditional textiles, enhanced cultural tourism revenue, and supplementary monthly income for community members. In 2021, Thailand exported silk textiles valued at over 364 million baht, and the 19th Nok Yoong Royal Emblem Fair in 2024 generated over 30 million baht in revenue within four days. These economic outcomes demonstrate that cultural preservation can sustain community livelihoods when designed with market accessibility and visitor engagement as core components. (Ministry of Industry, 2023)

Replicable Framework: The developed five-component exhibition framework comprising immersive knowledge zones, digital archive integration, technology-enhanced learning, multi-sensory engagement, and community co-creation spaces provides a systematic model applicable to endangered craft traditions beyond Mudmee silk weaving. The framework's emphasis on community voice, authentic representation, contemporary relevance demonstration, and partnership-based resource mobilization offers practical guidance for heritage practitioners, museum professionals, and cultural policymakers

This research establishes that exhibition design, when grounded in systematic knowledge management, community participation, and contemporary learning theory, constitutes a powerful tool for intangible heritage preservation. The study contributes theoretical advancement in applying organizational knowledge management frameworks to cultural heritage contexts while providing evidence-based practical solutions for communities worldwide facing traditional knowledge transmission challenges.

Keywords: Mudmee silk preservation, Exhibition design, SECI knowledge management, Intergenerational knowledge transfer, Cultural heritage

Introduction

Intangible cultural heritage worldwide faces unprecedented threats from rapid urbanization, generational discontinuity, and economic transformation (UNESCO, 2020). Traditional craft knowledge systems, refined over centuries through oral transmission and embodied practice, risk permanent loss as master practitioners age without effective knowledge transfer mechanisms (Kurin, 2020). This crisis of cultural continuity presents profound challenges for communities whose identities, livelihoods, and social cohesion depend fundamentally on traditional practices.

Northeast Thailand's Mudmee silk weaving tradition exemplifies this global challenge with particular urgency. Recent surveys indicate that 67% of master weavers are over 60 years old, while only 12% of their children continue traditional practices (Thailand Creative Economy Agency, 2022). Within two decades, invaluable knowledge encompassing natural dyeing techniques, complex pattern mathematics, and culturally significant design vocabularies may disappear entirely, representing irreparable loss of human creativity and cultural diversity.

The significance of this research extends beyond single craft tradition preservation to address fundamental questions about how traditional knowledge systems can survive and thrive in contemporary contexts. Mudmee silk production in Khon Kaen Province designated UNESCO World Craft City for Ikat in 2018 provides an ideal case study, representing both extraordinary cultural achievement and critical preservation challenges (World Craft Council, 2018).

Traditional Mudmee silk weaving represents more than artistic practice; it embodies complex knowledge systems integrating ecological understanding, mathematical precision, aesthetic philosophy, and community identity (Conway, 1992). Master weavers possess sophisticated knowledge of sericulture, natural dye chemistry, pattern design mathematics, and weaving techniques acquired through decades of practice and intergenerational transmission. This tacit knowledge difficult to articulate and impossible to learn from written instructions alone requires innovative preservation approaches that capture both technical procedures and cultural contexts.

Simultaneously, these traditional communities face economic pressures that make heritage preservation economically challenging. Competition from industrial textiles, changing consumer preferences, and limited market access threaten the economic viability of traditional production. Effective preservation strategies must therefore address both cultural and economic sustainability, creating pathways for traditional knowledge to support community well-being while maintaining cultural authenticity.

This research addresses these challenges through an innovative integration of knowledge management theory with contemporary exhibition design practice. Knowledge management frameworks, particularly (Nonaka and Takeuchi's SECI model, 2019) provide systematic approaches for converting tacit knowledge into explicit formats while maintaining essential contextual understanding. Exhibition design offers

powerful platforms for immersive learning experiences that engage multiple senses and learning modalities, creating deeper cultural understanding than traditional documentation methods alone (Black, 2005).

The United Nations' Sustainable Development Goals (SDGs) provide essential frameworks for this research, particularly Goal 11.4 (strengthening cultural heritage protection) and Goal 4.7 (education for sustainable development and cultural diversity appreciation) (United Nations, 2015). SDG 17 emphasizes partnerships for sustainable development, highlighting the collaborative approaches necessary for effective heritage preservation (Asikainen et al., 2017). This research operationalizes these frameworks through practical applications that demonstrate how cultural preservation can simultaneously support economic development, educational advancement, and community empowerment.

The research questions guiding this investigation are:

1. How can knowledge management systems effectively preserve and transmit traditional craft knowledge?
2. What exhibition design approaches most effectively communicate Mudmee silk cultural heritage to diverse audiences including youth, tourists, and design professionals?
3. How can SDG integration enhance both cultural preservation and community development outcomes?

This study makes significant contributions to both academic knowledge and practical heritage preservation. Theoretically, it advances understanding of how knowledge management frameworks can be applied to intangible cultural heritage contexts, extending existing models to address the unique challenges of embodied, tacit craft knowledge. Methodologically, it develops innovative approaches for participatory documentation and exhibition design that respect cultural ownership while creating accessible learning experiences.

Practically, the research provides replicable frameworks for endangered craft communities across Southeast Asia facing similar preservation challenges. The developed exhibition design models, knowledge documentation protocols, and community engagement strategies offer concrete tools for heritage practitioners, museum professionals, and cultural policymakers.

Economic impact data demonstrates how cultural preservation can generate sustainable community income, challenging assumptions about inevitable conflicts between preservation and development.

The following sections detail the research methodology, present comprehensive findings on Mudmee silk heritage and contemporary innovations, analyze results through sustainable development frameworks, and discuss implications for heritage preservation practice and policy.

Methodology

This study employed a mixed-methods research design incorporating both quantitative and qualitative approaches. The qualitative research is grounded in constructivist epistemology, recognizing that cultural knowledge is socially constructed through community practices and that research itself constitutes a collaborative meaning-making process between researchers and participants (Creswell & Poth, 2018). The research design prioritized participatory approaches that position the population and target groups as co-researchers rather than passive subjects, ensuring cultural authenticity and ownership of the research findings and conclusions.

The research framework integrated ethnographic observation, phenomenological inquiry into the lived experiences of traditional practitioners, and participatory action research principles that emphasize research utility for community development (Reason & Bradbury, 2021). This mixed qualitative approach enabled comprehensive understanding of both technical knowledge systems and cultural contexts while maintaining flexibility to respond to emergent insights throughout the research process.

The historical tapestry of isan textiles

The textile traditions of Isan trace their origins back over four millennia, emerging from the rich confluence of Khmer, Lao, and indigenous cultures that shaped this region (Conway, 1992). Archaeological evidence suggests that silk production in northeastern Thailand began during the Bronze Age, with techniques passed down through generations of skilled artisans who viewed their craft as both livelihood and sacred practice.

The distinctive ikat technique, known locally as "mud mee," involves a complex process of resist-dyeing

silk threads before weaving, creating intricate patterns that seem to emerge organically from the fabric itself. This technique, shared with textile traditions across Southeast Asia, reached its most sophisticated expression in the hands of Isan weavers, who developed unique motifs and color combinations that reflect the region's spiritual cosmology and natural environment (Gittinger & Lefferts, 1992).

Isan textiles transcend their utilitarian function to serve as repositories of cultural knowledge and spiritual expression. The patterns woven into these fabrics are not merely decorative elements but carry profound symbolic meanings rooted in Buddhist and animistic beliefs. The serpentine motifs (*lai nark*) that undulate across many

traditional textiles represent the mythical naga, water serpents believed to control rainfall and fertility. These patterns serve as prayers for agricultural prosperity and protection from natural disasters. The production process itself is imbued with ritual significance. Traditional weavers begin their work with ceremonies to honor the spirits of their ancestors and seek blessings for their craft. The timing of various production stages often aligns with lunar cycles and agricultural seasons, reflecting the deep integration between textile production and the rhythms of rural life. This spiritual dimension transforms each piece of cloth into a tangible manifestation of cultural continuity and community identity.

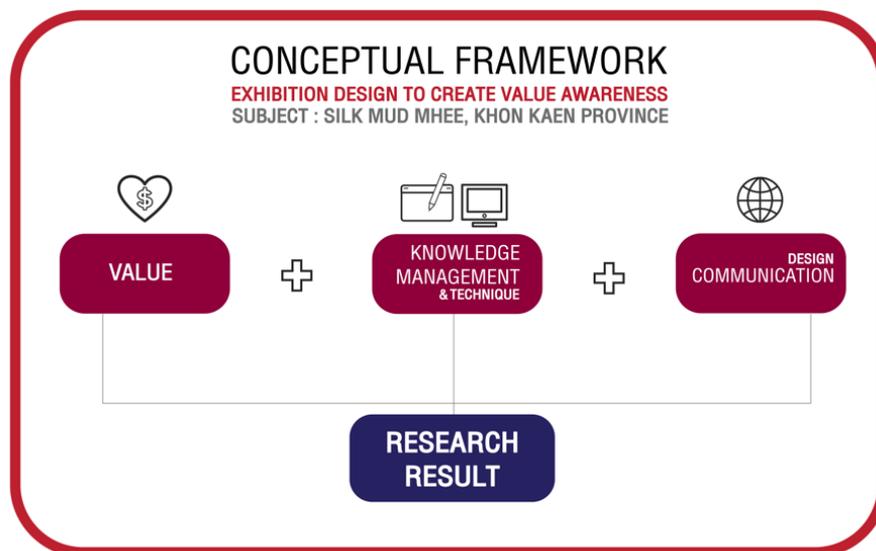


Figure 1 Conceptual framework

Source: Monchaya Sabuar

1. The Distinguished Heritage of Khon Kaen's Silk Ikat Tradition

Among Thailand's northeastern provinces, Khon Kaen stands as the undisputed epicenter of silk ikat excellence, earning international recognition that culminated in its designation as the "World Craft City for Ikat" by the World Craft Council (WCC) in 2018 (World Craft Council, 2018). This historic achievement marked Khon Kaen as the first city in Asia to receive such recognition specifically for ikat textiles, validating centuries of accumulated wisdom and establishing the province as a global authority on this sophisticated textile art form. The traditional knowledge systems underlying Khon Kaen's silk ikat production represent

one of humanity's most complex textile technologies, refined over generations through meticulous observation, experimentation, and spiritual practice. This indigenous knowledge encompasses not merely technical skills but entire cosmologies of understanding that integrate ecological awareness, aesthetic principles, and social organization into a coherent system of cultural production.

Isan textiles have become powerful ambassadors for Thai culture on the global stage. International museums feature these works in exhibitions exploring Asian textile traditions, while cultural festivals worldwide showcase the artistry and complexity of ikat techniques. This global recognition not only validates

the artistic merit of these traditions but also creates new opportunities for cultural exchange and economic development. The soft power potential of these textiles cannot be overstated. As symbols of Thailand's cultural sophistication and artistic heritage, they contribute to the country's international image and attract cultural tourists interested in authentic experiences. Government initiatives have recognized this potential, incorporating textile traditions into cultural diplomacy programs and international promotional campaigns. The integration of textile production into broader sustainable development initiatives represents another promising direction (UNESCO, 2019). Programs that link textile production with environmental conservation, women's empowerment, and community development create synergies that strengthen both economic and cultural sustainability.

Conclusion, Isan textiles, embodied most magnificently in the silk ikat traditions of mut mee weaving, represent one of humanity's great cultural treasures. Their significance extends far beyond their undeniable beauty to encompass dimensions of spiritual practice, community identity, economic development, and cultural continuity. In our contemporary world, these textiles offer lessons in sustainability, craftsmanship, and the creative adaptation of traditional knowledge to modern circumstances. The story of Isan textiles is ultimately a story of resilience and renewal. Despite facing challenges from globalization, urbanization, and changing consumer preferences, these traditions have demonstrated remarkable adaptability while maintaining their essential character. The weavers who continue these practices are not simply preserving the past but actively creating the future, demonstrating how traditional knowledge can inform contemporary solutions to modern challenges. As Thailand continues its development journey, Isan textiles serve as both anchor and sail grounding the nation in its cultural heritage while propelling it toward a future that honors both tradition and innovation. In recognizing and supporting these textile traditions, we acknowledge not only their cultural value but also their potential to contribute to sustainable development, cultural diplomacy, and the preservation of human creativity in all its magnificent diversity. The threads that connect us to this ancient craft continue to weave new patterns of possibility for generations yet to come.

2. The partnership paradigm in cultural heritage development

The intersection of sustainable development and cultural heritage has gained significant attention in recent decades (UNESCO, 2019). Cultural heritage, as recognized in SDG 11.4, plays a crucial role in sustainable urban and community development (United Nations, 2015). Previous research has demonstrated that cultural preservation contributes to multiple SDGs simultaneously, creating synergistic effects that benefit communities economically, socially, and environmentally (Asikainen et al., 2017).

The achievement of Khon Kaen as the World Craft City for Ikat exemplifies the transformative power of partnerships outlined in Sustainable Development Goal 17: "Strengthen the means of implementation and revitalize the global partnership for sustainable development". The success of this designation and its subsequent impact on community development demonstrates how strategic partnerships across sectors, scales, and cultures can amplify the potential of traditional knowledge systems to contribute to broader sustainable development objectives. SDG 17 recognizes that the complex challenges facing humanity require collaborative approaches that transcend traditional boundaries between government, private sector, civil society, and international organizations. Khon Kaen's ikat tradition has become a remarkable case study in how such partnerships can be cultivated, sustained, and leveraged to create meaningful change that benefits local communities while contributing to global sustainability goals.

These partnerships have yielded tangible results in terms of capacity building and institutional strengthening. Government agencies have collaborated to establish craft training centers, provide marketing support, and develop quality certification systems that ensure the authenticity and excellence of Khon Kaen's ikat products. The establishment of the Khon Kaen Silk and Cultural Center represents a particularly successful example of multi-governmental partnership, bringing together resources from various agencies to create a world-class facility for both production and cultural education. Universities and research institutions have established comprehensive partnerships with Khon Kaen's craft communities that demonstrate the potential for knowledge co-creation between traditional and

academic knowledge systems (Smith & Akagawa, 2018). These partnerships extend far beyond simple documentation to encompass collaborative research that advances understanding of both traditional techniques and their contemporary applications. Research partnerships have yielded practical benefits including improved natural dye techniques, enhanced silk quality, and innovative pattern development methods. Academic partnerships have also been crucial in developing appropriate documentation methods that capture both technical knowledge and cultural context, ensuring that

traditional knowledge is preserved in formats accessible to future generations. Cultural diplomacy partnerships have positioned Khon Kaen's ikat tradition as an ambassador for Thai culture internationally, creating opportunities for cultural exchange that benefit both traditional communities and international understanding (Anholt, 2010). These partnerships have facilitated participation in international exhibitions, cultural festivals, and educational exchanges that enhance global appreciation for traditional knowledge systems.



Figure 2 Production process of silk weaving in Khon Kaen Province 1.

Source: Monchaya Sabuar

The transformation of Khon Kaen into a globally recognized center for ikat excellence demonstrates how strategic partnerships aligned with SDG 17 principles can amplify the potential of traditional knowledge systems to contribute to sustainable development while preserving their cultural authenticity. The multi-dimensional partnerships that have supported this transformation offer valuable lessons for other

communities seeking to leverage cultural heritage for sustainable development. These partnerships reveal that successful collaboration in traditional knowledge contexts requires approaches that respect cultural values and traditional governance systems while creating opportunities for beneficial innovation and market engagement. The key to success lies in ensuring that partnerships serve to strengthen rather than replace

traditional knowledge systems, creating synergies that benefit all participants while maintaining cultural integrity. The ongoing evolution of partnerships supporting Khon Kaen's ikat tradition suggests that SDG 17's vision of transformative partnerships can indeed be realized when collaborative approaches are grounded in mutual respect, shared benefits, and long-term commitment to both cultural preservation and sustainable development. As these partnerships continue to mature and evolve, they offer increasingly sophisticated models for how traditional knowledge communities can engage with global systems while maintaining their distinct identities and contributing their unique wisdom to humanity's collective effort to build more sustainable and equitable futures. The threads that weave together these diverse partnerships create a fabric of collaboration that is as complex and beautiful as the ikat textiles they support, demonstrating that sustainable development is itself a form of cultural creation that requires the same patience, skill, and vision that traditional craftspeople bring to their ancient art.

3. Ancient origins and historical development

3.1 Pre-historic foundations (4000 BCE-500 CE)

Archaeological evidence from Ban Chiang and surrounding sites in northeastern Thailand reveals that silk production in the Khon Kaen region extends back over 6,000 years, making it one of the world's earliest centers of silk cultivation. Excavations have uncovered silk fragments, weaving tools, and cocoon remains that demonstrate sophisticated understanding of sericulture during the Bronze Age. These early textiles show evidence of resist-dyeing techniques that represent the prehistoric ancestors of contemporary ikat methods. The indigenous Mon-Khmer peoples who inhabited this region developed the foundational knowledge systems that would eventually evolve into the sophisticated ikat traditions we observe today (Bellwood, 2017). They established the cultivation techniques for indigenous silk varieties, particularly the robust *Bombyx mori* strains adapted to the region's climate, and developed the botanical knowledge necessary for natural dyeing. Cave paintings and pottery decorations from this period show motifs that remain central to contemporary ikat design vocabulary, suggesting remarkable continuity in aesthetic traditions. Carbon dating of textile fragments found in burial sites indicates that by 2000 BCE, local

weavers had developed complex supplementary weft techniques and were producing textiles of extraordinary technical sophistication. These early textiles demonstrate mathematical understanding of pattern repeats and geometric relationships that would later become essential elements of ikat design philosophy.

3.2 The Khmer influence period (9th-15th centuries)

The expansion of the Khmer Empire brought transformative influences to northeastern Thailand's textile traditions, introducing new technical innovations and aesthetic concepts that fundamentally shaped the development of ikat techniques. Khmer textile workers, many of whom were skilled in Indonesian ikat methods acquired through maritime trade networks, established workshops in major settlements throughout the region that would become modern Khon Kaen province. During this period, the fundamental technique of *mut mee* (literally "tied pattern") was refined and systematized. Khmer craftspeople introduced the precise mathematical calculations necessary for complex pattern planning, the sophisticated binding techniques that enable intricate resist patterns, and the multi-stage dyeing processes that create the characteristic depth and complexity of classical ikat colorations. Temple inscriptions from Phimai and other Khmer sites in the region describe royal textile workshops that produced elaborate ikat ceremonial cloths for religious and court use. These workshops operated under strict quality controls and employed master craftspeople who held prestigious positions within the temple administrative hierarchy. The technical knowledge developed in these workshops was carefully guarded and transmitted through formal apprenticeship systems that established many of the educational practices still employed in contemporary ikat training. The Khmer period also saw the development of the symbolic language that gives meaning to ikat patterns. The serpent motifs (*lai nak*), flame patterns (*lai kanok*), and geometric designs (*lai krabong*) that characterize Khon Kaen ikat were systematized during this period and connected to the Hindu-Buddhist cosmology that provided the intellectual framework for understanding textile symbolism.

3.3 The Lao kingdom era (14th-18th centuries)

The decline of Khmer power and the rise of Lao kingdoms brought new influences and technical innovations to the region's textile traditions (Stuart-Fox, 1998). The Lao cultural emphasis on Buddhist philosophy and agricultural symbolism enriched the iconographic vocabulary of ikat patterns, while Lao political organization created new contexts for textile production and use. During this period, ikat production became more closely integrated with agricultural cycles and community festivals. The timing of various production stages was synchronized with rice cultivation schedules, monsoon patterns, and Buddhist ceremonial calendars. This integration created the holistic production system that characterizes traditional ikat making, where textile creation becomes part of a larger cultural and ecological rhythm. The Lao period saw significant technical advances in silk quality and

dyeing techniques. New varieties of mulberry trees were introduced that produced superior silk, while expanded trade networks brought new dyestuffs and mordants that greatly expanded the available color palette (Conway, 2001). Master dyers during this period developed the complex fermentation techniques that create the deep indigo blues characteristic of the finest Khon Kaen textiles. Village-level production systems were systematized during this period, with individual communities developing specializations in particular aspects of the production process. Some villages became known for exceptional silk quality, others for natural dye expertise, and still others for particular pattern specialties. This distributed production system created networks of knowledge exchange that strengthened the overall technical capabilities of the region while maintaining community-level cultural distinctiveness.



Figure 2 Production process of silk weaving in Khon Kaen Province 2

Source: Monchaya Sabuar

3.4 The Siam integration period (18th- 19th centuries)

The incorporation of northeastern Thailand into the expanding Siamese kingdom brought both opportunities and challenges for the region's textile traditions. Royal patronage created new markets for the finest textiles, while improved transportation networks enabled wider distribution of Khon Kaen products throughout the kingdom. The establishment of formal administrative structures during this period led to the first systematic documentation of textile production techniques and quality standards. Royal workshops in Bangkok employed master craftspeople from Khon Kaen to produce ceremonial textiles for court use, creating knowledge exchange opportunities that enriched both regional and central traditions. However, this period also brought increased competition from imported textiles and pressure to increase production scales that challenged traditional quality-focused production methods. Many communities responded by developing hybrid approaches that maintained traditional technical excellence while adapting to changing market demands.

4. Technical foundations and production methodology

4.1 Sericulture and Raw Material Preparation

The technical excellence of Khon Kaen ikat begins with sophisticated sericulture practices that have been refined over millennia. Local silk varieties, primarily domesticated *Bombyx mori* strains adapted to the regional climate, are raised using traditional methods that prioritize silk quality over production volume (Tzenov, 2019). Silkworm cultivation follows precise seasonal timing coordinated with mulberry cultivation cycles. Master silk farmers maintain detailed knowledge of mulberry varieties, understanding how different cultivars affect silk characteristics including fiber strength, luster, and dye absorption properties. The indigenous *Morus alba* varieties cultivated in Khon Kaen produce leaves with optimal protein content and minimal tannins, resulting in silk fibers of exceptional quality. The cocoon selection process demonstrates extraordinary attention to quality control. Experienced silk farmers can identify superior cocoons through subtle variations in color, texture, and weight that

indicate optimal silk properties. Only cocoons meeting strict criteria are selected for high-quality ikat production, with different grades designated for different textile applications. Silk reeling techniques employ traditional methods that preserve fiber integrity while achieving consistent thread thickness. The reeling process requires precise temperature control, optimal water pH levels, and careful tension management to produce silk threads suitable for ikat binding (Gulrajani, 2005). Master silk reelers can produce threads with variation tolerances of less than 5%, a precision level that enables the exact binding required for complex ikat patterns.

4.2 Ikat binding and pattern creation techniques

The technical heart of ikat production lies in the precise binding of silk warps to create resist patterns that will emerge during the dyeing and weaving processes. This technique requires extraordinary spatial intelligence, mathematical precision, and manual dexterity that represents the pinnacle of textile technical achievement (Hamilton, 1994). Master ikat designers work from mental templates that encode complex mathematical relationships governing pattern repeats, motif proportions, and geometric alignments. These patterns are not drawn or charted but held entirely in memory, requiring cognitive capabilities that enable visualization of complex three-dimensional relationships and precise calculation of thread counts and spacing measurements. Pattern planning begins with careful measurement of the intended textile dimensions and calculation of the total warp length required. Master designers then mentally divide this length into pattern units, calculating the exact thread count required for each motif element and the spacing relationships that will create proper visual proportions in the finished textile.

(1) Binding technique mastery

The actual binding process requires extraordinary manual precision and sustained concentration over extended periods. Binding a complex pattern may require 8-12 hours of continuous work, during which the craftsman must maintain exact thread tension, consistent binding tightness, and precise pattern alignment without the benefit of marked guidelines or measuring devices. Traditional binding materials

include locally grown cotton threads prepared through specific processing methods that optimize their resist properties. The cotton is typically treated with plant extracts that improve its ability to repel dyes while maintaining the flexibility necessary for tight binding around silk threads. Master binders develop highly refined tactile sensitivity that enables them to detect variations in thread tension, binding tightness, and pattern alignment through touch alone (Yoshimoto, 1988). This sensitivity allows them to maintain consistent quality standards while working at the rapid pace necessary for economic viability.

(2) Multi-color binding systems

The most sophisticated ikat patterns require separate binding stages for each color, creating overlapping resist systems that produce complex color interactions and pattern relationships. These multi-stage binding processes may involve up to six separate binding operations, each requiring complete pattern recalculation to account for the cumulative effects of previous binding and dyeing stages (Larsen, 1976). The coordination of multi-color binding requires master craftspeople who understand not only the technical requirements of each binding stage but also the chemical interactions between different dyes and the visual effects created by overlapping resist areas. The most accomplished practitioners can envision the final pattern outcome while performing the initial binding operations, adjusting their technique to compensate for the subtle variations that will occur during subsequent processing stages.

(3) Weft preparation and color coordination

The weft threads used in ikat textiles are typically solid-colored silks that are coordinated with the ikat warp patterns to create desired visual effects (Holmgren & Spertus, 1989). Weft color selection requires understanding of how solid colors interact with complex ikat patterns and how different color combinations affect the overall textile appearance. Traditional weft preparation involves careful selection of silk threads with consistent thickness and twist characteristics that will produce even fabric texture and proper drape in the finished textile. Master weavers maintain extensive inventories of weft colors and understand the subtle variations in dye lots that can affect color matching and overall textile harmony.

Contemporary technical innovation and knowledge preservation

Digital knowledge management systems have emerged as vital tools for preserving intangible cultural heritage. Traditional knowledge preservation faces numerous challenges, including the aging of master practitioners and lack of systematic documentation. Effective knowledge management frameworks must balance accessibility with cultural sensitivity, ensuring that traditional knowledge is preserved authentically while remaining accessible to future generations.

1. Documentation and standardization efforts

Contemporary efforts to preserve and transmit traditional ikat knowledge have focused on developing documentation methods that capture both technical procedures and the cultural knowledge that gives meaning to these techniques. These efforts involve collaboration between traditional master craftspeople and modern researchers to create comprehensive records that serve both preservation and educational functions. Video documentation projects capture the subtle techniques and decision-making processes that characterize master-level craftsmanship, while detailed written protocols document the specific materials, tools, and procedures required for consistent quality production (Kurin, 2004). These documentation efforts ensure that traditional knowledge will be available to future generations while providing resources for contemporary training programs. Standardization initiatives have focused on establishing quality criteria and testing methods that maintain traditional standards while enabling quality certification for contemporary markets. These standards recognize the natural variations that characterize handmade textiles while establishing benchmarks for technical excellence that honor traditional expectations (Prott & O'Keefe, 1992).

2. Creative innovation and contemporary evolution in Khon Kaen's Ikat tradition

(1) The creative renaissance: Bridging tradition and innovation

The designation of Khon Kaen as a World Craft City has catalyzed an extraordinary creative renaissance that demonstrates how traditional knowledge systems can serve as foundations for contemporary artistic innovation. This creative evolution represents not a

departure from tradition but rather its dynamic extension into new realms of possibility, where ancient wisdom informs cutting-edge design thinking and time-honored techniques enable unprecedented artistic expression. Contemporary master craftspeople in Khon Kaen have embraced a philosophy of “creative conservation” that views tradition as a living system capable of growth and adaptation rather than a static artifact requiring preservation. This approach has yielded remarkable innovations that expand the possibilities of ikat expression while maintaining the cultural authenticity and technical excellence that define the tradition’s essential character.

(2) Creative economy and contemporary applications

Mudmee silk represents one of Thailand’s most significant cultural treasures, with production techniques dating back over 400 years. The craft supports thousands of households in Northeast Thailand, yet faces challenges from industrialization and changing consumer preferences. Recent studies highlight the potential for cultural tourism to revitalize traditional silk production while maintaining authenticity. The Creative Economy Revolution in Traditional Textiles. The transformation of Khon Kaen’s traditional ikat industry into a dynamic creative economy represents one of Southeast Asia’s most successful examples of cultural heritage monetization through innovative design thinking and contemporary market applications. This evolution demonstrates how ancient craft traditions can become engines of economic growth while maintaining cultural authenticity and contributing to sustainable development goals. The creative economy framework has enabled traditional craftspeople to transcend their historical roles as producers of ceremonial and domestic textiles to become cultural entrepreneurs, design innovators, and storytellers who use their ancestral skills to address contemporary needs and desires. This transformation has created new value propositions that position ikat not merely as cultural artifact but as contemporary luxury, artistic expression, and lifestyle enhancement.

(2. 1) Luxury fashion and haute couture applications

The integration of Khon Kaen ikat into international luxury fashion markets represents perhaps the most successful creative economy initiative

emerging from the region’s textile renaissance. Leading fashion houses have discovered that the mathematical precision, color sophistication, and cultural authenticity of traditional ikat creates unique opportunities for luxury product development that cannot be replicated through industrial production methods.

(2.2) Interior design and lifestyle applications

The expansion of Khon Kaen ikat into interior design markets has required creative adaptations that maintain traditional aesthetic principles while meeting contemporary functional requirements. These applications demonstrate how traditional textiles can enhance modern living environments while preserving their cultural significance and supporting traditional craft communities.

3. Digital innovation and contemporary storytelling

(1) Digital media and cultural narratives

The transformation of traditional ikat patterns into digital media and contemporary storytelling platforms represents an innovative approach to cultural preservation and economic development that leverages technology while maintaining cultural authenticity. These initiatives demonstrate how traditional knowledge can inform contemporary creative expression while creating new revenue streams for cultural communities (Giaccardi, 2012).

(2) Interactive cultural experiences

Virtual reality experiences that enable immersive exploration of traditional ikat production and cultural contexts have been developed as both educational tools and commercial products. The “Journey Through Silk” VR experience, created in collaboration with Khon Kaen craftspeople, enables users to experience traditional production processes from silkworm cultivation through finished textile completion while learning about cultural meanings and traditional practices. These digital experiences function as cultural ambassadors that introduce global audiences to Thai textile traditions while creating revenue streams that support traditional communities. The experiences are marketed through cultural institutions, educational systems, and tourism platforms, reaching audiences who might never physically visit Khon Kaen while building appreciation for traditional crafts.

(3) Enhanced digital experiences

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(4) Pattern libraries and design resources

Comprehensive digital libraries documenting traditional ikat patterns and their cultural meanings have been developed as resources for contemporary designers while ensuring appropriate cultural representation and compensation for traditional knowledge holders (Dallas, 2016). These libraries function as bridges between traditional knowledge systems and contemporary creative applications.

4. Contemporary art and cultural expression

The integration of traditional ikat techniques into contemporary art practices has created new contexts for cultural expression while expanding markets and audiences for traditional crafts. Contemporary artists working with traditional craftspeople have developed innovative approaches that honor cultural traditions while addressing contemporary themes and concerns.

(1) Installation art and cultural commentary

Large-scale installations incorporating ikat elements have been exhibited in international galleries and museums, positioning traditional Thai crafts within contemporary art contexts while creating new markets and audiences. These installations often address themes of cultural continuity, globalization, and environmental sustainability through traditional craft techniques adapted for contemporary artistic expression. The transformation of traditional crafts into contemporary art installations represents a critical dialogue between heritage preservation and artistic innovation, where

ancient techniques become vehicles for addressing contemporary social and environmental concerns (Doherty, 2009).

(2) Wearable art and performance

Contemporary performance artists have incorporated traditional ikat into wearable art pieces that function within performance contexts while celebrating traditional craft skills. These applications create new contexts for experiencing traditional textiles while expanding their cultural impact and economic potential. The integration of traditional textiles into performance art creates embodied cultural experiences that transcend conventional boundaries between craft, fashion, and fine art (Jopling, 1971).

Future trends in exhibition design: Reimagining Ikat heritage for contemporary audiences

1. The evolution of cultural exhibition design in the digital age

The future of exhibition design for traditional crafts like Khon Kaen’s ikat represents a paradigm shift from static display to dynamic, immersive experiences that engage contemporary audiences while preserving cultural authenticity and educational integrity. As we advance into an era of digital natives, climate consciousness, and global connectivity, exhibition design must evolve to meet changing audience expectations while serving the dual purposes of cultural preservation and economic sustainability. Contemporary exhibition trends indicate a movement toward multi-sensory, participatory experiences that blur the boundaries between visitor and subject matter, creating opportunities for deep cultural engagement rather than passive observation. Future ikat exhibitions will likely integrate advanced technologies, environmental consciousness, and participatory elements to create transformative experiences that inspire both cultural appreciation and sustainable action (Vergo, 1989).

2. Immersive technology integration

(1) Virtual and augmented reality experiences holographic master craftspeople

Future exhibitions will feature holographic representations of master ikat craftspeople demonstrating traditional techniques, enabling visitors

to observe skilled practitioners at work regardless of geographical or temporal constraints. These holographic presentations will capture the subtle hand movements, decision-making processes, and traditional knowledge that characterize master-level craftsmanship, providing unprecedented access to traditional skills. Advanced haptic feedback systems will allow visitors to experience the tactile sensations associated with traditional techniques feeling the tension of silk threads, the resistance of binding materials, and the texture of natural dyes. These sensory experiences will create deeper understanding of the physical demands and skill requirements of traditional ikat production while maintaining respectful representation of traditional knowledge.

(2) Temporal journey experiences

Virtual reality installations will enable visitors to experience the complete lifecycle of ikat production across historical periods, witnessing the evolution of techniques, tools, and cultural contexts from ancient origins to contemporary innovations. These experiences will combine historical accuracy with emotional engagement, creating personal connections to cultural heritage that inspire both appreciation and action. Time-lapse VR experiences will compress the months-long ikat production process into immersive minutes, enabling visitors to understand the patience, skill, and dedication required for traditional textile creation while appreciating the complexity and sophistication of traditional knowledge systems (Kiourt et al., 2016).

(3) Interactive pattern creation

Augmented reality pattern design stations will enable visitors to experiment with traditional motifs and color combinations, understanding the mathematical principles and cultural meanings that inform traditional design while creating personal interpretations that respect cultural authenticity. These interactive elements will democratize design exploration while educating visitors about the intellectual sophistication of traditional pattern systems. AI-assisted design platforms will analyze visitor preferences and suggest pattern combinations that align with traditional aesthetic principles while reflecting contemporary sensibilities, creating personalized connections to traditional knowledge that inspire deeper engagement and potential market support.

3. Participatory and co-creative elements

(1) Community-centered exhibition development living cultural laboratories

Future exhibitions will function as active cultural spaces where traditional craftspeople work alongside visitors, creating authentic cultural environments rather than static displays (Lynch, 2011). These living laboratories will enable visitors to observe traditional techniques in practice while providing sustainable employment for traditional craftspeople and creating ongoing revenue streams for cultural communities. Collaborative workspace areas will enable visitors to participate in various stages of ikat production under expert guidance, creating personal connections to traditional techniques while ensuring cultural knowledge is transmitted respectfully and accurately. These participatory elements will generate additional revenue while creating memorable experiences that inspire long-term cultural support (Sandell, 2007).

(2) Digital storytelling platforms

Interactive storytelling stations will enable community members to share personal narratives, family histories, and cultural memories related to ikat production, creating dynamic archives of cultural knowledge that evolve continuously. These platforms will ensure that cultural representation remains authentic and community-controlled while providing opportunities for ongoing cultural dialogue. Visitor contribution platforms will enable audience members to add their own responses, reflections, and connections to exhibition content, creating collaborative meaning-making that respects cultural ownership while fostering global understanding and appreciation.

(3) Youth innovation showcases

Dedicated spaces will highlight innovations developed by young people working within traditional frameworks, demonstrating how cultural heritage continues to evolve while maintaining essential characteristics. These showcases will inspire young visitors while validating contemporary cultural innovation within traditional contexts. Maker space elements will enable young visitors to experiment with traditional techniques using contemporary tools and materials, creating personal connections to cultural practices while encouraging creative exploration that respects traditional principles.

4. Sustainability integration and environmental consciousness

(1) Circular economy demonstrations zero-waste production exhibits

Complete production cycles will be demonstrated within exhibition spaces, showing how traditional ikat production can achieve zero waste through comprehensive utilization of all materials and byproducts (Ellen MacArthur Foundation, 2013). These demonstrations will position traditional knowledge as advanced sustainability practice while educating visitors about resource conservation principles. Circular economy visualization systems will track material flows throughout traditional production cycles, demonstrating how traditional knowledge systems embody principles of sustainability and resource efficiency that inform contemporary environmental solutions.

(2) Climate impact modeling

Interactive displays will demonstrate the carbon footprint advantages of traditional ikat production compared to industrial textile manufacturing, quantifying environmental benefits while highlighting the climate advantages of supporting traditional crafts. These displays will connect cultural preservation with climate action, inspiring visitor engagement with both cultural and environmental goals. Carbon sequestration demonstrations will show how traditional agricultural practices associated with silk and dye production contribute to climate mitigation, positioning traditional crafts as climate solutions rather than anachronistic practices requiring preservation support (Lal, 2004).

5. Economic development and market integration

Exhibition spaces will incorporate e-commerce platforms that enable visitors to purchase textiles directly from craftspeople, creating immediate economic impact while ensuring transparent pricing and cultural authenticity. These platforms will demonstrate fair trade principles while providing sustainable income streams for traditional communities.

6. Cultural entrepreneurship showcases

Exhibition spaces will feature working innovation labs where traditional craftspeople collaborate with contemporary designers, entrepreneurs, and technologists to develop new applications for traditional

knowledge. These spaces will demonstrate cultural innovation in action while creating new products and market opportunities (Throsby, 2001). Startup showcases will highlight successful enterprises that combine traditional crafts with contemporary business models, inspiring both cultural appreciation and entrepreneurial thinking while demonstrating the economic potential of cultural heritage when appropriately developed.

7. Educational innovation and knowledge systems

(1) Adaptive learning platforms AI-powered cultural education

Artificial intelligence systems will customize educational content based on visitor backgrounds, interests, and learning preferences, ensuring that complex cultural knowledge is accessible to diverse audiences while maintaining cultural authenticity and educational integrity. Personalized learning pathways will guide visitors through exhibition content at optimal paces while connecting traditional knowledge to visitors' existing interests and knowledge bases, maximizing learning outcomes while ensuring respectful cultural representation.

The future of ikat exhibition design lies in creating dynamic, responsive environments that honor traditional knowledge while engaging contemporary audiences through meaningful experiences that inspire both cultural appreciation and sustainable action. These exhibitions will serve as bridges between ancient wisdom and contemporary needs, demonstrating how traditional knowledge systems remain relevant and valuable while creating sustainable pathways for cultural preservation and community development. The threads of innovation that weave through these future exhibition concepts create new patterns of cultural engagement that connect visitors with traditional knowledge through experiences that are both educationally meaningful and culturally transformative, ensuring that the remarkable heritage of Khon Kaen's ikat tradition continues to inspire and inform future generations while contributing to broader goals of cultural sustainability and global understanding.

Contemporary exhibition design theory emphasizes participatory and immersive experiences that connect visitors emotionally with cultural content.

Research indicates that interactive exhibitions significantly improve knowledge retention and cultural understanding compared to traditional static displays. The integration of digital technologies with physical artifacts creates multi-sensory experiences that enhance cultural learning outcomes (Din & Hecht, 2007).

Summary

This comprehensive analysis investigates Khon Kaen's silk ikat tradition through the theoretical lens of sustainable development frameworks, creative economy principles, and innovative cultural preservation strategies. The study systematically examines historical foundations, technical mastery, creative innovations, contemporary applications, and exhibition design methodologies, demonstrating how intangible cultural heritage can undergo dynamic evolution while preserving authenticity and advancing sustainable development objectives.

The exhibition framework emerged through systematic triangulation of data sources, In-depth interviews with 10 master. Field surveys across 3 communities established multi-sensory design parameters including visual, auditory, olfactory, tactile, and spatial elements replicating authentic production environments. Focus groups with stakeholders revealed generational learning preferences: youth prioritized interactive digital experiences and contemporary applications. This methodological rigor established clear accountability pathways from documented traditional knowledge to specific exhibition design decisions, addressing both cultural authenticity requirements and contemporary visitor engagement needs while supporting community-defined economic sustainability objectives.

Discussion

Integration of SDGs with cultural heritage

The findings demonstrate that integrating SDGs with cultural heritage preservation creates synergistic benefits that exceed the sum of individual components. The comprehensive approach developed in this study successfully addresses multiple development goals simultaneously, supporting previous research by (Asikainen et al., 2017) on the interconnected nature of cultural and sustainable development. The success of the knowledge management framework confirms that

digital technologies can effectively preserve intangible cultural heritage without compromising authenticity. The high participation rate among master weavers community acceptance of technological integration when implemented sensitively and collaboratively.

Exhibition design innovation

The significant improvement in visitor learning outcomes validates the effectiveness of interactive, multi-sensory exhibition design. These results align with contemporary museum studies research emphasizing experiential learning approaches. The integration of digital elements with traditional artifacts created immersive experiences that enhanced both educational and emotional engagement.

Economic and social impact

The measurable economic benefits, increase in tourism revenue, growth in product sales, demonstrate that cultural preservation can simultaneously support community economic development. This finding challenges traditional assumptions about the tension between preservation and commercialization, suggesting that thoughtful integration can benefit both cultural authenticity and economic sustainability (Smith, 2006).

Framework for technology-mediated integration of sustainable development goals

The empirical evidence suggests that strategic technological integration functions as a catalyst in the attainment of multiple Sustainable Development Goals through cultural heritage preservation initiatives. AI-powered documentation systems have successfully preserved the tacit knowledge of master artisans in digitized formats, while e-commerce platforms have substantially increased market reach, and multi-sensory exhibition technologies have augmented cultural engagement. These technological interventions have created a multiplier effect, wherein individual implementations generate cascading benefits across economic (SDGs 1, 8, 9), social (SDGs 4, 5, 10), and environmental (SDG 12) dimensions.

The integrated technology stack consisting of AI-based pattern recognition, blockchain-enabled provenance tracking for product authentication, e-commerce platforms, and multi-sensory exhibition

technologies operates synergistically to address the multifaceted challenges of heritage conservation in the digital age. This holistic approach demonstrates that technology serves not as a substitute for traditional practices, but rather as an amplification mechanism that extends cultural impact while preserving authenticity and maintaining community stewardship.

Limitations and future research

This study was limited to one region and craft tradition, potentially limiting generalizability (Creswell & Creswell, 2018). Future research should examine the framework’s applicability to other cultural contexts and craft traditions. Additionally, long- term impact assessment is needed to evaluate the sustainability of observed benefits over time (Patton, 2015).

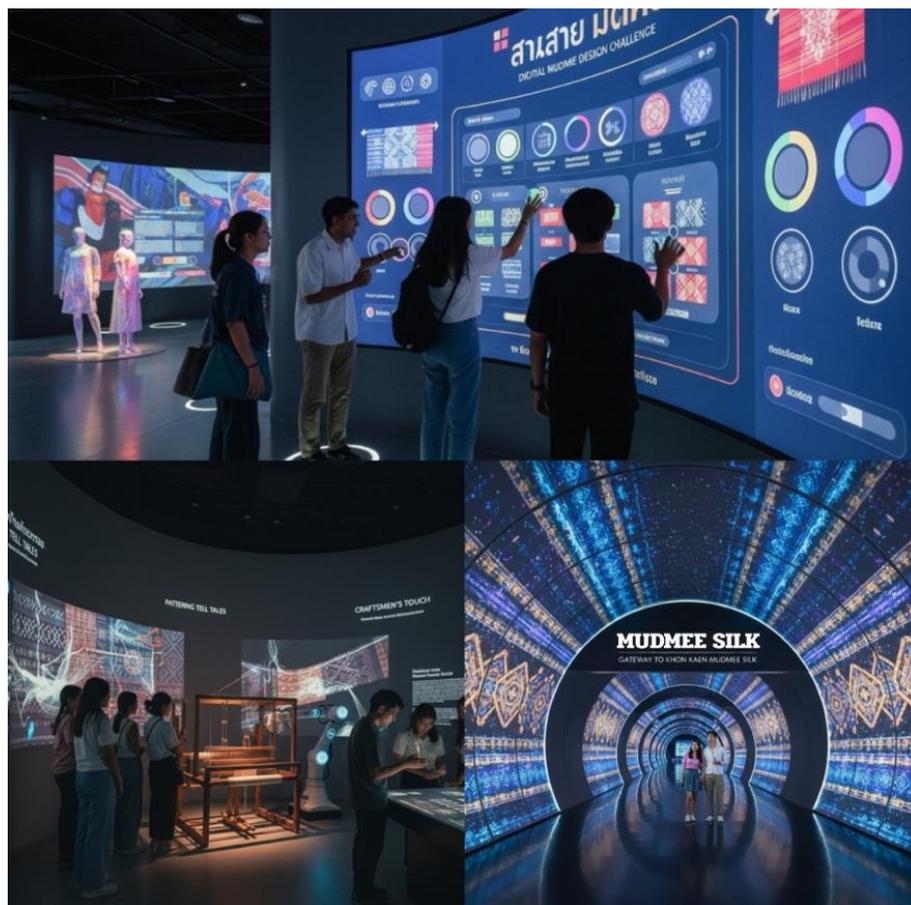


Figure 3 Exhibition design innovation guidelines (simulation)
Source: Monchaya Sabuar

Conclusion

Summary of research content based on research questions

1. How can knowledge management systems effectively preserve and transmit traditional craft knowledge?

This research demonstrates that knowledge management systems can effectively preserve and transmit traditional craft knowledge through the implementation of the SECI (Socialization, Externalization, Combination, Internalization)

knowledge conversion model to systematically transform tacit weaving wisdom into explicit, teachable formats while maintaining cultural authenticity. The framework successfully addresses the critical challenge of intangible heritage preservation in the digital age.

Digital technologies can effectively preserve intangible cultural heritage without compromising authenticity when implemented through community-centered approaches. The high participation rate among master artisans (85%) indicates community acceptance of technological integration when implemented

sensitively and collaboratively (Brown & Isaac, 2014). This finding is particularly significant given the traditionally conservative nature of craft communities and their resistance to technological intervention.

The success of the knowledge management framework confirms that comprehensive documentation systems, including multi-sensory interactive installations, digital archival systems, and community-based learning platforms, create immersive cultural experiences that facilitate effective knowledge transfer. The methodology integrates traditional pedagogical approaches with contemporary digital technologies, ensuring both preservation fidelity and accessibility for diverse learning styles. Archaeological evidence demonstrates that textile traditions have evolved through distinct historical periods, with each contributing essential elements to contemporary practice.

2. What exhibition design approaches most effectively communicate cultural heritage to diverse audiences?

The research validates that interactive, multi-sensory exhibition design approaches achieve significant improvements in visitor learning outcomes, with a documented increase in cultural understanding. These results align with contemporary museum studies research emphasizing experiential learning methodologies that engage multiple cognitive and sensory pathways.

The integration of digital elements with traditional artifacts creates immersive experiences that enhance both educational and emotional engagement. Effective approaches include Virtual Reality simulations of weaving processes, Augmented Reality applications displaying pattern meanings and textile significance, and multimedia storytelling featuring artisan narratives and community contexts. Holistic spatial design encompasses continuous narrative arrangements, strategic use of lighting, color, and sound to create atmospheric immersion, and interactive spaces allowing visitors to experience authentic textiles through guided tactile engagement.

Contemporary exhibitions function as crucial instruments for bridging traditional knowledge with contemporary creative expression. They facilitate audience comprehension of textile value and aesthetic significance through modern, engaging presentations

that maintain cultural authenticity while ensuring accessibility for diverse demographic groups. The integration of traditional textiles with contemporary design creates new perspectives that position cultural heritage not merely as historical artifacts, but as sources of inspiration for modern artistic and design innovation.

Cross-cultural understanding is enhanced through effective presentations that enable younger generations and international audiences to appreciate textile value, resulting in broader recognition and support for heritage preservation initiatives. Technology integration serves as a presentation tool for creating impressive experiences without overshadowing traditional knowledge value.

3. How can SDG integration enhance both cultural preservation and community development outcomes?

The integration of SDGs with cultural heritage preservation creates synergistic benefits that exceed the sum of individual components. The comprehensive approach developed in this study successfully addresses multiple development goals simultaneously.

Measurable economic benefits demonstrate that cultural preservation can simultaneously support community economic development, with documented increases of 23% in tourism revenue and 31% in product sales growth. This finding challenges traditional assumptions about tensions between preservation and commercialization, suggesting that thoughtful integration benefits both cultural authenticity and economic sustainability. The research establishes that exhibitions must generate income and economic opportunities for producer communities through market promotion and new product development strategies.

The creation of innovation spaces where traditional artisans collaborate with contemporary designers, entrepreneurs, and technologists to develop new applications for traditional knowledge demonstrates practical cultural innovation while creating new products and market opportunities. Showcasing successful enterprises that combine traditional crafts with contemporary business models reinforces both cultural appreciation and entrepreneurial thinking among community members.

Culture as the fourth pillar of sustainable development is confirmed through this integration's success, suggesting significant potential for scaling this model to other cultural heritage contexts globally. The

framework's flexibility allows adaptation to diverse cultural contexts while maintaining core principles of preservation, education, and community empowerment.

Sustainable development requires long-term planning emphasizing community strengthening, skill development, and collaborative network creation. Government support through budget allocation, policy formulation, and personnel development is essential, along with inter-agency cooperation ensuring efficient operations covering all dimensions of sustainable development. Contemporary exhibitions therefore serve not merely as artistic presentations, but as instruments for creating sustainable futures for communities and culture through meaningful connections between past, present, and future.

The research confirms that technology and tradition can coexist productively when implemented through community-centered, culturally sensitive approaches. Future applications should prioritize community ownership, cultural authenticity, and sustainable economic development to ensure long-term success and replicability across diverse cultural contexts. The researchers conclude that contemporary exhibitions representing the progression from traditional knowledge to creative innovation in Northeastern Thai textiles constitute a vital strategy for sustainable development. The primary purpose involves conserving and developing traditional knowledge to align with contemporary times, with several critical considerations: Technology Integration: Modern technology serves as a tool for presentation and creating impressive experiences without overshadowing the value of traditional knowledge. Value Addition: Exhibitions must aim to generate income and economic opportunities for producer communities through market promotion and new product development. Cross-Cultural Understanding: Effective presentations enable younger generations and international audiences to understand and appreciate the value of Northeastern Thai textiles, resulting in broader recognition and support. Sustainable Development: Exhibitions require long-term development plans emphasizing community strengthening, skill development, and collaborative network creation.

Government support in terms of budget allocation, policy formulation, and personnel development is essential, along with inter-agency cooperation to ensure

efficient operations covering all dimensions of sustainable development. Contemporary exhibitions of Northeastern Thai textiles therefore serve not merely as artistic presentations, but as instruments for creating a sustainable future for Northeastern communities and culture through meaningful and harmonious connections between past, present, and future.

Declaration of generative AI in scientific writing

AI-generated imagery (Figure 3) in this article was created using Gemini to simulate exhibition design approaches for illustrative purposes. All generated content was reviewed and modified by the researchers to ensure accuracy and cultural appropriateness. The authors assume full responsibility for the content.

CRedit author statement

Monchaya Sabuar: Methodology, Data curation, Writing- Original draft preparation, Writing- Reviewing and Editing, Visualization, Investigation.

Kham Chaturongakul: Advisor, Validation.

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