

# Artificial Intelligence Generated Content Reshaping Transnational Costume Patterns: Opportunities and Challenges of the Bajau “Olos Sandang” and Lahu “Unity Flower”

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## ABSTRACT

This study explores the potential of Artificial Intelligence Generated Content (AIGC) to reshape and reinterpret traditional textile patterns across cultures, focusing on the Bajau Olos Sandang from Sabah, Malaysia, and the Lahu Unity Flower from Yunnan, China. Although these communities are geographically and historically distant, their textile motifs share remarkable visual and symbolic similarities, reflecting common themes of social cohesion, unity, and harmony with nature. By employing AIGC-driven generative design, pattern reconstruction, and human-AI co-creation, the research demonstrates how digital technologies can both preserve cultural authenticity and foster innovative adaptations for contemporary design. The study also addresses challenges such as ethical considerations, cultural misrepresentation, and intellectual property concerns, proposing strategies including the creation of annotated pattern databases, human cultural validation, and ethical co-design frameworks. Findings suggest that AIGC can serve as a mediator between tradition and modernity, enabling designers to generate hybrid motifs, facilitate intercultural dialogue, and enhance global visibility of endangered crafts. Overall, this research highlights the transformative role of AIGC in sustaining intangible cultural heritage, promoting responsible innovation, and bridging the gap between local artisanal knowledge and contemporary creative industries in the digital era.

**Keywords:** AIGC; cross-cultural textile design; cultural heritage preservation; generative innovation

## INTRODUCTION

In recent years, Artificial Intelligence Generated Content (AIGC) has rapidly emerged as a transformative force in global creative industries (Stanikzai & Mittal, 2025). Its capacity to analyze, generate, and reimagine visual content has profoundly reshaped the landscape of art, design, and cultural production (Zhao et al., 2023). Within the field of design, AIGC offers unprecedented potential for the revitalization of traditional cultural motifs, enabling designers to preserve heritage while introducing novel forms of aesthetic expression. As the dialogue between technology and tradition deepens, AIGC becomes not merely a tool but an active collaborator in cultural reinterpretation. Through deep learning and visual data synthesis, it can recognize recurring patterns, reconstruct lost visual heritages, and facilitate the cross-cultural adaptation of traditional motifs into modern design contexts.

Against this technological backdrop, this research explores the cross-cultural dynamics between the Bajau community of Sabah, Malaysia, and the Lahu ethnic group of Yunnan, China (RENDDAN et al., 2023). Despite being separated by geography, language, and history, both communities possess remarkably similar textile motifs that convey deep cultural symbolism. The Bajau’s “Olos Sandang” a form of intricate embroidery characterized

by geometric repetition (Derak et al., 2025), bold color contrasts, and symbolic representation of harmony finds an unexpected resonance in the Lahu's "Unity Flower" (referred to as "ꨀꨁꨂꨃꨄꨅꨆꨇꨈꨉꨊꨋꨌꨍꨎꨏꨐꨑꨒꨓꨔꨕꨖꨗꨘꨙꨚꨛꨜꨝꨞꨟꨠꨡꨢꨣꨤꨥꨦꨧꨨꨩꨪꨫꨬꨭꨮꨯꨰꨱꨲꨳꨴꨵꨶ꨷꨸꨹꺀꺁꺂꺃꺄꺅꺆꺇꺈꺉꺊꺋꺌꺍꺎꺏꺐꺑꺒꺓꺔꺕꺖꺗꺘꺙꺚꺛꺜꺝꺞꺟꺠꺡꺢꺣꺤꺥꺦꺧꺨꺩꺪꺫꺬꺭꺮꺯꺰꺱꺲꺳꺴꺵꺶꺷꺸꺹꺺꺻꺼꺽꺾꺿꺰꺱꺲꺳꺴꺵꺶꺷꺸꺹꺺꺻꺼꺽꺾꺿" in the Lahu language), motif, which symbolizes community, balance, and connection with nature. Both motifs embody their respective cultural values: social cohesion, identity, and spirituality embedded in material forms. This unexpected visual homology raises fascinating questions about cultural diffusion, shared regional aesthetics, and the universal patterns underlying human creativity.

However, academic and design research on these two ethnic motifs remains scarce. Studies that integrate AIGC technologies into the exploration, preservation, and innovation of such traditional textile patterns are virtually nonexistent. While ethnographic and anthropological studies have documented the Bajau and Lahu textiles as cultural artifacts, few have examined how algorithmic design can reinterpret their motifs for contemporary global audiences without diminishing their cultural integrity (Badaruddin et al., 2021). Furthermore, there is a research gap in the systematic analysis of visual homology, how two visually similar motifs arising from distinct cultural and geographical contexts can be understood, compared, and creatively integrated using AI-based generative design. Addressing this gap not only enriches academic discourse but also contributes to sustainable cultural innovation and digital heritage preservation.

This study seeks to investigate how AIGC can be utilized to reshape and reinterpret transnational costume patterns, particularly focusing on the Bajau "Olos Sandang" and the Lahu "Unity Flower." The central research problem revolves around the tension between technological innovation and cultural authenticity: How can AIGC technologies foster creative design that respects the cultural essence of traditional patterns while enabling cross-cultural adaptation and modern relevance? To address this overarching problem, the research aims to explore how AIGC technologies assist in the documentation, analysis, and creative reinterpretation of these motifs.

This research carries both theoretical and practical significance. Theoretically, it contributes to the interdisciplinary dialogue between artificial intelligence, cultural studies, and design theory. The comparative focus on Bajau and Lahu motifs provides an innovative lens for analyzing transnational cultural convergence, offering insights into how distinct ethnic traditions may share underlying visual logics shaped by geography, cosmology, and craft techniques. From a practical perspective, the study offers valuable implications for creative industries, particularly in sustainable fashion and cultural product design. AIGC-assisted design can support the revitalization of endangered crafts by generating digital archives, assisting young designers in reimagining traditional motifs, and promoting cultural visibility on global platforms. Moreover, by articulating strategies to navigate the ethical challenges, the research proposes pathways for responsible AI integration in heritage-based design.

## LITERATURE REVIEW

### AIGC and Its Application in Creative Design

Artificial Intelligence Generated Content (AIGC) has become one of the most transformative developments in the global creative industries. Emerging from advances in deep learning, machine vision, and generative algorithms, AIGC extends beyond automation to active creative collaboration between humans and machines (Zi-yang, 2024). The concept of generative design emphasizes the ability of algorithms to generate multiple design iterations based on predefined parameters, allowing designers to explore creative possibilities beyond human intuition. With the rise of diffusion models and transformer-based architectures such as DALL·E, Midjourney, and Stable Diffusion, AIGC has entered a new stage where machines can produce original artistic outputs that reflect stylistic nuance and contextual meaning.

In the field of visual and textile design, AIGC has enabled the reimagination of material culture through digital co-creation. Scholars such as Chiang et al. (2025) argue that AI-assisted art challenges traditional definitions of authorship and originality, as creativity becomes a shared process between algorithmic systems and human intent. In fashion design, AI-generated patterns are increasingly used to forecast trends, simulate textures, and even create entirely new design aesthetics inspired by cultural motifs. Furthermore, AIGC's application in creative design extends to visual culture and cultural preservation. It allows for the digitization, reconstruction, and adaptive reuse of traditional art forms while ensuring that their symbolic value is translated into new

contexts. Yet, this technological potential comes with ethical challenges. As researchers like Pan et al. (2025) emphasize, AIGC must be contextualized within cultural sensitivity frameworks to avoid decontextualization or cultural appropriation.

### **Traditional Textile Patterns**

Traditional textile patterns embody the historical memory, spiritual beliefs, and aesthetic philosophies of a community. They are not mere decorative elements but visual languages that encode identity and cosmology. Research on Southeast Asian and Southwest Chinese textile traditions has revealed their deep symbolic complexity, where color, geometry, and structure represent moral, spiritual, and social orders. The Bajau “Olos Sandang” of Sabah, Malaysia, is a distinctive handcrafted patchwork embroidery (Lailawati et al., 2019). It is created by piecing together brightly colored, high-contrast thin fabrics and embroidering intricate geometric patterns with hidden stitches, resulting in an exquisite and visually striking piece. Scholars such as Ahmad (2011) describe Olos Sandang as both an artistic practice and a social ritual, traditionally used to decorate wedding garments and ceremonial cloths. Each motif carries connotations of unity, resilience, and divine harmony. Yet, with modernization and declining craftsmanship, Olos Sandang faces challenges of preservation, as younger generations increasingly move away from traditional weaving practices.

Similarly, as the core symbol of the traditional attire of the Lahu ethnic group in Shuangjiang County, Yunnan Province, China, the “Unity Flower” (referred to as “ $\text{ɔ}^2 \text{phu}^6 \text{ɔ}^2 \text{di}^2 \text{ve}^{54}$ ” in the Lahu language), pattern carries profound symbolic meaning. This black-and-white, symmetrical square pattern typically consists of four interlocking triangular units. Its orderly form metaphorically represents the wisdom of harmonious coexistence between humanity and nature, while also embodying the cultural essence of unity within the Lahu community. Today, it has become a unique emblem of spiritual reliance and identity for the local ethnic group. These patterns are embedded within oral narratives and ritual practices, serving as metaphors for cosmic balance and ancestral continuity. However, the rise of mass-produced textiles has led to cultural simplification, with many original motifs either lost or commercialized without proper cultural interpretation.

### **Transnational Cultural Connections in Traditional Textile Motifs**

Although the Bajau and Lahu communities are geographically distant, separated by seas and national border, their textile traditions reveal intriguing visual similarities. Scholars of cultural anthropology have long observed patterns of transnational visual convergence, where different ethnic groups develop analogous symbols and motifs due to shared environmental, spiritual, or social conditions (Das, 2006; Khan, 2023). These parallel developments may reflect universal human tendencies in pattern recognition, symmetry, and symbolism, as suggested by Colby et al. (1981). In Southeast Asia and Southwest China, textile patterns often follow similar cosmological structures, rooted in agrarian societies and animist beliefs (Buckley, 2023). The recurrence of geometric and floral forms expresses ideas of continuity and balance found across Austronesian and Sino-Tibetan cultural spheres (Scott, 2009). For example, both the Bajau “Olos Sandang” and the Lahu “Unity Flower” use symmetry and repetition to convey moral order and community unity, serving as spiritual protection and visual affirmation of collective identity.

However, comparative studies across borders remain limited. Most existing literature focuses on single-ethnic analyses rather than cross-cultural visual semiotics. By comparing the Bajau and Lahu motifs, this study addresses a crucial research gap: understanding whether these visual resemblances emerge from shared cultural logic, historical contact, or independent creativity. Additionally, the integration of AIGC technologies introduces a new dimension, thus creating a digital dialogue between traditions. This digital transnationalism challenges conventional ethnographic boundaries, positioning AIGC as both a research tool and a cultural bridge that redefines how we interpret design homology in global textile traditions.

### **Cross-Cultural Design and Semiotic Theory**

Cross-cultural design theory provides the conceptual foundation for integrating traditional motifs into global design systems while maintaining cultural authenticity (Rau et al., 2024). It emphasizes cultural empathy, contextual translation, and symbolic respect. According to Chiu et al. (2013), effective cross-cultural design

requires not merely transferring visual forms but also understanding their underlying meanings and social functions. In this sense, AIGC-driven design operates within a delicate balance: while it can generate new hybrid aesthetics, it must also safeguard cultural context and ethical integrity. Semiotic theory, as articulated by scholars like Roland Barthes and Charles Peirce, offers an analytical framework to decode the signs and symbols embedded in textile motifs. Each visual element (a color, shape, or repetitive pattern) functions as a signifier that conveys cultural narratives and values. In traditional textile art, semiotics helps reveal how motifs encode identity, spirituality, and social belonging. For instance, the Lahu “Unity Flower” acts as a symbolic representation of harmony and kinship, while the Bajau “Olos Sandang” signifies endurance and cultural unity.

Recent research in AI and semiotics proposes that algorithmic creativity can engage with symbolic systems, translating cultural signs into data-driven design languages (Matthews & Danesi, 2019). Thus, by combining cross-cultural design principles with semiotic awareness, designers and researchers can ensure that AIGC-generated outputs remain culturally informed, contextually grounded, and ethically sensitive. In this study, the integration of these two theoretical perspectives serves as a foundation for developing a cross-cultural AIGC design framework, enabling meaningful dialogue between technology and tradition, and between the Bajau and Lahu textile worlds.

## Cultural Context and Visual Analysis of Transnational Patterns

### The Bajau “Olos Sandang” Pattern

Traditional attire of the Sama-Bajau people in Tuaran Village, Sabah, Malaysia, includes a black or white long-sleeved shirt (badu sampit), adorned with gold buttons (betawi) and silver floral motifs (intiras) on the collar, placket, and sleeve slits. The lower garment consists of black trousers (seluar sampit) or a tube skirt, featuring gold lace trim along the sides or hem. This ensemble is paired with a boat-shaped headdress (Madlan et al., 2014; Derak et al., 2025). The term “sama” is said to derive from an Austronesian root meaning “together,” “same,” or “kin.” Traditional Bajau Clothing Craftsmanship: Centered on “intra-family hereditary transmission,” it lacks formal official inheritance mechanisms or intangible cultural heritage protection bases. Skills are primarily passed down through elders teaching weaving techniques to younger generations. The status of inheritors is naturally established based on mastery of the craft, requiring no external certification.

**Fabric Sourcing:** Acquisition channels exhibit a “combination of internal and external sources,” reflecting cultural exchange and integration with surrounding communities. On one hand, fabrics and copper decorative items are purchased from other ethnic groups or indigenous communities within Sabah, Malaysia. On the other hand, textile fabrics from China and other countries are imported through trade channels to meet bulk demands for everyday garment production. Homemade fabrics are limited to headscarves, woven by local artisans on traditional wooden handlooms. The crisp texture and distinctive patterns of these fabrics carry strong ethnic identity, serving as the core vehicle for preserving indigenous craftsmanship among the Bajau.

**Cultural Significance of Patterns and Colors:** This geometric motif corresponds to the distinctive decorative form of the Bajau community, known as Sempangan. It is commonly used in weddings, various celebratory events, and home decor. It features vibrant fabrics adorned with patterns reflecting the social and environmental context of the user's community. In color selection, the Bajau typically use yellow and green as the base colors for Sempangan, subsequently embellishing them with various geometric patterns. The act of affixing or stretching the Sempangan is termed Ngelemb, specifically referring to its method of use (adhesion/suspension). This is the Bajau people's exclusive designation for this decoration, vividly reflecting the uniqueness of their culture. The colors of Bajau clothing are not merely aesthetic designs but cultural symbols imbued with the group's historical memory and identity markers, forming a visual expression.

Later, adapting to changing times, these patterns gradually integrated into modern clothing design systems. In practical application, these patterns carry no specific cultural connotations nor unified names (commonly used as decorative scarves, they are generally termed “Selendang” in Malay). Thus, they persist as decorative symbols. Beyond adding vivid visual depth to dark garments, these patterns significantly enhance the overall ornamental aesthetic of the attire. Notably, within the Bajau-sama dialect system of Sabah's Tuaran region, this patterned decorative scarf is termed “Olos Sandang,” establishing a distinct regional cultural designation. Unlike

traditional ceremonial motifs, “Olos Sandang” carries no explicit cultural symbolism, focusing instead on ornamentation and vibrant color expression.

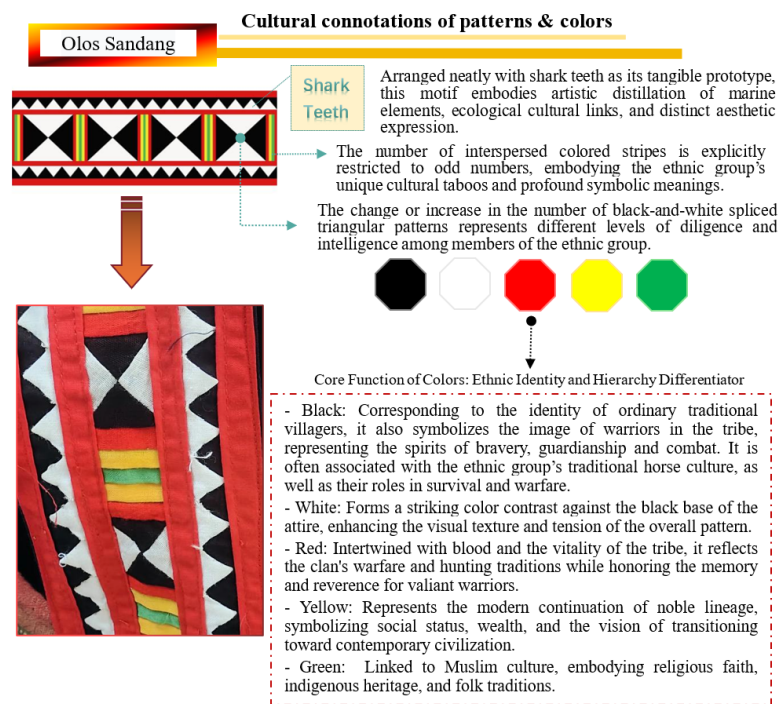


Figure 1. The cultural symbol of identity recognition of “Olos Sandang”

As shown in Figure 1, the neatly arranged triangular patterns concretely depict shark teeth motifs. The off-white color creates a shimmering visual effect reminiscent of rolling sea waves, metaphorically conveying an artistic distillation of marine elements. This design both echoes the cultural connection between the ethnic group and the marine ecosystem and showcases an aesthetic expression inspired by natural ecology. In terms of pattern composition, the number of triangles directly correlates with the pattern's composition 4, 8, or more triangles. An increased quantity signifies varying degrees of diligence and wisdom within the community. Additionally, the number of colored stripes interspersed between black and white squares is strictly limited to five or other odd numbers, with even numbers prohibited. This numerical restriction may reflect the distinctive cultural taboos and deep-seated symbolic expressions of identity upheld by the Bajau-Sama community.

**Historical and cultural context:** The embroidery traditions of traditional attire among various subgroups in Sabah exhibit slight regional variations. As noted by Lee (2019), the Linangkit pattern technique originated from traditional needlework practices in Mindanao, southern Philippines. Through long-term regional exchanges, the craft spread to Sabah. Its terminology reflects linguistic connections to the region, with the core practice involving the creation of intricate geometric patterns through interlaced threads and fabric patchwork, achieving decorative fabric functionality without looms (Isaiah, 2020). In the Tuaran region of Sabah, the “Olos Sandang” traditional pattern of the land-dwelling Bajau people predominantly feature black fabric as a base, onto which multicolored fabric pieces triangular, square, and zigzag in shape are meticulously pieced together into cohesive, tightly structured decorative panels. Characterized by durable and reusable construction, these panels fulfill practical functions in both adornment and attire. Moreover, through their precise geometric patterns and color coordination, Olos Sandang have progressively become iconic symbols embodying the traditional cultural skills and identity of Sabah's Sama-Bajau community.

**Visual characteristics:** Olos Sandang employs striking red fabric strips as horizontal dividing lines, neatly partitioning the overall pattern structure into uniformly sized black-and-white squares and triangular zigzag units. Through regular, repetitive arrangement, it constructs a continuous and tension-filled geometric texture, achieving balanced visual weight and a strong sense of order. Between these red dividers, small patches of yellow and green fabric are embedded. This technique paradoxically sharpens the pattern's skeletal structure, breaking the monotony of pure geometry while infusing dynamic rhythmic variation through color. Formally, both the block-like geometric details and the layout of dividing lines emphasize symmetrical beauty in vertical and horizontal axes.

Symbolic meaning: Olos Sandang patterns are intrinsically linked to indigenous religious beliefs and cultural identity. The Sama-Bajau people depend on their surrounding natural environment for survival, and folklore holds that this interlaced technique can “lock in blessings,” protecting wearers from natural disasters and malevolent forces. “Olos Sandang” serves not only as a totemic symbol of unity and resilience but also as a core identifier of their ethnic identity. Its continuous, interwoven decorative patterns (literally meaning “connection”) metaphorically represent the emotional bonds between people, the strong family ties, and the formidable resilience forged by the community within diverse environments. The emergence of this cultural symbol deeply resonates with the survival context of the Bajau Samas. Traditionally inhabiting the intricate ecosystems of island interiors, they sustain themselves through diverse livelihoods (Badaruddin et al, 2021). Renowned for their masterful horsemanship, they are celebrated as the “Eastern Cowboys” or “Sabah Cowboys,” embodying a uniquely Malaysian ethnic identity (Renddan et al, 2023).

Current challenges: Despite its cultural richness, Olos Sandang faces a decline in contemporary society. Younger generations often regard traditional embroidery as outdated, opting instead for mass-produced clothing. The lack of commercial viability and insufficient documentation has led to a gradual erosion of craftsmanship. Additionally, the commodification of ethnic textiles in tourism markets risks distorting the authentic meanings of Olos Sandang, transforming it into mere decorative exotica rather than a cultural narrative. Therefore, revitalization through digital innovation presents an emerging opportunity to reconnect Olos Sandang with modern audiences while safeguarding its cultural essence.

### The Lahu “Unity Flower” Pattern

The “Unity Flower” or “ $\text{ɔ}^2 \text{phu}^6 \text{ɔ}^2 \text{di}^2 \text{ve}^{54}$  (Lahu language)” is a prominent decorative motif in the traditional textiles of the Lahu ethnic group from Yunnan, China. Rooted in the Lahu’s agrarian and animist worldview, the motif symbolizes harmony, balance, and collective identity. In the “Gourd Legend” recorded in the Lahu epic creation myth “Mu Pa Mi Pa,” during the flood that destroyed the world, the gourd became the refuge for the ancestors (Zadi and Nadi), enabling the tribe to survive and multiply (Sun, 2022). The gourd is thus revered as a sacred womb (the celestial mother Eza) and a protective talisman, central to rituals like the Gourd Festival. This protective symbolism is deeply intertwined with the Unity Flower motif. Its paired, symmetrical form both perpetuates the cultural core of collective cohesion and visually embodies the aspiration for a better life. Pattern motifs like “seed clusters” and “huddled gourds” resonate across migration, agricultural rituals, and ceremonial festivals, endowing textiles with dual significance as both spiritual anchors for the community and markers of ethnic identity. Their cultural implications are detailed in Figure 2.

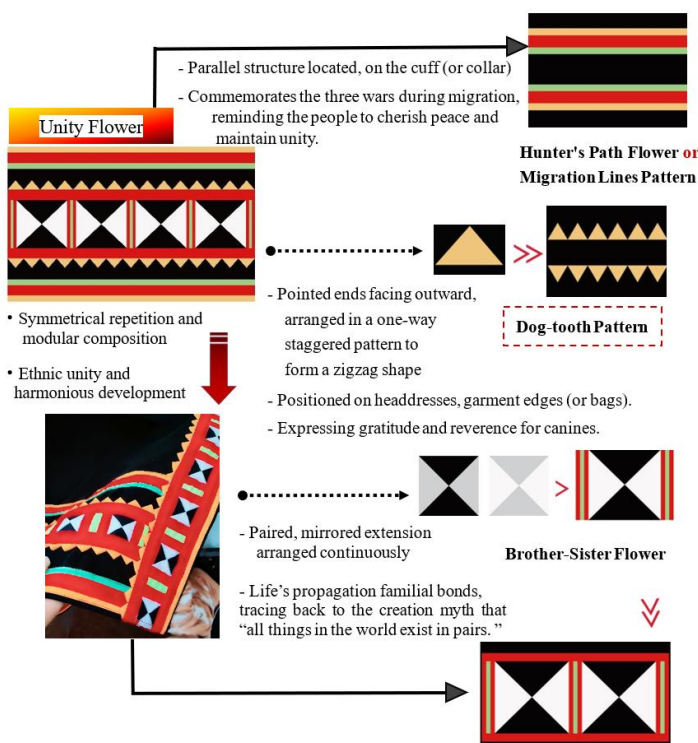


Figure 2. “Unity Flower” A cultural symbol worn on the body

**Structural and Visual Features:** The Unity Flower pattern features symmetrical, modular geometric motifs arranged in a continuous two-dimensional design. Typically, black and white triangular elements (horizontal or vertical) are mirror-symmetrically assembled into squares. Interspersed between the main structures are short vertical stripes of red and green, along with parallel horizontal red stripes arranged vertically, creating visual focal points and color balance (Chen et al., 2023). The pattern then extends horizontally, establishing a stable rhythmic flow through repeated color blocks. The upper and lower borders feature a single row of small yellow triangles arranged in an alternating, repeating pattern, forming a classic two-dimensional zigzag motif. This zigzag pattern, known as “phU<sup>53</sup> tji<sup>31</sup> ve<sup>54</sup>” in Lahu ethnic clothing designs, is interpreted in Chinese as the “dog-tooth pattern” or “dog-fang pattern.” As a significant border element, it is widely applied to decorative areas such as headdresses (head wraps), garment fronts, slits in long skirts, and cuffs. This continuous symmetrical structure visually conveys metaphors of order and balance, resonating with the Lahu belief in the interconnectedness of humanity, nature, and the cosmos.

Color plays a crucial semiotic role in the Unity Flower (Zhao & Sedon, 2024). The Lahu people revere black as a cultural identity, adhering to the traditional notion that “black is beautiful and black is precious.” This stems primarily from their slash-and-burn farming practices and the demanding, labor-intensive nature of their extensive cultivation methods. Yet simple blackness does not encompass the Lahu people's entire aesthetic pursuit. Beyond the black base color, their garments feature vivid primary hues like red and white, accented with subtle touches of yellow and green, symbolic mediators of energy and equilibrium. This integration of colors forms a cultural metaphor for sustainable coexistence between humanity and the natural world. When the patterns rhythmically repeat across garments, bags (referred to as “Mian cuo” or “Da lan bei” in the Lahu language of Shuangjiang city), and ceremonial cloths, their symbolic meaning activates within specific socio-cultural contexts, such as festivals and community gatherings, becoming vessels that embody the ecological ethics of juxtaposing ethnic colors.

**Symbolism and Meaning:** the symbolic essence of the Unity Flower is rooted in the historical memory, ethnic beliefs, and philosophical thought of the Lahu people, embodying a convergence of multicultural significance. Its core design features symmetrical black-and-white “brother-sister flower” patterns (referred to as “a<sup>33</sup> vi<sup>35</sup> a<sup>33</sup> ni<sup>33</sup> ve<sup>54</sup>” in the Lahu language). This motif originates from the Lahu dualistic worldview that “all things in the world exist in pairs.” It metaphorically represents the complementary cosmic order of yin and yang, embodies the collective ideal of “unity among all ethnic groups” shared by China's 56 ethnicities, and vividly illustrates the cultural essence of harmonious coexistence within the tribe. The interlocking “dog-tooth pattern (referred to as “phU<sup>53</sup> tji<sup>31</sup> ve<sup>54</sup>” in the Lahu language)” embedded within the design, as a material expression of totem worship, embodies the Lahu people's reverence for dogs that saved their ancestors. This resonates culturally with the folk tradition of abstaining from eating dog meat, reinforcing the vision of unity and mutual support within the ethnic group. Furthermore, the red, yellow, and green (or multicolored) fabric strips inlaid above and below the pattern, commonly known as “Hunter's Path Flower” or “Migration Lines Pattern” (referred to as “ja<sup>11</sup> qha<sup>53</sup> ve<sup>54</sup>” in the Lahu language), carry significance that extends far beyond mere ornamentation. Their presence directly maps onto the three primary war routes traversed by the Lahu people throughout their protracted migratory history.

**Current Challenges:** The rapid industrialization and commercialization of rural China have dramatically transformed the production and consumption of traditional textiles. Handwoven Lahu fabrics have been increasingly replaced by machine-printed substitutes, and younger artisans often lack the motivation or opportunity to learn traditional weaving techniques. Moreover, globalization has led to homogenization of aesthetic styles, threatening the uniqueness of the Unity Flower motif. Without systematic documentation or digital archiving, much of its symbolic vocabulary risks being lost. Integrating AIGC tools into the study and recreation of these patterns could thus play a crucial role in visual documentation, heritage education, and creative reactivation.

## Cross-Cultural Comparison

A comparative analysis of the Bajau “Olos Sandang” and the Lahu “Unity Flower” reveals that despite belonging to different nations and inhabiting distinct ecological environments mountainous regions versus island interiors their textile patterns exhibit striking visual similarities in structural form, color coordination, and craftsmanship,

while each subgroup maintains its unique design logic. Both employ a core compositional principle of geometric patterns featuring two-dimensional continuous combinations and unit repetition (horizontal and vertical). Symmetry and balance, rhythm and cadence, simplification and abstraction serve as creative elements, achieving formal beauty in ornamentation and unity. As compositional thinking in garment patterns, each motif embodies the community's ideals unity, religious beliefs (ritual ceremonies), and harmony with nature. In traditional attire, both tribes positioned textile production (including garment adornments) as a female-centered cultural practice, linking creativity to fertility, resilience, and cultural transmission. Notably, their pattern designs emphasize tonal contrast tension and spatial layout balance a shared aesthetic rooted in universal human perception and symbolic cognition (Chen et al, 2023). Yet significant cultural differences exist in material techniques, color symbolism systems, cultural contexts, and decorative placements. Olos Sandang's design language reflects the regional sensibilities of the Sama-Bajau (Land Bajau) inland island branch, with its expressive content deeply intertwined with the group's survival foundations. The fusion of stripes and solid surfaces, along with vivid, intense hues, resonates with the Bajau's traditional equestrian culture and its associated worldview of freedom.

Olos Sandang (Bajau)

Unity Flower (Lahu)



In contrast, the Unity Flower pattern's symmetrical duality and monochromatic palette resonate with the Lahu's agricultural cosmogony and mountainous environment. In terms of technique, Both designs employ patchwork flat-seam method. Olos Sandang (approximately 12-15cm), adorned with segmented embellishments of pom-poms and beaded tassels along the edges, while Unity Flower incorporates silver beads into the fabric, reflecting differences in material sourcing and production processes. Functionally, Olos Sandang primarily serves as decorative pendants adorning the front panels of garments, emphasizing ethnic identity. Unity Flowers, however, carry greater ceremonial significance, often integrated into religious beliefs and sacrificial systems, symbolizing blessings and sacredness. Comparative analysis is detailed in Figure 3 and Table 1.

Dimensions	Similarities	Differences
Pattern structure (Form beauty)	The pattern uses a two-dimensional continuous layout, with triangular motifs repeating along the edges and rectangular bars interwoven horizontally and vertically for balance.	Quantity and color differ; Mirrored positions differ.
Color symbolism (Symbolic meaning)	Core palette of red, black, and white, accented with subtle yellow and green for contrast, creating distinct layers and strong visual impact	Olos Sandang's colors symbolize heritage and valor, while Unity Flower favors black and red to express nature reverence and understated culture.
Production process	Both employ patchwork techniques to assemble black-and-white triangular fabric	Olos Sandang highlights tactile textures with beads and yarn, while Unity Flower

(Technique flow)	pieces into squares, then inlay horizontal, vertical, and zigzag fabric strips.	uses stitching and silver to convey heritage and symbolism.
Material extraction (Weaving techniques)	Overall fabric panels are assembled using plain-weave cotton and local hemp fabrics as bases.	Bajau clothing is light and layered for tropical climates, while Lahu attire is thick and durable for cold highlands.
Cultural context (National spirit)	Both embody the spirit of ethnic unity and coexistence, reflecting cultural exchange and familial bonds among ethnic groups.	Olos Sandang signals tribal identity and historical memory, while Unity Flower embodies ritual, community cohesion, and reverence for nature.
Decorative areas (Presentation form)	Both use patterns to enhance key visual points on clothing, emphasizing symmetry, repetition, and balance in design.	Bajau patterns drape symmetrically around the neck and chest, while Lahu designs appear on headwear, collars, slits, and cuffs.

Table 1. Comparative perspectives through a cross-cultural lens

These similarities and differences offer valuable insights for AIGC-driven cross-cultural design. The visual structures of both patterns provide archetypal prototypes for algorithmic learning. By analyzing these motifs through digital means, designers can experiment with hybrid forms that respect both traditions while fostering new intercultural aesthetics. Ultimately, the dialogue between Olos Sandang and the Unity Flower exemplifies how AIGC can mediate between local tradition and global creativity, creating pathways for cultural innovation without erasing authenticity.

### Aigc Empowerment and Design Methodology

#### The Role of AIGC in Traditional Pattern Innovation

The rise of Artificial Intelligence Generated Content (AIGC) marks a paradigm shift in how visual culture, particularly traditional textile patterns, is reinterpreted in the digital age (Jora et al., 2024). AIGC technologies, ranging from deep generative networks to diffusion models, enable the transformation of intangible cultural elements into dynamic and reconfigurable digital visuals. Within this framework, AI does not simply replicate human creativity; it functions as a visual bridge between tradition and modernity. In the context of ethnic textiles such as the Bajau Olos Sandang and the Lahu Unity Flower, AIGC serves to extend the creative potential of traditional artisans by offering tools that can visualize latent cultural motifs, recombine pattern structures, and simulate stylistic evolution across time and geography.

From a technical standpoint, generative models like Midjourney, DALL·E, and Adobe Firefly offer diverse capabilities for textile innovation (Rizzi & Bertola, 2025). Midjourney excels in stylistic coherence and composition, making it suitable for pattern rhythm exploration; DALL·E emphasizes conceptual fusion, ideal for generating hybrid cultural forms; Firefly provides controllable editing functions, facilitating post-generation refinement. The input data consisted of curated visual datasets, including ethnographic textile images, museum archives, and field-collected photographic records, combined with structured textual prompts derived from cultural symbolism and design attributes. Collectively, these tools enable researchers and designers to extract symbolic elements from traditional sources, simulate pattern mutations, and visualize cross-cultural syncretism. Importantly, this process must go beyond aesthetic novelty, allowing traditional motifs to evolve without being detached from their original semiotic foundation. Thus, AIGC becomes not only a generator but a mediator that balances technological innovation and cultural authenticity.

#### Design Principles and Ethical Constraints

The integration of AIGC into cultural design introduces new ethical and epistemological questions. At the heart

of this challenge lies the principle of Respect and Authenticity, ensuring that AI-generated outputs reflect the cultural essence of the original traditions rather than merely aestheticizing them (Szostak, 2025). The Bajau Olos Sandang, deeply associated with maritime identity and women's craftsmanship, and the Lahu Unity Flower, symbolizing collective harmony, both carry layers of meaning that transcend visual form. Designers must therefore adopt a culturally informed approach, embedding contextual understanding into AI prompts and model training data to avoid superficial appropriation.

Equally critical is the avoidance of Cultural Appropriation and Misrepresentation. When AIGC systems combine motifs from distinct cultural origins, they risk producing hybrid outputs that distort or trivialize traditional narratives. Establishing an ethical design boundary requires a transparent methodology, documenting data sources, involving community representatives, and ensuring that AI-generated visuals undergo cultural validation. In this context, "human-AI co-creation" must not be a replacement for indigenous creativity but rather a facilitative process where AI functions as a cultural collaborator. Such an approach redefines authorship in digital heritage design, positioning AIGC as an enabler of cultural revitalization under ethical stewardship.

### **Creative Generation and Experimental Workflow**

The experimental methodology for cross-cultural textile innovation through AIGC follows a structured pipeline: Pattern Element Extraction → Keyword Training → AIGC Generation → Human-AI Co-Editing → Cultural Review. First, visual and symbolic elements are systematically extracted from ethnographic documentation and textile archives. The dataset includes high-resolution images of Bajau and Lahu textiles, annotated with metadata such as motif type, color distribution, and symbolic meaning. These elements, such as the zigzag embroidery of the Bajau Olos Sandang and the symmetrical radiance of the Lahu Unity Flower form the semantic foundation of AI prompts. In the keyword training phase, descriptive linguistic models are developed to embed both aesthetic attributes (color tone, geometry, rhythm) and cultural semantics (unity, oceanic identity, community bonding) into the generation process.

During the AIGC generation stage, multiple diffusion or transformer-based models are deployed to produce diverse visual outcomes. These outputs are then subjected to co-editing to refine composition, adjust cultural symbolism, and maintain design coherence. The final stage, cultural review, involves community or expert evaluation to ensure that the AI-generated designs align with authentic cultural expression. The evaluation criteria include visual coherence, cultural accuracy, innovation level, and usability in textile applications, assessed using a qualitative scoring framework. As a case illustration, the integration of "Olos Sandang" and "Unity Flower" patterns results in hybrid compositions featuring rhythmic linework embedded within floral symmetries, visualizing a dialogue between the sea-oriented Bajau cosmology and the mountain-centered Lahu worldview. This not only demonstrates AIGC's potential in reconfiguring visual identity but also reveals how computational creativity can mediate cross-cultural empathy through design.

### **Visual Evolution and Innovation Model**

To systematize the creative process, this research proposes the AIGC Cultural Re-Creation Model (AIGC-CRM), a framework that maps how AI can facilitate cultural pattern innovation through structured visual evolution (Zhang, 2025). The model comprises five interconnected dimensions: (1) Structural variation: Employing geometric algorithms to parametrically deconstruct the foundational units of traditional patterns, followed by reconstructing and innovative morphological variations achieved through generative adversarial networks. (2) Accessory Abstraction: Systematically extracting visual features from decorative elements like Olos Sandang's beadwork, wool enpom-pom and beaded tassels, or the silver beads of the Lahu Unity Flower, completing dimensional reduction and abstract coding to generate low-dimensional feature vectors recognizable and deployable by AI. (3) Color Migration: Conducted cross-context tonal migration while preserving the core color symbolism of both ethnic groups. (4) Cultural Reorganization: Deconstructing and correlating ethnic pattern symbolism through layered analysis. Employing attention mechanisms to organically fuse symbolic meanings, generating new symbols that embody multiculturalism. (5) Feedback Learning: Establishing a "user-expert" collaborative feedback loop to continuously refine cultural adaptability assessments, guiding the model toward culturally coherent solutions through iterative optimization.

Through this model, AIGC transforms from a generative mechanism into an evolutionary system capable of cultural adaptation. The model also serves as a blueprint for developing sustainable AI design ecosystems that respect heritage while fostering innovation. It underscores that the future of textile design lies not in digital replication but in digital dialogue, a process in which AI interprets, learns from, and co-evolves with human culture. In this sense, AIGC's engagement with traditional patterns like Olos Sandang and Unity Flower exemplifies a new phase of cultural intelligence.

## **Opportunity, Challenges, And Strategic Responses**

### **Opportunity Analysis**

The integration of AIGC into the design and reinterpretation of ethnic textile patterns offers unprecedented opportunities for cultural revitalization and creative innovation. First, AIGC facilitates the digital dissemination of ethnic cultures, transforming local crafts into globally recognizable visual assets (Zhu et al., 2025). For communities such as the Bajau and Lahu, whose textile traditions are deeply rooted in localized environments, AI-driven visualization tools enable their motifs to be shared beyond geographical boundaries. Second, AIGC significantly enhances design efficiency and diversity. Through iterative generation and adaptive learning, AI systems can produce a wide range of stylistic variants within minutes. This process empowers designers to experiment with new compositions, color schemes, and hybrid motifs that merge Bajau Olos Sandang geometries with Lahu Unity Flower symmetries. Third, AIGC fosters cross-cultural resonance and artistic exchange. The comparative study of Bajau and Lahu patterns demonstrates that despite cultural and geographical differences, shared aesthetic logics can be algorithmically identified and creatively merged. This capability supports intercultural understanding by visualizing common human values embedded in traditional designs.

### **Challenge Analysis**

While AIGC unlocks immense potential, it also introduces a range of technological, cultural, and legal challenges that must be critically addressed. From a technological perspective, AI-generated outcomes often suffer from uncontrollable variations and cultural bias. Diffusion and transformer models tend to amplify the characteristics most represented in their training data, which may distort minority aesthetic norms or misrepresent cultural symbols. For example, the delicate hand-stitching rhythm of Olos Sandang or the sacred radial balance of Unity Flower may be algorithmically "beautified" into commercialized motifs, losing their artisanal subtlety and symbolic depth. The lack of culturally diverse datasets exacerbates this issue, as AI systems primarily trained on Western design references risk reinforcing visual hegemony in global design practices.

At the cultural level, AIGC introduces the risk of decontextualization, where traditional motifs are detached from their social and ritual meanings. When cultural symbols are extracted and recombined solely for aesthetic purposes, they may become visual ornaments devoid of their original narratives. This "over-simplification" undermines the integrity of indigenous knowledge systems. Furthermore, generative remixing between culturally distinct patterns, while visually intriguing, may blur ethnic identities and erode cultural specificity if not properly guided by contextual understanding and ethical awareness. From a legal standpoint, AIGC challenges the conventional frameworks of authorship and intellectual property (IP). Since AI-generated designs are often co-created by humans and machines, questions arise regarding originality, ownership, and copyright attribution. Moreover, existing IP systems rarely account for communal ownership of indigenous motifs, creating loopholes that could enable cultural exploitation.

### **Strategic Responses**

To maximize AIGC's benefits while mitigating its risks, a multi-dimensional strategy is required to integrate technological governance, cultural validation, and ethical collaboration.

**Establishing Ethnic Pattern Databases and AI Corpus Standards.** Creating a structured and annotated database of traditional textile patterns is essential for ensuring cultural accuracy in AI training. This repository should include visual samples, symbolic interpretations, oral histories, and technical details of weaving or embroidery methods. By encoding cultural metadata into AI corpora, designers can guide generative models to respect

traditional semantics and reduce bias. International collaboration among museums, universities, and local artisans could further standardize data practices and preserve intangible heritage digitally.

**Introducing Human “Cultural Calibration” Mechanisms.** While AI can generate patterns autonomously, human experts, particularly cultural scholars, artisans, and community representatives, must serve as cultural calibrators in the design loop. This hybrid process ensures that AI-generated visuals align with cultural meanings, ethical norms, and aesthetic authenticity. Co-creation workshops involving Bajau and Lahu craft practitioners could validate design outputs, providing feedback that refines AI models and enriches cultural representation. Such participatory frameworks transform communities from passive subjects into active co-designers.

**Building Ethical Frameworks and Co-Creation Models.** The rapid expansion of AIGC calls for an explicit AI design ethics framework emphasizing transparency, consent, and accountability. Ethical co-creation models should define guidelines for data sourcing, cultural referencing, and output dissemination. These frameworks can help prevent cultural appropriation by ensuring proper credit attribution and community involvement. Furthermore, educational initiatives and design curricula should embed ethical literacy, preparing future designers to engage responsibly with AIGC technologies in multicultural contexts.

**Strengthening Collaboration Between Academia and Local Communities.** Sustainable innovation requires a collaborative ecosystem that bridges research institutions, local societies, and cultural organizations. Academic studies can provide theoretical depth, while community partnerships ensure contextual grounding and cultural sensitivity. Through long-term fieldwork, digital archiving, and interdisciplinary dialogue, such collaborations can generate inclusive methodologies for AI-driven cultural preservation. Joint exhibitions, virtual showcases, and digital storytelling platforms may further enhance the social visibility and economic viability of traditional designs.

## CONCLUSION

### Summary of Key Findings

This study set out to explore how AIGC (Artificial Intelligence Generated Content) can reshape and reinterpret cross-national textile patterns, using the Bajau “Olos Sandang” from Malaysia and the Lahu “Unity Flower” from China as the core case studies. Both cultural motifs, though emerging from geographically distant and historically distinct ethnic groups, demonstrate striking structural and symbolic parallels. The introduction of AIGC into the field of cultural design represents a new paradigm shift. No longer confined to serving as a mere computational tool, AIGC now acts as an intelligent collaborator, capable of synthesizing traditional motifs, generating new aesthetic variations, and expanding the creative possibilities of cultural heritage preservation. The study found that AIGC’s generative models can effectively simulate traditional weaving textures, pattern symmetries, and color harmonies, allowing for hybrid reinterpretations that respect tradition while embracing modern aesthetics.

However, the research also revealed the complex duality of AIGC-driven cultural innovation. On one hand, it democratizes design production, enhances efficiency, and amplifies the international visibility of minority art forms. On the other hand, it raises serious cultural and ethical concerns, including risks of misrepresentation, loss of contextual meaning, and the blurring of authorship boundaries. The study therefore emphasized that technological empowerment must be balanced with cultural sensitivity, ethical reflection, and human oversight. To guide this balance, the research proposed an AIGC Cultural Re-Creation Model, which integrates five core phases: pattern extraction, semantic encoding, AI-assisted generation, human-AI co-editing, and cultural validation.

### Policy and Practical Implications

Based on the findings, several key recommendations can be made for policymakers, cultural institutions, and creative practitioners seeking to responsibly apply AIGC in the field of heritage design: (1) Establishing digital heritage databases. Governments and academic institutions should collaborate to build comprehensive cultural pattern databases that include visual archives, symbolic interpretations, and historical documentation of ethnic

textile art; (2) Encouraging participatory co-creation mechanisms. It is crucial to involve local artisans, cultural historians, and community representatives in the AI design process. Their participation ensures that generated outputs are aligned with traditional aesthetic principles and cultural values; (3) International and national agencies should formulate AIGC cultural ethics guidelines, clarifying the boundaries of cultural appropriation and promoting transparency in AI-generated content; (4) Integrating AIGC literacy in design education. Design and art education programs should embed AI cultural literacy into their curricula, enabling students to understand both the creative potential and ethical responsibilities of AIGC; (5) Promoting cross-border cultural collaborations. Joint exhibitions, digital museums, and international research projects should be encouraged to foster global dialogue on cultural innovation.

### Limitation and Future Research

While this study contributes to understanding AIGC's role in cultural innovation, several limitations must be acknowledged. First, the analysis primarily focused on qualitative visual interpretation. Future studies could adopt quantitative or experimental approaches, such as visual perception analysis, audience surveys, or market response evaluation, to measure how AI-generated cultural designs influence viewers' emotional and cognitive engagement. Second, this study examined only two case studies, the Bajau Olos Sandang and the Lahu Unity Flower. Although they offer a rich comparative foundation, they cannot fully represent the vast diversity of Asian textile heritage. Expanding the research to include other ethnic patterns across Southeast Asia and the Pacific regions would help to generalize findings and identify broader patterns of visual homology. Third, as AIGC technologies evolve rapidly, ethical and regulatory challenges remain dynamic. Future research should focus on establishing adaptive governance models, incorporating community consent, algorithmic transparency, and digital traceability mechanisms for AI-generated cultural content.

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