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Exploring the Craftsmanship of Traditional 'Baby Carriers' of the Miao Minority: Theoretical Insights and Digital Visualization Approaches

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Abstract
Contemporary design gradually combines traditional crafts with digital innovation to protect cultural heritage, exemplified by the traditional "baby carriers" of the Miao minority, which are rich in cultural heritage and exhibit unique design elements. To explore how digital visualization technologies can effectively preserve and communicate the cultural significance of Miao traditional "baby carriers," this study focuses on their digital representation using tools such as Photoshop, Adobe Illustrator, Style3D, and Browzwear. The aim is to establish a methodological approach for digitally extracting, reconstructing, and disseminating these artifacts' key aesthetic and symbolic features.

Keywords: Miao Traditional "Baby Carriers"; Digital Visualization

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1.0 Introduction

With a rich historical background, the Miao people constitute a significant ethnic group within the 5,000-year tapestry of Chinese civilization. Historically, the traditional "baby carriers" of the Miao minority (TBCM) were referred to as "swaddling." This practice is integral to the Miao people's intangible cultural heritage.

Nomenclature

TBCM	Traditional "Baby Carriers" of the Miao Minority – A symbolic textile artifact representing Miao cultural identity, childcare.
ICH.	Intangible Cultural Heritage –Non-material cultural expressions passed through generations, including practices, skills, and traditions.
AR	Augmented Reality – A digital technology that overlays virtual content onto the real world to enhance interactivity.
VR	Virtual Reality – An immersive technology that simulates a fully digital environment via headsets.
UCD	User-centred Design – A design framework that prioritizes user needs, behaviors, and context throughout development.
UX	User Experience – The overall perception and satisfaction a user gains from interacting with a digital system.

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1.1 Cultural Background

The history of the traditional "baby carriers" of the Miao minority (TBCM) can be traced back to the Tang Dynasty. These carriers utilize a rich palette of colors, intricate patterns, and skilled craftsmanship to merge fabrics and embroidery, thereby expressing aspirations for future generations' health, happiness, and well-being. It reflects the values and beliefs of the community. Beyond their practical utility, TBCM is emblematic of Miao culture and has cultural stories behind it (Cho, 2021). Narratives such as "sewing the carrier part after the child is born" and "the custom of borrowing a boy's carrier" show the unique social and cultural customs of the Miao people. Traditionally, leading the boy's thumb to a newly pregnant mother symbolizes the hope of continuing the family lineage. In contrast, a thong not reclaimed is regarded as an omen of good fortune and wealth. These symbolic acts illustrate that TBCM are not merely utilitarian objects, but culturally significant artifacts embedded in mythology, fertility rituals, and ancestral traditions (Zhang & Sharudin, 2024).

1.2 Rationale for Digital Visualization Techniques

Digital visualization technologies such as Virtual Reality (VR) and Augmented Reality (AR) have significantly enhanced the preservation and exhibition of traditional cultural artifacts like TBCM. These advanced technologies provide immersive experiences and deliver realistic representations of cultural heritage that might be inaccessible or difficult to engage with directly (Hong et al.; H.,2021).

1.3 Problem Statement

The preservation of TBCM faces severe challenges due to the fragile nature of textile materials and the reliance on oral transmission through informal master-apprentice systems (Tseng Li, 2009). Furthermore, geographical isolation and the absence of readily available documentation have further restricted the intergenerational transmission of traditional embroidery knowledge. When considered collectively, the aforementioned factors threaten the sustainability of this intangible cultural heritage (ICH). Despite the evident potential of digital visualization technologies to facilitate cultural preservation, there remains a significant gap in the systematic methodologies that can be utilised to digitally capture, reinterpret, and disseminate the symbolic and aesthetic values embedded in these carriers. Addressing this gap is imperative for ensuring both the cultural continuity and broader appreciation of Miao traditional craftsmanship in the contemporary era.

1.4 Research Objectives

This study aims to achieve the following objectives:

To identify the cultural features, symbolic meanings, and structural components of TBCM through visual, historical, and ethnographic analysis.

To extract key visual elements suitable for digital reconstruction using contemporary design tools and visualization technologies.

To develop a methodological framework integrating 3D modeling, virtual fitting, and augmented reality (AR) to preserve and reinterpret these cultural artifacts digitally.

To evaluate the effectiveness of digital visualization approaches in enhancing user engagement, cultural understanding, and the transmission of intangible heritage.

2.0 Literature Review

2.1 Historical Perspectives and Symbolism of the Traditional "Baby Carriers" of the Miao Minority

The traditional "Baby Carrier" of the Miao minority (TBCM) serves as a functional childcare tool and a vessel of cultural memory. Historical records, including *Yu Pan Yi Bu* and *Diapers, Swaddling Clothes, and Baby Carriers*, document their use as early as the Tang Dynasty. Typically crafted from thread woven into bands eight inches wide and two feet long, TBCM were designed to carry infants securely on the shoulders (Donna, 2012).

Beyond their utilitarian role, TBCM embodies rich cultural symbolism. They are closely associated with fertility, ancestry, and social continuity notions. Ethnographic studies highlight practices such as sewing the carrier only after childbirth or borrowing a male infant's carrier to ensure lineage prosperity, which reflect the Miao worldview on kinship and intergenerational fortune (Cho, 2021; Zhang & Sharudin, 2024).

2.2 Shape and Key Characteristics

A standard TBCM comprises three main parts: the core, the straps, and the handles. The core forms the central part that envelops the child; the straps are square embroidered pieces slightly narrower than the core and designed to cover the child's head. The handles are long straps to secure the child (Donna, 2012). Structurally, TBCM can be categorized into one-piece and composite types. The composite typefurther divides into two-part and three-part models. For example, the Huishui Miao in Guizhou utilize a three-piece design consisting of a strap body, a trouser-shaped cotton blanket, and a triangular cloak, suitable for colder and mountainous climates.

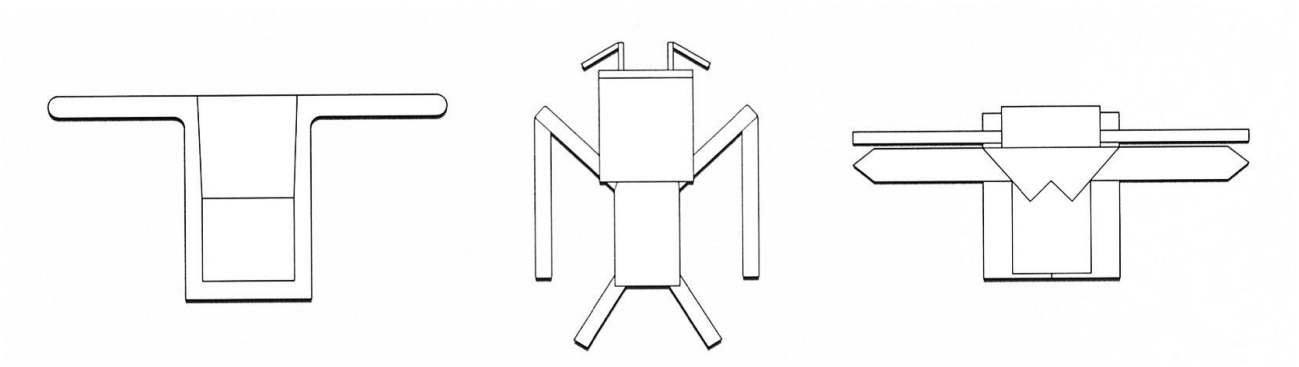

Fig. 1: TBCM Structure
(Source:Author's Illustration based on ethnographic data)

TBCM production process is intricate and characterized by critical features such as embroidery, batik, weaving, fabric cutting, color selection, and pattern design. The design features of TBCM exhibits regional diversity. Miao communities residing in flat terrains tend to make relatively comfortable TBCM and slings that allow children to stretch their bodies. In contrast, Miao communities in rugged regions typically tie their children to their chests or backs, prioritizing protection (Fang, J.-W., 2007).

2.3 Regional Diversity and Cultural Variations

The design and construction of TBCM exhibit significant regional diversity shaped by ecological conditions, sub-ethnic identities, and symbolic systems. Variations in materials, motifs, and stitching across southeastern Guizhou, western Hunan, and the Guangxi border reflect local adaptation. For example, western Hunan embroidery integrates mythological motifs rooted in animism and ancestral worship, transforming TBCM into spiritual carriers of intangible heritage (Yang et al., 2023). In mountainous Shanjiang, durable materials like bamboo and iron are used for practicality and aesthetic preference (Wen et al., 2022). Southeastern Guizhou features refined motifs such as dragons and floral patterns symbolizing fertility and lineage (Tang, 2013; Pu & Chen, 2019). This study focuses on Guizhou, where TBCM reflects exceptional symbolic richness. Regional variation highlights the need for culturally contextualized preservation and digital reinterpretation strategies.

2.4 Good Cases of Digital Visualization of Traditional Crafts

Digital technologies such as 3D modeling, digital embroidery, and immersive VR/AR environments have been increasingly adopted to preserve and present intangible cultural heritage. Notable institutions and design brands—including The Palace Museum (China), Hand & Lock (UK), and Tatty Devine (London)—have developed diverse visualization strategies to engage the public with cultural narratives (Table 1).

Table 1. Digital Visualization of Traditional Crafts

Research Brands	Digital Design	Service	Application Methods
Hand & Lock (UK)	Digital drawing software	Teaching, tools, consumption, customization, courses, activities.	Use Photoshop, Adobe Illustrator, and other software for digital machine embroidery.
Tatty Devine (London)	Digital drawing software	Capsule design, jewelry, personalization, collaboration, gifts, clothing.	Utilizing digital technology to realize computerized textile machines, textile software, image processing, etc.
Farming Made, Digital Weaving (China)	3D Modelling	Floating gallery, original design, exhibition, commercial cooperation	Presentation and design completed using 3d modeling.
The Palace Museum (China)	Digital drawing software, 3D Modelling, Virtual Reality (VR)	Museum exhibitions and tours, online ticketing, venue rentals, digitalized efforts, digitized artifact repositories, online libraries, cultural and creative products, journals, wallpapers, stories, events, academic and research support, educational activities and curricula, games, and more.	Three-dimensional digital exhibitions, restoration of cultural relics, virtual tours, and interactive experiences enhance users' experiences.

(Source:) Author's Illustration

The study identified successful applications of digital technologies that contribute to the preservation and presentation of ICH. Nevertheless, these scholars' emphasis remains predominantly on visual presentation and marketable outputs, often overlooking the cultural specificity and symbolic structure of Indigenous textiles such as TBCM. While these models offer important technological reference points, they underscore the need for more culturally embedded design strategies that account not just for form but also for narrative, ritual, and regional meaning.

2.5 Critical Review of Digital Approaches to Intangible Textile Heritage

Much existing scholarship centres on institutional digitization or educational applications, without establishing methodologies for embedding intangible values within textile artifacts (Shih & Chen, 2020). This gap is particularly evident for minority textile heritage like

TBCM. Current approaches often focus on surface-level simulations, such as 3D renderings or AR overlays, while neglecting embroidery, structure, and cultural usage's experiential, ritual, and symbolic dimensions. Consequently, digital representations risk becoming visually accurate yet culturally hollow. In contrast, this study integrates local symbolic logic, user-centred interaction, and narrative coherence, offering a more immersive and culturally grounded visualization framework than conventional image-based or technically driven methods.

2.6 Digital Engagement and Preservation Strategies for TBCM

Digital innovation, such as TBCM, is increasingly shaping the preservation of ICH. Technologies like 3D scanning, augmented reality (AR), and virtual reality (VR) enable the replication of embroidery details, material structures, and symbolic motifs while facilitating immersive cultural experiences (Chen & Zhang, 2023; Daya et al., 2024). These tools allow audiences to engage with artifacts beyond physical limitations, enhancing accessibility and educational potential.

At the same time, the rise of personalized digital consumption underscores the importance of user-centred design (UCD) and emotional experience. For instance, social retail penetration in China has reached 71%, reflecting the growing expectation for interactive, narrative-rich interfaces (TMI & BCG, 2020). Applying UCD principles ensures that TBCM's digital exhibitions resonate with users by aligning visual immersion with cultural storytelling.

In digital reconstructions, the symbolic language of TBCM, expressed through animal, floral, and geometric patterns, can evoke cultural memory and foster identity continuity. When grounded in localized meaning, digital visualization becomes a preservation strategy and a medium for participatory cultural transmission.

3.0 Methodology

This study adopts a qualitative research design to investigate the symbolic, structural, and cultural characteristics of TBCM. This approach suits artifact-based cultural studies (Xin, Cagan, & Vogel, 2007).

Firstly, contextual document analysis was conducted to trace the socio-historical evolution and regional variation of TBCM. This method facilitates interpretation within temporal and cultural contexts and is particularly useful when working with archival material. Source materials were obtained from museum collections, academic publications, and digital repositories such as the Palace Museum and China Folk Culture Database.

Secondly, visual content analysis was used to identify motifs, construction types, and aesthetic attributes. A coding framework was applied across 48 representative samples, classifying them by motif category (geometric, botanical, zoomorphic), structure (one-piece vs. composite), and regional origin. High-resolution images were sourced from museum exhibitions, ethnographic records, and field photography.

This procedure followed a constructivist visual methodology, which links visual form with cultural narrative (Kalina, 2021). Triangulation of visual and textual data ensured the reliability of motif interpretation.

The chosen methods align with the study's objective of extracting culturally embedded design features for digital reinterpretation while preserving TBCM's intangible heritage value.

4.0 Analysis

4.1 Geographical Classification of The Traditional "Baby Carriers" of the Miao Minority in Guizhou Province

TBCM in Guizhou Province can be divided into 13 regions. Fig. 2 is a visual display of TBCM from Rongjiang, Liping, Taijiang, Xingren, Rongjiang, Kaili, Huishui, Guanling, Wudang, Zijin, Danzhai, Sandu, Anshun, and other regions.

4.2 The Key Characteristics

Embroidery: TBCM features intricate embroidery, each stitch reflecting specific regional aesthetics and cultural meanings. Various techniques—including flat, twist, and appliqué embroidery—contribute to the complex textures and three-dimensional effects seen across Miao textiles (Torimaru Chiko, 2018).

Batik: The traditional batik technique uses various complex techniques and exquisite craftsmanship to create colorful and lush patterns that embody the wisdom and ICH of the Miao people. The most famous examples are the Miao batik in Huangping County, Guiyang City, Guizhou Province, and the traditional batik patterns of the Miao people in Anshun City.

Flower weaving: Guizhou Miao brocade (flower weaving) uses dark-colored materials and traditional weaving techniques to weave colorful patterns such as diamonds, triangles, flowers, and animals. The intricate production process is often used for significant events such as weddings and baby births to send blessings for their health and happiness.

Fabric column: The origin of fabric quilting is rooted in ancient "sewing" techniques in which dark fabrics are cut into geometric shapes and bonded to light-colored bases, and vice versa, to create visual contrast. Typical patterns include butterflies, crabs, and various flowers. Fine seams firmly attach these patterns to the fabric, creating a beautiful decorative outcome. The quilted fabric, often used in everyday items, is decorative and practical.

Color: Miao artisans skillfully use bold and contrasting colors such as black, red, and yellow, reflecting resilience and vibrancy shaped by their natural environment.

Pattern: Patterns in TBCM include geometric, animal, and plant motifs. Geometric forms such as diamonds and sawtooth patterns often symbolize life and continuity. Animal designs—like fish, dragons, and butterflies—and plant motifs—such as leaves and flowers—represent fertility, growth, and the reproduction of life.

Table 2. Integration of Key Elements and Digital Technologies

Key Characteristics	Digital Technologies	Application Methods	Objectives
Embroidery	3D Modelling (Blender), Virtual Fitting (CLO 3D or Style 3D)	Digitally replicate embroidery structure; simulate usage via virtual try-on	Visualize texture, demonstrate stitch detail.
Batik	Photoshop, Illustrator	Reconstruct batik patterns with calibrated design tools	Convey visual impact and symbolic meaning
Flower weaving	3D Modelling (Blender)	Use digital simulation to illustrate weaving steps	Present tactile detail and spatial logic
Fabric column	Photoshop, Illustrator	Digitally reproduce decorative fabric strips	Create digital decorative effects
Color	Photoshop, Illustrator	Apply color correction for accurate reproduction	Enhance aesthetic and cultural accuracy
Pattern	AR (Wikitude, Vuforia)	Overlay traditional motifs dynamically in an AR environment	Promote symbolic literacy and participation
TBCM	Virtual Fitting, 3D Modeling, AR	Simulate structural detail and wearing effect	Enable immersive experience and narrative comprehension

(Source: Author's Illustration)

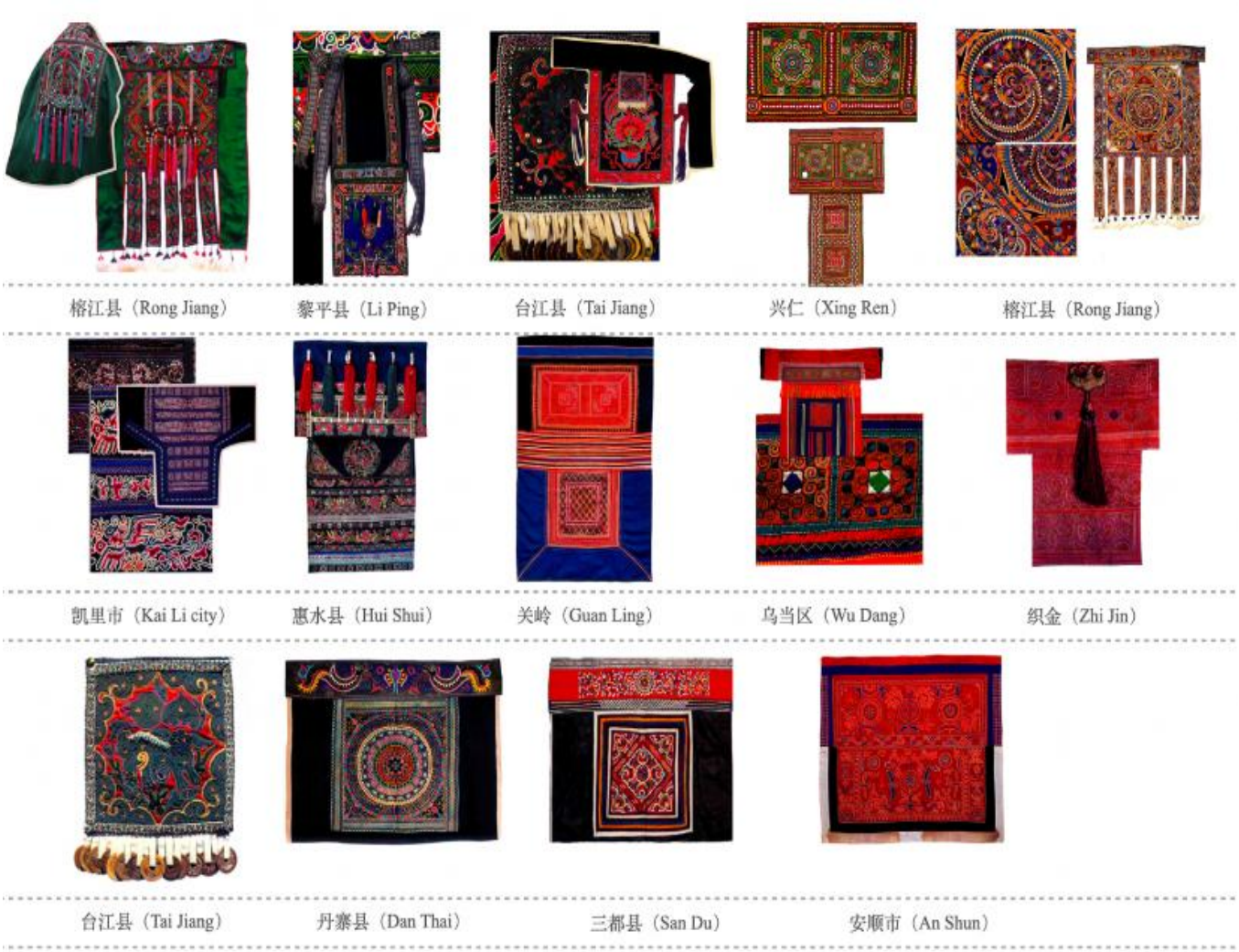

Fig. 2: Geographical Classification
(Source: 'Minority Arts in Guizhou China', sorted by the author).

This study effectively showcases the fundamental characteristics and procedural intricacies of TBCM, utilizing the abovementioned research tools and methods. Innovations like virtual fitting, 3D modeling, visualization, and augmented reality experiences enrich interactive user engagement and visual appeal, creating new possibilities for preserving and disseminating traditional customs. The collective application of these technologies offers manifold chances to digitally exhibit traditional crafts, thereby contributing to the conservation and promotion of Miao culture.

5.0 Discussion

This study has successfully highlighted the potential of merging TBCM craftsmanship with cutting-edge digital technology. By examining the key characteristics of these artifacts and their digital integration, the research has shown how 3D modeling, virtual reality (VR), and augmented reality (AR) can meticulously recreate the cultural context, enhancing audience engagement and comprehension of the cultural heritage. However, this study has identified certain limitations. For example, the digitalization process requires sophisticated equipment and support from professional technical expertise, which leads to high costs and cannot wholly replace the realism of the physical object. Discussions on how to strike a balance between digital and physical realms remain crucial.

6.0 Conclusion& Recommendations

This study develops a digital framework for preserving TBCM by combining 3D modeling, AR/VR, and cultural interpretation. Limitations include a narrow visual sample and a lack of ethnographic validation. Future work should integrate field interviews and co-design processes with artisans and explore mobile AR for wider accessibility. Additional directions include evaluating user engagement with digital exhibits and testing cross-cultural comprehension of motifs. Despite these constraints, this study contributes to digital heritage methodology and offers insights for educational and design practices.

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Paper Contribution to Related Field of Study

This study notably contributes to cultural heritage preservation and digital visualization, explicitly focusing on TBCM. Using advanced digital tools and technologies enhances Miao culture's preservation, comprehension, and dissemination. This integration creates a unique method for safeguarding intangible cultural heritage in the digital era. Furthermore, the research explores the core visual components of TBCM, such as embroidery, batik, weaving, fabrics, color schemes, and patterns, offering thorough cultural and aesthetic perspectives for experts and professionals in fashion design, cultural studies, and digital humanities.

This research establishes a pragmatic framework for digitally showcasing traditional procedures. It allows individuals to engage with TBCM in an immersive and educational manner using virtual and augmented reality technologies to generate interactive digital encounters. This framework could propel the fields of cultural heritage preservation, digital visualization, and fashion design forward.

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