GATR Journal of Business and Economics Review
GATR JOURNALS
Journal homepage: http://gatrenterprise.com/GATRJournals/JBER/vol9_2024_issue2.html
J. Bus. Econ. Review 9(2) 85 – 94 (2024)

Research on Innovative Development of Miao Embroidery Intangible Cultural Heritage in Guizhou, China Based on Digital Design.

Zhang Na[1]*, Sharul Azim Sharudin [2]

[1,2]City University Malaysia, Menara City, 8, Jalan 51a/223, 46100 Petaling Jaya, Selangor, Malaysia

ABSTRACT

Objective – Miao embroidery is vital to Miao culture, representing their national identity through its patterns and colours. However, in the face of globalization and the digital age, there is an urgent need to combine tradition with modern technology to innovate and preserve Miao embroidery.

Methodology – In this study, we explored the artistic characteristics of Miao embroidery by digital means and used computer design tools to refine the pattern elements and colour genes. Research methods combine qualitative and quantitative analysis, including phenomenology, ethnographic research, content analysis, questionnaires, image and colour analysis, etc.

Findings – Through computer graphics software, pattern colour extraction, and innovation are realized, the integration of traditional culture and modern design is promoted, and a new way is provided for the digital protection and dissemination of intangible cultural heritage.

Novelty – The research enhances the vitality and influence of Miao embroidery in global cultural diversity and includes case studies and practices of digitized intangible cultural heritage.

Type of Paper: Empirical

JEL Classification: O10, O19, O33.

Keywords: Guizhou Miao embroidery; cultural innovation; qualitative and quantitative analysis; digitized intangible cultural heritage

Reference to this paper should be made as follows: Na Z; Sharudin, S.A. (2024). Research on Innovative Development of Miao Embroidery Intangible Cultural Heritage in Guizhou, China Based on Digital Design, *J. Bus. Econ. Review,* 9(2), 85–94. https://doi.org/10.35609/jber.2024.9.2(1)

1. Introduction

Modern digital technologies cover various areas, including tools and applications for information processing, storage, transmission, and transformation. The digitization of Miao embroidery refers to the process of recording, preserving, analyzing, and recreating the Traditional embroidery of the Miao nationality using modern digital technology. The specific framework can be referred to in Figure 1. This study aims to comprehensively use digital means and integrate multidisciplinary perspectives such as design, anthropology, and folklore to deeply explore Miao embroidery's artistic connotation and its new forms of expression in modern society.

* Paper Info: Revised: July 14, 2024
Accepted: September 30, 2024
* Corresponding author: Zhang Na
E-mail: nazhang202205@163.com
Affiliation: City University Malaysia, Petaling Jaya, Malaysia

ISSN 2636-9184, e-ISSN 0128-259X © 2024 **Global Academy of Training & Research (GATR) Enterprise. All rights reserved.**

Specifically, this paper will use a mixed research method to study the following aspects to realize the digital exploration of Miao embroidery. Firstly, the qualitative research method is used to explore the historical and cultural background of Miao embroidery. The status of digital technology in the protection and inheritance of Miao embroidery is analyzed. The resources and objects of digitization are clarified. Computer-aided design (CAD), Adobe Photoshop (PS), and other software carried out vector processing and creative design of Miao embroidery. Evaluate its practical effect, discuss the application of digital means in the artistic innovation of Miao embroidery, and put forward strategic suggestions on how to use digital means to help intangible cultural heritage (intangible cultural heritage) such as Miao embroidery to be more widely recognized and disseminated in modern society.

This research provides a new perspective and methodology for the digital design of Miao embroidery, transforming traditional handicrafts into art forms and cultural products that can adapt to the needs of modern society. At the same time, this study also has an enlightening effect on the digital transformation of other traditional handicrafts. It explores a new path for the global dissemination and sustainable development of "intangible cultural heritage."

Preamble Batik China is a multi-ethnic country, and the Miao nationality is one of the influential ethnic groups with rich and colourful cultural characteristics and diversity. The Miao people, one of the 56 ethnic groups in China, mainly live in Guizhou, Hunan, Yunnan, and Guangxi, with a population of more than 10 million, and are the fourth most significant ethnic minority in Chinese. Miao culture is broad and profound, and Miao embroidery is a prominent symbol in its culture and art. It is not only an ornament but also a carrier of history and culture, carrying the mythology, religion, philosophy, and aesthetic concepts of the Miao people (Yuanxiang, 2022). Miao embroidery, spread in Guizhou Province in southwest China, is a treasure of Miao culture with a history of thousands of years. Miao embroidery is a part of Chinese national culture and a precious wealth of all humanity.

Miao embroidery is the crystallization of the wisdom of Miao women, and this handicraft is not only a life skill but also an essential expression of social identity and aesthetic taste. Miao embroidery is a necessary part of the excellent traditional Chinese culture, with a long history and profound emotional connotation, and is a unique artistic expression of Miao culture (Mei Jun, 2022). The patterns of Miao embroidery are diverse and colourful, and each stitch and thread contains profound cultural implications, such as natural totems, religious beliefs, and folk tales (Jiamin, 2023). With the advancement of modernization, the traditional Miao embroidery handicraft faces the dual challenges of inheritance and development. On the one hand, protecting and maintaining their unique cultural identity and handicraft values is necessary. On the other hand, there is an urgent need to innovate and adapt to modern society's aesthetic needs and market environment.

2. Literature Review

As a part of China's intangible cultural heritage, Miao embroidery has always been the focus of academic research. With the rapid development of digital technology, the inheritance and protection of Miao embroidery have attracted widespread attention in recent years. Through a comprehensive analysis of relevant academic literature, this paper reveals the research status and trend of Miao embroidery in different fields.

From the perspective of global Miao embroidery research keywords and research themes, the current research on Miao embroidery mainly focuses on the cultural connotation of Miao embroidery and other related content. For example, (Wu Ping, 2006) emphasize that Guizhou is where the Miao people live the most. It is also the area where the Miao culture is most well preserved, and it is the base camp for the living inheritance of the Miao culture. With its unique embroidery method, value, and cultural connotation, Miao

embroidery has become an excellent flower in the embroidery art of ethnic minorities (Han Huiqing, 2009). Miao embroidery is an essential part of Miao culture. As a typical representative of ethnic minorities in southwest China, the history of the Miao people can be traced back to 5,000 years ago, and Miao embroidery is the spiritual symbol and material carrier of this history (Nie Nan, 2022). (Liu Yi, 2021) pointed out that the patterns, compositions, colours, and styles presented in Miao embroidery have substantial application value in modern society. (Huang Juan, 2016) illustrates that butterflies are one of the most common motifs, expressing the love of Miao women who yearn for the same loyalty and amphibious flight as butterflies. (Torimaru, 2020) finds that the Miao can be traced back to a specific northern region of ancient China, at least to the Warring States period (770-221 BC).

In the digital creation practice of Miao embroidery, designers and artisans have explored the application possibilities of Miao embroidery patterns in modern cultural and creative design through digital tools. For example, (Chao, 2019) demonstrated the potential of integrating Miao embroidery and modern design by applying Miao embroidery patterns to contemporary fashion design and provided empirical evidence for commercializing traditional culture. (Jiale, 2019) proposed that the conventional elements of Miao embroidery should be combined with modern design concepts to inject new vitality into traditional culture. (Chang Wei, 2021) pointed out that combined with the design of tourism cultural and creative products, the elements of Miao embroidery art, such as patterns, colour matching, technological processes, and cultural heritage, were deconstructed to realize the innovative inheritance of Miao embroidery art. (Huang Jun, 2020) emphasized that scenario-based thinking should be applied to the design of Miao embroidery cultural and creative products to solve the problem of single category and lack of creativity from the source. (Goveia da Rocha et al., 2020) discusses the use of digital machine embroidery in combination with chemical embroidery techniques, describes the challenges behind the process, and reflects on the opportunities presented by combining digital machines and chemical embroidery techniques to make research products.

In recent years, the research on digital technology of traditional handicrafts has become an academic hotspot, and many scholars have emphasized that digitalization plays an active role in protecting Miao embroidery from multiple dimensions. For example, (Liu Suqiong, 2018) pointed out that the development of digital technology has provided new opportunities for the protection and innovation of traditional culture. Chinese scholars have actively explored the application of digitalization to the protection and innovation of traditional culture. (Luo Yuantao, 2021) proposed that the digital protection of Miao embroidery needs to be combined with ethnology, sociology, computer science, and other disciplines for research. (Ban Xixia, 2023) further analyzed the declining interest in traditional culture among the younger generation in the era of information technology and its direct impact on the inheritance of traditional handicrafts. Digital technology plays a crucial role in the dissemination and innovation of Miao embroidery art (Wu Wei, 2022). (Gu Yanli, Yang Yongbo, 2021) suggested integrating culture and modern technology, starting with the intelligent design strategy and redefining Miao Embroidery's cultural and creative products. (Ahmed, 2021) aims to instruct students to use embroidery and printing skills innovatively to revive traditional Arab culture by producing works of art from the perspective of preserving Arab heritage.

To sum up, the research results of Miao embroidery are increasing yearly, providing a rich theoretical basis for this research. However, some shortcomings can also be found, such as the lack of in-depth analysis of interdisciplinary integration, the research being mainly qualitative, and the lack of quantitative research. More importantly, the research on the cultural and creative design of Miao embroidery ignores the interrelationship between the cultural connotation and visual representation of Miao embroidery, which may lead to the loss of Chinese genes in the inheritance process of Miao embroidery. Therefore, this study uses a blended research method, adopts a multidisciplinary research perspective, integrates the research results of multiple disciplines such as design, anthropology, and folklore, and combines qualitative and quantitative

research tools to comprehensively explore the protection, inheritance, and innovation of Miao embroidery in the digital era. This research will provide new perspectives and practical cases for combining traditional handicrafts and modern technology and offer new research directions and practical guidance for protecting and developing intangible cultural heritage.

3. Research Methodology

In this study, a mixed research method was adopted, combining the advantages of qualitative research and quantitative research and using digital means to deeply explore the cultural genes of Miao embroidery to protect, inherit, and innovate better. In the early stage, the research focused on qualitative research to explore and understand the cultural genes and inheritance status of Miao embroidery. In the later stage, quantitative research was mainly used to verify the findings and hypotheses of the initial research through data analysis. The following is the framework of the study.

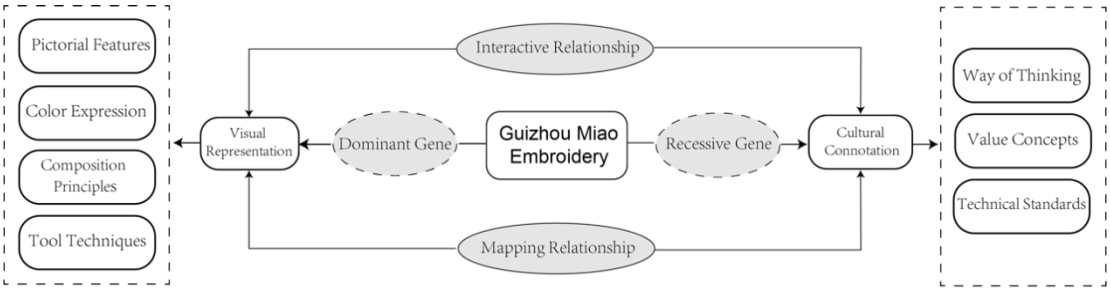


Figure 1. Research framework

3.1 Qualitative research

Qualitative data collection methods include phenomenological research, ethnographic research, content analysis, and literature research, which can be used to deeply explore and understand research questions. This study lasted six months in the qualitative research stage, aiming to explore the artistic characteristics, cultural background, and deep meaning of Miao embroidery in the socio-cultural context through content analysis and contextual research. To ensure the diversity and representativeness of the research sample, the researchers selected Miao embroidery patterns in various typical areas of Guizhou Province as the research object. Considering that most of the physical Miao embroidery works are precious museum collections and are challenging to collect extensively, this study will use electronic images as the primary form of collection, supplemented by physical embroidery samples, to ensure the extensiveness and depth of the research to the greatest extent. Qualitative data collection methods include Phenomenological research, Ethnographic research, Content analysis, and literature research.

Phenomenological research: Mainly through unstructured interviews, the profound insights of 24 participants in Miao embroidery intangible cultural heritage inheritors, design experts, and cultural researchers were captured. Each participant will receive two rounds of interviews, each lasting approximately one hour. This in-depth conversation aims to obtain detailed information about the cultural heritage, artistic expression, and personal experience of Miao embroidery. In the in-depth interviews, more attention was paid to artisans' creative concepts and skill inheritance, and the impact and challenges of digitalization on traditional crafts were understood. Ethnographic research: This study will use field investigation and participatory observation to go deep into the Miao settlement area to intuitively record the practice process of embroidery art and the living conditions of the inheritors of intangible cultural heritage. A comprehensive Miao embroidery art archive is constructed by collecting and digitizing Miao embroidery samples and analyzing embroidery works, historical documents, and other relevant materials. Content analysis and

literature research: Combining the methods of content analysis and literature research, this study will construct a detailed database of Miao embroidery patterns and systematically analyze the qualitative data such as images, text descriptions, and interview records collected to reveal its cultural connotation and historical evolution. An extensive review of relevant international literature will deepen our understanding of the historical background and cultural significance behind Miao embroidery patterns.

This study used content, topic, framework, and comparative analysis to analyze qualitative data. The basis of qualitative data analysis is content analysis. This process involves a detailed interpretation of the collected texts, images, and oral histories and the identification and generalization of the cultural connotations and visual representations contained in Miao embroidery patterns. Further thematic analysis methods will meticulously code and classify the information found to reveal the core concepts and value systems unique to Miao embroidery culture. At the same time, the framework analysis will combine the existing theories and the specific situation of Miao embroidery to construct a structured analytical framework. This framework will help collate and compare research data and clarify digitalization's theoretical and practical implications for Miao embroidery conservation. Combining data and theory provides the theoretical basis and strategic guidance for digital protection. Finally, comparative analysis will be an essential tool to understand the depth of digital influence. This study will explore the digital design methodology suitable for Miao embroidery by comparing different cases, such as other ethnic crafts, the works of different embroiderers, embroidery patterns in different eras, and applying various techniques combined with modern design theories. By comprehensively applying the above qualitative research methods, this study is expected to capture the artistic characteristics and cultural connotations of Miao embroidery more thoroughly and provide a solid research foundation and practical strategic suggestions for subsequent quantitative research.

3.2 Quantitative research

Quantitative data collection was mainly done through questionnaires, image analysis, colour analysis, etc., which can quantitatively measure and evaluate the research variables. Quantitative data collection is an indispensable part of the digital research of Miao embroidery, which can provide accurate data support for the research. This study took four months in the qualitative research phase, and using computer graphics processing tools such as PS, AI, and computer-aided design, CAD collected quantitative data more accurately. It improved the efficiency and accuracy of data analysis. These computer technologies provide strong support for the digital research of Miao embroidery and help researchers to understand the artistic characteristics and cultural value of Miao embroidery more deeply. Quantitative data collection methods include Questionnaire survey, Image analysis, and Color analysis. Through these methods, quantitative data collection will provide an accurate data basis for the digital research of Miao embroidery and support researchers to conduct a more in-depth and scientific analysis of the inheritance and development of Miao embroidery in the digital age.

Questionnaire survey: A structured electronic questionnaire is used to systematically collect data on Miao embroidery culture and its digital acceptance. The public's awareness of Miao embroidery culture, digital design, and consumers' preference for Miao embroidery product design was investigated by combining questionnaire design with computer-aided CAD tools to graph the relevant patterns. Questions about colour preference, craftsmanship, and geographical distribution were included in the questionnaire to ensure that the data obtained were representative and extensive. Image analysis: use computer graphics processing tools to extract and analyze typical Miao embroidery patterns. With these tools, researchers can accurately measure pattern size, identify colour frequencies, and classify pattern types. For the rich embroidery method of Guizhou Miao embroidery, the pattern can be vectorized through the graphic processing tool to obtain higher-quality image data, which expands the expression and application field of traditional art. Colour analysis: use graphic processing tools to accurately extract the primary colour of the Miao embroidery pattern

and its RGB value. By contrasting modern pop colours, designers can combine traditional Miao embroidery patterns with current design trends to form a novel colour scheme. In addition, by accurately capturing colour parameters such as hue, saturation, and brightness, it is possible to extract the classic colour matching of Miao embroidery patterns and freely define their colour styles, such as festive, solemn, classical, etc. These colour data not only help to restore the actual colour of Miao embroidery but also provide a reference for the design industry.

Quantitative data analysis mainly includes elemental visualization analysis, statistical analysis, and user experience testing, which can help validate research hypotheses and models.

Element visualization analysis: This study adopts the element visualization analysis method to depict the multi-level characteristics of Miao embroidery, such as pattern, colour, spatial composition, and craftsmanship skills. For example, the critical elements in the Miao embroidery pattern are drawn and extracted using appropriate graphics processing software. These elements' deep cultural significance and historical connotation are explored by combining historical documents, oral histories, and interview materials. This kind of information will be displayed through various visual charts such as colour distribution maps, pattern sample maps, process flow charts, and geographical distribution maps so that the complex characteristics of Miao embroidery can be intuitively presented. Statistical analysis: Statistical analysis plays a fundamental role in this study. The researchers will use statistical software to process the questionnaire survey data to grasp the public's attitudes quantitatively and needs towards the cultural connotation of Miao embroidery and its digital design. Statistical methods such as frequency analysis and correlation analysis reveal patterns and associations in the data. For example, the study of the frequency of use of different colours in Miao embroidery works, as well as the quantitative measurement of the size of various patterns' statistical results, provide a scientific basis for understanding the colour and pattern characteristics of Miao embroidery. User experience testing: Adopt an iterative design methodology. After the initial design, the solution is continuously optimized based on expert and user feedback. The core of the experiment is to show the digital design works of Miao embroidery to the public through the online platform and actively collect comments from experts, scholars, and general audiences. This feedback will serve as the basis for quality improvement, and the solution will be finely designed through iterative adjustments. At the same time, to improve the applicability of the design scheme further, the researchers carried out systematic user experience testing. These tests include usability testing, user acceptance surveys, and post-use evaluations. The data of the UX test will be collected in the form of an electronic questionnaire, and the questions set will focus on multiple dimensions, such as visual appeal, the expressiveness of cultural elements, and users' overall satisfaction with the Miao embroidery design. Such quantitative feedback will provide a scientific basis for finalizing the design scheme, ensuring that the design results meet the requirements of aesthetic and cultural heritage and the actual needs of the market and users.

Using mixed research methods is conducive to giving full play to the advantages of qualitative and quantitative research. It is conducive to a comprehensive understanding of the artistic, historical, and cultural value of Miao embroidery. Qualitative research provides the basis for an in-depth knowledge of the problem at an early stage, while quantitative research validates the research hypothesis. Through the mixed research method, the research questions can be answered more accurately, and a comprehensive understanding of the protection and innovation of the intangible cultural heritage of Miao embroidery can be formed.

4. Results & Discussion

The ultimate goal of this study is to provide suggestions for the protection, inheritance, and innovation of Miao embroidery by exploring the digital path of Miao embroidery and to provide reference and inspiration for the digital exploration of other "intangible cultural heritage" in the world. Applying digital technology to

the study of Miao embroidery not only injects new vitality into traditional art forms but also broadens the boundaries of Miao embroidery design. This study confirms that digital technology can be used to inherit and protect traditional culture and as a new way to innovate and develop traditional arts.

The modern interpretation of cultural genes: designers dig deep and inherit the artistic genes of Miao embroidery. Recessive genes include ways of thinking, values, and technical norms, and dominant genes have schema characteristics, colour expression, composition rules, and tool skills (Shaoxu, 2017). Give new forms and meanings to traditional motifs through modern design techniques. Combination of innovative design and traditional elements: The designer combined traditional Miao embroidery elements with new media technology to conduct redesign experiments. In terms of colour use, the conventional colour mode is refined and reorganized in combination with internationally famous colours, broadening the Miao embroidery colour application range. In pattern construction, innovative design is emphasized using repetition, exaggerated deformation, deconstruction, reorganization, etc., to enhance the pattern's modern recognition and cultural symbolism. The integration and application of digital technology: using the computer drawing tool Adobe Illustrator (Ai) software, the vectorization of Miao embroidery patterns is realized, and the visual art language of Miao embroidery is recreated through Photoshop (PS) combined with decomposition and combination method, dispersion and reconstruction, displacement composition method and morphological variation method. It not only maintains the traditional charm of Miao embroidery but also meets the needs of modern aesthetics. Through a mixture of quantitative and qualitative research methods, this study provides a multi-dimensional understanding of the cultural genes of Miao embroidery, ensuring the comprehensiveness and depth of the research results. The research shows that computer technology can promote the innovation and style development of Miao embroidery based on maintaining the traditional spirit of Miao embroidery.

At the same time, this study puts forward a new perspective and method based on inheriting and learning from previous studies. It opens up a new path for digital protection, inheritance, and innovation of Miao embroidery, an intangible cultural heritage. This study adopts a mixed research method to carry out the integration analysis and technical application of interdisciplinary research, integrates the research results of multiple disciplines such as design, anthropology, and folklore, and proposes a protection and inheritance strategy based on digital technology, which provides a new perspective for the sustainable development of Miao embroidery.

Previous studies have primarily focused on the artistic characteristics and cultural significance of Miao embroidery, such as (Lin Yalan, 2022) describe the traditional skills and cultural context of Miao embroidery and believe that the patterns and patterns of Miao embroidery are an intuitive reflection of the Miao people's life philosophy, cosmic concept, and artistic pursuit. At the same time, (Meihui, 2022) research highlights the symbolic meaning of the patterns in Miao embroidered (Xiaole, 2022), (Leijing, 2019), (Hu Rongzhong, 2017) discussed the application of Miao embroidery in modern design. They proposed the need to improve product creative research and development and promote the contemporary expression of traditional elements. Digitalizing intangible cultural heritage has become a research hotspot in China and other countries, driven by market, commercial, and economic development demands. (Zhang et al., 2021) proposed a new method using deep convolutional neural networks to identify different categories of Miao embroidery, achieving a recognition accuracy of 98.88%. (Luo et al., 2022) analyzed the cultural heritage of digitized Miao costumes. They studied the impact of modern cultural communication tools on the inheritance of Miao costume culture under the digital background. (Chen et al., 2023) explored the construction and operation mode of a multi-user collaborative innovation digital resource library for Miao embroidery, addressing the current problems of high development costs, low user participation, and unsustainable development. (Du & Jiang, 2024)

focused on effectively integrating Guizhou Miao embroidery skills and university teaching courses, using a database to enhance the multi-faceted understanding and interpretation of Guizhou Miao embroidery culture.

In contrast, this study finds an innovative intersection between conventional craftsmanship and modern aesthetics. It is mainly manifested in applying modern digital technology, such as computer drawing tools, through the in-depth deconstruction and redesign of Miao embroidery patterns, strengthening its recognition as a cultural symbol and effectively combining traditional art with modern design concepts. In addition, the integration of traditional elements and modern design has been tried, showing the unique national characteristics of Miao embroidery and meeting the needs of contemporary aesthetics. The research also revealed that through innovative design practices, such as the novel use of colour and the deconstruction and reorganization of patterns, the recognition of Miao embroidery patterns can be enhanced and freely expressed and disseminated as artworks or design media. In short, through these innovations, the boundaries of materials and media are broken so that Miao embroidery can be distributed and displayed in the context of globalization and multiculturalism. Through the application of modern digital technology and the in-depth excavation of Miao embroidery cultural genes, the innovative transformation of Miao embroidery from tradition to modernity has been realized, the cultural connotation of Miao embroidery works has been enriched, its artistic expression and cultural communication in contemporary society have been enhanced, and new possibilities have been provided for its development in the context of globalization.

5. Conclusion

This study explores the innovation of Miao embroidery digital design through a hybrid approach, highlighting the role of modern digital technology in the protection and development of intangible cultural heritage. Combining qualitative and quantitative research strengths helps fully understand and explain research questions.

The significance of this study is as follows: this study proposes and verifies a multidisciplinary interdisciplinary research framework based on design and integrating the perspectives of anthropology and folklore, uses computer graphics processing software to explore the cultural genes of Miao embroidery deeply, and explores the role of computer technology in the innovation and inheritance of intangible cultural heritage, which provides a new direction for the theoretical development of "intangible cultural heritage" research methods. As a "history book without words," the embroidery pattern of the Miao nationality not only reflects the historical background, social culture, and aesthetic taste of the Miao people but also restores the appearance of primitive life abstractly through symbols, showing its profound artistic research value. As a national intangible cultural heritage, the global sales potential of Miao embroidery is of great significance to promoting local economic development, tourism boom, and the traditional culture of the Chinese nation, as well as strengthening international cultural exchanges.

The practical value of this study lies in the following aspects: the use of modern technology to enhance the market competitiveness and cultural influence of Miao embroidery has set an example for the modernization and transformation of intangible cultural heritage. By transforming the concrete thinking of Miao embroidery into design symbols and applying them to modern design, the design of Miao embroidery is endowed with fashion and modernity, enhancing its recognition and representativeness in contemporary product design and meeting the aesthetic needs of modern consumers. At the same time, this transformation has brought economic and social value to ethnic minority embroiderers. By expanding the industrial chain, the cooperation between national skills and industrial manufacturers has been promoted, which not only obtains economic benefits but also promotes economic growth, guarantees the inheritance of national culture, and realizes a win-win situation of cultural dissemination and commercial interests.

Through in-depth exploration and practice of digital design innovation of Miao embroidery, this study demonstrates that the use of digital technology can effectively inherit and protect this precious "intangible cultural heritage." In the wave of globalization, Miao Embroidery's innovative digital design is conducive to broadening the development space of its artistic aesthetics and cultural connotation, promoting mutual understanding and respect for cultural diversity. With the continuous evolution of digital technology and the enhancement of society's awareness of intangible cultural heritage protection, Miao embroidery has become increasingly prominent on the world stage of multicultural integration. Furthermore, this study offers a robust, practical case and theoretical reference for modernising traditional handicrafts and preserving intangible cultural heritage among other ethnic groups. It can inspire the revival of other conventional art forms in modern society, injecting new vitality and possibilities into their future development.

Acknowledgments

Thank you to the City University of Malaysia for nurturing me and my supervisor, Sharul Azim Sharudin, for his guidance.

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