Framework for Digital Transformation of Intangible Cultural Heritage: Chinese Paper-Cutting Art

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Abstract

Background Intangible cultural heritage (ICH) serves as a tangible manifestation of the multiplicity of human culture. The fusion of ICH art with contemporary design amplifies the cultural and artistic value of products and instills cultural self-assurance. However, in escalating global cultural amalgamation, the protection and advancement of ICH assume greater significance. This is an important question that how can modern technology be used to promote the sustainable development of ICH? Consequently, this manuscript endeavors to explicate the plausibility of synergizing ICH, typified by paper cutting, with digital transformation (DX) as well as the development framework for promoting the formation of a paper-cutting digital ecosystem through digital transformation.

Methods This study adopts a qualitative exploratory research design to propose a framework for the DX development of paper-cutting art. The research methodology involves a literature review and expert interviews. First, the framework for the digital transformation of ICH was derived from the literature review. Subsequently, semi-structured expert interviews were conducted to collect data, which was then coded and integrated.

Results The research findings have proposed a framework for the digital transformation and development of paper-cutting art, which integrates the digitization of paper cutting, digitalization, and the digital ecosystem. This framework emphasizes the safeguarding of traditional art forms through digital technology and enhances their application and value in modern society. The digital transformation framework, represented by paper cutting, provides a roadmap for maintaining and enhancing the value of ICH, as well as promoting the development of the cultural and creative industries.

Conclusions After conducting a comprehensive qualitative investigation, we have reached the following conclusions: DX represents a new trend in safeguarding paper-cutting art. Building on this, a framework for the DX and development of paper-cutting art has been proposed, encompassing the entire spectrum from digital preservation to active application, ultimately resulting in the creation of a paper-cutting digital ecosystem. This approach satisfies the multifaceted needs of safeguarding paper-cutting art, enhancing its potential for sustainable development. By taking paper-cutting art as an example, this study provides a guide for researchers in the field of ICH safeguarding and developers in the culture and creative industries to help them devise new strategic plans for safeguarding ICH and promoting the strong development of the culture and creative industries.

Keywords Paper-Cutting Art, Intangible Cultural Heritage (ICH), Digital Transformation (DX), Cultural and Creative Industries

This work was supported by the Ministry of Education of the Republic of Korea and the National Research Foundation of Korea (NRF-2022S1A5C2A04093599).

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Citation: Huang, Y., Chang, J., & Li, G. (2024). Framework for Digital Transformation of Intangible Cultural Heritage: Chinese Paper-Cutting Art. *Archives of Design Research, 37*(1), 43-59.

http://dx.doi.org/10.15187/adr.2024.02.37.1.43

Received : May. 24. 2023 ; **Reviewed :** Oct. 23. 2023 ; **Accepted :** Nov. 02. 2023

pISSN 1226-8046 **eISSN** 2288-2987

1. Introduction

In the context of global integration, cultural diversity is of paramount importance. Intangible cultural heritage (ICH) exhibits a highly distinctive nature, providing people with a sense of cultural belonging and enabling modern individuals to reconnect with their ethnic and cultural memories(Kang, 2016). As a significant representative unit in China's ICH, the art of paper-cutting has been listed on the UNESCO Representative List of the ICH of Humanity(Chen, Lyu, 2015). Widely applied in numerous design fields, paper-cutting not only serves as a means of promoting aesthetic concepts and consciousness of national culture to the public but also enhances the diversity of design(Zang, Jang, 2014). However, the rapid development of modern civilization has widened the gap between it and traditional culture, making the inheritance of ICH a severe problem(Lenzerini, 2011). The inheritance of paper-cutting has also fallen into a similar predicament. On one hand, the aging of bearers of paper-cutting practitioners has become a serious problem, leaving the techniques in danger of being lost. On the other hand, the paper-cutting art form has limited carriers, making it difficult to preserve and disseminate widely, resulting in a decline in its economic benefits and a diminishing audience. In light of this, the sustainable progression of paper-cutting artistry necessitates the safeguarding of art, integration of digital technology, and optimization of economic value. In recent times, the cultural and creative industries have exhibited a significant impact on the advancement of the economic market for non-paper-cutting heritage. These industries are closely intertwined and bolster one another. Remarkably, technological advances have instigated a wave of Digital Transformation (DX) in the realm of digital culture, enabling cultural and creative industries to reach a wider market and expedite their rapid growth of it. DX involves not only digitizing resources but also accentuating the pre-existing value of objects, thereby providing novel avenues for value creation (Mok, 2022). The DX of ICH involves the comprehensive integration of digital technology and cultural and creative industries to digitally reshape the production, dissemination, and consumption of cultural artifacts (Tang, 2020). This approach addresses the multifaceted requirements of ICH development, spanning from digital applications to generating economic value. DX will undoubtedly serve as a novel pathway for the modernization and progression of ICH (Zheng et al., 2021). However, while research and development related to DX are advancing rapidly, there has been limited systematic investigation into the DX of ICH, and a concrete framework for the DX of ICH has yet to be established.

Therefore, this study adopts the perspective of DX and the development of ICH. Taking paper-cutting art, a widely known and highly utilized modern representation of ICH, as an example, the study aims to (1) explore the future safeguarding trends of paper-cutting art and ensure the correctness of the research direction. And to establish the evolutionary steps of ICH digital transformation under the DX and development framework. This lays a solid foundation for the proposed conceptual framework. (2) Based on the collected data related to the DX of paper-cutting, the study proposes a framework for the DX and development of paper-cutting art. Building on the preservation of digital paper-cutting, the framework aims to enhance the utility and economic value of paper-cutting, foster innovation, and development to increase its market competitiveness, and thereby promote the development of

paper-cutting culture and creative industries. This framework is conducive to advancing the modernization of ICH, achieving the organic fusion of ICH and modern design, enhancing the modern and fashionable elements of traditional culture, and increasing its attractiveness. It also expands the sustainable development path of related ICH, providing a foundational theoretical achievement for the research of ICH digital transformation.

2. Literature review

2. 1. Chinese paper-cutting art and safeguarding research

2. 1. 1. Chinese paper-cutting art(剪紙)

Chinese paper-cutting, a traditional folk art using scissors and knives to carve and hollow out paper, possesses unique artistic charm and holds significant influence as an ICH. Alongside its long history and exquisite techniques, paper-cutting bestows auspicious meanings and regional cultural symbols on its patterns, conveying the creator's positive vision and uplifting messages to the public, making it both decorative and communicative. Frequently present in traditional Chinese festivals, its intricate patterns and auspicious meanings endear it to the public, fostering a strong sense of identity and embedding paper-cutting culture in the hearts of people. Moreover, paper-cutting significantly impacts various design fields, enhancing public understanding of regional cultural aesthetics and awareness, as well as augmenting the beauty of design and enriching the cultural connotation of products (Yoon, 2013).

Figure 1 The Twelve Zodiac Animals and "Fu" Creator: Xia Zukang
Source: Self-photographed

In 2003, the art of Chinese paper cutting was designated as one of China's top ten endangered ICH projects. As of 2023, the average age of China's national-level bearers of ICH paper-cutting techniques is over 70 years old, indicating a serious aging issue among bearers of practitioners. The aging workforce in paper cutting has directly resulted in several issues: (1) the inability to utilize various media for the transmission and innovation of paper-cutting art; (2) closed channels of dissemination; (3) the inability to meet the latest market demands, resulting in (4) diminished economic value and inability to attract more people to learn; (5) ultimately hindering the sustainability of paper cutting. These issues are pressing and demand immediate attention.

2. 1. 2. Research on the safeguarding of Chinese paper-cutting art

Scholars have extensively researched the protection of China's paper-cutting art. Currently, the protection of paper-cutting mainly focuses on three areas: digitization technology, modern design applications, and industrial protection. Peng (2008) argues that digitization technology offers significant advantages in safeguarding paper-cutting, creating new opportunities for its preservation and development. The primary goal of paper-cutting art protection is to establish a database to ensure its continuity and subsequent development. Virtual reality technology can accurately recreate the cultural space of paper-cutting, enabling audiences to better appreciate its essence as an ICH. Open digital platforms facilitate the sharing and exchange of artistic resources, promoting the evolution and development of paper-cutting (Wang, 2009; Li, 2015; Li, 2022). Zhang (2011) advocates for diverse forms of paper-cutting design to modernize the art. While preserving its core cultural characteristics, incorporating modern design can evoke the public's cultural emotions and deepen the cultural connotations of works (Zang et al., 2014). On the other hand, He (2005), Jiang (2010), and Lan (2013) focus on aligning paper-cutting with modern market demands, promoting the development of paper-cutting cultural and creative industries. Industrialization supports the evolution and transmission of paper-cutting, shifting its cultural and economic development from personal or small-group commercial models to large-scale cultural and creative industries (Liu, 2006).

In summary, scholars believe that digital technology offers new opportunities for safeguarding paper-cutting art. Active development of paper-cutting culture and creative industries is crucial for promoting innovation and modernization in its applications. However, discussions on integrating these three areas are limited. In 2022, the Chinese government launched the "Significance of Promoting the Implementation of the National Cultural Digitalization Strategy" plan, emphasizing the importance of cultural and creative industries. The plan suggests actively carrying out DX and innovation, combining digital technology and cultural industries to promote the activation and application of ICH and promote sustainable development.

We believe that this will be a new trend for ICH, including paper-cutting art. Through DX, by integrating paper-cutting applications, technology, and industrialization, comprehensive development can be achieved. However, more fundamental research is needed to improve the strategy for DX and the development of ICH. As a representative art of ICH in China, paper-cutting is conveniently digitized and exhibited through paper as a carrier. Its rich patterns are widely used in modern design and have a certain audience base, offering economic value for the development of cultural and creative industries. Therefore, selecting paper-cutting as a representative study has high demonstration and reference value for the DX of ICH, effectively promoting the DX process of other ICH projects.

2. 2. Digital Transformation (DX) and Development Process

2. 2. 1. Digital Transformation

At the 46th World Economic Forum, Digital Transformation (DX) was recognized as the key to mastering the Fourth Industrial Revolution (Kim et al., 2021). At the micro level, DX is defined as the utilization of digital technologies by enterprises to adapt to or drive significant changes, creating digital products and services, promoting business model innovation, and enhancing market competitiveness (Solis, 2016; Piccinini, 2015; Reis, 2018; Chanias, 2019).

At the macro level, DX refers to the significant transformation brought about not only to company operations, but to the entire economy and society, utilizing new digital technologies to achieve major improvements in cultural and social change (Brown, 2014; Van Veldhoven, 2019; Mok, 2022), creating completely new capabilities in society, economy, and even in people's lives (Martin, 2008).

In our research, we approach the topic of DX from the perspective of ICH, adopting the broad definition of DX as our basis for study. In the context of cultural heritage, DX is more than a mere term; it represents a worldwide process enabled by technological advancements, which affects individuals, societies, and nations, and is a result of digitization (Collin, 2015). By promoting the dissemination of digital technology, cultural diversity, relativism, and pluralism are pursued, encouraging exchange and contact with other cultures, while maintaining an open-minded approach to creating new cultural ecosystems. Furthermore, the entire process of DX development generates a novel cultural and creative industries mode, thus expanding the potential of safeguarding and promoting ICH.

2. 2. 2. Development Process of Digital Transformation

The rapid development of DX has garnered significant attention across various disciplines, prompting researchers to present diverse perspectives in pursuit of a more comprehensive model for DX advancement.

According to Bloomberg (2018), digitization serves as a point of entry into the digital realm. Compared to the singular information digitization that digitization emphasizes, digitalization places greater emphasis on the application and interactivity of digital technology. DX transcends digitization, utilizing digital technology to implement cross-domain organizational change. Kim (2019) further expounded on three stages aligned with the digital transformation process: Digitalization, Digitalization, and DX. These stages concentrate on information gathering, digital services, and business system reform, respectively. He posited that DX encompasses strategic planning and implementation aimed at creating new business models or market opportunities through digitization across the entire lifecycle (Kim et al., 2021). However, Kim's study originated from an economic market development perspective. Thus, this paper, building upon that research, emphasizes the cultural development aspect of the three stages of digital transformation. (See Figure 2)

Figure 2 Digital Transformation Development Framework

Firstly, the initial stage, "digitization," epitomizes the digitization of information, with a focus on digitally collecting cultural information and content to enhance time or task efficiency. Next, "digitalization" denotes the phase of digital development, emphasizing the application of cultural digitization. Leveraging digital technologies, it improves existing models, expands application scope, and enhances economic value. Lastly, "digital transformation" represents the ultimate phase of DX development, centering on advancing

digital technology and support capabilities, propelling the reinvigoration of traditional culture. Establishing digital communication platforms or dynamic digital business models converts use value into market exchange value (Mosco, 2005). Therefore, DX transcends the mere digitization of information or digital application processes and instead concentrates on "ecosystem digitization," fostering the development of novel businesses (business models) and robust core competencies within the new digital business environment (Chen et al., 2019). For instance, Amazon's transformation from an original online direct bookstore to a comprehensive e-commerce platform exemplifies the power of DX. By utilizing digital technology and collaborating across multiple fields, it innovatively expanded to give birth to AWS cloud services. This enterprise spans from online to offline services, establishing Amazon's dominance in the digital business realm. DX builds upon the foundations of digitization and digitalization, extending its reach to the core business, and creating a new and innovative business model. While digitization improves existing business processes and enhances efficiency, the new digital business offers greater innovation possibilities, surpassing simple digital applications. It is designed based on the logic of the modern digital economy to generate novel business models, new opportunities, and revenue streams. Continuous innovative collaboration nourishes the core business, fostering a vibrant ecosystem (Chen et al., 2019).

2. 3. Digital Transformation of Intangible Cultural Heritage

Digital technology plays an indispensable role in the safeguarding and transmission of ICH. For instance, the use of virtual reality technology in ICH exhibitions enables the public to experience immersive ICH without the constraints of space and time (Kim et al., 2019). In light of the stages of DX, this traditional digital safeguarding of ICH primarily finds itself within the realm of Digitalization. This entails the application of pre-existing technologies to metamorphose present modes of presentation and dissemination, thus achieving the automation of the digital safeguarding process—an elevation of antiquated elements into the digital domain. Conversely, the DX of ICH centers on 'innovation,' placing great emphasis on the dual impetus of technological innovation and business model innovation. This approach seeks to explore a new digital ecosystem, engendering an abundance of cultural value and business opportunities.

In 2022, the WEAVE project led by Coventry University aimed to expand European access to cultural communities based on Europeana. The project developed a framework that links tangible and ICH in cultural communities to protect representative cultural heritage. Based on this project, Rosa Cisneros and Marie-Louise Crawley (2022) put forth practical steps for the DX of ICH. Their endeavors are focused on dismantling the conventional "top-down" inheritance paradigm of ICH and, instead, empowering communities through DX to strengthen their ownership and stewardship of ICH. This approach aims to foster a proliferation of "bottom-up" channels for inheritance, enhancing community engagement in safeguarding ICH.

Firstly, from a preservation perspective, digitizing dispersed tangible collections and forming digital collections brings traditional culture to a wider audience. Second, through a reinterpretation within the community of interest, traditional culture can be given contemporary relevance, thereby assisting ICH to return to its original community culture and facilitating the revitalization of ICH. Finally, the use of digital technology in the

development and innovation of ICH can promote cultural practice and inheritance. By advocating for collaborative strategies, communities can regain a sense of "ownership" of their cultural heritage. Connecting global and local communities can enhance the influence of overseas diasporic communities and further promote local cultural characteristics. Increasing inclusivity and participation opportunities allows more people to be involved in the protection and inheritance of traditional culture. Ultimately, enhancing the representativeness of ICH within its community strengthens the status and influence of traditional culture in the local area.

Based on the steps of DX in ICH and the three stages of DX development outlined previously, a framework for the DX and development of ICH can be integrated as follows. (Figure 4)

The proposition of practical steps for the DX of ICH paves the way for revolutionary advancements in heritage inheritance. Utilizing digital technology to forge new channels of transmission not only facilitates the revival of traditional culture but also bolsters cultural self-assurance, while expanding the scope of the inheriting community. However, despite the positive impact of existing transformation steps, there remains untapped potential in the realm of research on the DX of ICH. The influence of DX on ICH goes far beyond enhancing community engagement in safeguarding. It also involves exploring the economic value of ICH and promoting the development of the cultural and creative industries. Through DX, ICH artworks can achieve broader promotion and sales, thereby further elevating their economic value. Moreover, DX presents new opportunities for the growth and innovation of the cultural and creative industries. Therefore, in researching the DX of ICH, we should adopt a comprehensive and diverse perspective to foster the multifaceted integration of heritage inheritance and development.

Digital Transformation Stage	Steps
Digitization	**1.1.** Digital Collection **1.2.** Digital Information Transformation
Digitalization	**2.** Reinterpretation of collections
	3. Digital reuse of collections
Digital Transformation	**4.** Promoting the revival of cultural practices
	5. Collaborating to empower communities to regain ownership
	6. Connecting global and local communities
	7. Increasing inclusivity and opportunities for participation
	8. Increasing the representation of ICH in communities

Figure 3 ICH Digital Transformation and Development Framework.

3. Method

The research on the DX of paper-cutting art is in its early stages. To fully understand its characteristics and potential, this study adopts an exploratory qualitative research approach. In-depth expert interviews were conducted to collect qualitative data and gather expert opinions and recommendations. Seven relevant experts were invited for semi-structured interviews, providing the original research data. Triangulation was used to ensure research credibility, employing diverse theories, methods, and sources of information. Multiple validation measures were applied to strengthen the comprehension and interpretation of the DX framework for paper-cutting art, ensuring the accuracy and reliability of the research outcomes.

3. 1. Expert Interviews

The stage aims to comprehensively develop a theoretical framework for the DX of paper-cutting art through in-depth interviews with seven experts. These experts include two seasoned practitioners in paper-cutting heritage, four professors in long-term ICH safeguarding research, and one experienced designer (Table 3). Engaging with paper-cutting practitioners explores practical needs in art development, while the experts' ICH safeguarding experience provides visionary insight into digital safeguarding. The designer's perspective harmonizes traditional art with market demands, offering feasible suggestions for economic development.

Table 3 Basic information of interviewees

	Age	Research Field/study time(year)	Professional Title
A	69	paper-cutting bearers of practitioners/ 52	national level
B	56	paper-cutting bearers of practitioners/ 31	provincial level
C	43	ICH Digital Safeguarding Research / 17	Professor
D	38	Digital Art/ 11	Associate Professor
E	45	Digitalization of Traditional Patterns/ 20	Associate
F	38	ICH Industries Research/ 15	Associate Professor
G	42	Traditional Pattern Design / 14	Director of Design

The interviews were conducted in a semi-structured manner, with a thorough approach employed to expand the interviewees' responses until the data sample was theoretically saturated with no new concepts. These interviews were conducted online via a face-to-face format, with the interviewee's consent for audio recording throughout, and interview notes were taken contemporaneously, including key content labeling and summaries, author's reflections, and other relevant notes. The interview guide comprised five questions, each focused on the digital transformation and development of paper-cutting art:

1. In your opinion, what is the essence of paper-cutting art? What is at the root of the issue?
2. How do you believe paper-cutting can be digitally preserved?
3. How can digital technology be leveraged to foster the modern active application and development of paper-cutting art?
4. How do you perceive the DX of paper-cutting art?
5. What are the stages of the DX development process for paper-cutting art in your perspective, and what does each phase specifically entail?

3. 2. Coding Process

This research endeavors to holistically develop a theoretical framework for the DX of paper-cutting art from a multidisciplinary perspective. To achieve this aspiration, three stages of comprehensive coding and categorization were conducted to delve deeply into various dimensions and themes of the DX of paper-cutting art.

(1) Open Coding

Through conducting semi-structured interviews with experts, the collected interview data and notes taken during the interview process have all become primary analytical materials. During the open coding phase, the material content was analyzed with an open mind, discerning and categorizing the viewpoints, insights, and concepts present within. Special attention was given to recurring keywords found in the original materials. Through this process, initial insights were gained into the developmental process of the DX of paper-cutting art. The coding process continued until no new concepts emerged, ultimately revealing 38 keywords from the original materials (as depicted in Figure 4). And during this process, the accuracy of the extracted keywords was repeatedly verified by the experts. Upon careful examination of the content of these keywords, they encompass specific factors such as on-site investigations, data organization, and categorization involved in the execution of the DX of paper-cutting art. However, the exact step in the transformation process to which they belong has not yet been clearly defined and requires further summarization and synthesis, aiding in a profound comprehension of various aspects of the developmental steps in the DX of paper-cutting art.

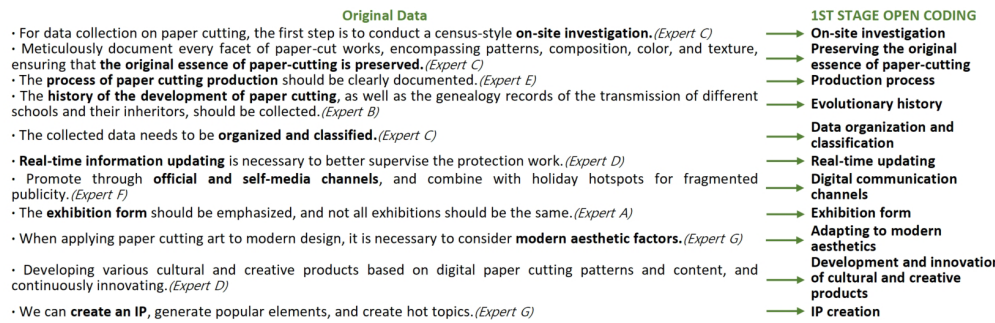

Figure 4 Open coding keyword extraction process (partial)

(2) Axial Coding

In the second phase of axial encoding, we built upon the foundation of open coding and employed the inductive method to categorize concepts. After integrating similar or related concepts, the original keywords were eventually subsumed under nine of them to form further categories. These categories encompassed paper-cutting data collection, database establishment, digital exhibition, digital application, multicultural integration and innovation, reintegration into the community, international exchange and cooperation, participation and interaction, and development of cultural and creative industries. These categories reflect the broader direction and trends of DX and the development of paper-cutting art. By juxtaposing these categories with the steps of ICH digital transformation practices, it becomes apparent that these nine categories, while maintaining commonalities, also extend into areas such as enhancing economic value through the development of

cultural and creative industries, thereby fostering the long-term evolution of paper-cutting DX. These categories, serving as the bedrock for the ensuing selective coding phase, facilitate the identification of pivotal stages in the DX of paper-cutting art by pinpointing the commonalities between categories.

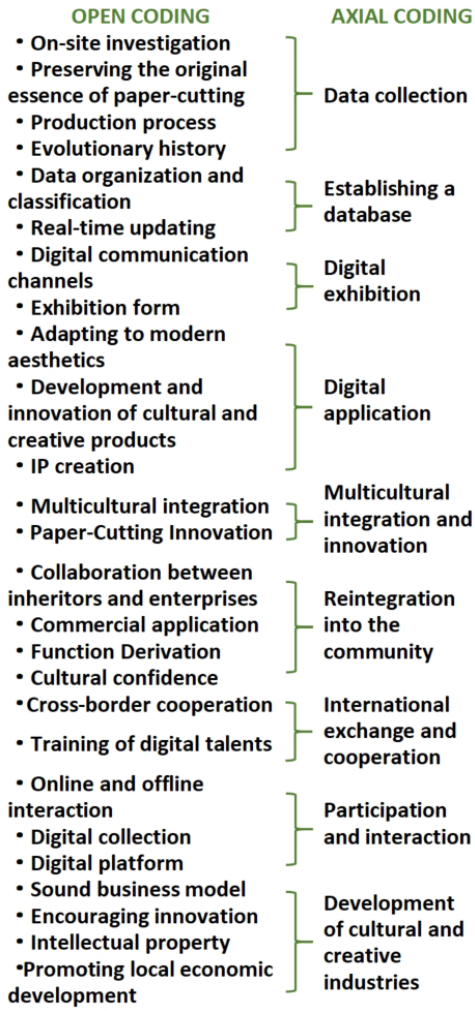

Figure 5 Axial coding

(3) Core Coding

Finally, the core coding phase was carried out. At this juncture, further abstraction and induction of the concepts and categories obtained from the previous two stages were conducted. With the earlier summarized DX development process and the steps of ICH digital transformation practices as references, these nine categories were further consolidated into three themes: Digitization of paper-cutting art, Digitalization of paper-cutting art, and Digital ecosystem of paper-cutting art. These three themes encompass the critical stages and significant topics in the development of paper-cutting DX, deeply interpreting the development model and practical pathways of paper-cutting DX from various perspectives.

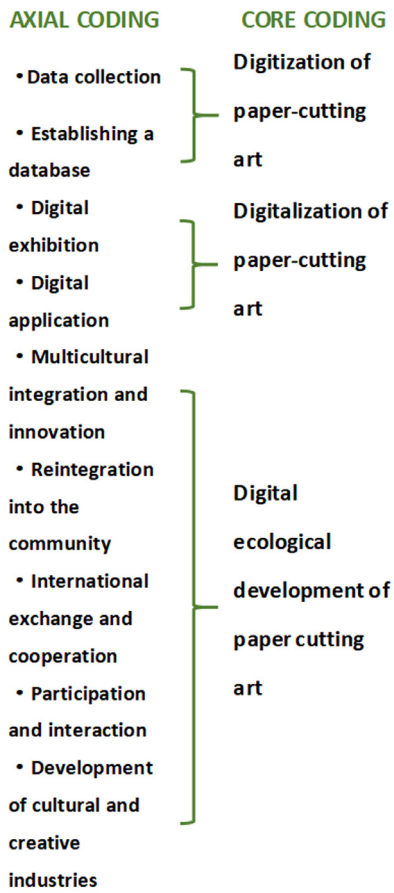

Figure 6 Final Theme

4. Result and Discussion

By integrating the research methods mentioned above and based on the actual context of the original data, a gradual process of coding and analysis was conducted. Through the deductive process of qualitative research, diverse viewpoints from various levels and perspectives were synthesized, resulting in a comprehensive and multidimension al theoretical framework for DX development of paper-cutting art. The research result ultimately converged on three themes, serving as pivotal strategies for the DX of paper-cutting art.

4. 1. Digitization of paper–cutting art

The initial thematic domain of paper-cutting digitalization is the digitization stage, constituting the bedrock of the DX of paper-cutting art. Within this stage, as highlighted by the experts, paper-cutting art, as an ICH, differs from tangible cultural heritage, necessitating more than merely capturing static cultural relics digitally. It also requires exhaustive on-site investigations into the birthplace of paper-cutting art, amassing comprehensive information on the art forms, creative processes, and evolutionary history of paper-cutting art. *The primary emphasis lies in safeguarding the culture and craftsmanship*

intrinsic to paper-cutting art through digital technology (Expert A). Striving to preserve the original essence of paper-cutting as comprehensively as possible. On this foundation, a paper-cutting database is established, and the paper-cutting data is meticulously organized and classified. The content of the database undergoes real-time updates, continually refining its substance. *It is essential to focus on the database's ceaseless refinement and enhancement, as the efficacy of the database only escalates with each subsequent update (Expert D).*

4. 2. Digitalization of paper–cutting art

The second stage of paper-cutting DX is Digitalization, dedicated to digitally exhibiting and applying paper-cutting art, expanding its influence, and enhancing digital application. *It goes beyond simply displaying captured images but seeks to convey the cultural essence of ICH through diverse digital formats (Expert B).* Digitalization not only safeguards and revives traditional culture but also creates new opportunities for paper-cutting development, liberating it from being static exhibits in museums. Expanding digital dissemination channels revitalize paper-cutting, captivate public interest, and integrate it into community culture. *DX provides a broader platform for ICH art dissemination, enabling the inheritance and promotion of traditional culture (Expert G).* Additionally, integrating traditional paper-cutting with contemporary commodities using digital technology expands its application scope and enhances the cultural and artistic essence of the products, elevating their market competitiveness.

4. 3. Digital ecosystem of paper–cutting art

The third theme identifies the final stage of DX: the development of a digital ecosystem for paper-cutting art, comprised of five strategic factors: multicultural integration and innovation, the reintegration of paper-cutting into communities, international exchange and cooperation, participation and interaction, and the development of the cultural and creative industries. The experts unanimously agree that *integrating digital technology into the digital ecosystem and establishing a digital paper-cutting cultural and creative industry chain (Expert E) will foster cultural confidence among the public through the successful DX of paper-cutting art, thereby achieving the maximization of ICH value and ensuring sustainable development (Expert C).*

4. 4. Framework for digital transformation development of paper–cutting art

This research conducted a comprehensive study on the DX and development of paper-cutting art, leading to a proposed framework for its DX development. The framework aims to guide paper-cutting art towards DX while enhancing the safeguarding and perpetuation of ICH. Building upon the foundation of ICH's digital transformation, it expands on crucial aspects, unveiling the economic potential of ICH and fostering cultural and creative industries. It strives to form a digital ecosystem for paper-cutting, ensuring the sustainable development of this art form. (Figure 7)

First, the Digitization phase emphasizes the meticulous collection of paper-cutting data and the establishment of a comprehensive database, ensuring the integrity of ICH preservation. These data encompass not only the historical and artistic aspects of paper-cutting art but also serve as vital resources for the continuation of ICH. The continuous updating and refinement of the database are of utmost importance. By employing cutting-edge digital technologies,

the dynamic evolution of ICH revitalization can be vividly recorded. This process not only facilitates a thorough exploration of the development trajectory of paper-cutting art but also enables the use of big data to speculate and simulate its future evolution, thus guaranteeing the efficacy of DX.

Next, the Digitalization phase places particular emphasis on the application and dissemination of paper-cutting art in the process of DX, expanding new avenues for the propagation of ICH and broadening the scope of its audience. Through DX, paper-cutting art is better suited to meet the demands of modern audiences, possessing enhanced interactivity and operability. The key strategies in this phase include: (1) Expanding digital communication channels, breaking away from the traditional static display of paper-cutting, and providing novel ways to showcase this traditional art form. (2) Innovating exhibition formats, offering diverse display styles that transcend temporal and spatial constraints, allowing audiences to appreciate and engage with ICH at any time and place, thereby inspiring public interest in paper-cutting art. (3) Infusing modern aesthetic elements to breathe new life into traditional paper-cutting art, promoting its continuous inheritance and innovation in contemporary society. (4) Creating paper-cutting IP, placing significant emphasis on the effectiveness of cultural branding, and establishing distinctive paper-cutting art IPs. (5) Advancing cultural and creative product development by leveraging the unique regional culture embedded in paper-cutting, actively driving the innovation and creation of ICH creative products.

The paper proposes the final phase of a paper-cutting digital ecosystem, aiming to construct a comprehensive platform integrating diverse cultures and promoting international exchange. By blending digital technology with the preservation of ICH, this phase seeks to revitalize and grow ICH within communities, fostering the cultural and creative industries. Safeguarding ICH requires dynamic revitalization, with equal attention to intrinsic cultural transformation through digital technology for environmental enhancement. In this phase, community culture plays a crucial role as the nurturing ground for paper-cutting development. Thus, reintegrating into community culture becomes imperative to instill cultural confidence based on regional ICH. Advocating the fusion of diverse cultures and modern elements, thereby actively propelling paper-cutting innovation, and crafting digital paper-cutting art pieces of heightened allure and uniqueness. Externally, cross-national collaborations and references to international education systems facilitate the formulation of digital talent cultivation programs, promoting cross-cultural exchange. Establishing a platform for digitizing paper-cutting through digital technology leads to the creation of digital paper-cutting collections, enhancing public participation and interactivity, both online and offline, and stimulating local tourism. Additionally, it emphasizes the importance of robust business models and refined intellectual property laws, encouraging practitioners and creators of paper-cutting products to continually innovate, enhancing the competitiveness of local cultural and creative industries, and driving local economic development. Overall, the formation of a paper-cutting digital ecosystem, driven internally and supported externally, propels the progress of paper-cutting art's DX.

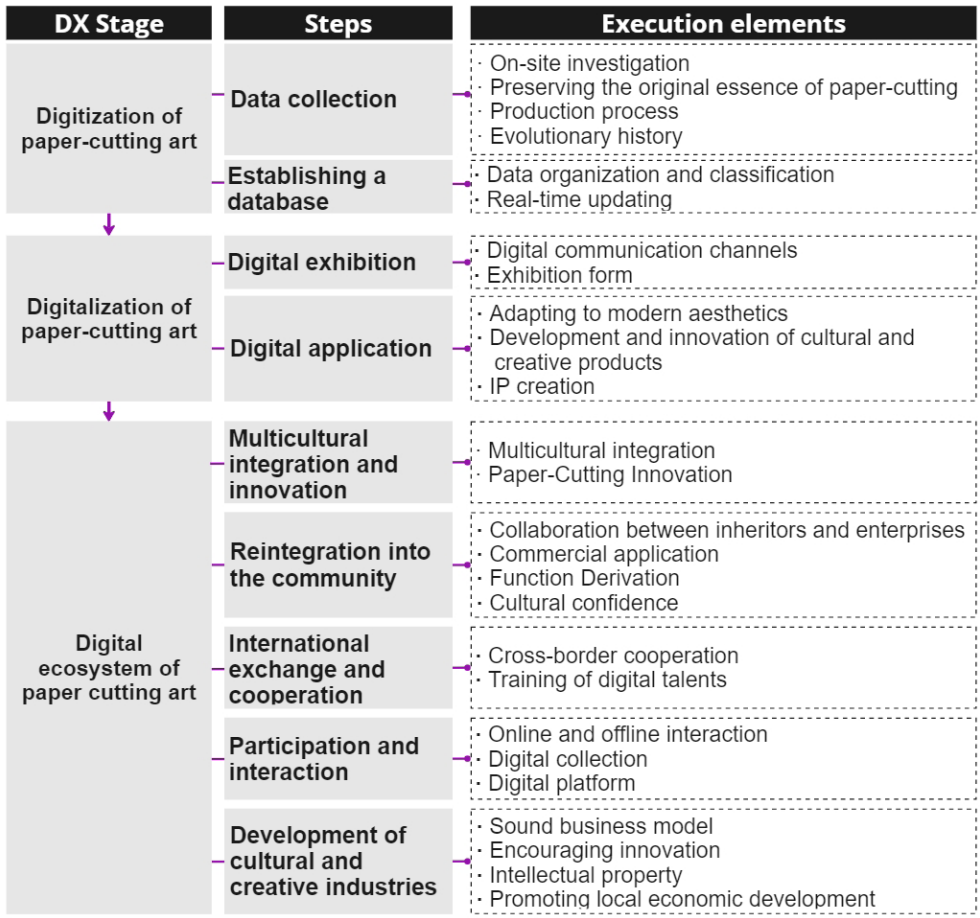

Figure 7 Framework for DX development of paper–cutting art

5. Conclusion

This study delves deeper into how ICH can leverage DX to innovate and evolve, using paper cutting as a representative case. Firstly, we establish that DX is the future development trend for safeguarding paper-cutting art. Secondly, it proposes a framework for DX and the development of paper-cutting art. Based on DX and development, this framework aims to digital preservation of paper-cutting art, promote multidimensional promotion and display, encourage communication and innovation between paper-cutting art and other arts, enhance the economic value of paper-cutting art, drive the development of paper-cutting culture and creative industry, and ultimately form a paper cutting digital ecosystem.

The proposed framework has significant advantages for ICH evolution. It offers a comprehensive reference pathway, as ICH inheritance heavily relies on personal experiences and interaction. The newly established ICH digital platform and ecosystem through DX serve as communication channels bridging the public and ICH. DX enables convenient and extensive methods of safeguarding and disseminating ICH, expanding its influence and enhancing its prospects for survival and perpetuation. Digitalization allows ICH

reinterpretation, leading to its evolution into diverse forms and functions that better adapt to modern society's demands and changes. This revitalizes its roles in inheritance and innovation. Within the digital ecosystem, bearers of practitioners can develop new products rooted in their local culture, exploring fresh business models and opportunities. This brings economic benefits to the bearers of practitioners and allows traditional art to thrive in modern community culture, promoting the revival and innovative development of culture and contributing to the sustainable growth of ICH.

For modern design in the context of global integration, the DX of ICH represented by paper cutting will lead to more digital artworks becoming the inspiration and resources for modern design. The combination of traditional and modern design elements creates designs that are more contemporary and culturally significant, allowing them to stand out in the competitive market while establishing a strong sense of identity and enhancing the effectiveness of cultural dissemination, as well as promoting cultural diversity and prosperity.

In summary, the framework for DX development of paper-cutting art offers novel insights into the safeguarding and development of ICH. This framework emphasizes the exploration of the artistic applications and economic value of ICH, facilitating its continuous growth and innovation in modern society. Moreover, it provides a theoretical reference for the global integration of ICH through the utilization of technological convenience and the development of cultural and creative industries. Simultaneously, it lays a foundation for future research on the DX of ICH.

References

1. Bloomberg, J. (2018). Digitization, digitalization, and digital transformation: Confuse them at your peril. *Forbes*. Retrieved on August, 28, 2019.
2. Chen, J., & Lyu, D. (2015). The Digitalization of Chinese Paper-Cut: Intangible Cultural Heritage Protection and Culture Communication. In *2015 International Conference on Education, Management, Information and Medicine* (pp. 391–395). Atlantis Press.
3. Cisneros, R., Crawley, M.-L., Taes, S., & Truyen, F. (2022). WEAVE White Paper: Digital Transformation of Intangible Cultural Heritage.
4. Collin, J. (2015). Digitalization and dualistic IT. in *Transition*, 29–34.
5. Kang, Y. (2016). *Digital performance for the transmission and inheritance of intangible cultural heritage : using chinese traditional performance* (Doctoral dissertation). Soongsil University. Available from Research Information Sharing Service database.
6. Kim, S., Choi, B., & Lew, Y. K. (2021). Where is the age of digitalization heading? the meaning, characteristics, and implications of contemporary digital transformation. *Sustainability, 13*(16), 8909. doi:https://doi.org/10.3390/su13168909
7. Kim, S., Im, D., Lee, J., & Choi, H. (2019). Utility of digital technologies for the sustainability of intangible cultural heritage (ICH) in korea. *Sustainability, 11*(21), 6117. doi:https://doi.org/10.3390/su11216117
8. Lenzerini, F. (2011). Intangible cultural heritage: The living culture of peoples. *European Journal of International Law, 22*(1), 101–120.
9. Li, X. (2022). Visualization display system of gannan hakka paper-cut works based on computer graphics algorithm. *Computational Intelligence and Neuroscience* : CIN, 2022 doi:https://doi.org/10.1155/2022/2419689
10. Liu, X. (2006). A Study of Cultural Industries as a Model for "Living" Heritage Protection-Taking Gao Dianliang's Paper Cutting in Weixian County as an Example. *Art Observation, 2006*(6), 17–18. doi:CNKI:SUN:MSGC.0.2006-06-008

11. Martin, A. (2008). Digital Literacy and the "Digital Society". *Digital literacies: Concepts, policies and practices, 30*(151), 1029–1055.
12. Mok, J. (2022). *The Priority of the Factors that Implement Digital Transformation* (Doctoral dissertation). Dankook University. Available from Research Information Sharing Service database.
13. Mosco, V. (2005). *The digital sublime: Myth, power, and cyberspace*. Cambridge, MA: MIT Press.
14. Peng, D. (2008). *Research on digital preservation technology for intangible cultural heritage of paper-cutting art* (Doctoral dissertation). Zhejiang University. Available from China National Knowledge Infrastructure database.
15. Solis, B. (2016). The six stages of digital transformation maturity. *Custom Research by Altimeter Group on behalf of Cognizant, Altimeter*.
16. Tang, L. (2020). Research on the Digitization Transformation of Intangible Cultural Heritage Industry in Dual Circulation. *Journal of Nanning Normal University (Philosophy and Social Sciences Edition), 2020*(06), 32–40. doi:10.16601/j.cnki.issn2096-7349.2020.06.004.
17. Zang, Y. W., & Jang, M. K. (2014). A Study on Expression Characteristic Analysis and Efficient Application Measures of Chinese Tourism Cultural Poster Applying Paper-Cut Art. *Treatise on The Plastic Media, 17*(4), 255–266.
18. Yoon, M., & Nam, H. (2013). Types and Expressive Methods Analysis of Chinese Paper Cutting Symbols: A Study of Brand Design. *Journal of Brand Design Association of Korea, 11*(3), 101–112.
19. Zheng, A., Zheng, J., & Wang, X. (2021). The Real Challenges and Promising Pathways of Digital Transmission of Sports Intangible Cultural Heritage in the Post-Pandemic Era. *Journal of Guangzhou Sport University, 2021*(01), 57–61.