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Preservation and Visualization of Cultural Heritage Knowledge based on Topic Maps and Knowledge Graphs

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Abstract
Cultural heritage, which embodies a nation's historical background, cultural symbolism, rich connotations, and value systems, bridges the past, present, and future. However, it faces extinction due to urbanization, socioeconomic development, and land reclamation. Therefore, preserving and visualizing cultural heritage knowledge becomes crucial to ensure its sustainability. This paper reports the preservation and visualization of festivals, songs, medicinal practices, and folk traditions of the Jing ethnic group in Southeast China using Knowledge Graphs, Topic Maps, Vue.js, and Neo4j technologies. The resulting knowledge graph provides an interactive and visually engaging platform to enhance understanding and promote sustainable heritage practices.

Keywords: Cultural Heritage Knowledge, Knowledge Preservation and Visualization, Topic Maps, Knowledge Graphs.

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1.0 Introduction

Cultural heritage comprises traditions or living expressions inherited from ancestors and passed down to descendants, including oral traditions, performing arts, social practices, rituals, festive events, knowledge and practices concerning nature and the universe, and the skills involved in producing traditional crafts (UNESCO, 2011). It also encompasses monuments and collections of objects. It embodies historical contexts and cultural symbolism, holds rich cultural connotations and value systems, and serves as an essential link bridging the past, present, and future (Liu, 2020). Cultural heritage is immensely significant for preserving and understanding our collective history and cultural identity (Zhai, 2023).

In May 2022, China's General Office of the State Council issued the "Opinions on Promoting the Implementation of the National Cultural Digitization Strategy" detailing four specific objectives aimed at extracting culturally significant Chinese elements, symbols, and identifiers from extensive cultural resources. This initiative aims to enrich the contemporary expression of Chinese cultural genes and present a comprehensive view of Chinese culture (Gao, 2022). As a result, several cultural heritage digital preservation projects have been established. The Palace Museum employs VR and AR technologies, enabling visitors to experience and understand its history and culture more intuitively (Digital and Information Department of the Palace Museum, 2024). The Ministry of Culture and Tourism launched the "Cultural Heritage Cloud" platform, integrating nationwide cultural heritage data through cloud computing and big data

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technologies, thereby providing researchers, administrators, and the public with abundant information resources and convenient access methods (Bai, 2022). Tsinghua University has partnered with Tencent Corporation to participate comprehensively in the World Cultural Heritage application project for the "Beijing Central Axis", employing digital technologies throughout the process (Beijing Daily, 2024). Earlier, digital technologies such as 3D scanning and modeling have been utilized in the digitization project of murals and sculptures at the Mogao Grottoes in Dunhuang (Wang et al., 2020).

This national initiative addresses the issue of the extinction of valuable heritage among Chinese ethnic groups, such as the Jing ethnic group. The ethnic group is indigenous to Guangxi and represents the only maritime minority group in China (Cao, 2024). The Jing ethnic group possesses a rich historical culture, traditional arts, and unique language. However, these invaluable heritages face a significant risk of extinction as many intangible cultural heritages knowledge are not properly managed and preserved and has a lack systematic documentation and mechanisms for inheritance.

With the issue of extinction and improper cultural heritage knowledge management in hand, this paper describes the development of an interactive digital platform that enables the management, preservation and dynamic visualization of Jing's cultural heritage knowledge. The development of Jing's cultural heritage knowledge digital platform is made possible through Topic Maps and Knowledge Graphs system that classify, correlate, and integrate heritage content knowledge by constructing a multi-level topic network. By topic nodes and their associated relationships, the historical legends, traditional festivals, song and dance arts, handicrafts, culinary practices, and language of the Jing ethnic group can be organically interconnected and organized thus forming a comprehensive heritage knowledge system.

2.0 Literature Review

2.1 Cultural Heritage

Preserving and celebrating cultural heritage is vital for maintaining global cultural diversity and sustaining historical narratives (Nilson & Thorell, 2018). Currently, digitization of cultural heritage has emerged as a significant trend, safeguarding the longevity of cultural assets and expanding public access, thus enabling broader audiences to engage deeply with diverse cultural histories. Numerous significant initiatives exist globally to preserve diverse cultural heritages, in addition to UNESCO projects. Examples include studies by Stein (2022), Saiful Bahry et al. (2022), Mekonnen, Bires, and Berhanu (2022), Aristidou et al. (2022), and Bahry et al. (2024).

2.2 Challenges in Preserving China's Cultural Heritage

Globally, the cultural heritages face the issue of extinction. In the context of China's rich cultural heritage, the challenges are due to urbanization and modernization pressures (Mao & Sun 2024; Yuan et. al (2025); demographic shifts and generational gaps; economic pressure; and cultural homogenization and over-commercialization (Yuan et. al 2025). The vast elements of cultural heritage - including languages, traditions, and folklore – of China's ethnic minorities are critical for preservation to maintain their identity and continuity of such ethnic groups.

The Jing ethnic, among China's smallest ethnic groups, primarily inhabit coastal areas of the Guangxi Zhuang Autonomous Region (Cao, 2024) and is renowned for its rich maritime culture, distinctive folk songs, and traditional festivals such as the Ha Festival (Hongyu, 2024). Nevertheless, their cultural heritage faces increasing risks due to various factors, including regional economic development, which has shifted community focus from traditional livelihoods such as fishing toward industrial and service-oriented jobs. Additionally, climate change and environmental degradation further threaten the Jing's cultural practices. The rapid urbanization and migration to inland cities pose significant threats to the Jing's tangible cultural heritage. All these challenges imply that preserving the Jing's cultural heritage elements is a worthwhile effort.

2.3 Cultural Heritage Knowledge Management and Preservation Initiatives using Knowledge Graphs Technologies

A cultural heritage knowledge graph refers to the utilization of knowledge graph technology to systematically organize, integrate, and present diverse information related to cultural heritage. Such graphs link various cultural heritage aspects—including historical contexts, geographic locations, artistic styles, and influencing factors—via relationships, facilitating a comprehensive and structured understanding (de Boer, 2023). Both globally and locally, diverse projects have extensively explored cultural heritage preservation and management. Notable examples include the Getty Vocabulary Cultural Heritage Terminology Service (Baca & Gill, 2015), the Finnish Semantic Data Service (Sampo) project (Hyvönen, 2020), the Europeana Semantic Framework-driven Cultural Heritage Service (Silva & Terra, 2024), the Italian cultural heritage project ArCo (Carriero et al., 2019), GraphBrain knowledge graph framework proposed by Ferilli (2020), the Chinese Genealogy Knowledge Service Platform (Xia & Zhang, 2016), the Dunhuang Murals Knowledge Graph (Wang et al., 2020), and the Taizhou Ancient Villages Digital Memory Platform (Feng et al., 2019). Furthermore, Yang and Wang (2019) employed artificial intelligence to create a knowledge graph mapping the academic lineage of the Song Dynasty. Wang and Hou (2023) developed a framework outlining smart data construction for cultural heritage revitalization and utilization. Xia (2023) explored intelligent service models for multimodal cultural heritage resources with an emphasis on user-centered approaches. Wang and Zhu (2023) conducted research on intelligent data resources for intangible cultural heritage based on Grounded Theory. Additionally, Jia et al. (2024) investigated the transformative effects of AI technologies on knowledge organization, particularly from the perspective of knowledge graph applications.

2.4 Management, Preservation and Visualization of Jing's Cultural Heritage Knowledge Based on Knowledge Graphs

This paper presents an initiative aimed at managing, preserving, and visualizing the Jing ethnic group's cultural heritage through the use of knowledge graph technology. This approach reflects a commitment to deeply understanding traditional heritage while integrating advanced technologies to support its protection, research, and intergenerational transmission. By utilizing a knowledge graph, the initiative addresses the challenges of organizing, analyzing, and transmitting complex cultural knowledge in a systematic, scalable, and interconnected way.

1) Capturing Complex Relationships

The Jing ethnic group's cultural heritage includes both tangible and intangible elements such as traditional festivals, folk songs, fishing methods, artifacts, and historical narratives. Knowledge graphs are particularly effective in modeling these complexities by defining entities (e.g., "Ha Festival," "folk songs") and their interrelationships (e.g., "is celebrated during," "is associated with"). This interconnected structure enables a nuanced representation of Jing culture, capturing its richness and depth.

2) Preserving Contextual Knowledge

Cultural heritage is inherently contextual, often rooted in specific geographic, historical, and social settings. Knowledge graphs preserve this context by linking information to periods, locations, and associated communities. For example, a knowledge graph can connect traditional Jing fishing techniques to the coastal regions where they originated, illustrating the interplay between cultural practices and their environmental background.

3) Facilitating Research and Knowledge Discovery

Knowledge graphs support advanced querying and reasoning capabilities, allowing researchers to explore and analyze cultural heritage in innovative ways. For instance, scholars can query the graph to trace the evolution of a specific Jing festival, assess the influence of external cultures on their music, or uncover patterns in maritime traditions. This functionality fosters a deeper understanding of Jing culture and its historical development.

4) Dynamic and Scalable Knowledge Management

Unlike static databases, knowledge graphs are dynamic and highly scalable. New insights or data about the Jing culture can be seamlessly integrated into the graph without disrupting existing structures. This adaptability is essential for maintaining a living and evolving repository of cultural heritage that reflects ongoing research and discovery.

3.0 Methodology

The management, preservation, and visualization efforts described in this paper focus on the Jing ethnic group's cultural heritage as the core content for constructing a knowledge base, in response to the extinction concerns discussed in the literature section. To enable effective representation and interaction, Topic Maps, Knowledge Graphs, Vue.js, and Neo4j are employed in the construction of the knowledge graph. Topic Maps (ISO-13250) are utilized because they integrate traditional indexing, subject indexing, and classification concepts with modern computing technologies, offering a novel approach to knowledge linking, representation, and navigation (Pepper, 2000; Estrada, 2011). Knowledge graphs are employed for their ability to organize and utilize information at a semantic level by constructing interconnected semantic networks. Vue.js is a progressive JavaScript framework commonly used for developing user interfaces, particularly dynamic single-page applications. Neo4j is selected as the data storage tool due to its advantages, including embedded deployment, high performance, lightweight structure, strong scalability, and versatility (Miller, 2013). The DMX system (https://dmx.berlin) is the software platform used for the development of the knowledge base system.

The implementation of the Jing ethnic group's cultural heritage knowledge preservation and visualization system consists of three main research stages: (1) preparation of Jing cultural heritage knowledge components, (2) ontology design and association modeling using Topic Maps, and (3) visualization of Jing heritage through DMX interfaces. The knowledge components include three key elements: the knowledge structure, event/program descriptions, and association types. The knowledge structure is organized into various topic types, including places, persons, food, clothing, architecture, festivals, musical instruments, song types, songs, dances, fishing gear, folk stories, treatment methods, and medicinal prescriptions. The event/program component includes specific program names - such as the Jing ethnic Ha Festival, monochord art, Yulu techniques, costume-making techniques, folk songs, wind-blown pancake preparation, high stilts shrimp-catching customs, Ha songs, the 'nan' character, Tiandeng dance, large net pulling, incense-offering dance, and flower stick dance—each with corresponding attributes. The association types include relationships such as inherit, belong to, composed of, author, mother-daughter, include, treat, use, and perform. Table 1-3 excerpt the knowledge components that serve as input for the preservation and visualization.

Table 1. Topic Types Knowledge

No.	Topic Types	Instances
1	Places	Dongxing Municipal, Dongxing Town, Jiangping Town, Wu Tou Island, Shanxin Island, …
2	Persons	Yang Yuanyan, Tao Xuanning, Li Yingmin, Li Ji, Su Chunfa, Huang Yongguang, Ruan Yuanyuan, Zhao Xia, …
3	Food	Wind-Blown Pancake, Mud Crab with Carrot Shreds, Ginger Scallion Stir-fried Crab, Dry-fried Sandworms, …
4	…	…

Table 2. Event/Program Descriptions

No.	Event/Program	Category	Level	Batch	Responsible Units	Start Date
1	Jing ethnic Ha Festival	Folklore	National	1	State Council	May 2006
2	Jing ethnic Monochord art	Traditional Music	National	3	State Council	May 2011
3	Jing ethnic Yulu techniques	Traditional Skills	Provincial	2	Autonomous Region Government	May 2008

4	…	…	…	…	…	…

Table 3. Association Type Descriptions

No.	Association Type	Topic 1	Topic 2	Example
1	Inherit	Intangible Cultural Heritage Project	Person	“Su Haizhen” inherits “Jing ethnic Monochord art”
2	Belong to	Intangible Cultural Heritage Project	Category	“Jing ethnic Ha Festival” belongs to the “Folklore” category of intangible cultural heritage
3	Composed of	Musical Instrument	Component	"Jing ethnic Monochord" is composed of an "instrument body", "pivot rod", "string shaft", and "picking stick"
4	…	…	…	…

4.0 Development

The development of the Jing cultural heritage knowledge preservation and visualization system follows three main steps.
Step 1: Create new topic types, including categories such as persons, songs, dances, festivals, and fishing gear.

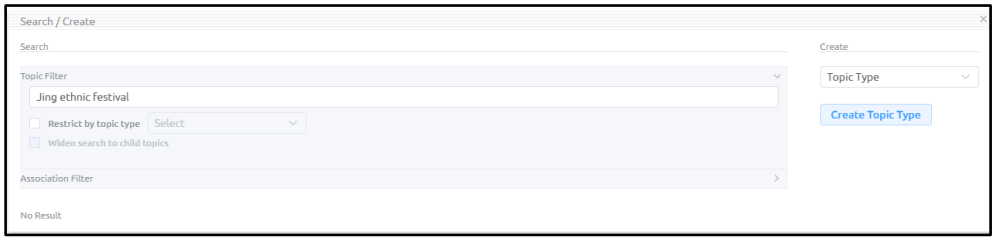

Figure 1. Creation of Topic Types in DMX

Step 2: Create new instances corresponding to the topic types defined in Step 1. For example, for the topic type “Dance,” instances include “Flower Stick Dance,” “Toast Dance,” and “Incense Dance.”

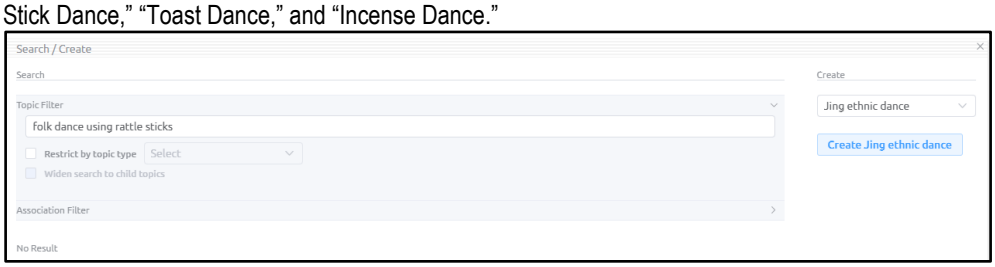

Figure 2. Creation of Topic Instances

Step 3: Define new association types to establish relationships between topic types. For example, use the association type “Inherit” between “Person” and “Intangible Cultural Heritage Project,” “Father-Daughter” between two individuals, and “Composed of” between a “Musical Instrument” and its components.
Step 4: Establish relationships between specific instances. For example, “Su Chunfa” inherits the “Jing Ethnic Monochord Art,” and the Jing ethnic “Sky Lantern Dance” involves tools such as “plate” and “candle.”

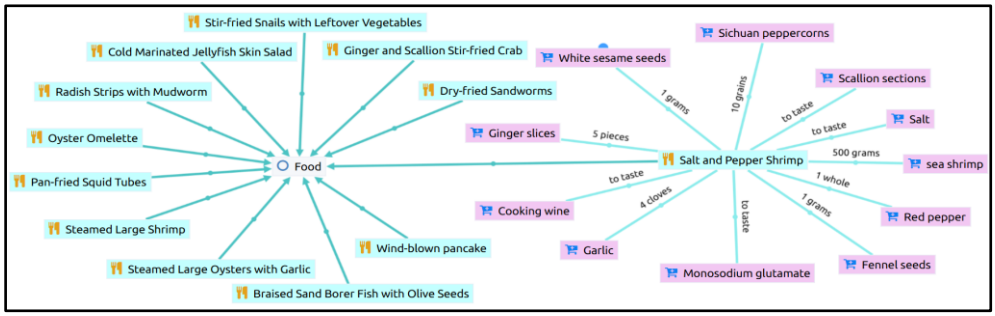

Figure 3. Establishing Relationships Between Instances

5.0 Results and Findings

The development of the Jing cultural heritage knowledge base has resulted in visually compelling knowledge graph visualizations across multiple dimensions, including graphical representation, descriptive text retrieval, knowledge extensiveness, and topical associations.

5.1 Knowledge Visualization

Information on "Jing Ethnic Monochord Art" is retrievable and visualized in Figure 4. The knowledge graph illustrates that this art form is classified as a national-level intangible cultural heritage under traditional music. It comprises components such as the instrument body, tuning peg, string axis, and picking stick. Its inheritors include Su Chunfa and Su Haizhen, who have performed pieces like the "Jing Sea Qin Rhythm." The Ha Festival incorporates rituals such as welcoming the gods, worshiping, communal feasts, and farewelling the gods. Luo Zhouwen is identified as a key inheritor, and the monochord art is performed during this festival.

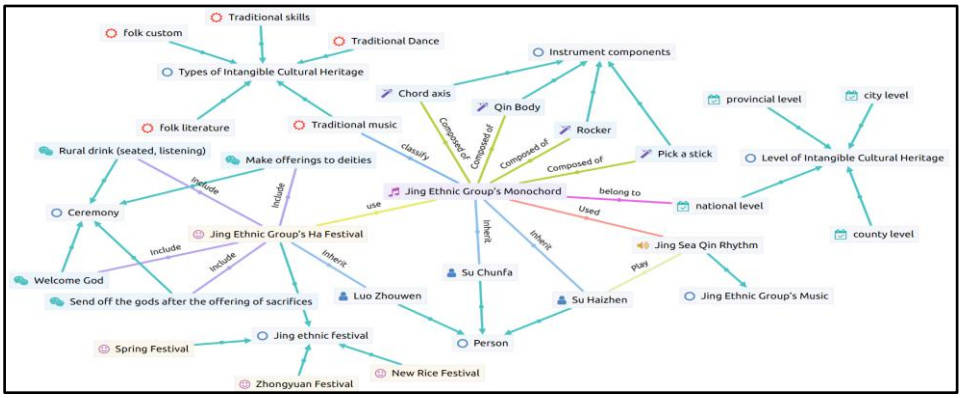

Figure 4: Visualization of "Jing's Ethnic Monochord" Knowledge

The visualization of graphical node relationships, descriptive text retrieval, and topic association exploration as in Figure 4 can enhance users' ability to navigate and understand complex cultural information. This aligns with prior studies by Silva and Terra (2024) and Hyvönen (2020), which highlighted the critical role of visualization in promoting accessibility and comprehension in digital heritage initiatives. The interactive design further encourages user-driven exploration, suggesting that visual semantic navigation is more effective for learning and retention compared to linear information retrieval methods.

5.2 Descriptive Text Visualization

The system's visualization capabilities extend beyond knowledge graphs, allowing retrieval of textual and image-based information. On the DMX platform, users can further explore and visualize additional knowledge. When a specific topic is selected, a detailed description appears on the right panel. For instance, selecting "Jing Ethnic Monochord" and clicking the "Details" button opens a pop-up with descriptive text, images, and related media, as shown in Figure 5.

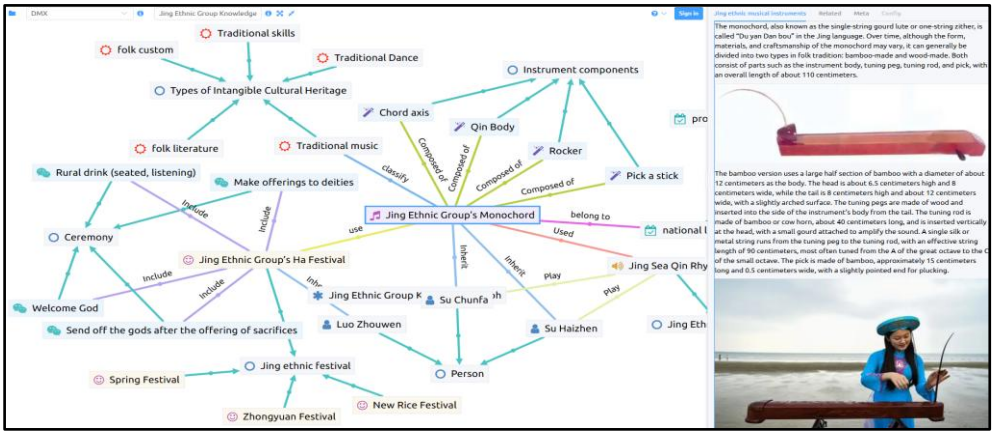

Figure 5: Visualization of "Jing's Ethnic Monochord" Descriptive Text

The system offers superior capabilities in preserving the contextual richness of cultural heritage information as indicated in Figure 5 above. Unlike traditional static database models, the semantic interconnections between entities (e.g., linking the Ha Festival with its associated rituals, songs, and tools) enable a more authentic and holistic representation of cultural practices. This finding supports earlier observations by de Boer (2023), who emphasized the importance of semantic structures in cultural heritage knowledge management.

5.3 Knowledge Graphs Extensiveness

The extensiveness and richness of the knowledge base are demonstrated through the knowledge graphs. As shown in Figure 6, the node "Jing Ethnic Medicine Prescription" contains instances such as "Prescription for Treating Stomach Pain" "Prescription for Colds and Flu" and "Prescription for Rheumatoid Arthritis". Another topic type, "Treatment Methods" includes instances such as "Medicinal Moxibustion" "Soaking" "Spray Powder" "Hot Ironing" and "Smoked and Roasted".

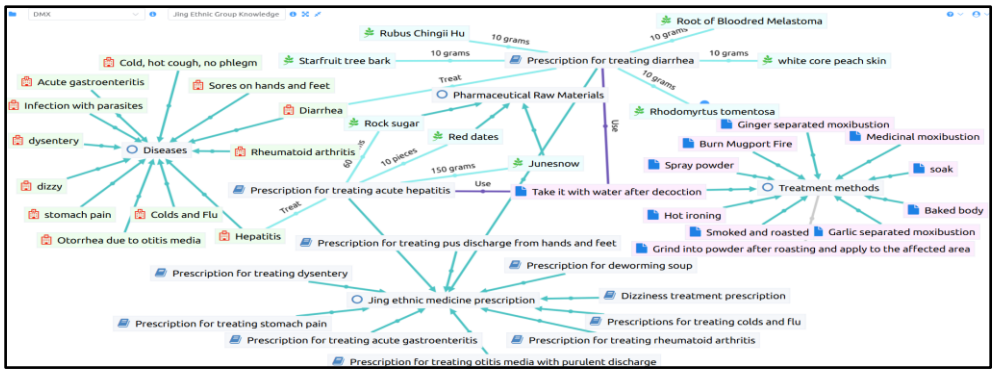

Figure 6: Visualization of "Jing Ethnic Medicine Prescription" Knowledge Extensiveness

Another key finding is the dynamic scalability of the knowledge system. In Figure 6, new cultural elements (e.g., songs, dance types, medicinal prescriptions) can be seamlessly integrated into the graph structure without disrupting existing knowledge relationships. This adaptability echoes the approach proposed by Wang and Hou (2023) for smart data construction frameworks and demonstrates practical feasibility in supporting the living, evolving nature of cultural heritage.

5.4 Topical Knowledge

As shown in Figure 7, the knowledge graph enables access to both topical and related knowledge. When a user selects a topic, the system automatically displays associated topics on the left panel, based on predefined relationships. By clicking the "Details" button, related topics appear on the right panel in the form of a topic list. For example, "Prescription for Treating Diarrhea" is classified under "Jing Ethnic Medical Prescription".

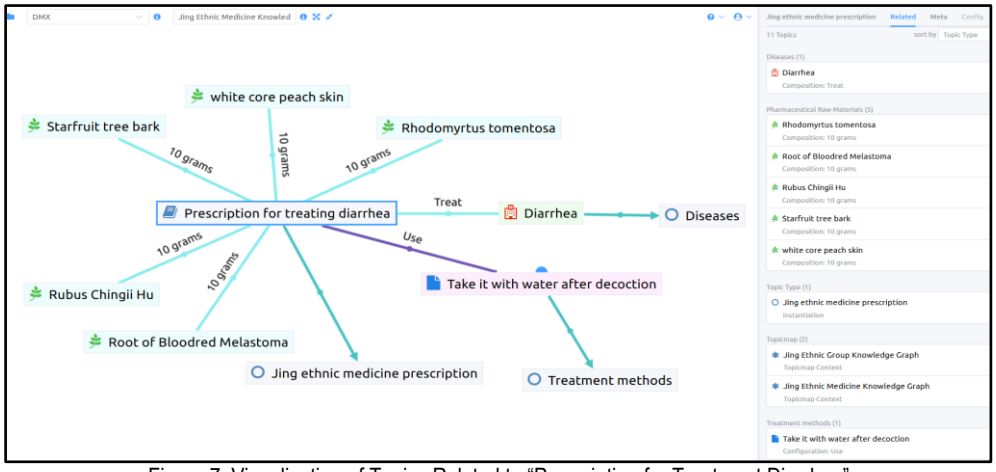

Figure 7: Visualization of Topics Related to "Prescription for Treatment Diarrhea"

The successful integration of Topic Maps (ISO-13250) with Knowledge Graph technologies within a cultural heritage context contributes to bridging theoretical models of knowledge organization and practical application in digital humanities. Figure 7 above indicates that this study extends previous work by Aristidou et al. (2022) by demonstrating a replicable methodology that enhances both the preservation and dissemination of intangible heritage through intelligent systems.

6.0 Discussion

Within the field of knowledge management, preservation, and visualization are essential activities that enable specialized knowledge to be systematically organized and meaningfully represented for retention, reference, and learning by current and future generations. In the context of Jing heritage, this specialized knowledge is not only collected and organized but also categorized and interconnected using Topic Maps and Knowledge Graphs, linking various dimensions of cultural knowledge such as festivals, traditional practices, and folklore. The semantic relationships established between entities enhance representational depth while preserving the contextual integrity of cultural information. This systematic and holistic approach ensures comprehensive documentation of Jing's culture and heritage, preventing fragmentation of knowledge. Knowledge becomes more meaningful and engaging when supported by visualization and interactivity. Effective visualization facilitates clear and impactful communication of knowledge content to users. Given that visualization is a critical means of knowledge communication, the use of Topic Maps and Knowledge Graphs for Jing's cultural heritage is expected to significantly enhance accessibility and understanding of descriptive knowledge related to the ethnic group. Interactive

interfaces enable users to intuitively explore complex cultural associations. For example, the relationships between the Ha Festival, associated rituals, and traditional musical instruments are visually represented, enriching the user experience.

From a technological perspective, the platform is designed to allow users to access knowledge content without the need for complex configurations or high-bandwidth environments. Consequently, the Jing cultural heritage preservation and visualization system—built upon technologies such as Vue.js, Neo4j, and Topic Maps—demonstrates the promising potential of digital tools in preserving cultural heritage. Neo4j's ability to manage graph-structured data, combined with DMX's semantic navigation capabilities, enables robust and scalable knowledge management. These tools offer adaptability and efficiency in processing large volumes of cultural data, thereby addressing traditional limitations in heritage preservation. Moreover, this study lays the groundwork for future technological enhancements, including integrating artificial intelligence (AI) to automate and optimize the construction of knowledge graphs.

Theoretically, the initiative presented in this paper represents a significant academic endeavor, bridging the gap between cultural studies and technological innovation, and contributing to interdisciplinary scholarship. It enriches the literature on cultural heritage preservation and visualization. The use of Topic Maps as an ISO-standard methodology for knowledge linking and representation strengthens the academic rigor of this research. Additionally, the proposed framework serves as a replicable model for preserving endangered cultural heritage globally, offering valuable insights for researchers in digital humanities, knowledge management, and cultural studies.

The work presented in this paper contributes to several related areas of study in meaningful ways. First, it translates conceptual knowledge management frameworks into practical applications by developing a system capable of conveying cultural knowledge effectively. This kind of system can promote cultural awareness and intergenerational transmission of heritage. Second, the study integrates preservation and visualization processes into the field of knowledge management through the application of digital technologies. Through this, younger generations and cultural enthusiasts can engage with traditional practices using digital technologies. Third, the Topic Maps and Knowledge Graph technologies represent a notable advancement in cultural heritage preservation and enrich existing literature on knowledge preservation practices. Lastly, this paper documents a comprehensive effort to preserve, visualize, and disseminate Jing ethnic cultural heritage through innovative knowledge management and visualization methods, thus contributing to cultural sustainability and diversity.

7.0 Conclusion

This paper highlights the importance of managing cultural heritage knowledge. Using the Jing ethnic group's cultural heritage as a case study, this paper presents the management, preservation and visualization initiative of Jing's cultural heritage knowledge with a direct aim at mitigating the risk of extinction. The preservation and visualization efforts are enabled by the application of advanced technologies, including Knowledge Graphs, Topic Maps, Vue.js, and Neo4j. Through systematic organization of knowledge structures, the system presents multi-layered information on Jing's cultural heritage, laying a solid foundation for its dissemination and protection. In its current form, the system performs effectively and offers multiple benefits to users. Shortly, it can be further scaled to incorporate Artificial Intelligence Generated Content (AIGC) to improve the efficiency and accuracy of knowledge graph construction through natural language processing. This enhancement is expected to significantly reduce the time required for information collection and organization, improve scalability and dynamic update capabilities, and further advance the application of knowledge graphs in cultural heritage research.

Despite the successful establishment of the Jing ethnic cultural heritage preservation and visualization system, this study acknowledges several limitations. First, the data sources were limited to available textual, image, and video materials, and did not include extensive fieldwork or oral history collection, which may result in gaps in the knowledge representation. Second, while Topic Maps and Knowledge Graph technologies proved effective for semantic structuring, the scalability of the current system may be constrained when applied to significantly larger datasets or more complex cultural contexts. Third, the evaluation of the system's usability, effectiveness, and impact on cultural transmission has yet to be systematically conducted through empirical user studies.

Future research should address these limitations by expanding data sources through ethnographic fieldwork, enhancing the system's scalability and adaptability for broader applications, and conducting rigorous user-centered evaluations to assess the platform's educational and preservation effectiveness. Additionally, incorporating Artificial Intelligence Generated Content (AIGC) and machine learning techniques could further automate knowledge graph construction and improve system dynamism, making cultural heritage preservation more efficient and sustainable.

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