



Research on information visualization design of China towers -- A case study of Northeast and North China

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Abstract. Ancient Chinese towers embody a wealth of historical and cultural significance. Contemporary research on these structures, however, faces limitations due to scattered data, an absence of a digital humanities perspective, and suboptimal visualization methods. To mitigate these challenges, this study compiles and organizes pertinent resources including monographs, governmental publications, and scholarly articles from CNKI, focusing on ancient towers located in Northeast and North China. Utilizing a combination of literature review, interdisciplinary approaches, and case studies, we have developed a web-based visualization tool that effectively illustrates the spatial distribution and temporal trends of ancient towers in these areas. This tool supports detailed analyses of the historical evolution, religious context, and artistic design of these structures, uncovering both inconsistencies and patterns within the data. Additionally, it provides insights into the cultural and artistic narratives associated with these architectural marvels. This research endeavors to offer a visualized perspective to scholars studying ancient Chinese towers, with the aspiration of promoting the convergence of digital media design, art history, and the study of religious art.

Keywords: Chinese Ancient Tower, Digital Humanities, Information Visualization.

1 Introduction

China towers bear witness to the dynastic changes and historical progression of diverse ethnic groups over millennia. Nevertheless, current research is hampered by technical limitations, resulting in scattered data, a lack of a digital humanities perspective, and poor visualization outcomes. To address these issues, this study collected and organized relevant monographs, government website resources, and academic papers from the China National Library concerning towers in Northeastern and North China, encompassing a total of 471 towers and approximately 13,000 records. Utilizing bibliographic research, interdisciplinary methodologies, and case studies, a web-based visualization platform was employed to clearly exhibit the distribution and trends of data related to these ancient structures.

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S. Kaki et al. (eds.), *Proceedings of the 2024 6th International Conference on Literature, Art and Human Development (ICLAHD 2024)*, Advances in Social Science, Education and Humanities Research 885,
https://doi.org/10.2991/978-2-38476-319-1_60

2 Related Work

The academic study of ancient Chinese towers has a well-established framework. Liang Sicheng identified three phases in brick tower evolution: Ancient Simplicity, Splendid, and Varie-gated periods [1]. Liu Dunzhen outlined tower development across dynasties, detailing type transformations [2]. "Research on Digital Conservation of China towers" discusses digital preservation techniques and methodologies [3]. CNKI statistics to November 2023 show 212 entries on architectural technology, and fewer in other areas: architecture/history (49), design/art (11), history/culture (27), and digital media (19). Tadao Itō's 'A History of Chinese Architecture' [4] details pre-Six Dynasties Buddhist tower construction. Zhu Peiyu et al. classified and screened the ancient pagodas of the Tang Dynasty by digging and sorting out the ancient pagodas' documents, combined with field visits and investigations[5]. Ernst Boerschmann's 'Chinese Architecture and Religious Culture: Volume Three – Chinese Ancient Towers' outlines these towers and their distribution. Ji Xuxing et al. used GIS software to summarize the spatial distribution of ancient pagas in the Beijing-Tianjin-Hebei region[6].

In conclusion, despite the broad scope of research on China towers, there is a predominant use of traditional maps and single-dimensional infographics for visualization purposes. There is a noted deficiency in the application of modern composite data visualization tools and multidimensional data cross-analysis.

3 Design Strategies for China Towers Visualization

Professor Yuan Xiaoru, in 'Visualization in Digital Humanities', categorizes the data processed through visualization in digital humanities into textual data, geospatial data, network relational data, and image data [5]. This study, focusing on China towers, further refines digital humanities information into four categories: numerical (such as initial construction dates and number of floors), categorical (such as tower types and decorative patterns), textual (including historical records), and geographical (such as location). These data are then subdivided into explicit information (like height and floor count) and implicit information (such as historical development and changes in decoration). Explicit information is directly quantifiable, whereas implicit information requires a multidimensional logical analysis for its presentation. When implementing visual encoding, the selection of encoding methods is based on data type, attributes, and communication objectives, ensuring readability, accuracy, and consistency to guarantee the precision of the visualization outcomes and the fidelity of the information conveyed. The following picture is the information visualization design process of the tower in Northeast China and North China(see Fig.1).

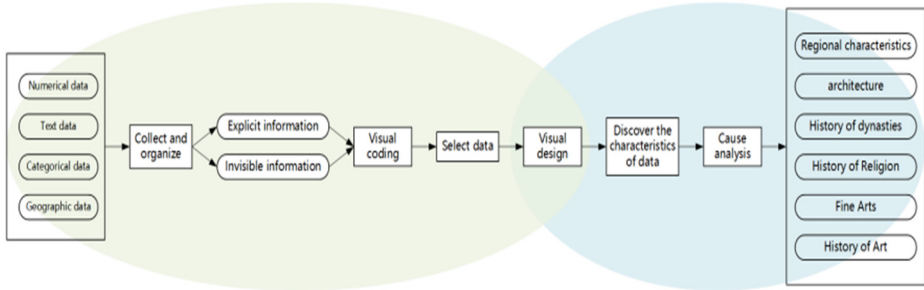


Fig. 1. Visualization design flow of information ancient tower in Northeast and North China

4 Information visualization Design and Analysis of Towers in Northeast and North China

4.1 Information on the Architectural Form of the Ancient Tower

The Relationship Between the Ancient Tower Category and Dynasties. The Venn chart cross-analyze the data of three dimensions, namely, the architectural category, the number of China towers and the China towers' dynasties and show the diversity and distribution of China towers in each dynasty (see Fig.2).

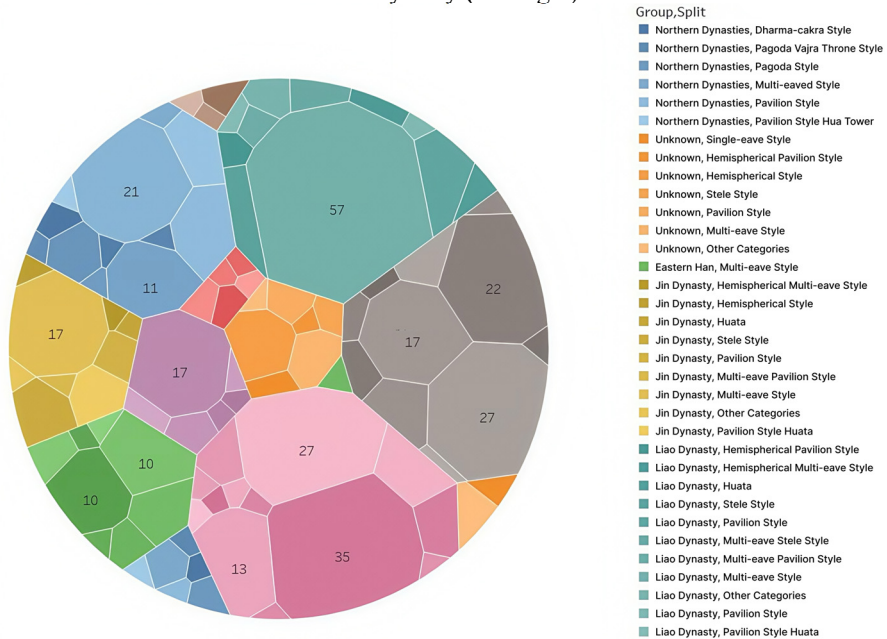


Fig. 2. Ancient tower categories in dynasties

The Relationship Between the Number of Angles and Stages of China Towers and the Types and Dynasties of China Towers. Through the analysis of box plots, it is observed that the average number of sides and stories of China towers from the Tang Dynasty tend to be lower compared to those from other dynastic periods (see Fig.3). The combined characteristics of side count and story count in multiple-eave style towers across different dynasties can serve as a reference for determining the probable period of construction for such structures.

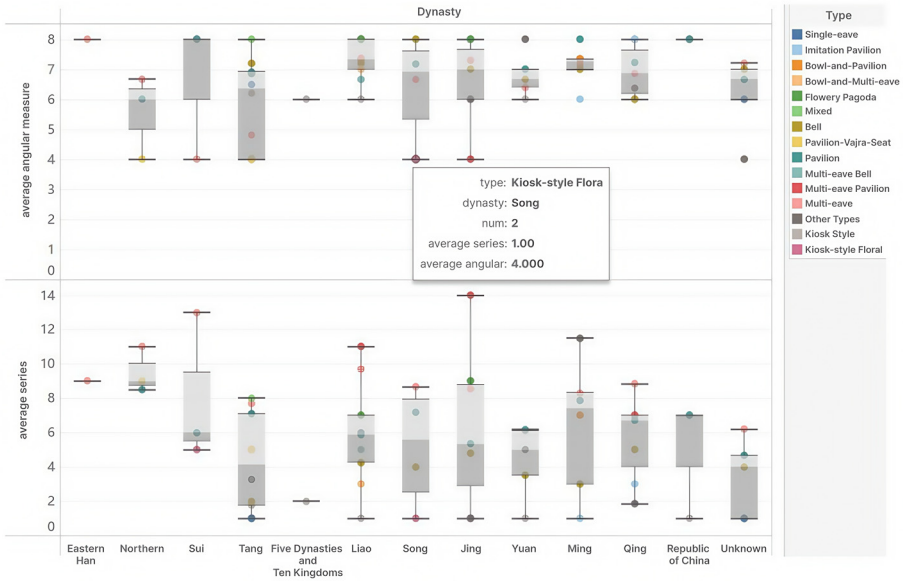


Fig. 3. Corner number, series and ancient tower category, dynasty box diagram Artistic and Humanistic Information About the Ancient Tower

The Relationship Between the Ancient Tower Material and the Tower Height, The City, and the Dynasty. Analysis of the charts reveals that most extant towers in North-east and North China are constructed of brick or stone, with only a single wooden tower remaining (see Fig. 4).

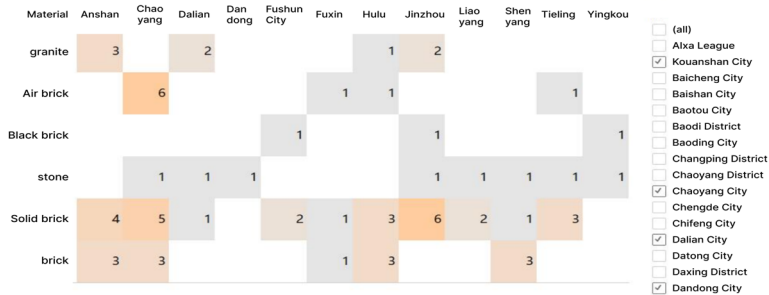


Fig. 4. Materials and quantitative heat maps of cities and Ancient towers

Decorative Patterns and Ancient Tower Categories. The tree map categorizes the decorative patterns found on China towers, utilizing rectangular nodes to represent the proportion of different tower types (see Fig.5).

Decorative Patterns and Dynastic History. The heat-map visualizes the development of decorative patterns on China towers across various dynasties (see Fig. 6). The x-axis represents the names of the decorative patterns, while the y-axis denotes the respective dynasties. The size of the color blocks corresponds to the frequency of occurrence of each decoration.

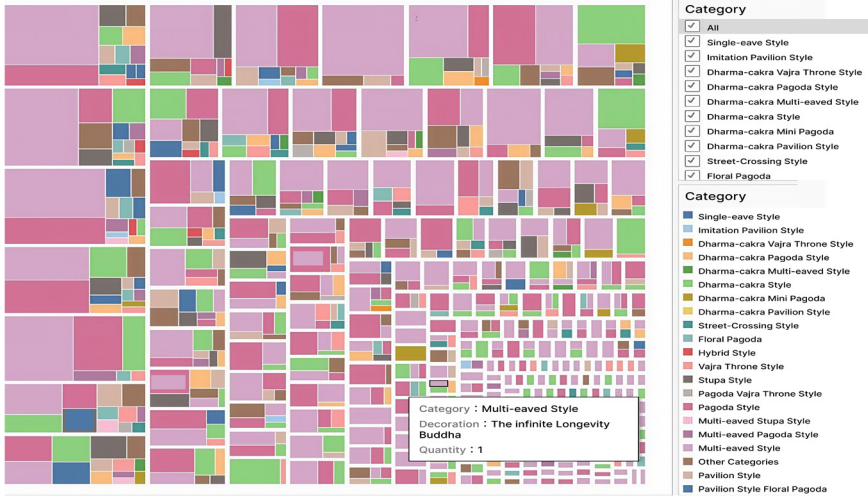


Fig. 5. Decorative patterns and ancient tower category tree map

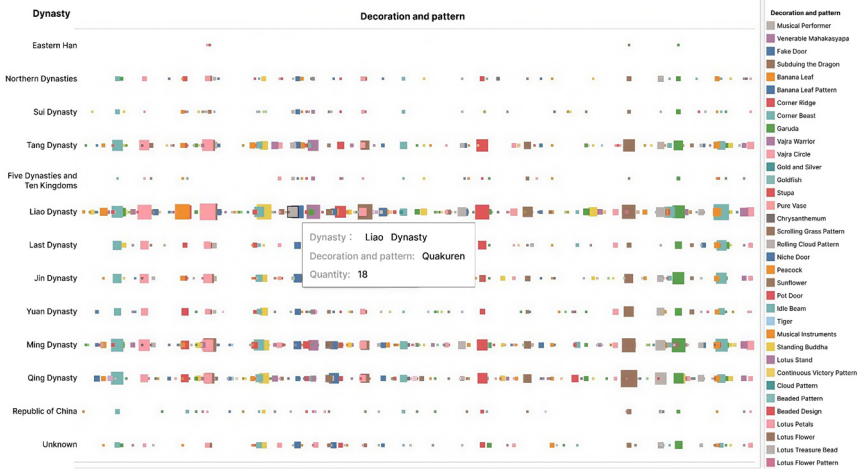


Fig. 6. Decorative patterns and heat maps of dynasties

The Relationship Between the Ancient Tower and the Emperor. Emperors' views greatly affected the rise and fall of Buddhist towers. In the Ming Dynasty, early emperors' support led to many tower constructions, peaking in the Wanli era. Mid-Ming saw a decline, but later, under Emperors Wu Zong and Shen Zong, there was a revival with numerous new towers.(see Fig.7).

4.2 The Current Status and Prospects of the Conservation of the Ancient Tower

The Sankey diagram reveals that a significant number of towers in Northeast and North China remain unlisted as cultural heritage sites (see Fig. 8). It is hoped that, with legal and policy support, a scientific approach can be adopted to plan and implement effective protection measures.

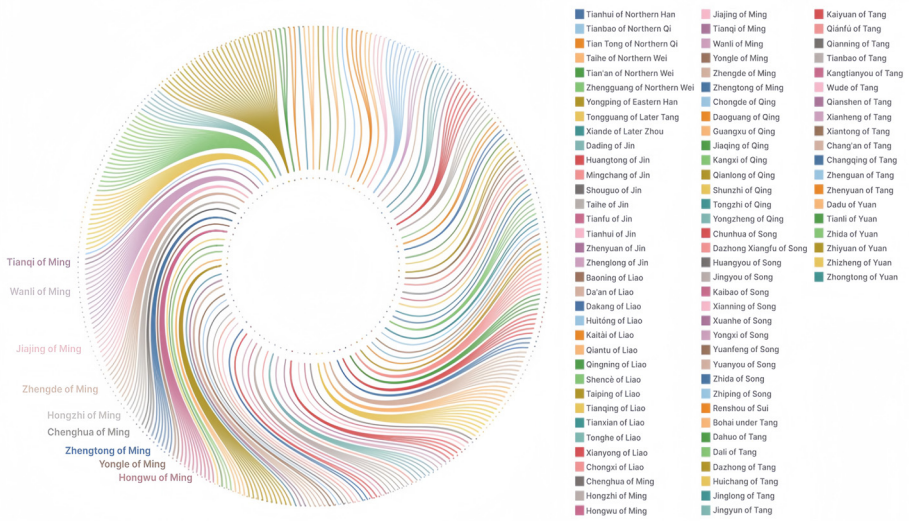


Fig. 7. Ancient tower with imperial circular Sankei diagram

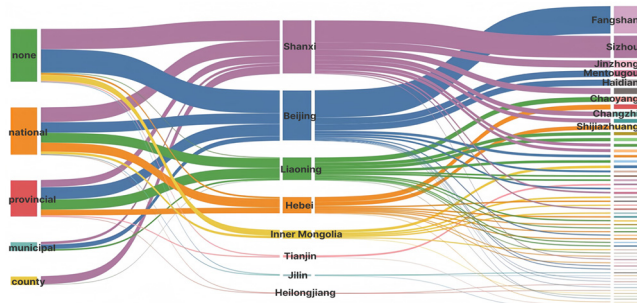


Fig. 8. Sanki map of the current state of conservation of the ancient tower

5 Conclusion

This paper employs a digital humanities framework to perform a multifaceted cross-analysis of ancient tower datasets from Northeast and North China. The research includes a comprehensive visualization design encompassing multiple dimensions, resulting in the production of 25 visualizations. These visual aids offer a detailed examination and synthesis of the historical progression, religious aesthetics, and artistic design principles of China towers in the aforementioned regions. Through this analysis, the study uncovers issues and discerns patterns within the data, further exploring the rich tapestry of artistic and humanistic insights. The ultimate aim is to contribute to the digital conservation efforts of China's ancient towers.

Funding

This work is supported by the Guangxi Thousand Young Key Teachers Training Program for Colleges (2020QGRW017) and Guilin University of Electronic Technology Graduate Education Innovation Program (2023YCXS082)(2022YCXS104).

Acknowledgments

The acknowledgment section would like to extend special thanks to Shi Zhuo, the original author of the research, for his significant contributions and support. His valuable data and insights, along with his professional expertise and enthusiasm for the research, have greatly facilitated the completion of this paper.

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