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Article

Constructing Cultural Genetic Mapping of Cantonese Furniture Genealogy: An Empirical Study Based on Intangible Cultural Heritage Transmission Mechanisms

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Abstract: However, as an intangible cultural heritage, Cantonese furniture is in a state of systematic transmission crisis. The study constructs a complete framework of cultural genetic mapping that combines gene identification, hierarchical coding, network analysis, and spatiotemporal decoding of transmission routes in this regional crafts tradition. The paper develops a four-dimensional genealogy categorization of the form, craft, decorative, and material fields via a mixed-method research strategy that relies on quantitative network modeling as well as qualitative fieldwork conducted across the Pearl River Delta production basins. Conjugated, geodetic, and institutional transmission channels coexist, and topological analysis of the networks reveals marked patterns in vulnerability concentration and stability. Weak connections between regions provide system redundancy; strong connections at the family level result in high-fidelity core gene transmission. Such a gene-network-map analytical model for Cantonese furniture demonstrates that it can be utilized in parts of the ICH fields, thereby facilitating the targeted conservation of precision interventions on empirically identified discontinuity risk points. Moreover, it embodies the requirements of adaptive innovation and authenticity maintenance, both important to long-term heritage reproduction in the current socio-economic context.

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Keywords: Cultural genetic mapping; intangible cultural heritage transmission; Cantonese furniture; network analysis; heritage conservation; traditional craftsmanship

1. Introduction

1.1. Research Background and Theoretical Foundation

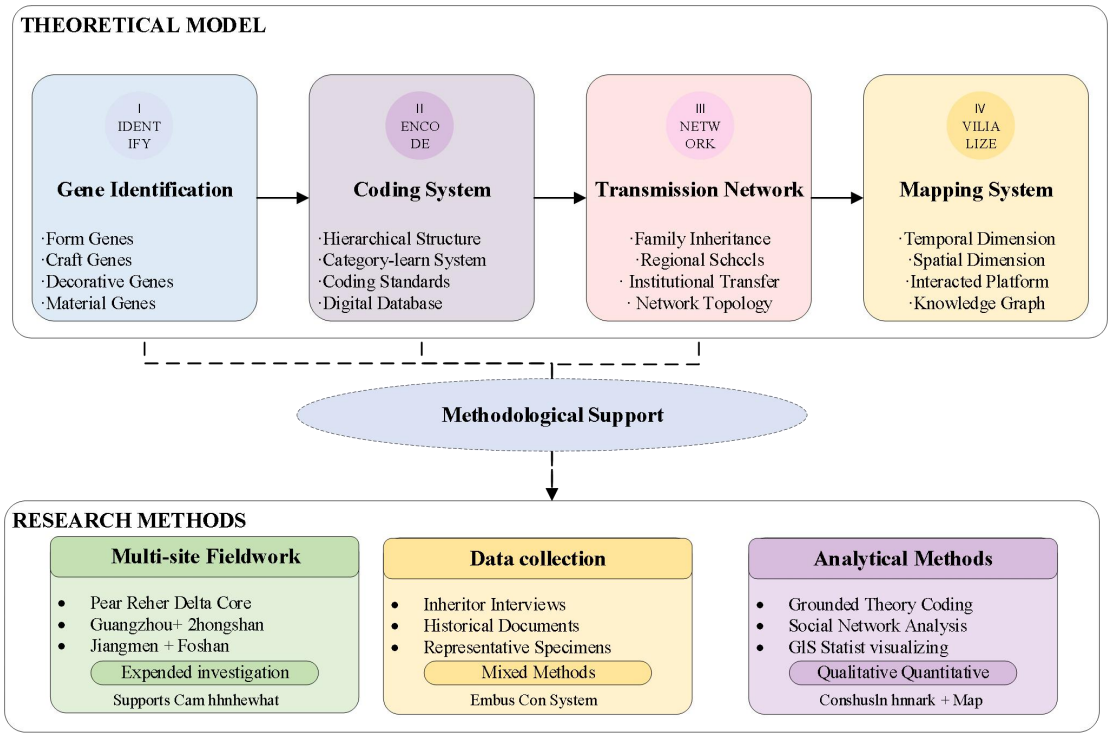
Cantonese furniture, as a regional school that is characteristic of the traditions related to Chinese classical furniture, is facing unprecedented transmission challenges because of the prevailing socio-economic changes. This has led to the loss of the intangible cultural heritage represented by its craftsmanship through a systematic loss of practitioners and collapsed transmission channels (Du et al., 2024). Preserving such systems of their intangible cultural heritage dictates the need for the application of innovative methodology that bridges the conservation of the heritage effectively for the present dynamics, especially where sustainability goals for ecosystems meet the evolving nature of tourism landscapes (Zhang & Ran, 2024). Cultural meme theory provides a useful analytical tool that endows scholars with a systematic framework for the analysis of how units of cultural information reproduce, change, and spread in a wide array of temporal and spatial frameworks. With the analysis of memes, scholars have successfully tracked stable aspects of cultures and their evolutionary histories such that the cultural traits are susceptible to a systematic analysis as discrete units of information that are exposed to a selection and transmission process akin to biological patterns of inheritance (Li et al., 2020).

Memes are becoming more and more accepted as valid units for cultural analysis in modern qualitative research paradigms, which can help illuminate the intricate dynamics of transmission in heritage contexts (Iloh, 2021). Concurrently, studies on digital cultural heritage have developed mapping approaches that combine bibliometric, spatial analysis, and quantitative visualization approaches (Huang et al., 2025). This methodological flaw is particularly noticeable when one considers that successful heritage conservation plans necessitate a precise identification of which cultural aspects are fundamental genetic components rather than merely incidental variations. Therefore, as **Figure 1** shows, there is an urgent need to develop unified

analytical frameworks that integrate identification, encoding, network analysis, and visualization techniques.

Figure 1

Theoretical Framework and Research Design Architecture



1.2. Research Questions and Theoretical Framework

How researchers can systematically identify, classify, and define the cultural genes found in Cantonese furniture while defining the mechanisms of transmission using empirical data is the primary research question that motivates this study. According to the theoretical model used in this study, cultural genetic mapping is a four-step analytical process in which visualization techniques turn abstract connections into tangible cartographic representations, network analysis reveals the transmission structures that connect these encoded units by different practitioners and institutions, and material culture analysis yields preliminary units that can then undergo systematic encoding.

The main objective of this study is to develop theoretical models and empirically validate them using case studies of Cantonese furniture in order to develop guidelines for a methodology that can be applied in a range of intangible cultural heritage domains. At the same time, it aims to produce useful insights that will guide

successful conservation initiatives. By showing how analytical frameworks for gene-network mapping can uncover transmission dynamics that are frequently missed in conventional heritage documentation techniques, as exemplified by the research framework below, this study seeks to close the analytical gaps between information science and cultural heritage studies.

2. Methodology

2.1. Research Design and Data Collection

In order to produce well-informed theoretical models that can handle the complex complexities inherent in mechanisms of cultural transmission, the study employs a mixed methods research design that blends qualitative and quantitative techniques (Shim et al., 2021). The study design is qualitative in nature, with quantitative methods offering network mapping capabilities that infuse analytical rigor and ethnographic research offering vital insights into the dynamics of identifiability and transmission of the cultural genes (Guetterman et al., 2019).

In the Pearl River Delta core zone, where Cantonese furniture traditions have united practitioner groups and agglomerations of workshops, multi-locational research is the main technique used to gather data. Data collection protocols combine three supplementary sources that triangulate views of cultural transmission dynamics. Qualitative interviews of intangible cultural heritage transmit-tors yield narrative histories of knowledge transmission processes, technical skill trajectory developments, and perceived continuity or disruption of craft tradition dynamics that shed light on subjective aspects of transmission (Wang et al., 2024). The analysis of historical sources covers archive materials such as guild documents, apprenticeship deeds, and inventories of working premises that define temporal landmarks of cultural heritage components and evidence the institutional mechanisms for transmission of traditional channels of knowledge. Study of material culture and the documented description of a characteristic set of furniture artifacts yield morphological information crucial for the identification of technical characteristics and stylistic differentiation, thereby establishing the empirical base for schemes of cultural gene encoding.

2.2. Data Analysis Methods

Methodologies of analysis employ grounded theory research by utilizing three-levelled protocols of coding that systematically extract aspects of cultural genes from qualitative data sets, without the loss of inductive sensitivity to patterns yet unseen, unlike the imposition of pre-specifiable categorical schemes. Three-level coding protocols (open, axial, selective) systematically extracted cultural gene elements from qualitative data.

Social network analysis allows for the quantitative modeling of transmission connections by assembling inheritors, workshops, and institutions as nodes connected by knowledge transmission networks through analytical structures that have proven effective in depicting cultural transmission in temporal and spatial terms (Cui et al., 2025). Network measures such as measures of centrality, clustering coefficient, and structural hole analysis define transmission system topology and pinpoint important nodes whose disruption potentially entails continuity risk. Spatial dimensions are included by Geographic Information System technologies in transmission analysis by delineating the geographical diffusion patterns of particular cultural gene elements across regional borders through digital heritage research methodologies that have proved invaluable for the visualization of complex cultural phenomena (Lian & Xie, 2024). Temporal analysis imposes history periods over the spatial distributions for the purposes of reconstructing the way in which cultural genes have developed through migration, adaptation, and selection retention processes that characterize living heritage systems in transforming socio-economic environments.

3. Cultural Gene Identification and Coding

3.1. Core Cultural Gene Elements

This research proposes a four-D analytical framework where cultural genes are framed in morphological, technical, ornamental, and material arenas that denote distinct but related systems of transmission which together define the distinct identity of Cantonese furniture as a localized tradition. Form genes cover the structural and proportional features that characterize furniture typologies such as the dimensional ratio relationships, spatial ordering, and compositional norms that govern the relation of functional constituents. In contrast to the unique complex joinery techniques, like the intricate mortise-and-tenon joinery, which is a key technological innovation that

distinguishes Chinese furniture traditions, craft genes codify the technical aspects involved in construction techniques. These methods use particular joint configurations to represent distinct genetic units that are passed down through experience-based knowledge as opposed to written documentation.

3.2. Coding System Construction

The translation of identified cultural genes into systematic coding schemes requires the construction of hierarchical organizational schemes that are able to incorporate both categoric differentiation and gradational variation within typologically defined constraints, such as those outlined in **Table 1**. A three-level hierarchical model is utilized by the coding scheme where primary categories delineate dimensional domains, secondary subcategories represent major typological differences that are relevant for each domain, and third-level components specify particular genetic units that may be recognized by analysis of material culture.

Table 1

Cultural Gene Coding Framework for Cantonese Furniture

Dimension	Primary Code	Core Gene Categories	Representative Features	Stability Classification
Form	A-series	Structural proportions, spatial configurations	Width-height ratios, component relationships	High stability
Craft	B-series	Joinery techniques, construction sequences	Mortise-tenon variations, assembly protocols	High stability
Decorative	C-series	Pattern repertoires, carving techniques	Motif systems, relief methods	Medium stability
Material	D-series	Wood species selection, surface treatments	Hardwood preferences, finishing protocols	Medium stability

Digital database design organizes coded genetic units in relational constructs amenable to multi-dimension querying and pattern analysis; each entry also comprises photographic evidence, dimensional data, technical description, and provenance information that connects genetic expressions to specific practitioners, workshops, and time periods.

4. Transmission Mechanism and Mapping Construction

4.1. Transmission Patterns and Network Structure

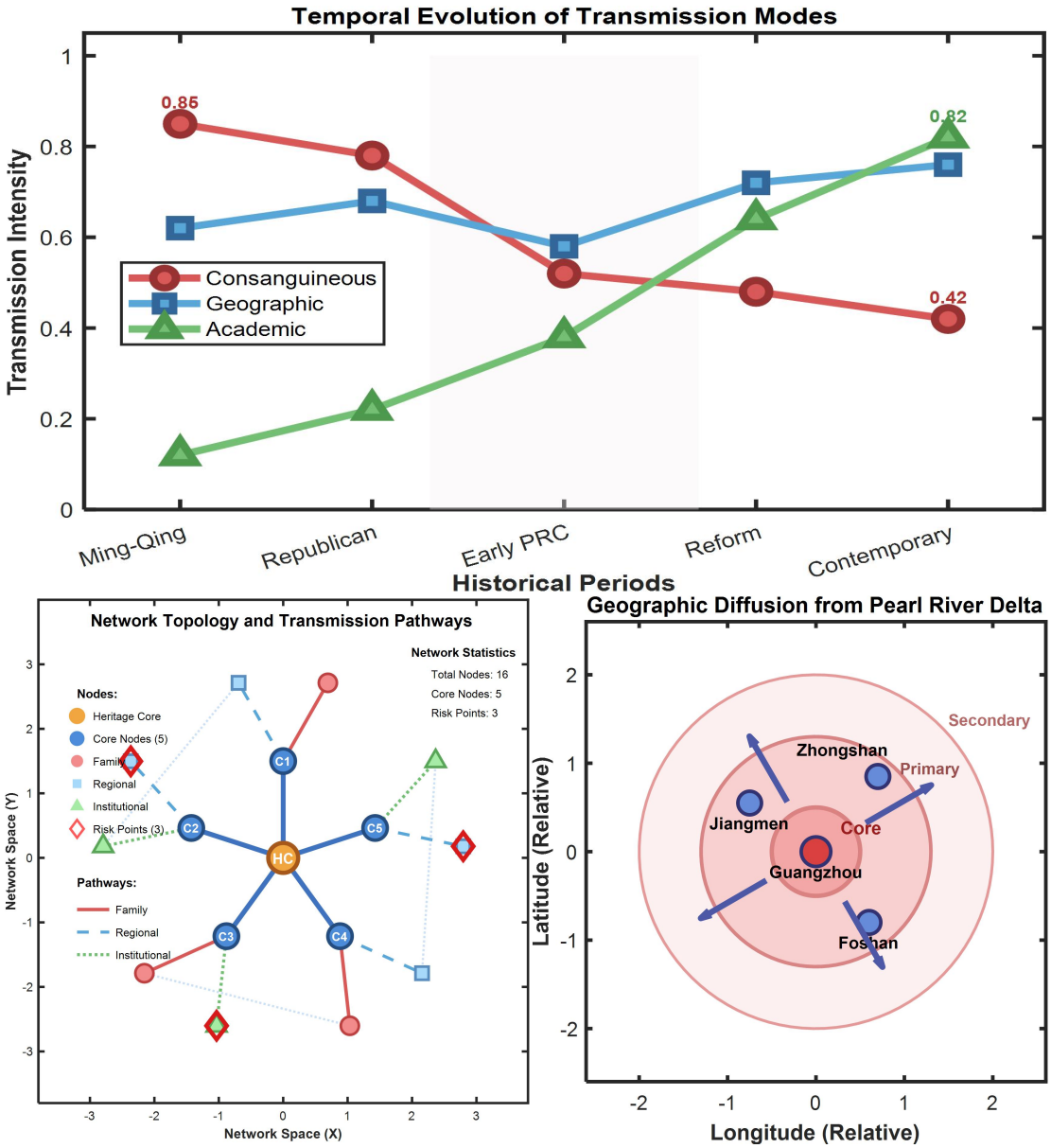
Cultural transmission of Cantonese furniture occurs along three related but independent channels that together form the system of heritage reproduction, each having specific structures of relationship between the transmission agents and associated protocols for the passage of knowledge and institutional access rules for transmission of expertise. Consanguineous transmission occurs by family-based master-apprentice training schemes where the transmission of craft knowledge occurs vertically between generations of kinship groups such that hereditary Workshop lineages carry proprietary techniques as the family's intellectual property by ensuring transmission by biological and adopted successor schooling protocols. This channel has high fidelity in primary technical gene transmission because of long-duration immersion learning and master-apprentice relationships that transmit tacit knowledge by observation of body-based practice. It is susceptible to extinction risk when lineage transmission breaks down. Geographic transmission occurs by regional agglomeration effects such that physical closeness amongst the workshops located in the craft districts facilitates lateral diffusion of knowledge amongst non-kinship networks by peer observation, joint projects, and competitive emulation mechanisms homogenizing regional stylistic attributes while introducing localization of innovative trajectory distinct for Guangzhou, Zhongshan, and the other centers of fabrication that form distinct schools having unique genetic imprints.

Academic transmission is an example of modern institutional interventions where organized training programs standardize knowledge through standardized curricula, codified texts, and credentialing processes that increase accessibility outside of traditional gatekeeping frameworks. The depth of master-apprentice relationships and the range of experiences that define traditional systems, however, may be jeopardized by this strategy. The structural characteristics that affect the resilience and vulnerability patterns of transmission systems are revealed by a network topology analysis. **Figure 2** shows this, with institutional programs and master craftsmen serving as the main nodes. These entities' high betweenness centrality metrics demonstrate their critical role as knowledge bridges between otherwise unrelated network segments. Key knowledge transmission routes that connect nodes across geographically separated regions and time periods are identified through transmission pathway mapping. Pathway redundancy is associated with transmission robustness, whereas single-path dependence generates discontinuity risk nodes that can be

disturbed by practitioner mortality, workshop closures, or institutional program termination.

Figure 2

Cultural Genetic Transmission Network and Spatiotemporal Evolution



4.2. Cultural Genetic Map Visualization

Due to the distinct socioeconomic conditions, technological capabilities, and market demand patterns of each historical era, which place selective pressures on genetic conservation and innovation pathways, the temporal analysis charts the evolution of cultural genes over time. While the spatial diffusion patterns demonstrate a centrifugal dispersion from the core regions of the Pearl River Delta to more

outlying areas, **Figure 2** combines network topology and temporal dynamics to show the variations in transmission intensity between three distinct modes over five historical periods. The delineation of spatial dimensions is used to reconstruct geographic diffusion trends, in which transmission vectors are linked to networks of trade routes, migratory flows, and institutional ties that connect central nodes with their surrounding areas through significant mobility and the establishment of workshop branches. The creation of an interactive online platform utilizes knowledge graph technologies that combine network analysis results with temporal-spatial data in easily navigable visualization interfaces that allow for the dynamic exploration of genetic distribution patterns, transmission pathways, and evolutionary paths across several analytical dimensions at once.

5. Discussion and Conclusion

5.1. Key Findings and Theoretical Contributions

This study breaks down the cultural heritage of Cantonese furniture into collections of forms, crafts, decorations, and materials using a four-dimensional identification framework. It shows how precise observation of inheritance patterns is made possible by the routine classification of transferrable cultural units, which also reveals varying rates of stability among different dimensional categories. Network analysis reveals the operation of both weak and strong ties in transmission systems. While strong ties are characteristic of intensive master-apprenticeship relationships and family kinship lineage routes, which ensure transmission of high-fidelity core genes but create vulnerability because they afford relatively few redundancies, institutional cross-fertilization and regional workshop proximity provide transmission robustness through multi-path redundancies, even though they may compromise interpretive variation and transmission fidelity dilution.

The gene-network-map three-level analytical framework developed here combines micro-level identification of cultural genes with meso-level topology of transmission networks and macro-level spatiotemporal visualization such that granular documentation of heritage feeds into structural relationship analysis that in turn permits panoramic cartographic rendering of evolutionary dynamics across temporal phases and geospatial sectors. This innovative methodology breaks

long-standing impasses in the research of intangible cultural heritage where documentation has oftentimes been severed from transmission analysis and both have been poorly connected to policy-making for preservation such that actionable knowledge infrastructure linking descriptive research investigation with useful conservation intervention is established. The model thereby opens prospects for transfer for diverse craft traditions, performing arts, together with other living heritage expressions where transmission is reliant upon knowledge networks amongst practitioners instead of textual codification alone. It thereby broadens applicably to the particular condition of Cantonese furniture, but it does so while requiring field-specific modifications so that transmission attributes unique to individual expressions of a given heritage may successfully be incorporated.

5.2. Practical Implications and Future Directions

The cultural genetic mapping techniques perfected in this work enable accurate conservation policy that tailor's intervention according to empirically revealed patterns of vulnerability instead of enforcing homogeneous protection measures for whole sets of heritage. This way, transmission system damage that may result from localization of risk of discontinuity in transmission channels and nodes of crucial importance may be prevented. Policy regimes that embrace genetic mapping technologies are able to differentiate between core genes required for rigid preservation of strict authenticity and accessory genes that accommodate innovative adaptation. Under this model, the high-stability core genes ensure continuity nodes are preserved, while the medium-stability peripheral genes are allowed creative variation that sustains the practitioners' livelihood and the market applicability without affecting the implicit integrity of the cultural property.

Research limitations are geographic sample centralization in Pearl River Delta core areas that may insufficiently represent transmission dynamics in the periphery and diaspora groups, while temporal range issues involved in constructing historical transmission networks from incomplete archival sources and oral histories by practitioners create uncertainty in evolutionary patterns before periods of systematic documentation. Future research avenues include the integration of artificial intelligence to create dynamically updated maps where machine learning frameworks work through streams of digital documentation efforts, social media weave community interplay, and institutional program databases to create current

transmission network representations that respond to real-time shifts in practitioner groups and institutional environments. International comparison studies extension towards simultaneous studies of regional furniture traditions in additional cultural environments such as Japanese, Korean, and European craft traditions would allow for the identification of patterns across cultures that identify universal transmission principles versus culture-sensitive mechanisms and inform the construction of generalized intangible cultural transmission theory that abstracts across specific case study constraints while being sensitive to unique cultural environments that condition the processes of heritage reproduction worldwide.

Conflict of interest: The authors declare no conflict of interest.

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