The Criteria for Selecting Outstanding Traditional Building Craftsmen in China Based on Interpretative Structural Modeling

Keran Lan [1, a], Wei-Ling Hsu [1, b], Lin Mou [1, c]

[1] School of Civil Engineering, Jiaying University, Meizhou, China

[a] 229181731@qq.com, [b] 200201049@jyu.edu.cn, [c] quartback@hotmail.com

Abstract. With the implementation of policies promoting the revival of traditional Chinese culture, traditional buildings are gaining increasing attention. Traditional craftsmen have become central to the protection of traditional buildings, and various regions are conducting selections for outstanding traditional building craftsmen. The objective is to establish leaders in the industry and promote the conservation and restoration of traditional buildings.Currently, the selection of outstanding craftsmen in traditional building mostly relies on descriptive criteria, making it difficult to define clearly and posing challenges to the selection process. This article, based on existing selection standards, utilizes expert questionnaires to establish an interpretative structural model for the criteria for selecting traditional building craftsmen. This model clarifies the relationships between selection conditions, providing a reference for the selection of outstanding craftsmen in traditional buildings and helping the revival of traditional architectural culture and heritage protection.

Keywords: outstanding; building; craftsmen; selection criteria; Interpretative; structural modeling; china.

1. Introduction

Traditional Chinese building possesses profound cultural significance and exceptional artistic value, representing the crystallization of the wisdom of the Chinese people over thousands of years. Traditional craftsmen have contributed to the great achievements in Chinese traditional building. The selection of outstanding craftsmen in traditional building serves to establish industry leaders, promote the revival of traditional building culture, and preserve the skills involved in traditional building craftsmanship. This endeavor holds profound significance in the inheritance and continuation of traditional building techniques.

ISM (Interpretive Structural Modeling) is a research method in systems engineering. It begins by identifying the constituent elements or influencing factors of a problem through investigation or technical means. Subsequently, it employs a matrix model to analyze the relationships between these elements, revealing the complexities of their interactions and hierarchical structures. The intricate relationships thus derived constitute the interpretive structural model.

2. Research processes

2.1 Determine Selection Criteria

Through government websites, searching for documents and criteria related to the selection of outstanding craftsmen in traditional Chinese architecture, it is evident that currently, there are not many nationwide, provincial, and municipal policy documents available. These are mainly concentrated in regions where traditional building conservation is well-established and renowned, such as Anhui with its Hui-style architecture, Guangdong with Chaoshan-style, Guangfu-style, and Hakka-style architecture, and Fujian with Minnan-style architecture, as detailed in the table below.(table1)

Table 1. Policy documents

No	Document	Time
1	《Notice on Carrying Out the Recommendation of Master Craftsmen in Traditional Chinese Architecture》	2017.07

2	《Implementation Plan for China's Rural Artisan "Double Hundred and Double Thousand" Training Program》	2023.08
3	《Notice from the Housing and Urban-Rural Development Department of Guangdong Province, China, on the Launch of the First "Guangdong Province Master of Traditional Architecture" Recognition Program》	2016.05
4	《Measures for the Identification and Management of Successors in Traditional Building Restoration Techniques and Traditional Building Restoration Craftsmen in Fujian Province, China》	2020.03
5	《Management Measures for the Identification of Rural Artisans in Changsha City, Hunan Province, China》	2023.06
6	《Evaluation Method for the "Huizhou Ancient Architecture Craftsman" Selection in Huangshan City, Anhui Province, China》	2022.07
7	《Management Measures for the Grading and Recognition of Rural Artisans in Linxia City, Gansu Province, China》	2023.07

Organize and filter the selection criteria from the evaluation documents, incorporating additional expert opinions, and assign the number Si（S1~S12） to them.as detailed in the table below.(table2)

Table 2. Selection criteria

S_i	Selection criteria	Origin
S_1	Leader in the Inheritance and Development of Skills	1，2，4
S_2	Faction Leader	1，4，6
S_3	Actively Cultivating Successors	1，4
S_4	Has a Good Reputation Among Peers and Owners	1，2，3，4，5，7
S_5	Made Breakthroughs or Achievements in Solving Technical Challenges	1，4，6
S_6	Engaged in the industry for over 20 years with participation in over 10representative projects	1，3，4
S_7	Abundant Practical Experience	2，3，4，5，7
S_8	Awards and honors received	4，5
S_9	Made Contributions to the Industry Development	5，7
S_{10}	Key Project Technical Leader	6，7
S_{11}	Hold exhibitions and other publicity activities	Expert opinion
S_{12}	Data collection and organization	Expert opinion

2.2 Construct Adjacency Matrix

Based on the selection criteria in Table 2, it is determined that there are interactions and mutual influences among various selection criteria. An adjacency matrix "S" for each selection criterion is established as shown in Table 3. In this matrix, "1" indicates a direct influence between the corresponding selection criteria, while "0" indicates no direct influence between the corresponding selection criteria. Therefore, the elements of matrix "P" are defined as follows:

$$S_{ij} = \begin{cases} 0\cdots(S_i \text{ is not directly related to the } S_j) \\ 1\cdots(S_i \text{ is directly related to the } S_j) \end{cases} \quad i, j = 1,2\cdots 12 \qquad (1)$$

Table 3.Adjacency Matrix（P）

P	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9	S_{10}	S_{11}	S_{12}
S_1	0	0	0	0	0	0	0	0	0	0	0	0
S_2	1	0	0	0	0	0	1	0	1	0	0	0
S_3	1	0	0	0	0	0	0	0	1	0	0	0
S_4	0	0	0	0	0	0	0	0	0	0	0	0
S_5	1	0	0	0	0	0	1	0	1	0	0	0

S_6	0	0	0	0	0	0	1	0	1	0	0	0
S_7	0	0	0	0	0	0	0	0	0	0	0	0
S_8	0	0	0	0	0	0	0	0	1	0	0	0
S_9	0	0	0	0	0	0	0	0	0	0	0	0
S_{10}	0	0	0	0	0	0	1	0	0	0	0	0
S_{11}	1	0	0	0	0	0	0	0	1	0	0	0
S_{12}	1	0	0	0	0	0	1	0	1	0	0	0

2.3 Construct Reachable Matrix

Based on the adjacency matrix "P" in Table 3, utilizing the laws of Boolean algebra, a reachable matrix "M" is established, where the identity matrix is denoted as "I":

$$M = (P+I)^{n+1} = (P+I)^n \cdots \neq (P+I)^2 \neq (P+I) \quad n = 1,2,3\cdots \qquad (2)$$

The matrix "M" represents whether there is a connected path from one criterion to another. In the reachability matrix "M," the element "M_{ij} = 1" indicates the existence of a reachable path from criterion "S_i" to "S_j," representing the direct relationship between criteria (this study only considers direct relationships). The reachable matrix is presented in Table 4 below:

Table 4. Reachable Matrix（M）

M	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9	S_{10}	S_{11}	S_{12}
S_1	1	0	0	0	0	0	0	0	0	0	0	0
S_2	1	1	0	0	0	0	1	0	1	0	0	0
S_3	1	0	1	0	0	0	0	0	1	0	0	0
S_4	0	0	0	1	0	0	0	0	0	0	0	0
S_5	1	0	0	0	1	0	1	0	1	0	0	0
S_6	0	0	0	0	0	1	1	0	1	0	0	0
S_7	0	0	0	0	0	0	1	0	0	0	0	0
S_8	0	0	0	0	0	0	0	1	1	0	0	0
S_9	0	0	0	0	0	0	0	0	1	0	0	0
S_{10}	0	0	0	0	0	0	1	0	0	1	0	0
S_{11}	1	0	0	0	0	0	0	0	1	0	1	0
S_{12}	1	0	0	0	0	0	1	0	1	0	0	1

2.4 Decomposition Reachable Matrix

In the reachable matrix, the horizontal set is the reachable set "R(Si)," representing the complete set of elements that can be reached starting from "Si." The vertical set is the antecedent set "Q(Si)," representing all the elements that can reach "Si." The intersection "R(Si) ∩ Q(Si)" denotes the set of elements from which "Si" can possibly be reached and, at the same time, can reach all the elements of "Si," as shown in Table 5:

Table 5. R（S_i）、Q(S_i)、R（S_i）∩Q（S_i）

S_i	R（S_i）	Q（S_i）	R（S_i）∩Q（S_i）
S_1	1	1，2，3，5，11，12	1
S_2	1，2，7，9	2	2
S_3	1，3，9	3	3
S_4	4	4	4
S_5	1，5，7，9	5	5
S_6	6，7，9	6	6

S_7	7	2，5，6，7，10，12	7
S_8	8，9	8	8
S_9	9	2，3，5，6，8，9，11，12	9
S_{10}	7，10	10	10
S_{11}	1，9，11	11	11
S_{12}	1，7，9，12	12	12

2.5 Drawing Hierarchical Structure Model

Based on Table 5, identify the criteria for which "$R(S_i) \cap Q(S_i) = R(S_i)$," indicating that the reachable set is the highest level. In the next step, remove the row corresponding to "S_i" from Table 5, and eliminate the elements "i" from both the reachable set "$R(S_i)$" and the antecedent set "$Q(S_i)$." Continue searching for criteria that satisfy "$R(S_i) \cap Q(S_i) = R(S_i)$" in the modified table; these criteria constitute the second level. Repeat this process iteratively, removing rows and eliminating elements, to determine the criteria for each level.

Using "L_n" to represent different levels, where "n = 1, 2, ..." search for criteria in the "L_{n-1}" level that share a reachable set "$R(S_i)$" with the "L_n" level. This signifies the relationship between criteria from the upper and lower levels. Utilize this approach to establish relationships among all criteria. Refer to Figures 1 and 2 for illustrations of this method.

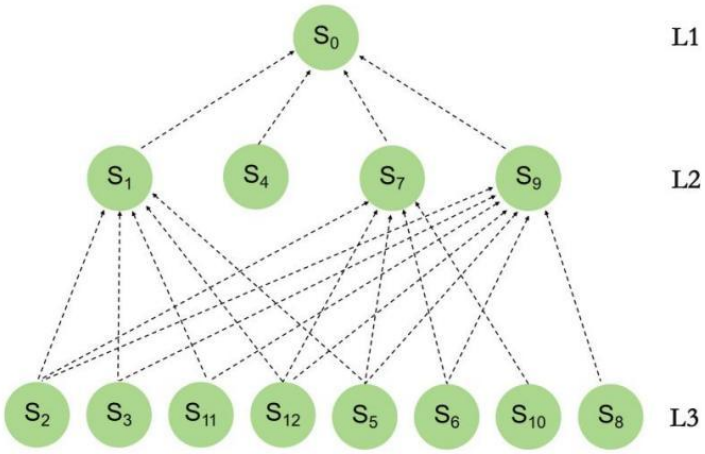

Fig. 1 Interpretive structural modeling of outstanding craftsmen selection in Chinese traditional building

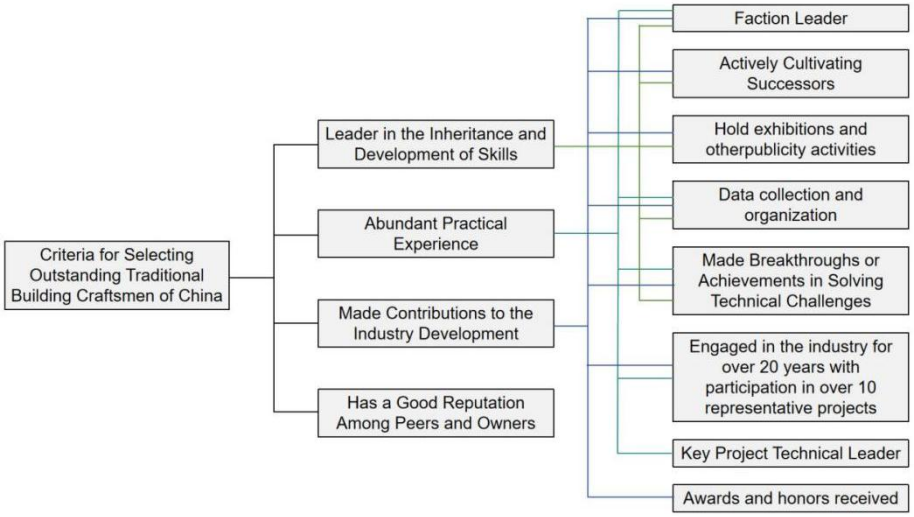

Fig. 2 Indicator System for the Selection Criteria of Outstanding Craftsmen in Chinese Traditional Building

3. Discussions

By interpretive structural model, it is evident that in the intermediate layer (L2) of the selection criteria for outstanding craftsmen in a traditional building, it is very important to contribute to the development of the traditional construction industry. In the deep layer (L3), only one selection criterion is unrelated to it, indicating the long-term dedication of outstanding craftsmen in the traditional building field, embodying the spirit of innovation, rigor, and practicality.In the intermediate layer (L2), S_4(a good reputation)is earned by each outstanding craftsman through their superb skills and diligent efforts. Since this study only considers direct relationships, other deep layer (L3) selection criteria are not linked to it. The multiple relationships between the deep layer (L3) and the intermediate layer (L2) reflect the importance of the selection criteria, with leaders of factions, innovation and breakthroughs in skills, and the organization of construction data being core elements in the deep layer (L3). Experiences such as receiving honors or being a technical lead on important projects are, therefore, not as crucial.

In summary, the selection criteria for outstanding craftsmen in traditional buildings emphasize the significance of traditional craftsmen's professional experience, exceptional skills, dedication to heritage and innovation, and contributions that contribute to the advancement of the industry. However, the interpretive structural modeling can only qualitatively describe the relationships among various selection criteria. Further research may involve combining the Analytic Hierarchy Process (AHP) to quantify and determine weights, highlighting the significance of each criterion.

Acknowledgments

A Project Supported by Traditional Crafts Institute, the Key Research Institute Academic Center of Chinese Culture for Sichuan Province:Construction of cultural connotation of traditional residential building skills under the background of rural revitalization(CTGY23ZC02);

A Project Supported by 2023 Humanities and Social Sciences Project, Jiaying University:The wisdom of traditional village construction in Meizhou area based on oral history method(2023SKM05);

A Project Supported by 2022 First-class Undergraduate Program,,Jiaying University:Architectural design practice(PX-85221830);

References

[1] Chen, Mingzhang & Liu, Jingxian & Weihao, Ma & Li, ZhaoZhang & Zhang, Zehan. (2017). Assessment of Marine Rescue Abilities Based on ISM and AHP as well as Fuzzy Evaluation. 10.2991/icmmct-17.2017.145.

[2] WU, Chun. (2017). Impact Factor Analysis in the Selection of Shopping Mode Based on ISM and AHP. DEStech Transactions on Social Science, Education and Human Science. 10.12783/dtssehs/mess2016/9741.

[3] Hsu, Wei-Ling & Chen, Yi-Sian & Shiau, Yan-Chyuan & Hsin-Lung, Liu & Chern, Tian-Yow. (2019). Curriculum Design in Construction Engineering Departments for Colleges in Taiwan. Education Sciences. 9. 65. 10.3390/educsci9010065.

[4] Zhao, Leilei. (2016). Study on Factors influencing college students to become self-employed Based on ISM and AHP. 10.2991/icemct-16.2016.203.

[5] Hamzeh Shalamzari, Reza. (2023). Interpretive structural modelling (ISM) an overview.

[6] Yingbo JI, Zihao ZHAO, Fuyi2 YAO. Analysis of application barriers for big data in construction field based on ISM[J]. Big Data Research, 2021, 7(6): 128-137.

[7] Attri, Rajesh, Nikhil Dev, and Vivek Sharma. "Interpretive structural modelling (ISM) approach: an overview." Research journal of management sciences 2319.2 (2013): 1171.

[8] Adegoriola, Mayowa I., Joseph HK Lai, and Rotimi Abidoye. "Critical success factors of heritage building maintenance management: An ISM-MICMAC analysis." Journal of Building Engineering (2023): 106941.

[9] Tan, Tan, et al. "Barriers to Building Information Modeling (BIM) implementation in China's prefabricated construction: An interpretive structural modeling (ISM) approach." Journal of Cleaner Production 219 (2019): 949-959.

[10] Xu, Xiaoxiao, and Patrick XW Zou. "Analysis of factors and their hierarchical relationships influencing building energy performance using interpretive structural modelling (ISM) approach." Journal of Cleaner Production 272 (2020): 122650.