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Revitalization and Development Strategies of Fostering Urban Cultural Heritage Villages: A Quantitative Analysis Integrating Expert and Local Resident Opinions

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Abstract: In order to promote sustainable development and economic growth, the city shall pay attention to the interaction rule between local cultural heritage resources and community residents, and advance the continuous consolidation of local cultural identity in the process of community activation and renewal. This poses a key challenge for many cities to continue to promote community renewal and activation of urban villages. In this study, the FI-RST model was constructed to effectively manage such projects by taking both top-down and bottom-up decision-making thinking into consideration in the formulation of the revitalization development strategies of urban villages. South China's Huangpu Village in Guangzhou City is taken as an example in this study to clarify the logical relationship between the top-down key points of community activation and renewal development and the consolidation of local cultural identity by respecting the rules of community life and behavior, and then the Huangpu Village revitalization and development strategies are developed. A new multi-attribute decision analysis model is developed and utilized in this study, which provides a project management idea for the activation of urban cultural heritage villages, that is a model that not only supports community renewal and cultural activation, but also pays attention to community residents' needs and emotional feedback.

Keywords: urban cultural heritage villages; FI-RST model; Huangpu Village; community renewal; local cultural identity



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1. Introduction

The culture guided urban renewal and the revitalization of old urban areas have been widely promoted all over the world. Cultural heritage in urban communities is regarded as a core driving force. Its historical and cultural value and development potential affect the layout of cultural industries, community governance, and the improvement of the environment of old urban communities [1]. Cultural heritage is not only an important way to understand regional history and culture, but also an important embodiment of regional culture. Especially for promoting social development, previous studies have shown that if cultural heritage was effectively developed and activated, it would bring new possibilities for promoting community cohesion, inclusiveness, and developing intercultural communication, and even indirectly promote the improvement of the community environment and the development of the tourism industry [2–4]. It is not difficult to infer that the resource investment in the development of cultural heritage can produce many benefits for the environment, economy, and society, so as to promote the sustainable development of urban communities [5].

Cerreta et al. [6] pointed out from the perspective of industrial development and economic management that the existing cultural heritage could be effectively explored

and activated from the three points: cultural vitality, creative economy, and supporting the environment. It can bring more possibilities for the development of cultural heritage and make good use of the derived values of cultural heritage, so as to promote social development. On the other hand, many studies also point out that the activation and development of cultural heritage are closely related to the social environment. Li et al. emphasized the importance of community participation in the development and management of cultural heritage after summarizing a lot of previous studies [7]. From the perspective of social exchange theory, the trend of regional development has an important interactive relationship with the residents' cognition [8]. Especially for the local cultural heritage revitalization project, the emotional cognition and feedback of community residents are related to the sustainability of the project. If local characteristics and community awareness are ignored, and local cultural heritage revitalization strategies are formulated on the basis of correct political replication of past successful experiences, it is likely to lead to a decline in community awareness, inhibit extensive community participation, and lead to the loss of residents' sense of local cultural identity [9]. This will make the social exchange between society and economic industry show a negative interaction, and may even have a negative effect on the "revitalization" of cultural heritage [10].

Chng and Narayanan [11] once proved that in certain conditions, community participation and the revitalization of local cultural heritage would have a two-way positive effect: the protection and revitalization of cultural heritage would promote the development of relevant industries and bring new economic growth; an adequate and stable financial base would further subsidize and encourage the extensive social participation, and the social welfare would be greatly improved. However, there is still a lack of sufficient empirical research to explore how to achieve the revitalization and activation of cultural heritage in urban communities on the basis of consolidating the identity of local residents. On the other side, real cases often adhere to the concept of top-down governance, which is to pursue the revitalization and reuse strategy of cultural heritage with high feasibility and objective economic benefits based on expert experience [12]. Real-life experience shows that, ignoring the cultural identity of local residents and detaching from bottom-up community awareness, the revitalization of cultural heritage will be difficult to sustainably develop. Although the revitalization of cultural heritage may achieve certain positive results in the short term, the growth of social isolation will have a negative impact on the emotional cognition and feedback of local residents. As a result, the cultural heritage revitalization project has moved towards an ineffective and unsustainable situation [13]. Therefore, scholars have emphasized the important role and positive impact of following bottom-up group decision-making planning in promoting the sustainable development of local cultural heritage in different empirical studies [14,15].

Under the premise of regional coordinated development and limited resources, this study suggests that the revitalization strategy of cultural heritage in urban communities needs to be formulated in combination with top-down and bottom-up decision-making reference basis. In the urban cultural development strategy, the consolidation of local residents' cultural identity is emphasized, and then it discusses the activation and revitalization strategies of regional cultural heritage. Therefore, the main question of this study is: which decision-making analysis model can take into account the top-down and bottom-up regional governance concepts in the empirical study and establish an impact mechanism between the revitalization and development of urban community cultural heritage and the consolidation of local residents' cultural identity? This includes two sub issues: how to define the activation and revitalization criteria of local community cultural heritage under the overall cultural development strategy of the city; how to clarify the behavior law knowledge between the emotional cognition of local residents to the surrounding cultural heritage and the formation and consolidation of community cultural identity in daily life.

In conclusion, the purpose of this study is to build a decision-making analysis model, which can give consideration to both top-down and bottom-up regional governance concepts, and clarify the impact mechanism between the development of cultural heritage

in urban communities and the consolidation of local residents' cultural identity. Based on the revitalization and development criteria, if a local cultural heritage revitalization and development strategy is well developed, it can not only continuously enhance the cultural identity of residents' communities but also solve resource investment. In order to achieve the research purpose, the design of this study is: First, find an index system suitable for the revitalization and development of cultural heritage through reading and sorting out the literature. Then, based on the expert opinion, find the index combination with multiplication effect in each index, and make an evaluation of its current situation with these index combinations as the development criteria through the Fuzzy Integral (FI) method, so as to put forward the development strategy of cultural heritage. Second, find the cultural heritage of Huangpu Village/Huangpu ancient port (including material and intangible cultural heritages), and then conduct data exploration on the residents of the research sampling area through RST (Rough Set Theory) to find the best residents' participation/cognition state of each heritage for local cultural identity. Then, construct the relationship between residents' participation/cognition status and revitalization development indicators of these cultural heritage related activities. Finally, discuss the detailed revitalization and development scheme of cultural heritage on this basis.

2. Previous Works

2.1. The Strategies and Values of Cultural Heritage Revitalization and Development

As the crystallization of the development of human regional history and civilization, cultural heritage has extremely historical significance. It is an important symbol of regional historical and cultural achievements and a symbol of regional culture. In today's society, how to make rational use of resources to achieve sustainable development is a focus of society. Dümcke and Gnedovsky noted that cultural heritage was an important pillar of sustainable development, and that effective investment in cultural heritage could bring good social benefits and economic growth. This conclusion shows that culture has unique social and economic values [5].

Social values of cultural heritage improve people's thinking, actively promoting their psychological and social well-being, enriching the social environment, providing the community with a collective "memory", and providing a treasure house of creative and intellectual ideas for future generations [5]. At the same time, cultural heritage can also increase the cultural identity of regional residents, especially the younger generation, to avoid the impact and damage caused by a globalized society, which will help shape the cultural identity of the younger generation who are in turmoil and transformation, while retaining regional cultural characteristics so as to protect cultural diversity [16].

The economic values of a cultural heritage can be defined as the amount of benefits that the heritage creates for the society. The three major economic values are leisure perceiving value, bequeath value, and living comfort value. Among them, leisure perceiving value refers to cultural heritage, as an important tourism resource, which can bring tourists many opportunities for leisure and cultural perception, thus bringing more opportunities to develop the tourism economy. Living comfort value refers to the land value gain generated by the material and environmental advantages brought by cultural heritage and the benign social benefits brought by cultural heritage. Bequest value refers to the many values of cultural heritage that have the characteristics of preservation and can bring sustainable benefits to future generations [16]. If the existing cultural heritage can be effectively explored and activated, it can bring more possibilities for the development of cultural heritage and make good use of the derived values of cultural heritage, so as to form a dual track of social and economic benefits, and enhance the regional cultural soft power, and then achieve the effect of promoting social development.

2.2. Revitalization and Development Indexes of Cultural Heritage

In order to better develop the values of cultural heritage, both social practice and academic research are constantly discussed on the revitalization strategies of cultural her-

itage. Previous scholars have put forward many strategies for the revitalization of cultural heritage. For example, the repair and protection of historical buildings can effectively improve the cultural influence and substantive environment of the city [17]; at the same time, areas with cultural heritage have greater advantages in the development of cultural tourism [18]. The commercialization of intangible cultural heritage is also conducive to its inheritance and protection [19]. These schemes may be effective in some specific situations, but they do not necessarily have universality. Therefore, in order to evaluate and select the schemes suitable for various specific situations, the decision-maker must rely on a set of reasonable evaluation index systems. Cerreta et al. [20] once improved the EU indicators used to monitor urban cultural and creative development in the study [21] and proposed a new cultural development index system. This indicator system refines the European Union's system for the cultural development of large cities into one suitable for the cultural development of low entropy regions of the cultural economy in cities. Such an indicator system can more accurately describe the cultural development and related problems in urban areas [6]. The index system well summarizes the hierarchical relationship of cultural development indicators and the corresponding relationship between indicators and actual social activities. Cerreta et al. used this set of indicators combined with quantitative evaluation methods in the research, which has put forward suggestions for the development of Italian landscape cultural heritage, and confirmed that this indicator system is also considered to be applicable in the evaluation of cultural heritage revitalization and development projects [20]. This study will continue to follow the index system as the theoretical basis for the subsequent discussion. In the index system, there are five dimensions that affect the revitalization and development of cultural heritage. They are: C_1 (Cultural venues and facilities); C_2 (Cultural participation and attractiveness); C_3 (Creative knowledge-based jobs); C_4 (New jobs in creative sectors); C_5 (Human Capital). Their corresponding social behaviors are shown in Table 1.

Table 1. Cultural development index system.

Dimensions	Indicators
C_1 . Cultural venues and facilities	I.1. Number of people who report the site as a point of interest
	I.2. Number of cultural events
	I.3. Number of participants at cultural events
C_2 . Cultural participation and attractiveness	I.4. Number of cultural projects activated
	I.5. Number of crowdfunding campaigns
	I.6. Funds collected by crowdfunding
C_3 . Creative knowledge-based jobs	I.7. Revenues for the year
	I.8. Private investment
	I.9. Number of associates
C_4 . New jobs in creative sectors	I.10. Number of temporary employees
	I.11. Number of business partners/collaborations
	I.12. Number of people employed
C_5 . Human Capital	I.13. Number of local promoters
	I.14. Number of international partners
	I.15. Number of like
	I.16. Number of social accounts

2.3. The Relationship between Community Development and Residents' Emotions

The revitalization and development of cultural heritage is bound to bring obvious changes to the area. The development of the region will also bring significant changes to the regional material environment and non-material environment. For example, the repair, protection, and development of large-scale architectural cultural heritage will directly affect the environment of the space, and the development and inheritance of intangible cultural heritage may greatly change its existing state. At the same time, the development of cultural heritage will develop tourism, which may have a great impact on the lifestyle of

local residents [9,17,22]. These changes will lead to differences in the living conditions and cognitive conditions of local residents, which will affect the emotional conditions of the residents in the area [8]. From the perspective of humanity, regional development should pay attention to the emotional status of local residents and try not to bring negative impact to them. From the perspective of development, the sustainability of development is closely related to residents' emotion. If residents can actively cooperate with and participate in regional development, it can promote regional development. Otherwise, it may hinder development. This shows that the development and residents' emotion affect each other. Only taking into account the situation of both sides can we make the region sustainably develop and maximize the values of resources [2,23].

The social exchange theory refers to the people who participate in the process of social interaction, in which they seek valuable things, whether in the material, social, or psychological aspect. Once individuals judge the reward and cost of exchange, they would choose to participate in the exchange. People may have different views on the exchange because individuals who perceive positive results will evaluate the exchange differently from those who perceive negative results [14]. From the perspective of cultural heritage revitalization and development, the social exchange theory assumes that an individual's attitude towards the industry and the level of follow-up support for its development will be affected by his or her assessment of community results. Communication is necessary to activate and develop cultural heritage in the context of local cultural identity of the community. Residents must develop and promote it, and then serve the needs of society for the values of cultural heritage. Some community residents benefit from it, while others may be negatively affected. Social exchange theory suggests that people evaluate exchange according to the costs and benefits of exchange. Individuals who perceive the benefits of the exchange may positively evaluate the exchange [22]. If the social changes brought by the revitalization and development of cultural heritage cannot benefit the residents in the material, social and psychological aspects, the residents are likely to have a negative evaluation of the exchange. So, they will dislike or even hinder this development. On the contrary, if the decision-makers give consideration to the material, social and psychological benefits of the residents as much as possible in revitalization and development strategies, then the residents might have a positive evaluation of the social changes brought by the development so as to promote the positive exchange and provide sustainable driving dynamics for regional development, they must respect the residents' cognition of local cultural heritage. That is to respect their local cultural identity.

In order to respect the local cultural identity of the residents, we must well define the local cultural identity. First, the word "identity" means two things: sameness (continuity) and distinctiveness (uniqueness). So, "local identity" should have included both sameness (continuity) and distinctiveness (uniqueness) [24]. However, when the concept of "identity" is applied to a place, it may have two completely different meanings. In the first meaning, "identity" refers to "place". It also refers to a set of local characteristics that ensure local uniqueness and time continuity [25,26], which reflects the meaning of "place identity". However, psychologists use "place identity" as a feature of a person, not place. According to Twigger-Ross and Uzzell, place is a means to distinguish yourself from others, maintain continuity, establish positive self-esteem, and create a sense of self-efficacy [27]. The center of local identity is to feel that "place" is a part of "identity", even a part of "me" [28]. In other words, local identity is a sense of belonging [29]. Local cultural identity, as a part of local identity, also follows the pattern above. Therefore, this study will also define the cultural identity of local residents from the following three perspectives: uniqueness, the importance of regional culture in life, continuity, whether there is a good social response to regional cultural activities, and residents' self efficacy and self-esteem, as well as self cognition of regional cultural values.

3. Methodology and Steps

3.1. FI-RST Model

It is very complicated to integrate residents' cultural identity into the revitalization and development strategies of cultural heritage. How to make the cultural heritage revitalization and development strategies not only take into account the effectiveness of revitalization, but also bring focus to the local cultural identity of residents, so as to achieve sustainable development? This is a problem of the decision-maker who needs comprehensive consideration from many aspects. The decision-maker should not only seek relevant information from bottom to top, but also clarify the decision-making basis from top to bottom. Facing this issue, residents' local cultural identity and the efficiency of accurate revitalization and development strategies are determined by multiple conditional attributes. Therefore, multiple decision attributes (decision criteria) need to be considered when making a revitalization scheme decision, which is a problem of multi criteria decision-making (MCDM). MCDM is a branch of operations research and it aims to find the aspiration level and balance conflicting objectives and standards in complex situations including various indicators [30]. The method system can make flexible decisions while considering all standards and objectives [31]. In the face of economic development, especially sustainable development issues, the effectiveness of MCDM has been confirmed from both practical and academic levels for many times [32]. The cultural heritage development targeted by this study happens to be an important pillar of sustainable development. However, the application of MCDM methods is not common on this topic. From the perspective of the methodology, it has great significance. According to the characteristics and needs of the research, it will choose in this study the Rough Set Theory (RST) in the MCDM tool to explore the relationship between residents' participation/cognition of cultural heritage and local cultural identity, and establish an accurate cultural heritage revitalization and development strategies through Fuzzy Integral, so as to explore the cultural heritage revitalization and development strategies combined with bottom-up residents' local cultural cognition.

3.2. Steps

3.2.1. The λ Fuzzy Measure and Fuzzy Integral

In the face of development problems, the influencing factors of development effectiveness are often not independent from each other. These factors affect each other. Therefore, in order to accurately evaluate a development project through these factors, the simple weighted summation evaluation will appear to be a little inaccurate. However, the Fuzzy Integral is the Choquet integral. By using the Fuzzy Integral to formulate the original data, not only can fewer or more representative factors be extracted to describe the system, but the interactions between attributes can be considered. This characteristic enables Fuzzy Integral to better describe some complex situations than ordinary weighted summation. The various common-factors that are extracted from factor analysis can be reasonably processed by a conventional additive measure, such as Grey relational analysis and the SAW method. Therefore, partitioning the type of Fuzzy Integral has to be applied to these related attributes to regroup a new hierarchy system and then apply the Fuzzy Integral proposed by Sugeno [33], Sugeno and Kwon [34]. The Fuzzy Integral combines the efficient value of those related attributes and develops a new combining performance value.

In the Fuzzy Integral method, the fuzzy measure can be used to describe the properties of each index combinations' combining performance value. In this study, fuzzy measure can provide combining performance value of revitalization and development strategies. The fuzzy measure of letting g_λ be a λ , which is defined on a power set $P(X)$ for the finite set $X = \{x_1, x_2, x_3\}$. The fuzzy measure has the following property:

$$\begin{aligned} &\forall A, B \in P(X), A \cap B = \Phi, \\ &g_\lambda(A \cup B) = g_\lambda(A) + g_\lambda(B) + \lambda g_\lambda(A)g_\lambda(B) \text{ for } -1 < \lambda < \infty. \end{aligned} \quad (1)$$

The density of the fuzzy measure $g_i = g_\lambda(\{x_i\})$ can be formulated as:

$$\begin{aligned} g_\lambda(\{x_1, x_1, \dots, x_n\}) &= \sum_{i=1}^n g_i + \lambda \sum_{i_1=1}^{n-1} \sum_{i_2=i_1+1}^n g_{i_1} g_{i_2} + \dots + \lambda^{n-1} g_1 g_2 \dots g_n \\ &= \frac{1}{\lambda} \left| \prod_{i=1}^n (1 + \lambda g_i) - 1 \right| \text{ for } -1 < \lambda < \infty \end{aligned} \quad (2)$$

Based on these properties, one of the three following situations will be sustained for a specific case with two attributes, x_1 and x_2 .

If $\lambda > 0$, then $g_\lambda(A \cup B) > g_\lambda(A) + g_\lambda(B)$:

This implies that x_1 and x_2 have multiplicative effect in $\{A, B\}$. In this study, when an index combination is in this state, it shows that the effective improvement of the index combination can achieve greater development and revitalization effect than the input resources, so that the revitalization purpose can achieve twice the result with half the effort, and the greater the fuzzy measurement is, the more significant the doubling situation between indicators is.

If $\lambda = 0$, then $g_\lambda(A \cup B) = g_\lambda(A) + g_\lambda(B)$:

This implies that x_1 and x_2 have additive effect in $\{A, B\}$. In this study, when an index combination is in this state, it shows that the effective improvement of the index combination can obtain the development revitalization effect equal to the input resources, so as to reduce waste in the development process.

If $\lambda < 0$, then $g_\lambda(A \cup B) < g_\lambda(A) + g_\lambda(B)$:

This implies that x_1 and x_2 have substitutive effect in $\{A, B\}$. In this study, when a certain index combination is in this state, it shows that the effective improvement of the index combination can only obtain the development revitalization effect smaller than the invested resources, which will lead to the waste of resources, reduce the development revitalization efficiency, and the smaller the fuzzy measure is, the more obvious the restriction effect between indicators is.

After obtaining the fuzzy measure of each index combination, the current situation performance of the various index combinations can be calculated in the following ways, and the current situation is evaluated on this basis:

Let h be a measurable set function defined on the fuzzy measurable space, and supposing that $h(x_1) \geq h(x_2) \geq \dots \geq h(x_n)$, then the Fuzzy Integral of fuzzy measure $g(\cdot)$ with respect to $h(\cdot)$ can be defined as Equation (3) [34,35] and shown in Figure 1:

$$\begin{aligned} \int h dg &= h(x_n)g(H_n) + [h(x_{n-1}) - h(x_n)]g(H_{n-1}) + \dots + [h(x_1) - h(x_2)]g(H_1) \\ &= h(x_n)[g(H_n) - g(H_{n-1})] + h(x_{n-1})[g(H_{n-1}) - g(H_{n-2})] + \dots + h(x_1)g(H_1), \end{aligned} \quad (3)$$

where $H_1 = \{x_1\}$, $H_2 = \{x_1, x_2\}$, \dots , $H_n = \{x_1, x_2, \dots, x_n\} = X$

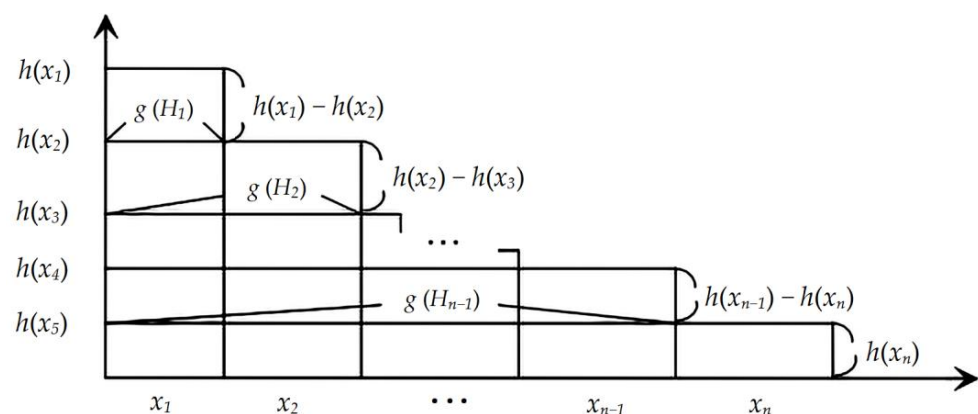


Figure 1. Concept of Fuzzy Integral.

3.2.2. Rough Set Theory (RST)

RST is an inductive analysis method for capturing the behavioral patterns between the condition and decision attributes for a dataset with a target. This method is often applied in the problem of data mining. Meanwhile, in the process of the survey, the RST questionnaire is very easy to understand and has low filling difficulty, which can be conveniently used in the survey for a large number of ordinary people so as to reflect the views of the people more intuitively. In this study, we can use the residents as a sample dataset for the study, so that the residents' 'participation/cognitive status of each cultural heritage is the behavioral pattern, while the residents' local cultural identity is the decision-making attribute. The purpose of using RST analysis is to find the cultural heritage participation/cognitive status of residents with the best local cultural identity. The theory uses a crisp set with equivalence relations to build a set of lower and upper approximate functions to find the classification boundary of the target. Based on this, the basic information is extended to obtain reduced attributes set, core attributes set, and if-then rules. The basic reduced function of the attributes is to compute the degree of significance of condition attributes through the degree of dependency of the attributes. Then, the information is used to exclude unnecessary attributes set (i.e., condition attributes which do not affect the decision attribute). Finally, the decision table is defined and applied to generate decision rules for each performance level. The definitions of the method are described as follows.

- Building information system

An information system can be represented as $S = (U, A = C \cup D, V, f)$, where U is a finite non-empty set of objects (called universe set), A is a finite non-empty set of attributes (which can be divided into two finite non-empty sets of condition attributes C and decisions D , respectively); $V = \bigcup_{a \in A} V_a$, where V_a is the set of values for each attribute a (called the domain of attribute a), and $f : U \times A \rightarrow V$ is an information description function defined from $U \times A$ towards V (e.g., $\forall x \in U$ if $a \in A$ then $f(x, a) \in V_a$).

- Confirming indiscernibility relation

$B \subset C$ For any condition attributes subset, which the associated equivalence relation is defined as Equation (4).

$$IND(B) = \{(x, y) \in U | \forall a \in B, f_a(x) = f_a(y)\} \quad (4)$$

where $IND(B)$ is the subset B-indiscernibility relation, which means couples of objects $(x, y) \in U$ are indiscernible by the subset of condition attributes B . In addition, the $IND(B)$ generates a partition $U/IND(B) = \{I_B | x \in U\}$ over U , where I_B is the equivalence class of an object which consists of all objects $y \in U$ such that x is indiscernible with y by attribute set B . The definition can help to identify relationships among the conditions and the decision attributes later in the process.

- Setting of lower and upper approximations

The set B ($B \subset C$) is a subset of condition attributes, and $I_B[x]$ is the equivalence class function of each object by the attribute subset B . The set approximation of object $X \subset C$ obtained by using the equivalence class function $I_B[x]$ gives a set of approximations of the lower BX and the upper $\overline{B}X$, which are defined as in Equations (5) and (6).

$$BX = \{x \in U | I_B[x] \subseteq X\} \quad (5)$$

$$\overline{B}X = \{x \in U | I_B[x] \cap X \neq \emptyset\} \quad (6)$$

where the lower approximation of X called the positive region of X and is denoted by $POS_B(X)$.

- Confirming dependency of condition attributes

The partitioning of the universe U by the indiscernibility relation of the decision attribute D is defined in Equation (7).

$$U/IND(D) = \{D_1, D_2, \dots, D_k\} \quad (7)$$

where $U = \cup_{i \in \{1, \dots, k\}} D_i$, BD_i is the lower approximation of each partition D_i by the subset of condition attributes B . The positive region of the decision attribute D that respects the subset of condition attributes B , denoted by $POS_B(D)$ is given by Equations (8) and (9).

$$POS_B(D) = \cup_i^k POS_B(D_i) \quad (8)$$

$$POS_B(D_i) = BD_i = \{x \in U | I_B[x] \in D_i\} \quad (9)$$

The dependency degree between condition attribute B and decision attribute D is given by Equation (10) in which $|POS_B(D)|$ denotes the cardinality of $POS_B(D)$, and $|U|$ denotes the cardinality of U .

$$\gamma_B(D) = \frac{|POS_B(D)|}{|U|} \quad (10)$$

where $\gamma_B(D)$ shows the dependency degree between the subset of decision attribute D and condition attribute B , which can be divided into three relations. The subset of decision attribute D is independent on a subset of condition B ($\gamma_B(D) = 0$). The set of decision attribute D depends completely on a subset of condition attribute B ($\gamma_B(D) = 1$). The subset of decision attribute D depends partially on the set of condition attribute B ($0 < \gamma_B(D) < 1$).

- Computing significance of condition attributes

As shown previously, $\gamma(C, D)$ expresses a degree of consistency in the decision table, the degree of dependency between attributes C and D , or accuracy of U/D by C . Then, we can investigate how coefficient $\gamma(C, D)$ changes with the removal of condition attribute C_1 . That is, what is the difference between $\gamma(C, D)$ and $\gamma(C - \{C_1\}, D)$. Finally, the difference can be normalized and is defined as the significance of attribute C_1 as in Equation (11).

$$\sigma_{(C,D)}(C_1) = \frac{(\gamma(C, D) - \gamma(C - \{C_1\}, D))}{\gamma(C, D)} = 1 - \frac{\gamma(C - \{C_1\}, D)}{\gamma(C, D)} \quad (11)$$

where $\sigma(C_1)$ between 0 and 1 (i.e., $0 \leq \sigma(a) \leq 1$), in which the larger value representing condition attribute C_1 is more important.

- Deriving knowledge rules

The reduction of the condition attribute set will preserve the relevant relationship between condition attributes and decision classes. Therefore, a set of decision rules can be derived from a decision table for the purposes of decision analysis. The decision rule is given by Equation (12).

$$\text{A decision rule in } S \text{ is expressed as } \Phi \rightarrow \Psi \text{ and read as if } \Phi \text{ then, } \Psi \quad (12)$$

where Φ and Ψ represent the conditions and decisions of the rule, respectively. The rules are statements “if ... then ...” statements relating to the condition and decision classes. The decision rule reflects a relationship between a set of conditions and a decision.

4. Results

4.1. Empirical Case

The Huangpu Village, Haizhu District, Guangzhou City, Guangdong Province, China is taken as the empirical case in this study (as shown in Figure 2). Huangpu Village is a natural and traditional Chinese village. The Huangpu Ancient Harbor in the village is a historical and cultural heritage in China. As a famous foreign trade port of “Canton System” in the Qing Dynasty, it is not only one of the birthplaces of China’s “Maritime

Silk Road”, but also a parking place for China’s foreign exchange and trade; for example, it is a parking place at the beginning of Sino US trade. It has many unique tangible and intangible cultural heritages. On 26 August 2013, Huangpu Village was announced as the second batch of Chinese traditional villages by the Ministry of Housing and Urban-Rural Development. The village has high historical and cultural values. At the same time, the village is also in the urban area of Guangzhou. In the development strategy of Guangzhou, the Huangpu Village is a key project to be developed.



Figure 2. Location and cultural heritages of Huangpu Village.

Even though Huangpu Village has a very high development value and potential, it is still not optimistic for the current cultural heritage revitalization and development situation of Huangpu Village. The Guangzhou Government has always attached much importance to the development of Huangpu Village, and has carried out large-scale rectification projects for many times in 2010, 2015, and 2017, but it still did not have the expected development of its cultural heritage. Therefore, it is an urgent need to study the revitalization and development strategy that can effectively make the cultural heritage of Huangpu Village achieve the status of sustainable development. At the same time, many regions with cultural heritage values in China and even around the world are facing similar problems. So, the methodology and logic of this study can also be extended and applied to other relevant cases.

4.2. Selection of Fuzzy Measure and Index Combination

Based on the five dimensions in Table 1 for evaluating the level of urban cultural development, this research designs a Fuzzy Integral questionnaire to evaluate the current level of cultural development in the cities where the empirical cases of this study are located. The five evaluation criteria include: C_1 (Cultural venues and facilities); C_2 (Cultural participation and attractiveness); C_3 (Creative knowledge-based job); C_4 (New jobs in creative sectors); C_5 (Human Capital). Seventy-four experts were invited by the Research Commission to fill in the Fuzzy Integral questionnaire, including 20 government staff, 40 university scholars and other researchers engaged in related research, and 14 social workers in related industries. The subjects were required to have a bachelor’s degree or above and have more than 5 years of relevant work experience. According to the calculation of Fuzzy Integral, in addition to assessing the overall cultural development status of Guangzhou, the fuzzy measure can be used to clarify the collective effect of different evaluation criteria. For the development of cultural and creative undertakings in cities, the relationship between these five criteria should not be assumed to be independent of each other. When the fuzzy measure ($g\lambda$) is greater than 0, it means that the set effect of these evaluation criteria is greater than the sum of the respective effects of each criterion in the set. Through the calculation of fuzzy measures, it is determined in this study which

criteria have the positive complementary effects on promoting the development of a city's cultural and creative undertakings. The results show that the fuzzy measure values of 9 criterion sets are greater than 0, include: $\{C_1, C_2\}$, $\{C_1, C_3\}$, $\{C_1, C_4\}$, $\{C_1, C_5\}$, $\{C_2, C_4\}$, $\{C_2, C_5\}$, $\{C_3, C_4\}$, $\{C_3, C_5\}$, $\{C_4, C_5\}$. Therefore, this study suggests that the local policy executors of Huangpu Village in Guangzhou should use these sets of guidelines as the reference for resource allocation in cultural heritage development. This study suggests that the resource development and utilization strategies of regional cultural heritage should be discussed in line with the current urban overall cultural development strategy from the viewpoint of mutual influence among criteria and resource matching combination.

4.3. Development Strategies Based on Fuzzy Integral

Based on the operation of Fuzzy Integral, in this study, it has been obtained the combined weights of the above-mentioned nine parameters with fuzzy measure greater than 0, and the current performance scores of Guangzhou on these nine parameter combinations (as shown in Table 2) has been specified. Referring to the management decision-making ideas of IPA, parameter combinations with the greater combination weights, and the worse performances, is the cultural development issue that Guangzhou needs to pay attention to. The research finds that, for Guangzhou, enhancing the participation and attraction of local culture, while reserving and cultivating sufficient and high-quality innovative cultural human resources, is the focus of the current urban cultural development and the weak aspect at present. In addition, in terms of the development of creative industries, the overall performance of Guangzhou is still poor, which is reflected in the capital flow, employment, industrial clusters, and other aspects. Especially when considering the construction of local cultural venues and facilities, in recent years, the incubation of creative industries and the construction of cultural venues in Guangzhou have stagnated, and the relevant support and stimulation policies have not been effective.

Table 2. Weight and performance status of parameter combination.

Parameter Combination	Combined Weight	Performance Status
$\{C_4, C_5\}$	0.696	3.847
$\{C_1, C_5\}$	0.708	4.216
$\{C_3, C_5\}$	0.714	4.320
$\{C_1, C_4\}$	0.719	3.982
$\{C_3, C_4\}$	0.725	4.085
$\{C_1, C_3\}$	0.736	4.432
$\{C_2, C_5\}$	0.738	4.240
$\{C_2, C_4\}$	0.748	4.336
$\{C_1, C_2\}$	0.758	4.623

This study suggests that there is a close and open relationship between cities and the cultural and creative economy, rather than a one-way dependence. Population, capital, and cluster capacity in cities provide basic elements for creative production. Cultural heritage has brought opportunities for the development of cultural tourism, increased employment opportunities and income, and also improved the building environment and facilities of the city. Continuous foreign investment and cultural and creative industries will generate the benefits of shaping the city's brand, which will also attract foreign talents to settle down. For Guangzhou, this study suggests that its urban space should be more inclusive of various cultural expressions and create a more harmonious and colorful living environment. Xiong et al. [36] pointed out that the inclusiveness of urban communities and extensive social participation may be the basic factors for the protection, reuse, and development of cultural heritage and the sustainable development of the creative environment. It is not difficult to find that the research results once again emphasize the public participation of urban communities. They play an important role in promoting the development of the local cultural and creative economy. Wu [37] pointed out that if people's participation can be well operated in the process of urban community construction, the interaction

between top-down rational planning and bottom-up willingness feedback and collaborative participation can be triggered. Furthermore, it can trigger a series of social learning processes, accumulate practical community building knowledge through the combination of learning and operation, and then develop creative solutions to local problems.

4.4. Cultural Participation/Cognitive Patterns of Residents and Local Cultural Identity

It is very important to have the local cultural identity of residents in the project of activating regional cultural heritage. A high sense of cultural identity expresses a positive emotional impact of local culture on residents. Additionally, the cultural identity of social groups plays a vital role in social interaction, communication, and so on. Therefore, the relationship between residents' local cultural identity and cultural heritage is closely related [38]. This shows that residents' participation/cognition patterns in cultural heritage-related activities will affect their local cultural identity. In this study, the participation/cognition status of residents' cultural heritage-related activities is taken as the information system of RST, and the local cultural identity of residents is taken as the decision-making attribute, so as to explore the corresponding degree of the local cultural identity of residents under the participation/cognition status of various cultural heritage-related activities.

The survey scope in this study is Huangpu Village, where there are many cultural heritages, after induction and summary, it can be divided into seven categories: H_1 . traditional festivals and unique celebrations; H_2 . handicraft, intangible cultural heritage; H_3 . local traditional food; H_4 . anecdotes of historical and cultural celebrities and their spirit; H_5 . ancestral hall, clan culture; H_6 . Huangpu Ancient Harbor, trade history and culture; H_7 . historical buildings, and cultural heritages' substantive environment. Through RST, the relationship between the local cultural identity of the surveyed residents and the participation/cognition status of cultural heritage-related activities can be obtained, then the key cultural heritage determining local cultural identity can also be obtained (the selection of core attributes). Meanwhile, RST's results can also give expression to residents' participation/cognition status of those cultural heritage-related activities with the best local cultural identity. Firstly, sum up the current relationship between residents and cultural heritage-related activities by observing the behaviors of residents in Huangpu Village (Table 3).

Table 3. Residents' and cultural heritage-related activities.

Culture Heritage	Resident Behavior	Semantic Scale
H_1 . Traditional festivals and unique celebration	I'm looking forward to the coming of the festival. The festival activities are very interesting, I will join in the fun, and even want to participate in it.	1
	Understand these activities, but do not have a strong willingness to participate and I seldom participate in them.	2
	I don't know about these activities and don't want to participate in festival activities.	3
H_2 . Handicraft, intangible cultural heritage	These are our unique local art forms. I think it's very beautiful. I even master some of them.	1
	Knowing about it, maybe some situations I'm willing to participate in the experience, but there are not much chances of contact.	2
	I'm not familiar with but heard of it, but I feel no interesting in it. Even never heard of it.	3
H_3 . Traditional local food	I usually eat these things, and I think these delicious foods can well represent our cultural characteristics.	1
	I sometimes eat these things, but I don't have any special feelings about them.	2
	I know these things, but I don't pay attention to them.	3

Table 3. Cont.

Culture Heritage	Resident Behavior	Semantic Scale
<i>H₄</i> . Anecdotes of historical cultural celebrities and their spirits	These people are the pride of Huangpu Village. I know some of their anecdotes and I'm even willing to tell their stories to people and children around me.	1
	I've heard of it, but I don't have a chance to know the details of it, but it doesn't matter to have a chance to understand it.	2
	I do not know about these historical cultural celebrities and their related anecdotes, and I do not pay much attention to them.	3
<i>H₅</i> . Ancestral hall and clan culture	I am a member of these clans. We have our own family culture, and even our own family ancestral halls.	1
	I know there are different clans here, and I may be one of them, but I don't know the culture of clans.	2
	I know there are different clans here, but I don't feel the existence of too many clans.	3
<i>H₆</i> . Huangpu Ancient Harbor, trade history and culture	Very important. I think this is an important culture in Huangpu Village, and it is necessary to carry forward it, even as a regional symbol.	1
	Maybe the government and tourists will pay more attention, but I don't care very much.	2
	Not important, this is just some traces of history, it does not have too much values.	3
<i>H₇</i> . Historical buildings and cultural heritage substantive environment	I think these buildings are very meaningful. They should be well repaired and protected. They are a good place for walking and leisure.	1
	I know some ancient buildings in Huangpu Village, but do they have any impact on me, and I seldom pay attention to them.	2
	I don't care about these ancient buildings, which has no impact on the development of Huangpu Village.	3
Remarks: Semantic Scale:	1 = High participation; 2 = Medium participation; 3 = Low participation	

The participation/cognitive status of residents related to cultural heritage in Table 4 is taken in this study as conditional attributes, and the local cultural identity through three aspects is established in Table 5 and it is taken as a decision-making attribute to explore the relationship between resident behavior patterns and local cultural identity.

Through the survey of 380 residents in Huangpu Village set as the survey samples, their participation/cognition status in cultural activities is taken as the conditional attribute (Table 3), and the residents' local cultural identity is taken as the decision attribute (Table 4). The results of this study are as follows (Tables 5 and 6).

According to the results of investigation and calculation, each grade has boundary values (Lower Approximation; Upper Approximation) in this survey, which shows the data and their rough phenomenon. At the same time, the quality of classification in this group of data has reached 0.8047, so the data are valid and can be used for subsequent discussion. On the other hand, RST can be used to extract indexes that has significant impact on decision-making attribute—Core Attributes. This group of data can be applied to extract the cultural heritage types that are significantly related to the residents' local cultural identity. *H₁*, *H₂*, *H₃*, *H₄*, *H₅*, *H₆* are all closely related to the local cultural identity, while *H₇*. Historical architecture and cultural heritage substantive environment are screened out of the index system.

RST can also produce minimal-coverage rules. There are 22 in this dataset. Among these, five rules applied to Good class (*D* = 1)", nine rules to "Medium class (*D* = 2)", eight rules to "Poor class (*D* = 3)". In order to make the residents' local cultural identity tend to be the highest, therefore, to produce a positive social exchange effect, this research only focuses on the rules that belongs to the "Good class (*D* = 1)" and the "Poor class (*D* = 3)", and the data percentage threshold of this grade is set to 10%. Therefore, when revitalization and development projects specify policies and plans, consider approaching "Good class

($D = 1$)” rules as possible and avoid the “Poor class ($D = 3$)” rules. The rules that conform to the above conditions are shown in Table 6.

Table 4. Local cultural identity.

Question	Cognition of Resident	Mark:
Are these cultural heritage activities in Huangpu Village and Huangpu Village important to your daily life?	A very precious part of life.	5
	These cultural activities are integrated into my life.	4
	These cultural activities will affect my life.	3
	Knowing these cultural heritage and cultural activities but I don’t care or participate in them.	2
	I do not know these cultural heritage and cultural activities.	1
Would you like to spend your time and vim into your cultural heritage related activities outside of work or study?	I have regular participation in some cultural activities or pay special attention to some cultural heritages.	5
	I will spend time and vim to participate in certain important cultural activities or frequent visit substantial cultural heritage environment.	4
	I know about these cultural activities and cultural heritage, occasionally participate in some cultural activities, but generally don’t care.	3
	I know these cultural heritages and activities, but I can’t take the time to participate because of my busy life.	2
	I simply don’t want to spend any time and vim in these cultural activities.	1
Do you think the cultural heritage and cultural activities of Huangpu Village and Huangpu ancient harbor are valuable to the cultural development and construction of Guangzhou?	Very valuable and it is an indispensable part of Guangzhou culture.	5
	It is a part of Guangzhou culture and has a very good development prospects.	4
	These cultures may be very good cultural resources.	3
	The essence of these cultural heritage and activities is just some local cultures of Huangpu Village, which is not very valuable.	2
	I haven’t heard of these cultural heritages or cultural activities of Huangpu Village.	1
Remarks:		
In this study, the score of local cultural identity of the respondents will be calculated through this table, and they will be equally divided into three scales of cultural identity: high, medium, and low, which are equivalent to the three scales of conditional attributes according to the ranking of scores, so as to be contented to the requirements of RST calculation.		

Table 5. Quality approximation of decision–core attributes–quality of classification.

Class	No. of Objects	Lower Approximation	Upper Approximation	Accuracy
$D = 1$	84	76	104	0.7308
$D = 2$	189	150	224	0.6696
$D = 3$	106	79	125	0.6320
Core Attributes	$H_1, H_2, H_3, H_4, H_5, H_6$			
Quality of Classification	0.8047			

Table 6. Rules that belong to the “Good class ($D = 1$)” and the “Poor class ($D = 3$)”.

Rule.	Conditions	Decisions	Number of Objects	Expected State
1	$(H_1 = 1) \& (H_3 = 1) \& (H_6 = 1)$	$D = 1$	70.24%	Approach
2	$(H_1 = 1) \& (H_2 = 1) \& (H_5 = 1)$	$D = 1$	55.95%	Approach
3	$(H_4 = 3) \& (H_5 = 3) \& (H_6 = 3)$	$D = 3$	27.36%	Avoid
4	$(H_1 = 3) \& (H_3 = 3) \& (H_7 = 3)$	$D = 3$	27.36%	Avoid
5	$(H_1 = 3) \& (H_3 = 3) \& (H_6 = 2)$	$D = 3$	20.75%	Avoid

The rules calculated by RST show that in order to make the local cultural identity of Huangpu Village’s residents tend to be the highest, the attention should be paid to both Rule 1; Rule 2. Additionally, Rule 3; Rule 4; Rule 5 shall be tried to avoid according to this situation, the study will discuss the revitalization and development scheme of cultural heritage in combination with three revitalization and development criteria $\{C_1, C_4\}$, $\{C_3, C_4\}$, and $\{C_2, C_5\}$ that are mentioned above.

In order to activate and develop cultural heritage reasonably and sustainably, it is necessary to comprehensively discuss the top-down cultural heritage revitalization and development strategies. Meanwhile, this means that the right revitalization and development schemes should focus on developing cultural heritage by improving the sequence of the three revitalization and development criteria $\{C_1, C_4\}$, $\{C_3, C_4\}$, and $\{C_2, C_5\}$. These three sets of community development criteria can be considered the focus of community governance and development for Huangpu Village, an urban village with rich cultural heritage resources. Through RST analysis, this study has grasped the state of the relationship between local cultural heritage resources and the lives of community residents under the guidance of reshaping the local cultural identity of Huangpu Village (as shown in Table 6). In other words, through the application of the FI-RST model, the key points of community development in urban villages are obtained in this study from the top down, and the knowledge of the rules of people's behavior is clarified from the bottom up.

Attention has been paid to the process of revitalization and development of cultural heritage and the participation/cognition status of residents' cultural heritage-related activities has been made as possible as Rule 1 or Rule 2 in Table 6 based on the social behavior corresponding to these revitalization and development criteria. These two states make revitalization and development produce positive social exchange results with the local society, so as to achieve two-way reciprocity between residents–development and development–residents, achieve the virtuous cycle states of sustainable development, and then improve the overall states of revitalization and development of cultural heritage. In order to determine the revitalization and development plan of cultural heritage more specifically, with Rule 1 as example, the following methods in Figure 3 can be used to complete the revitalization and development of the Huangpu Village case according to the study through the collation of some previous relevant documents.

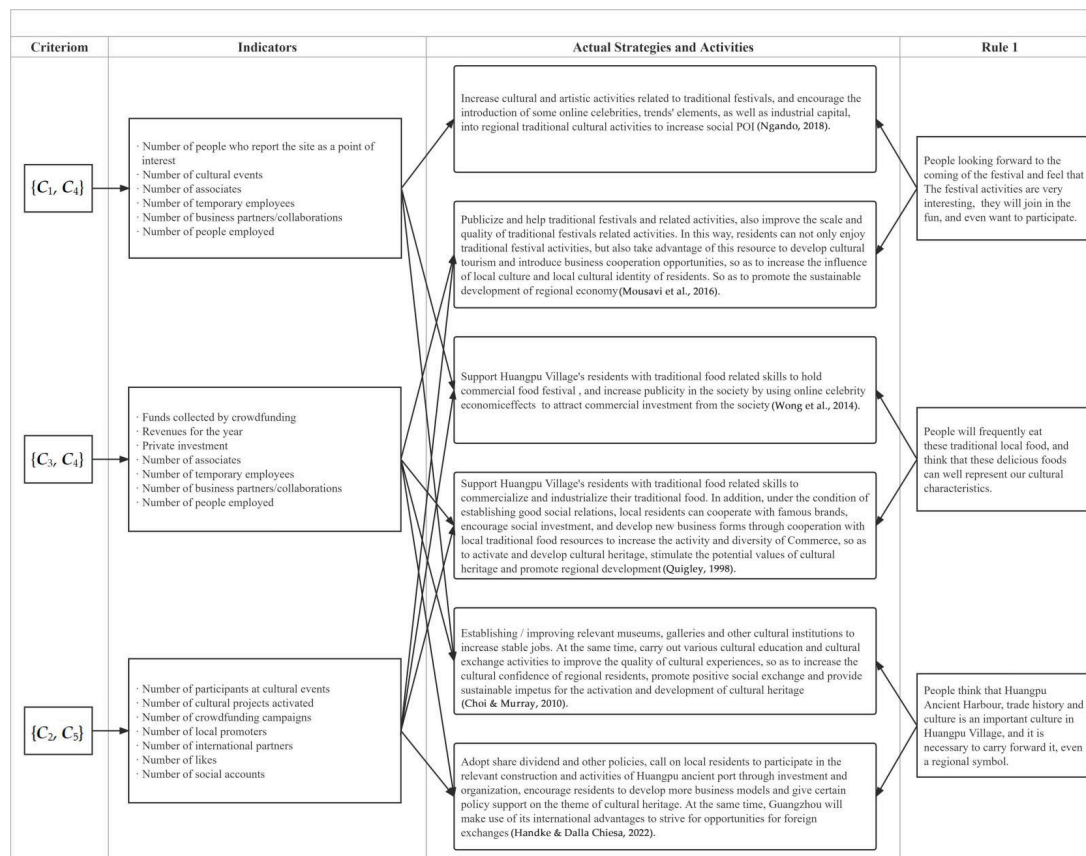


Figure 3. Community revitalization strategies for Huangpu Village to enhance local cultural identity [39–44].

5. Conclusions

The hybrid multi criteria decision-making method is applied in this study with Huangpu Village, Haizhu District, Guangzhou City as an empirical case, which integrates the expert decision-making opinions and public perception information, and the revitalization strategy of cultural heritage based on local cultural identity is explored. This study constructs an RST-FI decision analysis model, which can take into account both top-down and bottom-up opinions of community governance. On the one hand, it can promote the revitalization and development state of local cultural heritage resources; on the other hand, it can maintain and consolidate community awareness and cultural identity, it can also continuously promote the sustainable development of urban communities under the premise of limited resources. Among them, the part based on FI can clearly explain how to maximize social development with limited resource investment, which can improve the efficiency of revitalization and development of cultural heritage. On the other hand, the residents-based RST can accurately obtain the revitalization and development of cultural heritage through simple methods, which can also give consideration to the cultural identity of residents so as to improve the sustainability of the revitalization and development of cultural heritage.

Although the strategies obtained from the results of this study are specific to the individual empirical case of Huangpu Village, the research methods constructed by it can be widely used and promoted. In other countries or regions, there are urban communities similar to this empirical case in many cities. While these areas have historical and cultural heritage resources, they are also facing community renewal and regeneration. In the relevant practice and research projects, the decision analysis model constructed in this study can provide the basic ideas for making planning strategies for relevant projects. In addition, it is found in this study that for those cultural heritages that can significantly affect residents' local cultural identity, the industrialization and marketization of cultural heritage by using local social human resources and cultural resources can effectively activate and develop cultural heritage and enhance residents' local cultural identity, so as to achieve positive social exchange between cultural heritage revitalization and development projects and residents' cognitive participation, thus achieving the sustainable development of cultural heritage and promoting the sustainable development of the region.

It should be acknowledged that there are certain limitations in this study: the revitalization and development strategies mentioned in the results of this study are only aimed at Huangpu Village. Whether top-down development strategies or bottom-up residents' local cultural identity, they cannot be directly applied to other cultural heritage revitalization development projects. Moreover, this study is a cross-sectional study. The data collection were completed in nearly 3 months. It is not a long-term survey. At the same time, the discussion on the development strategy in the revitalization and development of cultural heritage in this study is limited to the dimension layer, which makes the results of this study relatively rough. If more research and analysis can be done on the detailed indicators affiliated to the dimension in the subsequent research, the results can become more refined. For example, through DANP and other techniques, the influence weights and influential network relationship of indicators can be discussed under each dimension, so as to more accurately understand the actual strategy of cultural heritage activation and development. Of course, the using of VIKOR, TOPSIS, and other technologies to explore the improvement scheme of empirical cases and the evaluation of multiple cases in an appropriate way can also make the relevant research more detailed and rich. This study suggests that in the future, the similar goal will be taken as the desired level, and the Fuzzy Integral technology will be applied to systematically evaluate and analyze the performance of some relevant cases. Compared with the traditional addition operation, this technology has higher accuracy and is more in line with the situation. In addition, in the future, efforts will be made to improve the decision analysis model based on the concept of big data analysis to promote the systematicness and effectiveness of the investigation and analysis of the current situation of urban built environment. Combined with virtual reality technology,

the iterative evaluation and selection of schemes before project transformation can be further discussed.

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