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Using Social Network Analysis to study Knowledge Transfer in Rural Destination: A Case Study of Nangang, China

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Abstract:

The tourism industry can benefit from knowledge management, especially in knowledge transfer and knowledge-based innovation. Knowledge generation, dissemination, and acquisition in tourism were more complex, informal, and sometimes not well-planned. Therefore, it is important to understand the process and mechanisms through which knowledge is shared and transferred in tourism system. To address it, this paper applies SNA (social network analysis) to identify the major actors in knowledge networks in a rural tourism destination located in north-east China. Empirical findings show that sector of culture and tourism of local government and government industry collaborations can be the leading hub of 'administered knowledge networks' – understood as efficient knowledge governance arrangements – in which a wide variety of actors, including public sectors, enterprises, local community and pressure groups play complementary roles depending on the nature of the interactions (formal transfer versus informal exchange flows). These structures are found to be fundamental for the functioning of rural destination knowledge sharing.

Keywords*: Rural tourism, Knowledge transfer, Social network analysis.*

I. INTRODUCTION

Knowledge has gradually evolved into a fundamental resource of wealth and capital for organizations [1]. Organizational competitiveness is related to the effectiveness of knowledge and intellectual capital management [2]. Knowledge-rich organizations are more likely to maintain a competitive advantage and achieve financial success [3]. Researches on knowledge dissemination in industrial sectors or high-tech industries attracted more interests than service-oriented regions. Tourism system confronts with various challenges (e.g., unscientific overall planning, lack of standardized management, shortage of human resources), which required practical knowledge transfer to remain competitive via innovation for tourism participants [4-6]. The tourism industry can clearly benefit from knowledge management concepts and practices, especially in knowledge transfer and knowledge-based practice innovation. The role of information management in tourism has gotten increased emphasis in recent years [6, 7].

There are empirical studies examining knowledge transfer within tourism [8]. The main body of the

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knowledge transfer network also has gradually expanded from within the enterprise to between enterprises and even put forward the concept of knowledge community [9].However, knowledge in service-oriented regions like tourism is mostly tacit, which makes it sticky and difficult to turn into explicit, communicable information'. Knowledge sharing between different actors in destination required strong levels of trust and common values [10]. The characteristics of tourism sectors including the dominance of SMEs in tourism industry, fragmentation and diversity of supply, occupational strengthening factors, specificity of ownership, lack of trust and collaboration, scarcity of human resources, and lack of measures of intangible knowledge resources [5, 7] hamper knowledge transfer between destination stakeholders.

For the rural tourism destinations, there are often a lack of core attractions to make profits in the early stage, so it is challenging to attract conglomerates to settle in. Rural tourism participants have to obtain knowledge from various channels. Lin Jian et al. (2007), Huang Zuhui (2006), and Huang Jun (2007) analyzed from the perspective of the heterogeneity of cooperative organizations, finding that there are capable people with strategic vision and a sense of cooperation. They are deeply anchored in the community, yet they also possess information and resources unavailable to regular people. These resources make tourism enterprises willing to yield part of their benefits to promote cooperation [11, 12]. The positive effects of network structure in the transfer of knowledge are generally acknowledged [4], but the tourism industry lacks the necessary infrastructure to engage in knowledge management [5, 7]. Therefore, it is important to understand the network structure and the networks created by knowledge-transfer processes facilitating innovations for strategic decision making, R&D and et.al. Further research is required to tackle the specificities of the mechanisms through which knowledge is shared and transferred in tourism [13].

Although few works have explored upgrading synergies facilitated by global–local strategic coupling relations [14] and knowledge dissemination [4, 13], the process of knowledge transfer in tourism system has not yet clarified. These are the main issues this paper aims to address. Knowledge cannot be understood, used, managed, or examined as an individual substance or be separated from the social interactions and overall environment in which it flows [15]. The supply of tourism is so decentralized that tourism products are produced through the collaboration of various sectors [16, 17].Tourism is a perfect example of a network industry [18]. Thus, using network analysis, this paper discusses the process of knowledge transfer in rural tourism destinations located in a small village of North East China.

This paper is structured as follows. Section 2 provides a review of related researches dealing with the issues on social network approaches, as well as the specification of tourism regions and the advancements of knowledge transfer achieved in tourism studies. Section 3 explains the research design and methodologies integrating survey to collect knowledge transfer relationships among key actors and social network analysis. InSection 4, based on knowledge transfer network, social network analysis is carried out, and the results are analyzed and discussed. Finally, we discuss future research directions and present the conclusions of the study inSection 5.

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II. LITERATURE REVIEW

Scholars have studied information transfer between individuals and organizations since the notion of knowledge transfer was introduced. These studies mainly include the construction of knowledge transfer models [19], influencing factors of knowledge transfer [20-22], and knowledge transfer applications. They primarily focused on perspectives of knowledge characteristics, strategic alliances, industrial clusters, innovation, organizational learning.

2.1 Knowledge Transfer between Organizations

Early knowledge sharing research targeted knowledge sharing communities, individual knowledge sharing drivers under unorganized constraint. After that, researchers began to explore the motivation of individual knowledge transfer within the organization, including interpersonal relationship, organizational goals, organizational culture, policy conditions, etc. Knowledge transfer between teams within the organization is mainly conducted around the SECI ("knowledge spiral") model proposed by Nonaka or the communication model proposed by Szulanski [23, 24]. With the development of virtual organizations, knowledge transfer research has expanded to industrial clusters and technology alliances, effectively transforming individual knowledge into organizational knowledge [25, 26]. Researches proved that the network structure is the key factor affecting knowledge transfer, and how to promote the cluster knowledge transfer through an effective network is a key issue in knowledge management [27]. Industrial clusters and technology alliances are both typical network organizations, so the researches on their network structure and knowledge transfer has become a hot research issue in the category of knowledge economy. Whether industrial clusters or technology alliances, they are the means for enterprises to obtain competitive advantages, and their essence is the alliance of knowledge. The relationship of rural tourism destination actors is different from the above relationships, and the actors are not entirely aimed at gaining competitive advantage [28, 29].

The study of knowledge transfer motivation has always been the focus, including reciprocity, reputation, interest and other personal factors [30], and environmental factors such as organizational goals, organizational policies, organizational culture and technical conditions [31].Range of perspectives and literature on knowledge transfer, indicated thus far, has only received limited recognition within tourism research. Most scholars studied knowledge transfer based on the analysis at the binary level, and they focus on the individual attributes placed on the subject of knowledge transfer. However, in a social system with numerous relationships, however, any pair of individuals can be connected directly or through third-party communication. Therefore, the observed actor attribute qualities must be interpreted in terms of relationships. Relationships between actors should be placed in priority, while individual attributes of actors should be placed in a secondary position [8].

2.2 Knowledge Transfer and SNA

The above studies on knowledge transfer models and influencing factors all frame the node-to-node knowledge transfer process, emphasizing the interaction state and its situation between the two transfer

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objects. In recent years, researchers have gradually increased their attention to the transfer scenarios. Granovettor's view that "individual behavior is embedded in a concrete, real-time social connection system" is similar. Because the tacit knowledge is hidden in the individual, so the knowledge transfer activity as a social activity also occurs in a certain social connection system [32]. A unique feature of social network analysis is the emphasis on explaining behavior in terms of the structural limitations of the behavior rather than the intrinsic drive of the actor [33]. SNA provides a unique perspective on social activity and a fundamental framework for constructing activity models, stressing that relationships between actors should be placed in priority, and individual attributes of actors should be placed in a secondary position [8].

Actor-Network Theory (ANT) requires that each actor is a node in the network, mutually equal, mutually identified, recognized, dependent, and influenced [34]. The study [35] of the interactions between actors in tourism cultural districts opens up new research avenues for cultural project management and identifies conflict resolution methods.

The application of network concepts in tourism knowledge transfer, as well as the application of network analysis, has attracted the attention of researchers. To manage sustainable tourism, networks can be established if actors can successfully coordinate human and non-human factors, using common platforms to pursue separate but complementary goals [36]. There are strong and weak ties between tourism enterprises and other organizations, so the network composition is not balanced. Through the knowledge sharing and cooperation mechanism, the tourism network structure will be promoted [37].

There are some studies about the effect of a node's network location. For example, Tasi argues that if a business unit is located at the center of an organization's network of business units, it will be simpler to interact and learn from other business units, and its absorptive capacity will be higher. Gnyawali et al. studied the influence of centrality, structural autonomy, structural equivalence, and network density on the possibility of corporate aggressive behavior and response behavior. This is because an organization's network structure influences its capacity to receive information and other resources [38]. Baggio and Cooper (2010) [4] and Del Chiapa and Baggio (2015) [39] used epidemiological modeling methods and computer simulations to study knowledge transfer within tourist destinations. However, the networks they learned were based on general relationships between organizations rather than precisely defined knowledge transfer relationships. McLeod, Vaughan, and Edwards (2010) [40]analyzed the structure of knowledge-sharing networks among tourism enterprises in a destination. Their research focused on the analysis of self-networks and formal and informal relationships. Schaeffer and Lawley (2012) [8] studied the evolution of information flow networks among actors during the development phase of a conservation park. Their study providedan application of network analysis to distinct stages of network evolution. In summary, network analysis so far is left at the level of basic description.

2.3 Knowledge Transfer in the Tourism Sector

Knowledge generation, dissemination, and acquisition in tourism were more complex, informal, and sometimes not well-planned manner because of highly personal, not formalized communication and knowledge generating from different sectors in tourism sectors. Thus, both network structure and the

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networks created by knowledge-transfer processes are important [4, 41].

Although few works have explored upgrading synergies facilitated by global–local strategic coupling relations [41, 42] and knowledge dissemination [4, 13], the process of knowledge transfer in tourism system has not yet clarified. These are the main issues this paper aims to address.

Knowledge transfer in tourism is a divergent area of research, but existing research tends to focus on specific relationships, such as policy making [43], tourist movements and activity flows [44, 45],tourist network community [46], online social media, forums and electronic word of mouth [45, 47]. Different from industrial sectors, knowledge in service-oriented regions like tourism is mostly tacit, which makes it sticky and difficult to turn into explicit, communicable information'. Knowledge generation, dissemination, and acquisition in tourism were more complex, informal, and sometimes not well-planned manner because of highly personal, not formalized communication and knowledge generating from different sectors in tourism sectors. Knowledge sharing between different actors in destination required strong levels of trust and common values because tacit knowledge was viewed as key competitive advantage [10]. Thus, both network structure and the networks created by knowledge-transfer processes are important [4, 41].

Understanding the diversity of knowledge sources is also essential when studying knowledge transfer [48]. Later, the concept of knowledge transfer was expanded to include a company's external relationships. Knowing how knowledge flows may be viewed from the perspective of a business entrenched in a web of intra-, inter-, and extra-firm linkages [49].The utilization of strategic networks holds significant potential for research on knowledge movement within the tourism sector [50, 51]. Wenger (1998) [52] has outlined the role of communities of practice in aiding knowledge movement. Such communities may take the form of a business community informally organized or more formal organizations. These communities can act as significant organizations in promoting knowledge of innovations. Beesley（2005）examines collaborations between industry, government, and tourism research institutions[53]. Sørensen（2007）also concluded that inter-firm networks are only one piece of the knowledge transfer puzzle, while other sources such as employees and tourists are also important[54]. Frechtling (2004) provides partial insight into these issues of the role of journals in aiding the transfer of knowledge from leading academics to practitioners within tourism and hospitality [55]. The development of rural tourism destination mainly relies on the transfer of knowledge from multiple subjects. High levels of knowledge spillovers from labor may be seen as a shared mutual benefit. Generally, actors in the rural tourism sector should be considered knowledge transfer participants and should be included in studies on the relationship between knowledge transfer and social networks.

Both network structure and the networks created by knowledge-transfer processes are important [4, 41]. Although few works have explored upgrading synergies facilitated by global–local strategic coupling relations [41, 42] and knowledge dissemination [4, 13], the process of knowledge transfer in tourism system has not yet clarified. Recognizing the need for a more thorough network study in rural tourism, we suggest to explore the topological properties of a rural tourism knowledge transfer network using a range of network metrics builds on and increases research understanding in this area. By providing practitioners with knowledge on critical issues, they may develop knowledge dissemination and increase capacity for

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innovation and competitiveness. These are the main issues this paper aims to address.

III. METHODOLOGY

This section utilizes a questionnaire to collect knowledge transfer relationships between actors, after which the web analytic metrics are chosen.

3.1 Case Study Context

The information was gathered from government agencies, businesses, and other entities involved in the creation of Garidi Scenic Spot. Nangang Village is located 65 kilometers west of Dulbot County, in Lianhuanhu Town, Dulbot County, Daqing City, Heilongjiang Province, between 130 and 145 meters above sea level, having a frost-free duration of 151 days. Nangang village has 525 dwellings and a population of 2,114 people. In the village, there are 59 destitute homes with a total population of 138 people. The hamlet as a whole spans 74,000 hectares, including 19,120 hectares of arable land, 7,200 hectares of grassland, 33,500 hectares of water, 2,996 hectares of woodland, and 11,184 hectares of miscellaneous land (including 3,000 hectares of saline-alkali land and the rest of tidal flat land).

Severe drought disasters and poor infrastructure are the main constraints to the agricultural development of Nangang village. The village has thin soil ridges, severe wind, and sand, and the ecological environment continues to deteriorate. Up till 2017, more than 95% of villagers still live on farming. The average grain yield per hectare is only 400 kilograms. The grain production and net income are at a low level among the 79 administrative villages in the county. The once poor villages have greatly improved due to the development of tourism.

The construction of Nangang village started in early 2018. More than ten facilities (e.g., scenic roads, flower sea planting, beach grooming, wooden plank roads, yurts, water entertainment, and environmental friendly toilets, parking lots) have been completed in just over two months, with a total investment of more than 10 million CNY. On July 28, 2018, the scenic spot opened for trial operation. In that year, it received more than 20,000 tourists and achieved a tourism income of more than 2 million CNY. In 2019, it received 30,000 tourists and achieved a tourism income of more than 6 million CNY. In 2020, it became a check-in place for Internet celebrities in Daqing, receiving a total of more than 70,000 tourists and more than 14 million CNY of tourism revenue. Through tourism poverty alleviation, the collective income of the village has directly expanded to 312,000 CNY. Through tourism poverty alleviation, the collective income of the village has directly expanded to 312, 000 CNY.

3.2 Data Collection and Analytical Method

A tourism system may be thought of as a collection of interconnected organizations. When exploring new ideas and producing innovations, one of the most significant knowledge activities is knowledge sharing, which promotes team efficiency and engages teams in expressing and assessing information [26, 60]. Team knowledge sharing refers to actions that enhance knowledge transfer among team members [32] and aid in

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the application of lessons learned by ensuring that existing information is shared among team members with various types of expertise[8,11]. The basis of managing the network is the relational data between actors.Rural tourism actors refer to those individuals and organizations who are tightly connected with the development of rural tourism [56]. Weaver et al. (2000) divided rural tourism actors into local communities, governments, businesses, non-governmental or non-profit organizations (NGO/NPO). Many scholars have basically followed this division, and the most used are the actors of government agencies, communities, enterprises, and pressure groups [57, 58]. Therefore, this paper follows this division method. Based on the actual situation of the actors in the development process of Nangang Village, this paper combines the suggestions from relevant experts to summarizes 19 actors (Table I).

TABLE I. Representatives Under Investigation

GOVERNMENTAL ORGANIZATIONS	The sector of finance (A)	An official of the Heilongjiang Provincial Department of Finance
	Development and Reform Commission (B)	An official of Heilongjiang Provincial Development and Reform Commission
		An official of the Daqing Municipal Development and Reform Commission
	The sector of Culture and tourism (C)	An official of the Heilongjiang Provincial Department of Culture and Tourism
	The sector of National Resource (D)	An official of the Heilongjiang Provincial Department of National Resources
	The sector of Commerce (E)	An official of the Heilongjiang Provincial Department of Commerce
	Administration for Forestry and Grassland (F)	An official of Daqing forestry and Grassland Bureau
	Administration for Market regulation (G)	An official of the Daqing Market Regulation Administration
	Individual government officials (H)	Relevant government official 1
		Relevant government official 2
COMMUNITY	Village committee cadres (I)	Major Secretary of Nangang village
	Village stationed task	Researcher in village stationed task force 1

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	force (J)	Researcher in village stationed task force 2
	Tourism practitioners (K)	Representative of Tourism practitioners 1
		Representative of Tourism practitioners 2
		Representative of Tourism practitioners 3
	Ordinary residents (L)	Left-behind elderly 1
		Left-behind elderly 2
		Children of ordinary residents as a migrant worker
	Periphery villages (M)	Representative of Shengli village cadres
		Representative of Wanli village cadres
TOURISM ENTERPRISES	Garidi(Shoushan Tourism Co., Ltd) (N)	Manager of Shoushan Tourism Co., Ltd
		The staff of Shoushan Tourism Co., Ltd's planning department
	Other tourism enterprises and merchants (O)	Manager of Tourism Investment Department of state-owned group enterprises
		Manager of the Technology Department of the Shujuku Technology Co., Ltd
		Agricultural Products Merchant
PRSSURE GROUPS	Trade associations and NGOs (P)	Municipal Tourism Industry Association
	The Media (Q)	Reporter of Heilongjiang TV station
		Editorial representative of Heilongjiang daily
		Editorial representative of Pinching Tourism
	Tourism research institutions (R)	Researcher of Tourism Development Research Institute
		Professor representative of Tourism College of University

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	Tourists (S)	Tourist 1
		Tourist 2
		Tourist 3

According to the main actors and classifications listed in Table I, this study investigated a total of 35 prominent actors in 19 categories, which are representative and typical. Among them, ten officials were selected by representatives of governmental organizations. These officials are responsible for specific and related work such as regional tourism planning and tourism enterprise management. This paper selected three local business representatives. Among their respective enterprises, the state-owned group enterprise is Garidi's largest investor. Garidi's main technical service provider is Shujuku Technology Co., Ltd. The Garidi scenic spot is managed by Shoushan Tourism Co., Ltd. Their collaboration has resulted in a symbiotic model of community and enterprise management, so the businesses chosen are representative.In addition, 12 local community representatives were also studied. The village cadres and the village stationed task force were responsible for the construction of Nangang village and cultivated land protection, tourism promotion, environmental sanitation, etc. They were very familiar with the tourism development of the village. Resident representatives also witnessed the whole process of the planning and construction of the Garidi. Besides, nine people were selected as representatives of the pressure groups. The Municipal Tourism Association is the official consultant for Garidi. Heilongjiang TV stations, Heilongjiang daily and Pincheng, are the media platforms where the Garidi actually participates in tourism promotion. The tourism research institutes and university tourism colleges have participated in designing the planning scheme, so they are representative as well. The above survey subjects included 17 males and 18 females, whose ages range from 28 to 70 years old.

Data were collected from October to December 2021 using an online questionnaire method. In the pre-investigation, questionnaires were sent to 19 actors who had been sorted out through the literature. They were asked to rate their knowledge sharing with other actors. This study draws on The Team Knowledge Sharing Scale proposed by ChangC.H.（2016）[59] to measure the extent to which team members share their particular knowledge and expertise with others. Each respondent answered this seven-item scale. The scale is a seven-level Likert scale with a Cronbach coefficient of 0.90, referring to good reliability and validity. Some of the scale's wordings have been changed based on the actual research, and the final items are as follows (Table II).

TABLEII. Questionnaire Items

Members of us share their special knowledge and expertise with one another.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
If a member of us has some special knowledge about how to perform the team task, they will tell other members about it.	**1**	**2**	**3**	**4**	**5**	**6**	**7**

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There is virtually no exchange of information, knowledge, or sharing of skills among us. (reverse coded)	**1**	**2**	**3**	**4**	**5**	**6**	**7**
More knowledgeable members freely provide other members with hard-to-find knowledge or specialized skills.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Members of us provide a lot of work-related suggestions to each other.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
There is a lot of constructive discussion during our communication.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Members of us provide their experience and knowledge to help other members find solutions to their problems.	**1**	**2**	**3**	**4**	**5**	**6**	**7**

This paper asks each respondent to rate their knowledge sharing with other actors. The knowledge-sharing relational data will present a non-integer distribution state between 1 and 7. In order to later calculate the various networks in the indicator, the relational data needs to be integrated with the median as the breaknode value (there is a slight left deviation in the data distribution. Using median instead of average can eliminate the influence of data skew and is more representative). The value below the median is marked 0, indicating that the knowledge-sharing relationship between actors is weak, and the median and above are marked 1, indicating that the knowledge-sharing relationship between actors is strong.

Semi-structured interviews with actors based on the questionnaires were done at the same time as the questionnaires were released, inquiring about the reasons for the scores, as well as the channels and content of information transfer between them. Also, towards the end of the questionnaire, they were invited to indicate any groups with whom they had knowledge-sharing encounters that were not covered in the questionnaire. To establish a network, relational data was gradually imported throughout data collection. This aids in the identification of new and prominent players. The "village stationed task force", for example, was cited several times by the respondents.

After discussion, the village-stationed task force was included to the survey group, and they were issued questionnaires as part of the formal survey. Because the unit of analysis is organizations, yet the data is collected from individuals, the respondents, as representatives of the organization, must be aware of the connections between them. We attempted to select more than one person for each group for the poll. The relational data collected from representatives in each organization is pre-averaged because the network will be built using the organization as the unit node.

Following the data collection, the actor relation matrix was constructed. An assignment matrix is created for each relationship. The corresponding slot in the matrix is assigned to an actor who has a knowledge-sharing relationship with another actor. To acquire the actor's relationship matrix, turn all of the interview data into an assignment matrix and execute a superposition operation on the assignment matrix data. Finally, a network with 19 nodes and 61 ties is created using the 35 valid questionnaires that were

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collected. Each node represents a group of actors, and the link between the groups of actors is the knowledge transfer connection. The transmitter of knowledge is represented by each row of the matrix, while the recipients are represented by the columns.

TABLEIII.Adjacency Matrix

ACTORS	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
A	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	1	0
B	0	0	1	1	0	0	0	1	0	0	1	1	0	1	1	0	0	0	0
C	1	0	0	1	1	0	1	1	1	1	1	1	0	1	1	1	0	1	0
D	0	0	1	0	0	0	0	0	0	0	1	1	0	1	1	0	0	0	0
E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
F	0	0	0	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0
G	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
H	1	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
I	0	0	1	0	0	0	0	0	0	1	1	1	0	1	0	0	0	0	0
J	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
K	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
L	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
N	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	1
O	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Q	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
R	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S	0	0	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0

The purpose of this research is to investigate the topological properties of a knowledge transfer network in the planning and construction of a specific rural tourism attraction. As a result, the network notion lies at

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the heart of this study's design, methodology, and data analysis. The expansion of knowledge flows and collaborative tactics in a knowledge-based global economy [16, 46] justifies this research strategy. In network analysis, we used a variety of network metrics to gain a general picture of the network topology. We introduce and describe network metrics in TableIV for clarity and to minimize repetition.

TABLEIV.Network Metrics

NETWORKTERMS	DESCRIPTION AND MEASUREMENT
DENSITY	Density describes the degree of tight connection within the network, calculated as "the total number of actual relationships" divided by "the total number of theoretically possible and theoretical relationships", actually equals to the average of all possible relationships.
RECIPROCITY	In directed networks, reciprocity shows the tendency of pairs of nodes to form mutual ties between each other [33].
CENTRALITY	Centrality measures identify the most critical nodes in the network. The four main centrality measures are: - Degree centrality: The number of direct ties linked to a node. - Closeness centrality: The average distance of a given node to all other nodes in the network. - Betweenness centrality: Measures the extent a node acts as a bridge on shortest paths between other nodes. - Eigenvector centrality: Measures the centrality of a node based on the centrality of nodes to which it is connected. Eigenvector centrality distinguishes connections; a tie to a central node is of more importance than to a node with low centrality
SUB-GROUPS	Girvan Newman's algorithm is used in this paper’s subgroup analysis. It is a heuristic community discovery algorithm for complex systems[60]. Communities in the graph are found by iteratively removing the edges of the graph. The edge with the greatest centrality of edge median is removed first.
STRUCTURAL HOLES	Burt uses structural holes to represent non redundant connections "Non-redundant contacts are connected by structural holes, and a structural hole is a non redundant connection between two actors"[61]

IV. RESULTS

The topological properties of the knowledge transfer network of the Nangang rural tourism destination will be illustrated in the paragraphs below. The SNA analysis in this study begins from a general overview of the network, and then focuses on characteristics of the whole network, like density, centralization,

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components, and Reciprocity. After that, centrality analysis and structural hole analysis are conducted on the profound level of the network, and cluster analysis and exploratory analysis of community structure are performed. Interviewees are asked to state whether they are a source organization or acceptance organization of knowledge in each knowledge sharing interaction, so networks are directed.

4.1 Network Global Properties

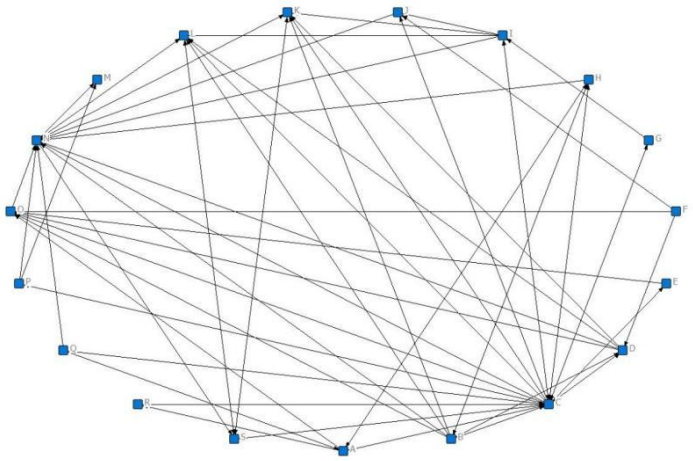

Fig 1: Knowledge Transfer Network

TABLEV. Network Global Properties

TYPE of NETWORK	Directed
NUMBER of NODES	19
NUMBER of TIES	61
COMPONENTS	1
DENSITY	0.1784
NETWORK CENTRALIZATION	66.01%
AVERAGE DISTANCE	2.379
HYBRID RECIPROCITY	0.1961

Fig. 1 shows the network visualization. An abstract of the properties of the whole network is shown in TableV. The network possesses 19 nodes and 61 ties that form an interconnected component. The network is pretty sparse, with a density of 0.1784, namely, just 18 connections existing in the target network among 1000 potential knowledge transfer relationships. This offers more evidence to earlier conclusions,

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demonstrating that low density appears to be a general trait of tourism networks [39, 62, 63]. Network centralization of 67.32% indicates that the network is set up around the core node to a degree of 67.32%. The reachability of the graph is represented by the average distance between nodes. The average distance between nodes is 2.379, which means that the number of connecting lines required to communicate between any two nodes is 2.379. In this direct network, we also study the reciprocity to evaluate the degree of mutual transfer between organizations. Reciprocity is low, with just 19.6% of the actors having reciprocity relationships. Thus, transmitters and recipients mostly own only unidirectional relationships, and bidirectional, flowing knowledge just lies in 19.6% of relationships. Collaboration via reciprocal knowledge transfer can reinforce the trust and strength of interpersonal relationships and facilitate the flow of knowledge within the network [64].

4.2 Centrality

Disparate network locations represent different contact opportunities for an actor group to the required novel knowledge, as well as capacity variance in obtaining and transferring external knowledge and information [65]. There are four common methods of centrality analysis. "Degree centrality" depicts the local centrality index of actors, and tests the transaction capability of the actors in the network, without considering whether it can control others. "Betweenness centrality" investigates the degree to which an actor is intermediate between two other actors, and thereby is an index of controllability. "Closeness centrality" considers the degree to which an actor is not dominated by other actors. If an actor in the network is less dependent on others in the transaction process, this node has a high centrality. Since this research does not particularly stress the property differences between actors, the study of eigenvector centrality is not performed, while three indicators including degree centrality, closeness centrality, and betweenness centrality are analyzed. The results are listed as follows (Table VI).

TABLEVI.Centrality

	Indegree	Outdegree	inCloseness	outCloseness	Betweenness
A	3	3	28.571	23.377	2.833
B	1	7	22.785	28.571	2.233
C	8	13	36.000	31.579	166.467
D	3	5	28.571	27.273	12.267
E	1	1	28.571	17.476	0.000
F	0	3	5.263	29.508	0.000
G	1	2	27.273	25.232	0.000
H	3	4	28.571	27.273	22.867

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I	2	5	27.692	27.273	2.833
J	3	1	29.508	19.780	0.867
K	6	1	36.735	21.429	2.200
L	6	2	36.735	22.500	3.867
M	2	0	42.857	5.263	0.000
N	10	4	40.909	23.077	77.567
O	6	1	33.333	19.780	17.767
P	1	2	28.571	20.000	2.000
Q	0	3	5.263	35.294	0.000
R	2	1	28.571	25.000	3.733
S	3	3	32.727	26.087	82.500

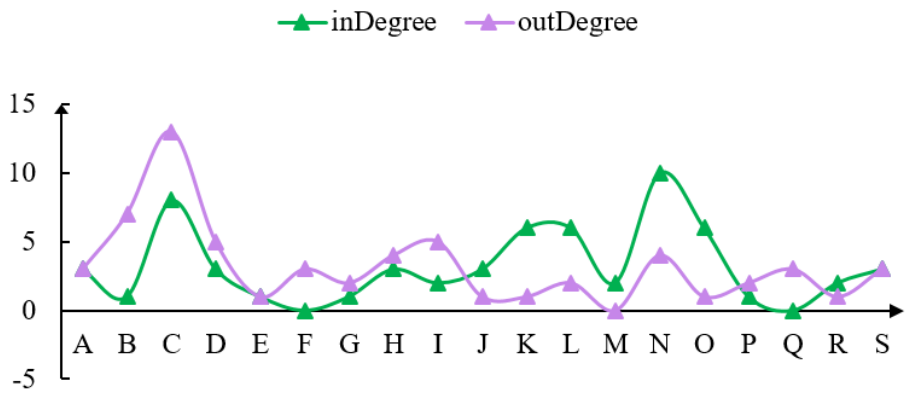

Fig 2: Degree Centrality

Fig 2 shows the degree centrality of nodes. The nodes with outdegree greater than indgree are Development and Reform Commission (B), Sector of Culture and tourism (C), Sector of National Resource (D), Administration for Forestry and Grassland (F), Administration for Market regulation (G), Individual government officials (H), Village committee cadres (I) and the Media (Q).The actors represented by these nodes belong to the knowledge source organizations.Tourism practitioners (K), Ordinary residents (L), Periphery villages (M), Garidi (Shoushan Tourism Co.,Ltd) (N), Other tourism enterprises and merchants (O), and Tourism research institutions (R) are the knowledge receiving organizations, because their indegree is larger than the outdegree. Nodes whose indegree equals the outdegree are: Sector of finance (A), Sector of Commerce (E) and Tourists (S). Thereinto, the Sector of Culture and tourism (C) owns the largest outdegree and is the most powerful knowledge source organization. The Science and Education Office of the

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Provincial Culture and Tourism Department is in charge of talent introduction and skill training in the Nangang village. From the officers of the Provincial Culture and Tourism Department, we know that when there is a conflict between facts and policies (for instance, activities are conducted urgently, and there is not enough time to perform the government procurement procedure), the Provincial Department of Finance will provide other workable cooperation approaches for enterprises after asking the provincial leaders for instructions. Moreover, in the earlier stage of attraction planning, the culture and tourism department of the government dispatches lots of investigators to inspect the exploitable superior resources of the village. These investigators, as a village-stationed working party, will be dispatched to rural communities to provide straightforward guidance for the construction of tourism destinations. Indegree of Garidi (Shoushan Tourism Co., Ltd) is the largest. In effect, the operation main body of the chosen facility is the government-subordinated Shoushan Tourism Co., Ltd. As its development is on the threshold, with a feeble competitive advantage. With the assistance from the government, other enterprises, and the community, this firm is constantly receiving knowledge and information in the process of planning, construction, and operation. The Provincial Culture and Tourism Department has employed famous expertsto train the professional personnel of scenic area management for Nangang construction from the theoretical knowledge, regime and measures, as well as management level. Between 2018 and 2020, Garidi signed cooperation agreements with three Internet companies to accept their technical assistance, so as to erect an integrated public digital cultural service networ.

The greater the closeness centrality, the farther a node is from other nodes, and the more dependent the knowledge transfer of this node is on others. Although the oucloseness of node M is significantly lower than that of other nodes, there is no organization in the adjacency matrix to which M sends knowledge. Among the nodes that actually have knowledge transmission behavior, the five nodes with smallest oucloseness are Sector of Commerce (E), village stationed task force (J), Tourism practitioners (K), other tourism enterprises and merchants (O) and Trade associations and NGOs (P). They have shorter paths when transferring knowledge and information to all other nodes. Excluding Administration for Forestry and Grassland (F) and The media and the public (Q) without actual knowledge acquisition, the five nodes with smallest incloseness are Sector of finance (A), Development and Reform Commission (B), Sector of Natinoal Resource (D), Administration for Market regulation (G) and Village committee cadres (I). They have a short path in acquiring knowledge and information from all other nodes. Most of these nodes are government departments. It can be seen that it is more convenient for government departments to obtain information in the knowledge transfer network.

Betweenness measures the degree to which an actor has control over a resource. A node is said to have a high betweenness when it is on the shortest path of many other pairs of nodes. Sector of Culture and tourism (C), Garidi (Shoushan Tourism Co., Ltd) (N) and Tourists (S) have strong control over knowledge transfer, Sector of Commerce (E), Administration for Forestry and Grassland (F) , Administration for Market regulation (G) and The media and the public (Q) have very weak control over knowledge transfer.

The centrality trait of several nodes is evident, which is worthy of attention. The first “the Media” has high incloseness and outcloseness. Namely, actors who are quite far from the central node are the weakest in aspects such as information resources, power, reputation, and influence. It possesses high closeness

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centrality but low degree centrality, which can be deemed as a key node associated with the important node. "The knowledge propagated by the media is superficial. They may know a lot, but the knowledge is just more helpful to people who are interested in them. Hence, it is not fit for appearing on bulletin boards of media," the manager of Garidi (Shoushan Tourism Co., Ltd) told us in a chat. The degree centrality, closeness centrality, and betweenness centrality of "Sector of culture and tourism" are pretty high, showing that the sector of culture and tourism is an extremely significant organization in the network. Located in the center of the network, it can easily gain the essential resources used for acquiring external information, and become the most capable actor in knowledge acquisition and delivery [65].Furthermore, we have discovered the high betweenness centrality and low degree centrality of Tourists. "Self-minority relationship" of such people is of great importance to the flow of the network. Few organizations tie with them, but they show a control effect to a great extent. The reason is that they are on many contacted network paths. Individuals in this position can influence groups via controlling or misrepresenting information transfer [66]. The village committee cadres owns a relatively high closeness centrality, but low betweenness centrality, showing that the it is related to many nodes. However, the correlation between other nodes is closer, so the village committee cadres has no control effect, though it can link to other nodes through shorter paths.

4.3 Structural Holes

TABLEVII. Sructural Holes

	Effsiz	**Efficient**	**Contra**	**Hierarch**
A	3.667	0.733	0.421	0.069
B	4.5	0.643	0.333	0.060
C	13.619	0.851	0.185	0.198
D	4.563	0.652	0.310	0.078
E	1.250	0.625	0.601	0.005
F	2.500	0.833	0.397	0.006
G	1.000	0.500	0.738	0.252
H	3.000	0.075	0.366	0.067
I	3.929	0.655	0.394	0.226
J	3.000	0.750	0.351	0.016
K	4.143	0.690	0.336	0.062
L	4.063	0.677	0.347	0.099

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M	1.250	0.625	0.731	0.034
N	10.250	0.778	0.241	**0.271**
O	5.429	0.776	0.282	0.072
P	2.167	0.722	0.521	0.060
Q	2.333	0.778	0.414	0.012
R	1.500	0.750	0.655	0.106
S	2.583	0.646	0.426	0.020

In actor network theory, the "bridge" between nodes is extremely significant. The establishment of the "bridge" can strengthen the connection between nodes, cut down the structural holes of the network, and elevate the operating efficiency of the network via a timely, efficient communication mechanism. For instance, the expansion of channels for information expression, sharing, and feedback plays a guiding role in the construction of an interest expression mechanism. Structural holes can offer opportunities to their occupants to gain "information interest" and "control interest", thereby providing them a competitive advantage to transcend members in other positions in this network [61]. The efficient size of each node is shown in the first column of TableVII. In general, the larger the efficient size, the freer and more unconstrained the action of this node in the social network. Nonetheless, interpretations of "efficient scale" are often not comparable due to the distinct individual network scale of every node. Then, a relatively efficient scale measure is necessary, that is, the efficiency measure of each node shown in the second column. It is believed that the greater the efficiency, the more efficient the action of this node in the social network. According to the calculation results, node"C" possesses the highest efficiency, up to 0.851, indicating that the action of the "sector of culture and tourism" is the most efficient. The total restriction degree that each node is subject to in the network is shown in the third column. In this sort of structural hole, the more structural holes in the group where the node is located, the less the restriction force on the nodes outside the network. It is observed that "Sector of culture and tourism" has the minimum restriction degree equal to 0.185, showing that "Sector of culture and tourism" is subject to the maximum restriction in the network. The last column shows the rank of each node in the network. The higher the rank of a node, the closer the node to the network core. The maximum of the fourth column is 0.271, showing that "N" is closest to the network core. And Garidi (Shoushan Tourism Co., Ltd) is the core node in this knowledge transfer network. The minimum of the fourth column is 0.005, the value of the node"E", indicating that the Sector of Commerce (E) is furthest from the core of the network.

4.4 Sub-Groups

The study of community structure in the network is a vital way to comprehend the structure and function of the whole network. The GN algorithm, a graph clustering algorithm on the basis of deletion of edges, is substantially based on the divisive idea of clustering. The core concept is to make the connections between the internal individuals of the found clusters as tight as possible, while the connections between individuals

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from the different clusters are as sparse as possible. The analysis of the link relationship is taken as the foundation, and the individual property, as well as the properties that the relationship owns, are overlooked [67]. The GN algorithm can precisely divide the network via the modularity Q, which is appropriate for the small and medium-sized networks in this study.

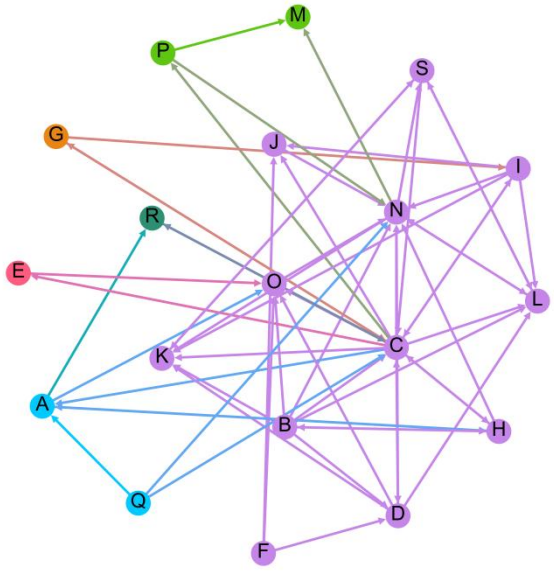

Fig 3: Communities

The corresponding ideal community structure of maximum found modularity=0.25363327 is calculated by adopting the Girvan-Newman algorithm in Gephi. Newman [67] proposed that, the network shows an evident community structure if Q > 0. In this paper, the maximum Q value does not come up to 0.3, but it is approximate to 0.3. Hence, it is essential to carry out an exploratory analysis of the cluster results [67]. The entire network is divided into six communities as shown in Fig 3, which are:

(1) Administration for Market regulation (G)

(2) Tourism research institutions (R)

(3) Periphery villages (M) and Trade associations and NGOs (P)

(4) Sector of finance (A) and The media and the public (Q)

(5) Sector of Commerce (E)

(6) Development and Reform Commission (B), Village committee cadres (I), Other tourism enterprises and merchants (O), Ordinary residents (L), Garidi(Shoushan Tourism Co., Ltd) (N), Administration for Forestry and Grassland (F), village stationed task force (J), Tourists (S) Sector of Culture and tourism (C), Sector of National Resource (D), Individual government officials (H) and Tourism practitioners (K)

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Network clustering plays an active role in knowledge transfer by affecting the willingness of knowledge sources to assist others. Clustering acts on knowledge transfer by affecting the motivation of knowledge sources, just like strong ties. In compact social networks, the third-party relationships commonly owned by strong ties are the source of motivation. When a pair of relationships is encircled by third-party strong ties, it is more likely to come up the knowledge transfer [18-19]. Reputation and cooperation norms are two major mechanisms of conducting positive knowledge transfer through the way of network clustering affecting knowledge sources. On the grounds of reputation theory, people lean to cooperate with colleagues when besieged by third-party strong ties. Because they know that if they do not cooperate with others, the news about their behavior will rapidly disseminate to other network members, which will confine their capacity to interact with other members in the future. Moreover, more efficacious and forceful sanctions are imposed on non-cooperative behavior among members inside a cluster [20]. This urges the active cooperation between the members of the network clustering and others, as well as the sharing of knowledge [68].

V. DISCUSSION AND CONCLUSION

This paper analyzes the topological characteristics of the knowledge transfer network among actors of the Nangang rural tourism destination. These results provide a clear picture of how information and knowledge flow within actors. The first notable feature of this network is its low density of 0.1784. According to cohesion theory [69], dense networks help build trust and improve cooperation. Higher density provides network participants with more opportunities to communicate with other members and aims to remove barriers and simplify knowledge transfer [70]. Therefore, it is suggested that the connectivity of knowledge transfer networks for such rural tourism destinations needs to be significantly improved.

However, too much density can also lead to knowledge redundancy [71] and cognitive lock-in [72]. To ensure cooperative and efficient knowledge transfer and flexibility, trade-offs between structures are required. According to the results of a network density analysis, there are only 17 potential links out of 1000 total. Low density means fewer actor connections, knowledge exchange, and thus fewer resources for innovation, lowering the destination's overall competitiveness. Rural tourism destinations have their own characteristics, that is, the strategic goals of actors are always in the social significance behind the development of tourism destinations rather than simply pursuing profits. This should be an opportunity to strengthen knowledge transfer between actors. The average path length of this network is relatively short. The small network distance between participants improves the efficiency of knowledge transfer in the network.

Further analysis reveals that the network is highly formed around the government’ssector of culture and tourism, which is primarily the network's center. This demonstrates that the government's cultural and tourism sector, as the network's leader and primary source of funding for rural tourism destination, has established itself correctly. It has a high indegree and outdegree, indicating that it is not only the critical knowledge source organization for most organizations, but also a critical knowledge receiving organization. It has a high capacity for acquiring knowledge and power. The outdegree of all government organizations is greater than or equal to the indegree, showing the apparent characteristics of knowledge transmission.

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However, the betweenness of various government departments is different. Except for the cultural and tourism sector, land and resources sector and specific officials, the betweenness of other government organizations is extremely low, showing their lack of control to the effectiveness of knowledge information dissemination in the network.

The five organizations in the rural tourism destination community (i.e., village cadres, village stationed task force, ordinary residents, tourism practitioners, and periphery villages) showed very similar characteristics. Among the five groups, only village cadres are knowledge source organizations, indicating that the community as a whole will still be knowledge recipient because they are the primary recipients of various trainings. The planning director of Garidi mentioned that they intend to cultivate the ability of the village collective to operate the scenic spot by itself, and intend to hand over the management to the village collective in the future, gradually changing the government-led operation mode. The closeness of the villagers is high, but their betweenness is very low. Community members have quick and close access to many actors in the network, which can increase the speed of knowledge dissemination. However, because the nodes to which they are connected are also very close to other nodes, these community organizations, while at the heart of the rural tourism destination network, are unable to exert control. Tourism enterprises, as the primary recipient of assistance during construction, exhibit prominent knowledge reception characteristics. Garidi (Shoushan Tourism Co., Ltd) appeared to be the largest only-accepting organization among them, as the main body of the chosen facility. In acquiring knowledge from various channels, it has a high efficiency and few constraints. Other tourism businesses, which are also knowledge-receiving businesses, provide Garidi with knowledge and information. During our follow-up visit, we discovered that this type of knowledge transfer between companies is primarily driven by management and technology. Garidi signed contracts with three Internet companies from 2018 to 2020 to accept their technical assistance in managing a public digital cultural service network.

Actors in pressure groups exhibit different characteristics. Trade associations and non-governmental organizations (P), the Media and the general public (Q), and Tourism research institutions (R) all have low centrality, indicating that they are on the periphery of the network, lacking the ability to develop strong relationships with others, as well as the ability to transmit information and control the interactions of others independently. This result was unexpected, as it implies that pressure groups in this knowledge transfer network are largely marginalized and ineffective. However, tourists have a high degree of betweenness and a low degree of centrality. Tourists are crucial to knowledge transfer because they are on the path of many network interactions. They are connected to a small number of organizations, but they have a relatively large voice in their discussions and can protect their own interests.

The clustering results of subgroups show that the knowledge transfer relationship of rural tourism destinations breaks the restrictions of departments to a certain extent, and the influence of departments gradually weakens. The knowledge transfer between them pays more attention to the information complementation in practical work. The trend of collaborative innovation and cooperation between fields and departments is becoming more and more apparent.

Compared with previous studies, this study further subdivides the actors, especially understanding the

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different roles that different government departments may play in rural tourism destination management. The final research results also confirmed this conjecture. The results show that the knowledge transfer network is not reciprocal, and the network capabilities of the actor organizations are relatively different.

The stronger the network capabilities of actors are, the more possible it is to build and optimize network relationships and enrich network connections. The establishment of relationships can help actors communicate and cooperate more effectively, improve their relationship's intimacy, and strengthen the transmission and absorption of tacit information. Meanwhile, it can successfully widen knowledge acquisition channels and improve actors' ability to acquire knowledge. These findings can assist DMOs better identify essential, neglected, or possibly vulnerable actors and aim to improve their network structure, which is a useful supplement to existing rural tourism network research.

This study still has certain limitations. First, due to the network's modest scale, the sample size used in this study is rather tiny, and the analysis approach is limited. If future study uses a bigger sample size, the available graph clustering algorithms will be more diversified, and the differences between subgroups will be more fully recognized. Second, while this study is based on a static network analysis, rural tourism attractionconstruction is surely evolving with time. When the rural tourist system is in a small-scale and intensive community state, the leader's prestige is primarily responsible for its management and internal transaction order. However, as the size of the network continues to expand, knowledge management may become more complex because of new challenges. Therefore, future research can focus on analyzing the dynamic evolution of the network.

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