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Evaluating spatial centrality for integrated tourism management in rural areas using GIS and network analysis

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ABSTRACT

The aim of this study is to identify and classify villages according to their spatial centralities, considering rural amenity resources, for integrated tourism management. Rural tourism is an important means of regional economic development because it permits new infrastructure to be developed and helps retain existing amenities. This study took place in Korea, where little attention has been given to an integrated rural tourism planning perspective, thereby undermining current initiatives. In this study, 43 villages in Jangheung-gun and Jeollanam-do were assessed and the centralities were measured using geographic information systems (GIS) and network analysis. The results show that Okdang-ri is the spatial core village supported by Yongjeon-ri and Bangchon-ri, thereby permitting a more effective provision of services. In addition, Inam-ri and Unheung-ri were identified as the sub-core villages of the two sub-groups, while Deogam-ri served as the connection node between these groups. This study demonstrates the applicability of centrality indices for evaluating spatial characteristics such as role, accessibility, and influence on surrounding villages for integrated tourism management.

1. Introduction

Tourism is increasingly regarded as a savior of rural areas, with many governments recognizing the industry's potential in fostering regional economic development (Jackson & Murphy, 2006). However, the enormous infrastructure and resource demands of tourism can have severe impacts upon local communities and their surrounding environment if not properly managed. Therefore, an appropriate tourism development management approach is required for the maintenance of rural amenity resources and the preservation of rural environments, including natural and traditional resources in rural areas.

In Korea, various efforts have been made to develop rural areas by taking into account the available rural amenity resources (Kim, 2004; Kim & Choi, 2007; Kwon & Hong, 2003). Since 2002, the Korean government has been promoting farm-stays, traditional themed villages, information network villages and fishing villages in response to the heightened interest and demand for the discovery and creation of rural amenities (Oh, Choi, & Bae, 2008). Moreover, various organizations have been created for the purpose of developing various amenity resources and invigorating rural tourism by the citizens themselves, such as the Research Society for the Amenities of Rural-Mountain-Fishing Villages. The Rural Development Administration (RDA) in Korea is conducting a nation-wide rural amenity resources survey project to construct databases of rural amenity distribution. In addition, various studies have been conducted with the aim of improving rural tourism in other countries (Erkuş-Öztürk & Eraydin, 2010; Novelli, Schmitz, & Spencer, 2006; Shih, 2006). However, overlapping investments in uniform tourism projects, such as farm-stays or sightseeing tours, have already been executed in most of the rural areas in Korea, even though the individual villages have retained the characteristic amenity resources. In addition, without connection to neighboring villages, the effective management of rural amenity resources would be difficult within the context of small-scale tourism projects because small-scale amenity resources are scattered throughout rural areas.

Accordingly, several studies have been conducted to examine integrated tourism in Korea. Sim (2002) established the standard for defining specialized tourism zones according to characteristic tourism resources and divided Jeollabuk-do into five zones. Park and Song (2004) constructed a culture-tourism area for integrated development and analyzed the strategy of an individual area. However, these studies only classify major cities or rural areas with respect to tourism resources or administrative districts without

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considering their relationships with neighboring villages in terms of both rural amenity resources and geographic location. An integrated tourism strategy should be implemented for the effective management of scattered amenity resources and the tourism plan connecting to neighboring villages. In addition, in the case of rural tourism development within many villages, it is important to identify which villages perform the main role for integrated rural tourism and how the main and sub-groups are constituted within several villages. In this study, a spatial index that considers geographic accessibility and the characteristics of rural amenities is evaluated with the application of centrality theory to promote an integrated tourism strategy. The idea of centrality is one of the earliest to be pursued by network analysts (Scott, 2000). Freeman (1979) gave a discussion of actor centrality and network centrality. Wasserman and Faust (1994) presented various centrality measures and referenced the literature on centrality. Numerous measures have been developed, including flow betweenness, the rush index, influence measures and various centralities (e.g., degree, closeness, betweenness, eigenvector, and information centralities) (Borgatti, 2005; Hoede, unpublished manuscript; Hubbell, 1965; Katz, 1953; Taylor, 1969). As centrality implies nodes in a network structure, a centrality that considers both rural amenity resources and the geographic positions of the villages could represent the degree, accessibility, and influence on the other surrounding villages. Accordingly, integrated tourism management that is based on spatial centralities could result in the effective management of scattered amenity resources and the development of connections between neighboring villages.

In this study, a geographic information system (GIS) and network analysis were employed to evaluate spatial centralities and classify villages based on their centralities to develop an integrated tourism strategy that considers rural amenity resources. Herein, we illustrate the methodology for spatial network construction and present an evaluation of the degree, betweenness and eigenvector centralities of individual villages, respectively. Furthermore, the core and sub-core villages are identified for integrated tourism using these results. Additionally, the main and sub-group villages are categorized by their eigenvector and degree centrality, and the connecting villages that perform the role of linkage between these groups are evaluated by betweenness centrality.

2. Materials and methods

In this study, a spatial network structure applying network flow as a weight for the links was constructed to analyze the spatial centrality of rural villages. The spatial network structure was constructed as an adjacency matrix using the shortest paths among villages using GIS. The network flow was estimated using the spatial tourism interaction model, including various factors such as green tourism potential, human resources, and the shortest distances among villages. The green tourism potential is measured using the tourism amenity index and the weight of the rural amenity (Oh et al., 2008). The amenity resources, such as plants and reservoirs, are regarded as more important factors in green tourism, and most tourism plans in Korea include the application of amenity resources. The population also performs a significant role in integrated tourism strategy. Even if the rural amenity resources are plentiful and an integrated tourism plan is established in a rural area, it is difficult to maintain rural tourism and amenity resources without abundant manpower. The distances among villages are also a main factor in promoting integrated tourism. Therefore, in this study, the rural amenity resources, population and distances among villages were used as the main factors in creating a spatial tourism interaction. The spatial centralities (degree, betweenness, and eigenvector centrality) were then calculated in the spatial network structure by applying spatial tourism interaction as the network flow using network analysis. From these results, the core, sub-core and connection villages are identified, and the main group centering the core village is ascertained for application to the integrated tourism strategy. The core villages are identified by a high degree centrality and an eigenvector centrality, and the connection villages are indicated by a betweenness centrality. In addition, the main and sub-groups are evaluated by an eigenvector centrality in the integrated rural tourism. A flowchart of procedures for the spatial centrality analysis is shown in Fig. 1.

2.1. Spatial tourism interaction among rural villages

2.1.1. Spatial network structure by shortest path

Network analysis, which is derived from graph theory, attempts to describe the structure of relationships between given entities and applies a quantitative technique to produce relevant indicators and results for the study of characteristics of an entire network, and the position of individual entities within the network structure (Shih, 2006). In network structure, two nodes joined by a link are referred to as adjacent or neighboring and it is often useful to consider an adjacency (or connectivity) matrix. The adjacency matrix focuses on unweighted networks that are binary in nature, which means that the links between nodes are either present or not, and the diagonal of the adjacency matrix contains zeros and is thus a symmetric matrix (Boccaletti, Latora, Moreno, Chavez, & Hwang, 2006). In this study, an adjacency matrix was analyzed by the shortest paths among villages using GIS. However, along with a complex topological structure, many real networks display the intensity of the connections. Therefore, we considered spatial tourism interaction to be positive and the symmetric weight of the links in the adjacency matrix. In other words, the weighted network, which took into account the adjacency matrix and the weight of the link, was obtained using the weight distribution from the spatial tourism interaction among the given links.

2.1.2. Spatial tourism interaction as the weight of links in the spatial network

Spatial interactions cover a wide variety of movements, such as trips to work, migrations, tourism, public facility usage, the transmission of information or capital, retail marketing activities, international trade and freight distribution (Rodrigue, Comtois, & Slack, 2009). The basic assumption behind many spatial interaction

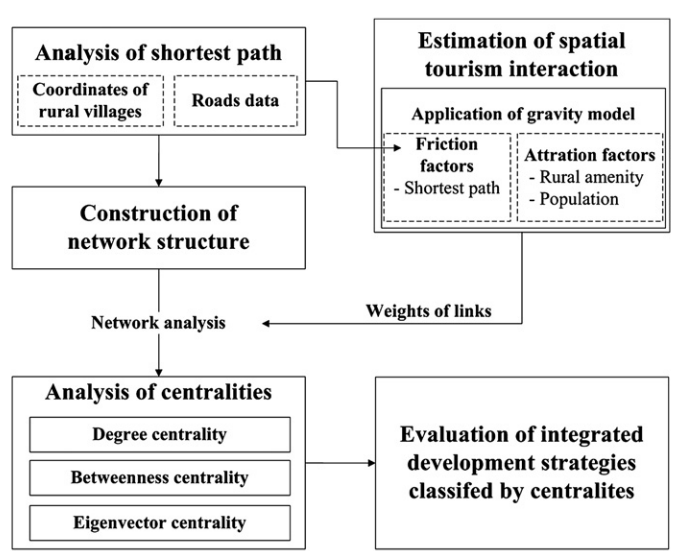

Fig. 1. Flow of procedures for spatial centralities analysis.

models is that flows are a function of the attributes of the origins and destinations and the friction of the distance between the origins and destinations (Rodrigue et al., 2009). Spatial tourism interaction is one of the spatial interactions related to tourism factors such as rural amenity resources and distances between villages. The spatial tourism interaction is represented as a network flow, which is the weight of the links in the spatial network, and it can be measured using a spatial interaction model, such as the gravity model. The gravity model is based on Newton's gravity theory, and it utilizes the gravitational force concept as an analogy to explain the volume of trade, capital flows, and migration among the countries of the world (Roy & Thill, 2004).

In this study, the gravity model was used to estimate the spatial tourism interaction because tourism also involves human movement resulting from tourism interaction due to such tourism factors as rural amenity resources, human resources and distance. Accordingly, the green tourism potential evaluated by the rural amenity resources and human resources was considered an attraction factor. The shortest distance among villages was used as a friction factor. The spatial tourism interaction based on the gravity model is given by:

$$STI_{ij} = H_i \bullet H_j \bullet T_i \bullet T_j \bullet D_{ij}^{-\beta}, \tag{1}$$

where STI_{ij} is the spatial tourism interaction between the ith and jth villages. H is the human resource index and T is the green tourism potential. D_{ij} is the distance index between the ith and jth villages, which was applied as the friction factor in this model, and β is a parameter ranging between 1.0 and 2.0.

2.1.3. Factors of the spatial tourism interaction model

Rural amenity resources are graded by five evaluation levels according to the mean and the standard deviation of the number of surveyed resources. Individual values (1.0, 0.8, 0.6, 0.4, and 0.2) are assigned to each grade. Then the weights of the rural amenity category are multiplied by these values, yielding the green tourism potential. The green tourism potential is standardized using the maximum and minimum green tourism potential. In the process of estimating the standardized green tourism potential, adding 1 prevents the results from being calculated as zero. Otherwise, the spatial tourism interaction of one village will be zero even if there are amenity resources. This process is given by:

$$A_i = \sum_k (A_{ik} \times \omega_k), \tag{2}$$

$$T_i = (A_i - A_{\min})/(A_{\max} - A_{\min}) + 1, \tag{3}$$

where A_i is the green tourism potential of the ith village, A_{ik} is the tourism amenity value (1.0, 0.8, 0.6, 0.4, 0.2) of the surveyed tourism amenity resources (k), ω_k is the weight classified by the amenity resources, T_i is the standardized green tourism potential. $A_{\max}$, $A_{\min}$ are the maximum and minimum green tourism potential values, respectively.

The population is regarded as human resources in the spatial tourism interaction. Even if there are plenty of tourism amenity resources in these rural villages, these amenity resources cannot be developed for green tourism without enough human resources. The process for evaluating the human resource index is similar to that for the standardized green tourism potential and is given by:

$$H_i = (P_i - P_{min})/(P_{\max} - P_{\min}) + 1, \tag{4}$$

where H_i is the human resources index, P_i is the population in the ith village and $P_{\max}$, $P_{\min}$ are the maximum and minimum populations of all the villages within the network, respectively.

The shortest path is regarded as the friction factor in the spatial tourism interaction. To calculate the shortest path among villages, the coordinates of the rural villages were surveyed and set as nodes in the spatial network. The shortest distances among villages via roadways were then calculated using GIS and network analysis. The process for evaluating the distance index is similar to that for the standardized green tourism potential and is given by:

$$D_{ij} = (SP_{ij} - SP_{\min})/(SP_{\max} - SP_{\min}) + 1, \tag{5}$$

where D_{ij} is the distance index and SP_{ij} is the distance of the shortest path between the ith and jth villages. Additionally, $SP_{\max}$ and $SP_{\min}$ are the maximum and minimum distance values among the villages in the entire network structure, respectively.

2.2. Spatial centralities of rural villages with respect to the spatial tourism interaction

In this study, three centrality indices (i.e., degree, betweenness, and eigenvector centralities) were estimated to identify the degree, accessibility, and influence on surrounding villages. The spatial tourism interaction discussed in the previous section was applied with the weight of the links in the spatial network, and the centrality indices were measured by network analysis.

Degree centrality is one of the simplest and best-known measures of centrality. As defined by Freeman (1979), degree centrality is a count of the number of edges incident upon a given node. The degree centrality that considers spatial tourism interaction among rural villages is given by:

$$C_D(i) = \sum_j^n I_{ij}/(n-1), \tag{6}$$

where C_D is the degree of centrality of an individual rural village, n is the total number of villages and I_{ij} is the spatial tourism interaction between the ith and jth villages.

The betweenness centrality of a node depends on the extent to which it is needed as a link in the chain of contacts that facilitate the spread of information within the network (Nooy, Mrvar, & Batagelj, 2005). In the spatial network, the betweenness centrality is the proportion of all of the geodesics between the node itself and the pairs it makes with other nodes and is given by (Freeman, 1979; Kim, 2003):

$$C_B(m) = \sum_i^n \sum_j^n \left(g_{imj}/g_{ij}\right) \Big/ \{(n-1)(n-2)/2\}, \tag{7}$$

where C_B is the betweenness centrality of individual rural villages, n is the total number of villages, g_{ij} is the number of the shortest path between the ith and jth villages, and g_{imj} is the frequency of instances in which village m is located on the shortest path between the ith and jth villages.

The eigenvector centrality is a measure of the importance of a node in a network and it is based on the idea that a node is more central if it is in relation with nodes that are themselves central (Ruhnau, 2000). It assigns relative centrality to all villages in the network based on the principle that connections to high-level centrality villages contribute more to the centrality of the village than equal connections to low-level centrality villages. Therefore the village connected to influential villages would have the high-level eigenvector centrality. In other words, the centrality of a village not only depends on the number of villages adjacent to it but also its value of centrality (Ruhnau, 2000). The village evaluated to the high-level eigenvector centrality could be conducted to the main village mediating other villages and the eigenvector centrality could be applied to determine the area of influence centering the main village. Bonacich (1972) defines the centrality $c(v_i)$ of a node v_i

Fig. 2. Location map of the study area.

as the positive multiple of the sum of adjacent centralities, as follows:

$$\lambda c(v_i) = \sum_{j=1}^{n} \alpha_{ij} c(v_j) \quad \forall \mathrm{i}. \tag{8}$$

In matrix notation with $c=(c(v_i),...,c(v_n))$, this yields

$$Ac = \lambda c. \tag{9}$$

This type of equation is well known and is solved using the eigenvalues and eigenvectors of A. An eigenvector of the maximal eigenvalue with only non-negative entries does exist, and we call a non-negative eigenvector ($c \geq 0$) of the maximal eigenvalue the principal eigenvector and entry $c(v_i)$ the eigenvector centrality of village v_i (Ruhnau, 2000). Eigenvector centrality, as defined by Bonacich (1972), of a node is proportional to the sum of eigenvector centralities of the nodes to which it is connected. It is calculated by computing principal eigenvector which has the biggest eigenvalue among every eigenvectors.

The network analysis program NetMiner 3.0 (http://www.netminer.com) was employed to analyze the degree, betweenness and eigenvector centrality.

3. Results and discussion

3.1. Estimation of spatial tourism interaction

This research was carried out to calculate an index for an integrated rural tourism plan targeting an area where such plans are actively pursued and a Rural Amenity Resources Survey is under way. Jangheung-gun in Jeollanam-do province is a coastal area geographically located at the southwest of Korea. Having excellent historical heritages and coastal views, various rural tourism projects about historical and cultural journeys and ecological experiences are under progress in Jangheung-gun. These historical cultural assets are especially present in Okdang-ri and tourism businesses on beaches are being developed in Sumun-ri, Janheung-

Table 1
Standardized indices of green tourism potential and human resources.

Villages	Standardized indices		Villages	Standardized indices	
	Green tourism potential	Human resources		Green tourism potential	Human resources
Sanggeum	1.47	1.12	Samsan	1.66	1.81
Hageum	1.17	1.04	Haechang	1.77	1.24
Goma	1.12	1.40	Bangchon	1.57	1.14
Nongan	1.42	1.00	Jijeong	1.28	1.11
Habal	1.17	1.16	Unheung	1.54	1.18
Songchon	1.69	1.16	Moryeong	1.13	1.14
Seongsan	1.81	1.10	Suyang	1.10	1.04
Jukgyo	1.27	1.39	Jukcheong	1.21	1.18
Yongjeon	1.46	1.10	Inam	1.35	1.27
Bupyeongni	1.77	1.05	Eosan	1.21	1.12
Okdang	2.00	2.00	Gwanji	1.09	1.04
Dangam	1.44	1.17	Surak	1.13	1.01
Gyesan	1.43	1.12	Haksong	1.49	1.06
Gisan	1.10	1.14	Unju	1.53	1.07
Namsong	1.42	1.19	Sinchon	1.08	1.07
Sindong	1.13	1.25	Sumun	1.30	1.53
Bidong	1.26	1.02	Sachon	1.26	1.37
Punggil	1.35	1.09	Jeopjeong	1.59	1.18
Jicheon	1.00	1.05	Nogwon	1.39	1.04
Deogam	1.17	1.07	Wolsong	1.19	1.04
Mosan	1.25	1.04	Sangbal	1.29	1.14
Oedong	1.34	1.49			

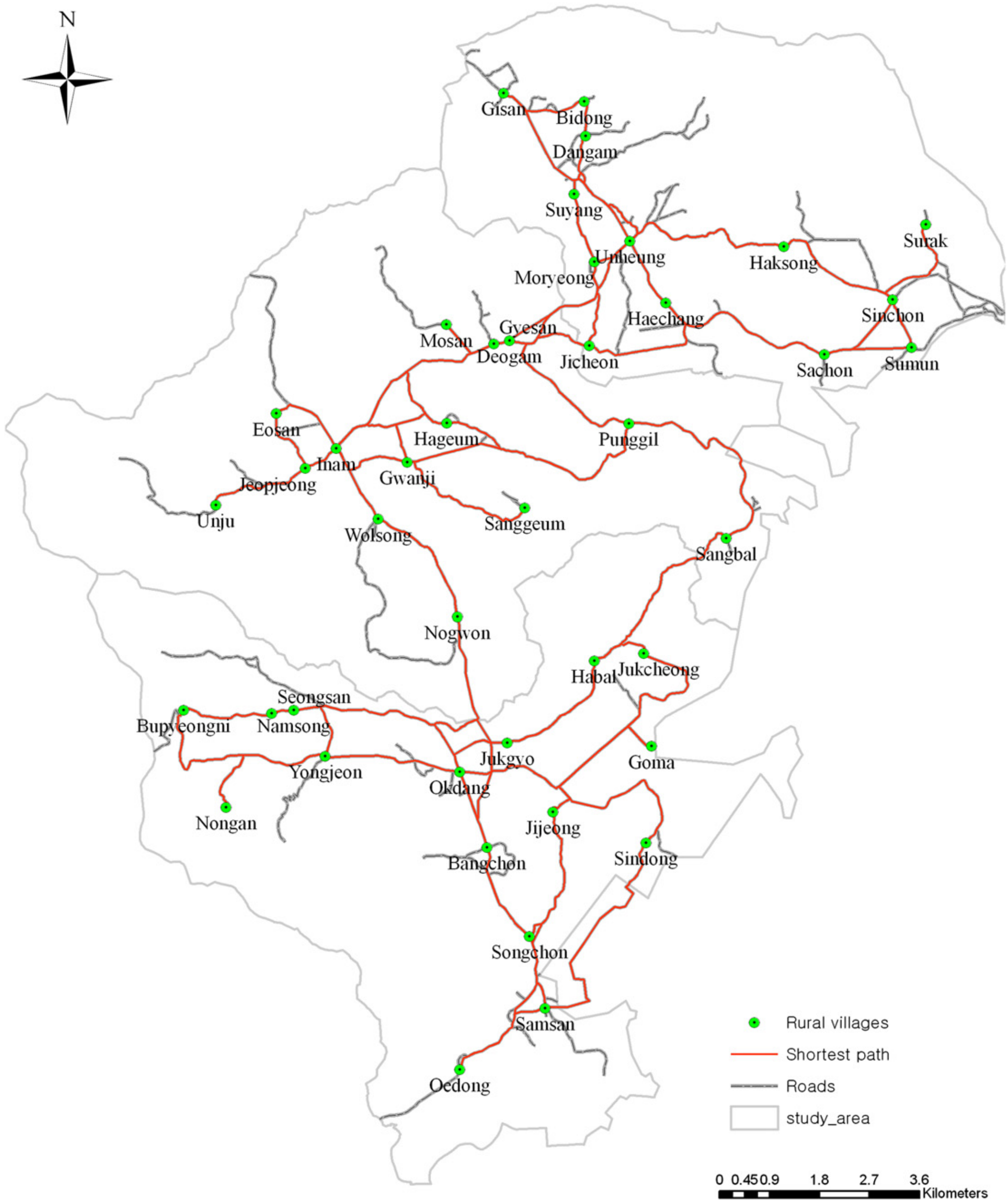

Fig. 3. Map illustrating the rural villages and shortest path in the study area.

gun. However, in the current rural tourism plans in Jangheung-gun, mainly amenity resources possessed by each village individually are being developed and utilized. In contrast, with integrated rural tourism, in which theme tours via historical resources and coastal tours along the Jeollanam-do are simultaneously planned, more effective rural tourism can be achieved. Therefore, a centrality analysis was conducted for the studied villages by evaluating the spatial interaction and network set up from local viewpoint of rural tourism. Accordingly, the intention was to identify the core, sub-, and connection villages by carrying out a centrality analysis of 43

Table 2
Results of spatial tourism interaction in the 8 selected villages in case of the friction parameter, 2.0.

Villages	Nongan	Habal	Songchon	Seongsan	Jukgyo	Yongjeon	Bupyeongni	Okdang
Nongan	–							
Habal	1.11	–						
Songchon	1.64	1.76	–			**Symmetric matrix**		
Seongsan	2.12	1.73	2.47	–				
Jukgyo	1.67	2.07	2.67	2.62	–			
Yongjeon	1.92	1.47	2.18	2.86	2.23	–		
Bupyeongni	2.12	1.47	2.10	3.37	2.21	2.39	–	
Okdang	4.08	4.27	6.35	6.19	6.57	5.50	5.21	–

villages, including Okdang-ri and Sumun-ri in Jangheung-gun, where a variety of rural tourism resources are present and where a Rural Amenity Resources Survey was conducted in 2008. The study area is shown in Fig. 2. In addition, an expansive centrality could be established, until the areas that would be considered in an integrated tourism plan were set up, if a survey of rural amenities and a population census of the villages were to be completed in other regions near the study area in the future.

To estimate the spatial tourism interaction, the coordinates of the 43 rural villages were first surveyed and set as nodes in the spatial network. The shortest paths among villages via roadways were calculated using GIS analysis, and an adjacency matrix was constructed with these results. The standardized green tourism potential, human resource index and the shortest distances among villages were estimated and applied to the spatial tourism interaction model. The estimation results of the standardized green tourism potential and the human resource index are presented in Table 1, and the shortest paths are shown in Fig. 3. The standardized green tourism potential in Okdang-ri and Seongsan-ri were higher than in any of the other villages.

The results of the spatial tourism interactions are shown in Table 2. Applying 1.0 as the parameter value of the friction factor, a high-level spatial tourism interaction was estimated in Okdang-ri and in the villages near Okdang-ri, such as Bangchon-ri and Jukgyo-ri. Upon increasing this parameter from 1.0 to 2.0, the spatial tourism interaction of Okdang-ri changed from 6.89 to 6.61, and the differences in spatial tourism interaction ranged from −0.55 to 0.0 in most of the villages. These results indicate that the parameter value of the friction factor in the spatial interaction model has little influence on the spatial tourism interaction. These results appear to be due to the shortest distances, standardized by the maximum and minimum shortest distances among villages, being used as the

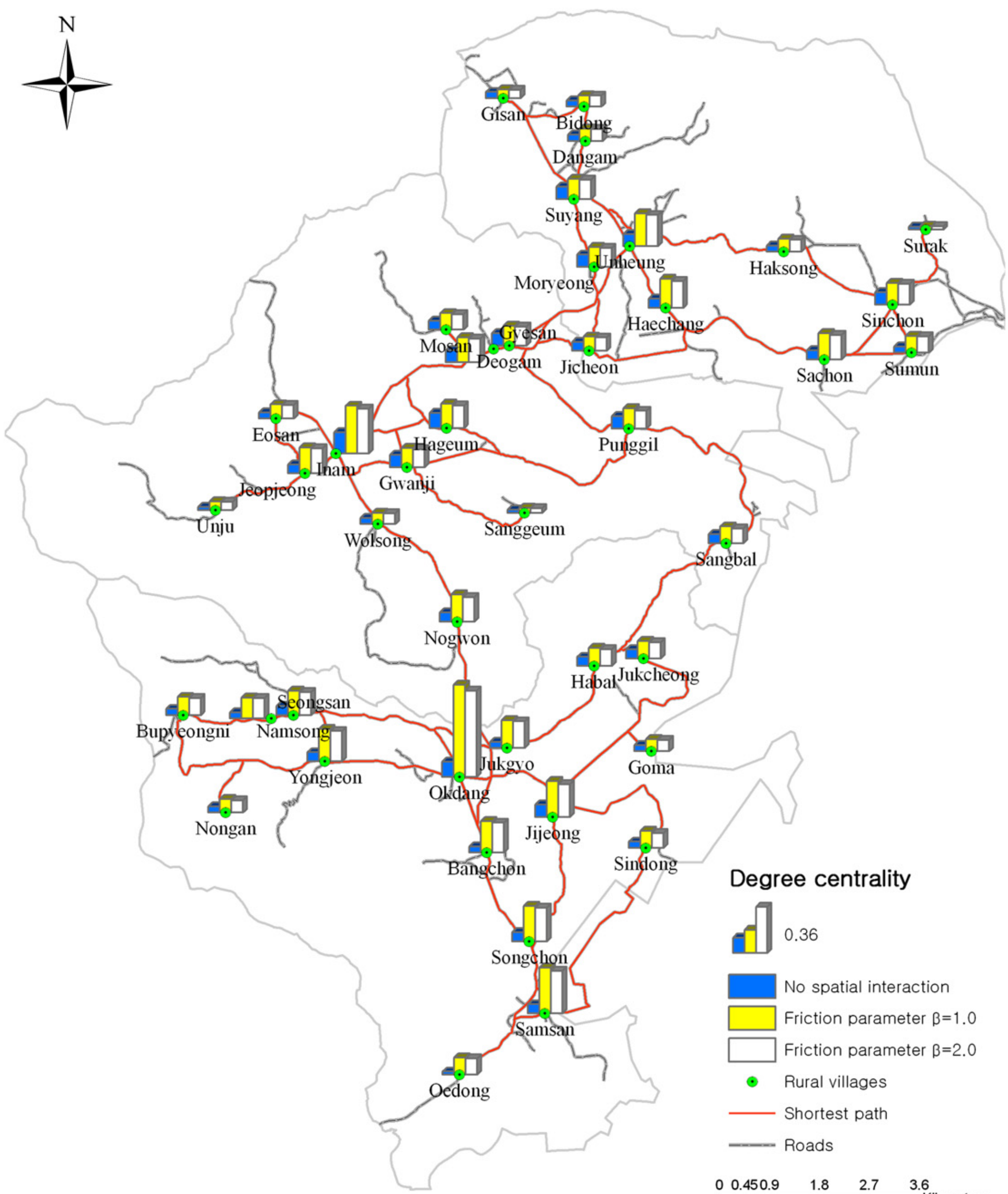

Fig. 4. Results of degree centrality.

friction factor. The average values of the spatial tourism interaction were used for measuring the spatial centrality, which is described in the next section.

3.2. Analysis of spatial centrality with respect to the spatial tourism interaction

First, we estimated the spatial centralities, such as degree, betweenness and eigenvector centralities, considering only the number of links by shortest path without applying the spatial tourism interaction. Then, the spatial centrality, applying the spatial tourism interaction as a network flow, was estimated by network analysis, and the results were compared with the previous results to evaluate the influence of the spatial tourism interaction on centrality. The results of these spatial centralities are shown in Figs. 4–6 and Tables 3and 4. When the number of links was the only variable considered, high-level degree centralities were calculated in Inam-ri (0.16), Okdang-ri (0.12) and Hageum-ri (0.12). However, when the spatial tourism interaction was applied as a network flow, the high-level degree centralities were estimated to be 0.693 in Okdang-ri, 0.361 in Inam-ri and 0.343 in Samsan-ri. These results indicate that these high-level degree centrality villages could be easy to access geographically from the other villages, and green tourism unions centering on these villages could be formed. The distinctive degree centralities were calculated for each of the villages, and the connectivity of the villages located in the southern villages were estimated to be higher than those in the northern villages when the spatial tourism interaction was applied as the weights of the links.

In spatial networks, the distance to neighboring villages is not the only important property of a village. Determining which villages lie on the shortest paths among pairs of other villages is also important. In other words, betweenness centrality considers the sum of the probabilities across all possible pairs of villages, and

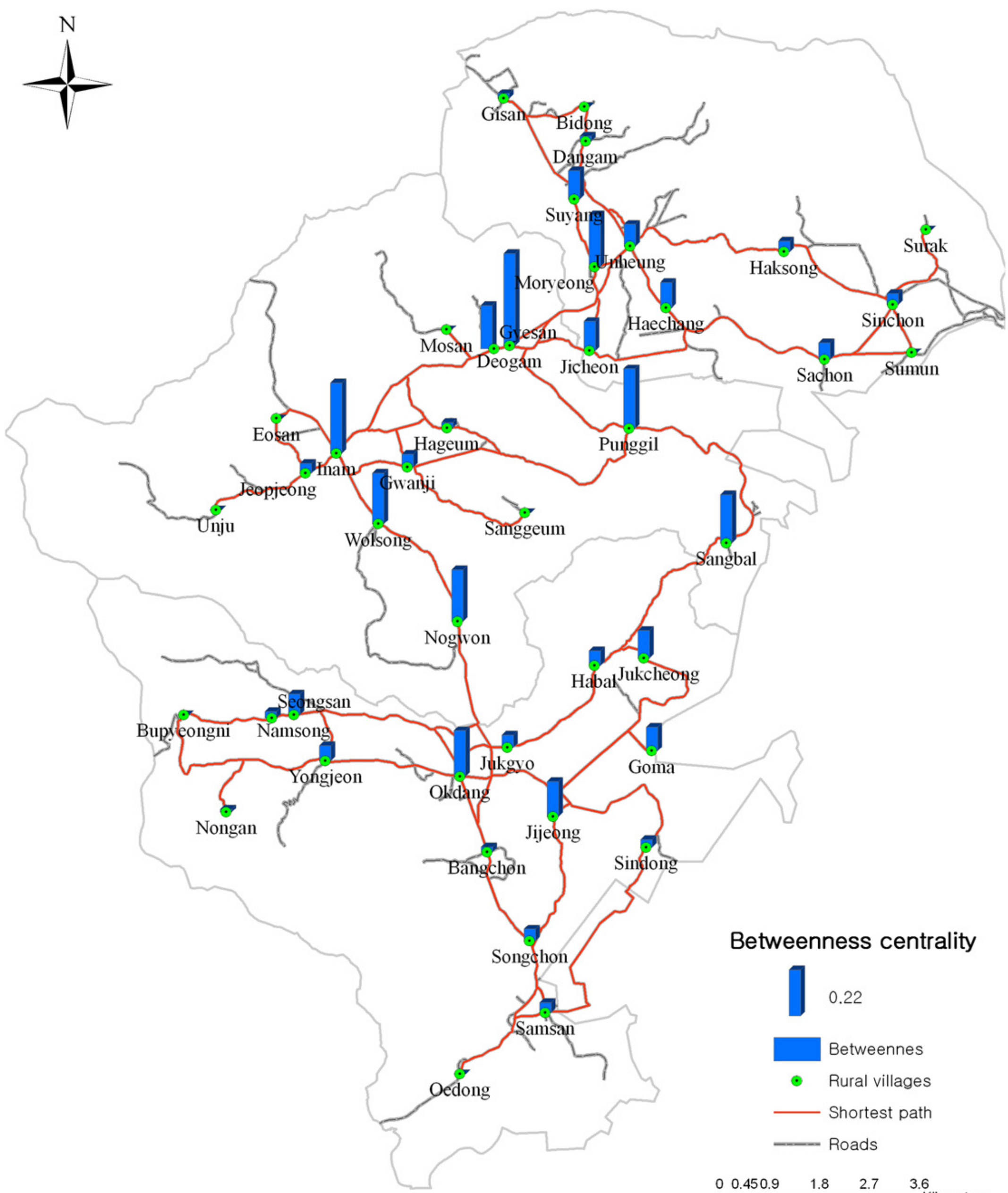

Fig. 5. Results of betweenness centrality.

it has no relationship to the spatial tourism interaction. High-level betweenness centralities were estimated in Deogam-ri (0.441), Inam-ri (0.339), Nogwon-ri (0.247) and Wolsong-ri (0.243). Furthermore, we determined that Wolsong-ri and Nogwon-ri are located in important positions, as they connect the northern and southern areas geographically.

The eigenvector centrality considers the centrality of connected villages. Therefore, a village connected to high-level centrality villages could have a high-level eigenvector centrality; this means that eigenvector centrality is an index indicative of the opportunity to improve the power of influence on other villages. The eigenvector centrality is closely related to the spatial tourism interaction, which is why the eigenvector centrality was estimated differently according to the spatial tourism interaction. Analysis of the eigenvector centrality without the spatial tourism interaction resulted in high-level eigenvector centralities in the villages of Inam-ri (0.484), Hageum (0.442), and Gyesan (0.366). However, analysis of the eigenvector centrality in terms of the spatial tourism interaction yielded results that differed from previous results when the spatial tourism interaction was not applied as the weights of the links. High-level eigenvector centralities were estimated in Okdang-ri (0.666) and the villages surrounding Okdang-ri, such as Bangchon-ri (0.370) and Jukgyo-ri (0.334), when the spatial tourism interaction was applied as a network flow.

3.3. Strategy for integrated tourism management according to spatial centralities

The three aforementioned centralities show the degree, accessibility, and influence one village has on surrounding villages. Therefore, the strategy based on the spatial centralities, shown in Table 5, should be implemented for an effective integrated tourism plan.

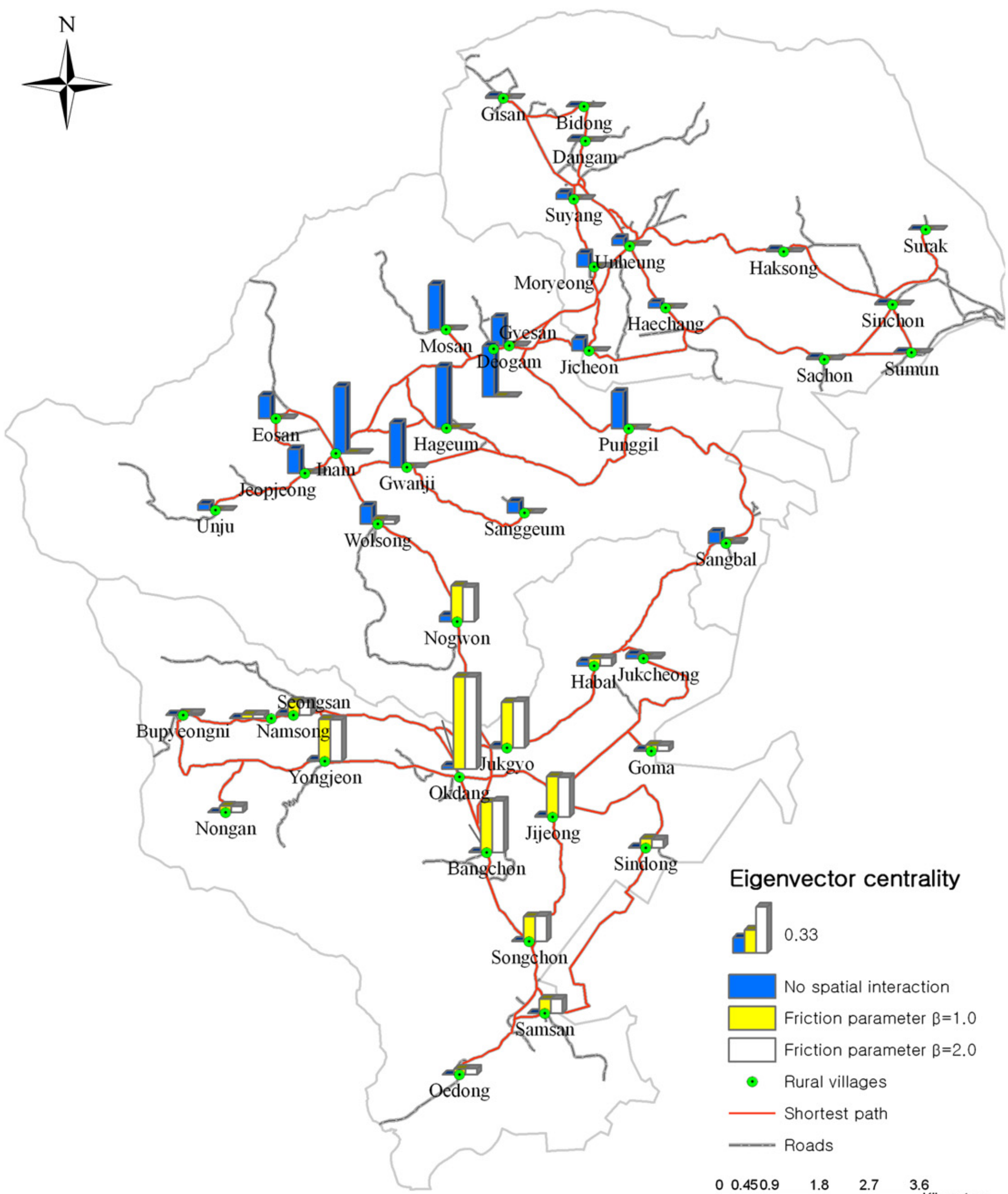

Fig. 6. Results of eigenvector centrality.

Table 3
Results of spatial centrality analysis when the number of links was applied without link weights.

Villages	Spatial centrality indices			Villages	Spatial centrality indices		
	Degree	Betweenness	Eigenvector		Degree	Betweenness	Eigenvector
Okdang	0.119	0.220	0.021	Gyesan	0.095	0.209	0.366
Bangchon	0.048	0.024	0.006	Gwanji	0.095	0.062	0.319
Jukgyo	0.048	0.060	0.013	Hageum	0.119	0.026	0.442
Yongjeon	0.071	0.074	0.010	Mosan	0.071	0.000	0.325
Jijeong	0.095	0.167	0.010	Eosan	0.048	0.000	0.165
Nogwon	0.071	0.247	0.042	Deogam	0.095	0.441	0.204
Songchon	0.071	0.056	0.005	Moryeong	0.095	0.250	0.096
Samsan	0.071	0.049	0.002	Jicheon	0.071	0.141	0.085
Namsong	0.071	0.099	0.014	Suyang	0.095	0.136	0.043
Sindong	0.048	0.037	0.003	Haechang	0.071	0.121	0.037
Habal	0.071	0.071	0.032	Unheung	0.095	0.105	0.049
Nongan	0.048	0.015	0.003	Sachon	0.071	0.080	0.013
Goma	0.048	0.114	0.011	Sinchon	0.095	0.053	0.009
Oedong	0.024	0.000	0.001	Haksong	0.048	0.052	0.015
Wolsong	0.048	0.243	0.132	Dangam	0.048	0.023	0.013
Seongsan	0.048	0.031	0.004	Gisan	0.048	0.023	0.013
Jukcheong	0.071	0.132	0.031	Bidong	0.048	0.001	0.006
Bupyeongni	0.048	0.001	0.002	Sumun	0.048	0.000	0.006
Sangbal	0.071	0.232	0.082	Unju	0.024	0.000	0.044
Inam	0.167	0.339	0.484	Sanggeum	0.024	0.000	0.080
Jeopjeong	0.071	0.048	0.174	Surak	0.024	0.000	0.002
Punggil	0.095	0.285	0.264				

Examination of the spatial centralities of each village revealed that Okdang-ri exhibited a very high index value for each centrality category in comparison with the other villages. As a result, it is believed that Okdang-di is capable of acting as the core village in an integrated tourism management that that includes sub-villages connected to the core village that assist with the responsibilities of the core village. Additionally, our results indicate that some of the analyzed villages are well suited to acting as the sub-villages that assist the core village. These villages are directly connected to the core village such that they exhibited a high eigenvector centrality and a high degree of centrality because of their high-level of connectivity to the surrounding villages. In this study, Yongjeon-ri and Bangchon-ri were identified as the representative sub-villages connected to the core village, Okdang-ri. Okdang-ri has an abundance of rural amenity and human resources in comparison with the other villages, and it is close to Yongjeon-ri and Bangchon-ri. Therefore, an integrated tourism route consolidating Yongjeon-ri and Bangchon-ri could be established, and the various tourism resources could also be maintained by the organization centered on Okdang-ri.

In addition, several sub-groups could be constructed in integrated tourism management, and the sub-core villages of these sub-groups could be identified using spatial centralities. The sub-core villages should be located at the center of the surrounding villages and should simultaneously serve as the connection nodes between all of these villages. In this study, villages with a high degree of centrality were classified as the sub-core villages, and these representative villages were Inam-ri and Unheung-ri. Inam-ri is not only located in the center of the surrounding connecting villages, but it is also an important location for connecting the southern and northern regions. Therefore, the integrated tourism plan of the sub-group could be established with Inam-ri as the center. In addition, Inam-ri and Unheung-ri could operate the

Table 4
Results of spatial centrality analysis when spatial interaction was applied as link weights.

Villages	Spatial centrality indices			Villages	Spatial centrality indices		
	Degree	Betweenness	Eigenvector		Degree	Betweenness	Eigenvector
Okdang	0.693	0.220	0.666	Gyesan	0.189	0.209	0.001
Bangchon	0.238	0.024	0.370	Gwanji	0.144	0.062	0.001
Jukgyo	0.211	0.060	0.334	Hageum	0.182	0.026	0.001
Yongjeon	0.244	0.074	0.302	Mosan	0.124	0.000	0.001
Jijeong	0.265	0.167	0.289	Eosan	0.109	0.000	0.001
Nogwon	0.200	0.247	0.255	Deogam	0.149	0.441	0.000
Songchon	0.268	0.056	0.181	Moryeong	0.151	0.250	0.000
Samsan	0.343	0.049	0.105	Jicheon	0.107	0.141	0.000
Namsong	0.184	0.099	0.097	Suyang	0.153	0.136	0.000
Sindong	0.123	0.037	0.063	Haechang	0.215	0.121	0.000
Habal	0.135	0.071	0.055	Unheung	0.248	0.105	0.000
Nongan	0.101	0.015	0.047	Sachon	0.198	0.080	0.000
Goma	0.091	0.114	0.043	Sinchon	0.165	0.053	0.000
Oedong	0.129	0.000	0.042	Haksong	0.097	0.052	0.000
Wolsong	0.086	0.243	0.031	Dangam	0.094	0.023	0.000
Seongsan	0.162	0.031	0.027	Gisan	0.067	0.023	0.000
Jukcheong	0.131	0.132	0.014	Bidong	0.087	0.001	0.000
Bupyeongni	0.136	0.001	0.014	Sumun	0.130	0.000	0.000
Sangbal	0.124	0.232	0.009	Unju	0.067	0.000	0.000
Inam	0.361	0.339	0.006	Sanggeum	0.039	0.000	0.000
Jeopjeong	0.199	0.048	0.002	Surak	0.029	0.000	0.000
Punggil	0.147	0.285	0.001				

Table 5
Classification of strategies for integrated tourism management according to centrality indices.

Types	High-level centrality	Strategy for integrated tourism development	Representative villages
I	All centralities	Core village in the main group	Okdang
II	Eigenvector centrality	Sub-villages assisting the core village	Yongjeon, Bangchon
III	Degree centrality	Sub-core villages in sub-groups	Inam, Unheung
IV	Betweenness centrality	Connection villages between groups	Deogam, Nogwon

organization for maintaining the tourism resources in the surrounding villages because their degree and betweenness are higher than the other villages in the sub-group.

Another strategy for integrated rural tourism involves the connection node with the high betweenness centrality. In this respect, the representative village was Deogam-ri, which is located between the two sub-groups where the first group is centered on Inam-ri and the second group is centered on Unheung-ri. This connection village could be developed as the stepping-stone in the total integrated tourism plan.

4. Summary and conclusions

Rural tourism is an important means of regional economic development because it permits new infrastructure to be developed and helps retain existing amenities. In this study, we analyzed spatial centralities that apply a spatial network and the spatial tourism interaction, which takes into account rural amenity and human resources and the distances between villages. Based on this analysis, we constructed strategies supporting integrated tourism management.

An adjacency matrix that considered the shortest paths between all of the villages was first constructed using a geographic information system (GIS) and was applied as the spatial network structure. The spatial tourism interaction was estimated using a spatial tourism interaction model based on a gravity model, which included various tourism factors and was then considered as the weight of the links in the spatial network. The green tourism potential considered the rural amenity and human resource index of the villages, which were regarded as attraction factors, and the shortest distances among villages were used as friction factors. Using network analysis, three centrality indices, namely degree, betweenness, and eigenvector centrality, were evaluated while applying the spatial tourism interaction as the network flow to identify the degree, accessibility, and influence each village has on the surrounding villages.

This study demonstrates the applicability of centrality indices for evaluating spatial characteristics such as degree, accessibility, and influence on surrounding villages, and it suggests a strategy for integrated rural tourism. The key point of integrated tourism is determining which village is to be the core village and how the villages are to be consolidated.

According to the results, the connectivity among northern villages was better than southern villages when we considered the degree and accessibility through the geographic location. In addition, Inam-ri and Unheung-ri were identified as the core and sub-core village. However, the rural amenity and human resources should be regarded as the main factors for promoting rural tourism effectively, as the advantage of this type of tourism is that the rural area has the incentive to retain its characteristic amenity resources, such as its historic sites and natural landscapes. Consequently, the centrality considering rural amenities could be applied as an important index for integrated rural tourism. When the population, amenity resources and shortest path among villages were considered to evaluate the centrality, the results show that Okdang-ri could be the core village supported by Yongjeon-ri and Bangchon-ri, thereby permitting a more effective provision of services. Inam-ri and Unheung-ri were identified as the sub-core villages of the two sub-groups while Deogam-ri served as the connection node between these groups. In case of Ocdang-ri, the abundant human and amenity resources are influenced on the high-level degree centrality, and the high-level centrality of neighboring villages such as Bangchon-ri and jukgyo-ri is the main reason for the high-level eigenvector centrality. In short, when the various factors of own village and the neighboring villages are considered to evaluate the centrality, the results is different from the case considering only the geographic location and connectivity among villages. Therefore, it is required to apply the human, amenity resources and the distances to the centrality when the integrated tourism plan is established in rural area.

The various strategies for the integrated tourism are established according to the results of the centrality. In case of the main group centering Ocdang-ri, the tourism facility such as accommodation and tourism complex could be established using the abundant human and amenity resources. In case of the sub-group centering Inam-ri, the tourism project connecting the small-scale tourism plan of each village could be established because the connectivity among villages is high despite the small-scale human and amenity resources.

However, the population, amenity resources and distances among villages in only study area are influenced on the results of centralities because the connectivity with external villages is not considered in this study. Accordingly, when there are the wide variations in population or the number of amenity resources, the core village could be identified by the basic databases without the process of evaluation of centralities.

Despite these weaknesses, the degree, betweenness and eigenvector centrality could be applied for the effective integrated tourism management. The degree centrality considers the various factors such as population, amenity resources simultaneously and the eigenvector centrality considers not only own centrality but also centrality of neighboring villages. In addition, the characteristic integrated tourism plan will be established through degree, betweenness and eigenvector centrality. When expanding the integrated tourism plan and cooperating with external villages, the process could be applied to identify the relationships between the existing core village and the external villages.

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