Annals of Tourism Research 80 (2020) 102817

Contents lists available at ScienceDirect

Annals of Tourism Research

journal homepage: www.elsevier.com/locate/annals

A network perspective of knowledge transfer in tourism

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ARTICLE INFO

Keywords:
Knowledge transfer
Network analysis
Tourism destination
Structure of network
Network topology
Western Australia

ABSTRACT

Efficient transfer of knowledge is the prerequisite for innovation and competitiveness of tourism destinations. This paper uses network analysis to examine inter-organizational knowledge transfer in Western Australian tourism. The findings indicate that Western Australian network has low connectivity and is highly centralized around public bodies with a hierarchical pattern. The network also exhibits few reciprocal relationships with limited boundary spanners. The findings improve the understanding of the Western Australian tourism knowledge network, its weaknesses and strengths, which can be used to make policies to have a more efficient and innovative destination. In addition, this research provides a model for future research of how to explore and analyze the inter-organizational transfer of knowledge within a tourism destination.

Introduction

Knowledge is well established as the most critical resource to create sustained competitive advantage in organizations (Grant, 1996; Quintas, Lefrere, & Jones, 1997). For a resource to hold the potential of sustainable competitive advantage, it needs to be valuable, rare, imperfectly imitable and non-substitutable (Barney, 1991). Knowledge can have all these characteristics, but in addition it has the advantage that it can be used simultaneously over multiple locations and is not depleted by use like other resources (Wilcox King & Zeithaml, 2003). In fact, the value of knowledge actually increases as it is used and shared (Takeuchi, 2001). The main goal of knowledge management practices is to use knowledge to gain competitive advantage (Dalkir, 2013).

Cooper (2018) believes that "tourism can clearly benefit from the ideas and practice of knowledge management, particularly in the area of knowledge transfer and knowledge-based innovation" (p. 507). Tourism destinations need to be innovative to maintain competitiveness, and effective transfer of knowledge is the prerequisite for innovation (Baggio & Cooper, 2010; Czernek, 2017; Hjalager, 2010; Zehrer, 2011). Knowledge management can be applied at two levels within a tourism destination: micro or within the organizations, and macro or between the organizations. The macro level is the main challenge of knowledge management in tourism because destinations, as the main competitive units of tourism, compete for tourists against other destinations (Cooper, 2018; Zehrer, 2011). Moreover, tourism is mainly dominated by small and medium-sized enterprises that usually do not have the resources to generate new knowledge and rely on external sources (Brandão, Costa, & Buhalis, 2018). This feature of the tourism industry also intensifies the critical role of inter-organizational knowledge transfer in knowledge creation and, subsequently, innovation. Moreover, tourism has not yet developed the necessary pre-requisites to engage in knowledge management (Cooper, 2018; Czernek, 2017). Some specific features of the tourism industry negatively affect the transfer of knowledge within the destinations, for example, the

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https://doi.org/10.1016/j.annals.2019.102817
Received 31 March 2019; Received in revised form 14 October 2019; Accepted 16 October 2019

domination of small and medium-sized enterprises, the fragmentation and diversity of supply, vocational reinforcers, ownership specificity, lack of trust and collaboration, poor human resources and a lack of measurement of intangible knowledge resources (Cooper, 2018; Czernek, 2017).

This paper uses network analysis to develop an understanding of knowledge transfer within a tourism destination. Theoretically, network 'structural' and 'relational' properties are the main dimensions of social capital theory. Social capital is "the sum of the actual and potential resources embedded within, available through, and derived from, the network of relationships possessed by an individual or social unit" (Nahapiet & Ghoshal, 1998, p. 243). The structural dimension of social capital focuses on the structure of the network (Inkpen & Tsang, 2005; Nahapiet & Ghoshal, 1998). Other factors have also been discussed in the knowledge management literature as influencing the transfer of knowledge, including the nature of knowledge, tacit or explicit knowledge (Polanyi, 1967), knowledge ambiguity (Reed & DeFillippi, 1990), knowledge stickiness (Szulanski, 2002) and the absorptive capacity (Cohen & Levinthal, 1990) of actors involved in knowledge transfer. However, the focus of this paper is on the structural characteristics of the network of knowledge flow.

The rationale for adopting the network perspective is strong and highly relevant. One reason for this is that knowledge cannot be understood, used, managed or examined as an individual substance and set apart from the social interactions and contextual and holistic settings through which it flows (Styhre, 2004). Innovation does not happen in isolation but through a complex network of interactions between different actors (Huggins & Johnston, 2010). The architecture of connections is found to impact on the efficiency of knowledge transfer in the network (Inkpen & Tsang, 2005; Nahapiet & Ghoshal, 1998; Reagans & McEvily, 2003). The second reason is that tourism is a perfect example of a network industry (Scott, Baggio, & Cooper, 2008). The tourism supply structure is fragmented (Scott et al., 2008a), with products developed through collaborations among a range of different sectors and stakeholders (Pavlovich, 2003). Thus, in this paper, we address an intrinsic network phenomenon in an ideal network industry through a network approach.

Despite the acknowledged importance of knowledge management in innovation and the competitiveness of tourism destinations, tourism practitioners, and indeed tourism researchers, have been slow to adopt knowledge management practices (Cooper, 2018; Yiu & Law, 2014). The significance of knowledge management in tourism has started to receive increasing attention in recent years (Cooper, 2018; Czernek, 2017; Hallin & Marnburg, 2008; Zehrer, 2011); however, few empirical studies have examined knowledge transfer within a tourism destination from a network perspective (Zhang, Xiao, Gursoy, & Rao, 2015). The potential contribution of the paper is based on the established premise that tourism organizations are generally reluctant to invest in knowledge and information transfer initiatives to increase their sustainability because they mainly fail to understand that knowledge and information are a vital source of competitive advantage.

This paper reports on a study of the topological characteristics of the knowledge transfer network in Western Australia as a tourism destination. Western Australian tourism is in significant competition with other Australian and international destinations. An efficient network of knowledge transfer within the destination is one of the major underlying factors that can affect the competitiveness of Western Australian tourism. The study helps illustrate the structural patterns and properties of this network and illuminate how the structural properties of the network can affect the transfer of knowledge. A secondary aim of this paper is to compare the structure of the Western Australian knowledge network with the hyperlink network of the destination that was modelled from a previous study (Raisi, Baggio, Barratt-Pugh, & Willson, 2018). This comparison can provide some insights about how web-based networks compare with real social networks within tourism and what their essential differences are.

The findings provide significant practical data for Western Australian destination management organizations and actors to use as the basis to develop strategies towards a more efficient destination network. Moreover, a major contribution of this paper is in relation to the current methodological application of network analysis within the tourism domain. Network analysis is a valid and robust method that can increase our understanding of collaborative structures and the potential knowledge flows that construct them. Despite the increasing applications of network analysis in tourism research, there are yet only a few studies that have used it in the context of knowledge transfer at a tourism destination level.

In the next section, a literature review of previous research on knowledge, knowledge transfer, and networks in tourism is presented. Then, the methods used in the study are explained. This is followed by a report on the results of the study, a discussion and a conclusion.

Knowledge and networks in tourism

Knowledge management is usually perceived as involving four main interrelated processes: creation, storage, transfer and application (Alavi & Leidner, 2001). Knowledge transfer, at the inter-organizational level, is a "process through which one organization learns from the experience and knowledge of another for gaining or sustaining a competitive advantage" (Martinkenaite, 2011, p. 54). Researchers have studied different antecedents of knowledge transfer, such as tacitness (Polanyi, 1967) and stickiness (Szulanski, 2002) of knowledge, absorptive capacity (Cohen & Levinthal, 1990), trust, proximity (Boschma, 2005), network structure (Inkpen & Tsang, 2005; Nahapiet & Ghoshal, 1998), tie strength (Granovetter, 1973) and transfer channels (Daft & Lengel, 1986). These antecedents of knowledge transfer can be broadly grouped into four dimensions: *structural or network properties, relational properties, organizational properties* and *knowledge properties* (Easterby-Smith, Lyles, & Tsang, 2008; Martinkenaite, 2011; Phelps, Heidl, & Wadhwa, 2012). The aim of this paper is to study the *structural* properties of knowledge transfer.

Knowledge management has a well-established body of literature; however, tourism researchers have been slow to adopt a knowledge management perspective within their investigations (Cooper, 2018). Despite the increasing emphases on the significant role of knowledge and knowledge transfer in innovation and the competitiveness of tourism destinations, the application of a knowledge management perspective within the existing research literature on tourism is limited.

The majority of studies that have addressed knowledge management concepts in tourism is related to hospitality (e.g. Hallin & Marnburg, 2008; Marco-Lajara, Zaragoza-Sáez, Claver-Cortés, & Úbeda-García, 2016; Nieves & Diaz-Meneses, 2018) and transfer of knowledge between the research and industry (e.g. Ruhanen & Cooper, 2018; Thomas, 2012; Walters, Burns, & Stettler, 2015). A number of conceptual and review papers have discussed the application of knowledge management in tourism (Cooper, 2015, 2018; Czernek, 2017; Shaw & Williams, 2009). Some studies have addressed more specific issues of knowledge management and tourism, such as absorptive capacity in tourism (Thomas & Wood, 2015), or application of knowledge management models in tourism (Zehrer, 2011), and several studies on innovation in tourism (e.g. Aldebert, Dang, & Longhi, 2011; Hjalager, 2010; Weidenfeld, Williams, & Butler, 2010). Recently, a few studies have also examined transfer of knowledge in tourism (Binder, 2018; Kim & Shim, 2018). They have also considered social capital and networks; however, examining the actual network structure has not been addressed in their approach.

The application of network concepts into tourism, and the use of network analysis, has gained attention among researchers. A literature review of the field can be found in van der Zee and Vanneste (2015). Baggio (2017) also presented a clear state of the art approach in terms of the tourism field. Van der Zee and Vanneste (2015) categorised the applications of network concepts in tourism into the four groups of policy networks, business networks, coopting networks and network configurations.

In recent years, researchers have used network concepts in a diverse range of tourism topics. A few examples, mainly from the last two years, to acknowledge the diversity of areas include policy making (McCleod, Chambers, & Airey, 2018), tourist movements and activity flows (Bendle, 2018; Provenzano, Hawelka, & Baggio, 2018), network configuration of stakeholders' relationships in a tourism destination (Gajdošík, 2015), web hyperlink connections (Raisi et al., 2018), bibliometric studies of tourism research (Ward & Peláez-Verdet, 2018), tourism innovation networks (Brandão et al., 2018), online social media, forums and electronic word of mouth (Provenzano et al., 2018; Williams, Inversini, Ferdinand, & Buhalis, 2017), destination evolution (Pavlovich, 2014), resilience and climate change (Luthe & Wyss, 2016), stakeholders and sustainable tourism (Erkuş-Öztürk & Eraydın, 2010), network dynamics (Kim & Scott, 2018; Provenzano et al., 2018) and the use of exponential random graph models (Khalilzadeh, 2018). These studies have validated a network analysis approach for research studies and indeed within the tourism domain. However, while they established the legitimacy of the approach, they were often focused on specific micro relationships and did not engage with the broader perspective of knowledge flows across whole tourism destinations.

Overall, while this field of study is emergent and divergent, our review of the literature of knowledge transfer and network studies in tourism suggests that there are very few empirical research studies that apply network analysis to study the actual transfer of knowledge between tourism organizations in a destination. Baggio and Cooper (2010) and Del Chiappa and Baggio (2015) used the epidemiological modelling approach and computer simulation to study the transfer of knowledge within tourism destinations. However, the networks they studied were based on the general relationships between the organizations rather than specifically defined knowledge transfer relationships. McLeod, Vaughan, and Edwards (2010) analyzed the structure of knowledge-sharing networks between tourism businesses in a destination. They mainly focused on the analyses of ego networks and formal and informal relationships. Schaffer and Lawley (2012) studied the evolving network of the information flow between stakeholders over the development stages of a conservation park. Their study provides an application of network analysis on evolving networks at different stages; however, the network analyses were left at the level of basic descriptions.

Recognizing the opportunity for a more comprehensive network study across a tourism network, we therefore argue that a study attempting to use a rich variety of network measures to comprehensively examine the topological characteristics of a tourism destination network builds from and advances research understanding in this domain. Moreover, in this study, the network analyzed is the actual network of knowledge and information transfer developed through data collected by a survey. It is also an ideal destination to study since the Western Australian network is well known as one of the most globally isolated and nationally detached in the world. By choosing this focus and method, this study attempted to fill an existing gap in the literature and to produce new empirical evidence to inform academics about the nature of knowledge transfer within tourism networks, and to provide practitioners with knowledge about critical issues that might develop knowledge flows and the capacity for increased innovation and competitiveness.

Research method

In this paper, we report on a study that aimed to *analyze the topological characteristics of the knowledge network of a specific tourism destination*. Thus, network concepts are central to the design, methods and data analysis of the research. We believe our approach is justified, first by the increasing focus on network analysis as a general research approach (Inkpen & Tsang, 2005; Nahapiet & Ghoshal, 1998) resulting from the proliferation of knowledge flows and collaboration strategies in a knowledge-based global economy. Second, this approach is justified by adding to the increasing focus on using such approaches within the tourism domain (Baggio & Cooper, 2010; Del Chiappa & Baggio, 2015; van der Zee & Vanneste, 2015) and developing a nuanced methodology for this domain. Diverse network metrics were used to analyze the network from multiple perspectives to produce an overarching understanding of the structure of the network. For clarity, and to avoid repetition, we have introduced and defined the network metrics in Table 1.

Data were collected from companies, businesses and organizations involved in the Western Australian tourism industry. Western Australia is the largest geographical state of Australia, and it suffers from isolation from other major destinations of the country. The state's tourism has to be very competitive to overcome the natural negative effects of long distances. Western Australian tourism is divided into the five regions of Experience Perth (capital area), Australia's South West, Australia's Golden Outback, Australia's Coral Coast and Australia's North West (Tourism Western Australia, 2009).

An online questionnaire was used to collect the data from February to December 2017. A list of 1000 tourism companies and

Table 1
Definition of network terms and metrics.

Network term	Description and measurement
Clustering coefficient	Clustering coefficient measures the density of ties in a node's neighborhood. When applied to the entire network, it is the average clustering coefficient of all nodes in the network (Barabási, 2016).
Modularity	Modularity is based on the assumption that the number of ties within communities should be larger than the average number of ties between communities (Newman & Girvan, 2004). "The modularity is, up to a multiplicative constant, the number of edges falling within groups minus the expected number in an equivalent network with edges placed at random" (Newman, 2006, p. 8578). Its value ranges from 0 to 1, in which 1 indicates that the network is made of completely separated communities.
Assortativity	Assortativity is the measure of nodes' similarity based on their degree. The assortativity coefficient is basically the correlation between a node's degree and the degrees of its neighbors. It ranges between −1 (disassortative) and 1 (assortative).
Reciprocity	In directed networks, reciprocity shows the tendency of pairs of nodes to form mutual ties between each other (Wasserman & Faust, 1994).
Homophily	Homophily refers to the degree to which pairs of nodes are similar with respect to certain attributes. The External-Internal index, formulated by Krackhardt and Stern (1988), calculates the ratio between external ties (between members of different groups) and internal ties (within groups). It ranges from −1 (completely homophily) to 1 (completely heterophily).
Degree distribution and scale-free structure	Degree distribution is the statistical distribution of the links each node has (degree). "Networks whose degree distribution follows a power law are called scale-free networks" (Barabási, 2016). In other words, this means that a small portion of nodes have many connections (high degree) and the majority of nodes have a few connections (low degrees).
Small-worldness	Small-world networks are "highly clustered, like regular lattices, yet have small characteristic path lengths, like random graphs" (Watts & Strogatz, 1998, p. 440). Based on the measurement formulated by Telesford, Joyce, Hayasaka, Burdette, and Laurienti (2011), the clustering coefficient of the network is compared with that of an equivalent lattice network, and the average path length of the network is compared with that of an equivalent random graph network: $\omega = \frac{L_{rand}}{dL} - \frac{C}{C_{latt}}$. The value ω ranges from −1 to 1; values close to zero indicate small-world properties.
Centrality	Centrality measures identify the most important and critical nodes in the network. The four main centrality measures are: - Degree centrality: The number of direct ties linked to a node (node's degree). - 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.

organizations working in Western Australia was created. The list was developed from a previous research study investigating hyperlinks within the same population (see Raisi et al., 2018) and originated mainly from the Australian Tourism Data Warehouse. The survey was emailed to the organizations in the list, with two subsequent reminders sent after two weeks. Because the units of the analysis were organizations, but the data were collected from individuals, as representatives of the organizations, it was stressed in the information letter and the body of the emails sent out that the respondents needed to be well informed about the contacts and connections of the organization. In a few cases, for the large organizations, more than one survey was completed. While collecting the data, relationship data (relational network data) was gradually imported and the network was created. This assisted the identification of new as well as important organizations in the course of data collection. New organizations were named by the respondents in the survey but did not exist in the first email list. The very central companies in the network who had not responded to the survey were emailed an extra reminder and the new companies were emailed with two reminders. This process continued until all companies were sent reminders and no new company in Western Australia was left in the network who had not been contacted. Finally, 166 valid questionnaires were collected, which resulted in a network with 510 nodes and 1054 ties. Nodes represent the organizations and ties are the knowledge transfer connections between the organizations. All organizations were assigned two attributes, which were collected from their websites: their tourism regions in Western Australia (or national or international) and their tourism sectors. In the following analysis, the term 'tourism region' is used to denote a specific geographical area where tourism enterprises are clustered, while the term 'tourism sector' denotes the grouping of enterprises into specific tourism services, such as accommodation and tours.

Measurement

The questionnaire was designed for a larger subsequent study and aimed to measure four main dimensions of knowledge transfer, those being structural (network) properties, relational properties, organizational properties and knowledge properties. These dimensions encompass the main antecedents of knowledge transfer, such as trust, tie strengths, proximity, transfer channels, absorptive capacity, tacit and explicit knowledge, and knowledge ambiguity. However, the focus of this paper is on the 'structural properties' of knowledge transfer, which examines the structural properties of the network. Therefore, only one question of the survey was relevant and sufficient for the aim of this paper, and that is the network name generator question. Name generators are the questions that ask respondents to name a certain number of actors with whom they have a certain type of relationship (Burt, 1984; Marsden, 1990). The following question was asked to generate the network of knowledge transfer: *"Please list up to 10 tourism organizations (or companies) from which your organization receives information and knowledge regarding your business. Please add their names in order of importance to your organization."*

Short explanations with examples followed the name generator question to add more clarity: "By tourism organization, we mean organizations or enterprises in different sectors of the tourism industry, such as hotels, restaurants, intermediaries, attractions, public tourism bodies, tourism associations ...", and "By knowledge, we mean any data, information, or knowledge regarding your work, such as marketing, management, technology, products, planning ...". This was critical to clarify key terms to improve the validity and reliability of the data collection.

The survey instrument used both the terms 'organizations' and 'companies' to steer respondents towards their relationships with both larger (and often state-based) bodies and commercial tourism organizations. We also applied a broad definition of knowledge in the name generator question and did not distinguish between the two terms 'knowledge' and 'information'. This allowed us to capture a broad range of knowledge-related relationships, which will be used for further analyses beyond the scope of this paper.

The instrument limited respondents to name 10 key knowledge flow relations. While this might be considered restrictive in developing a detailed map of the network, the pragmatic reality of the data collection process validated this decision. The average number of contacts supplied by respondents was five to six, and only 3% of the respondents returned the survey with more than eight contacts.

In addition, the respondents were asked to rank their relations, which required them to select their contacts more accurately. Further, regarding each relationship, several questions (name interpreters) were asked about other dimensions of knowledge transfer, such as type and content of knowledge transferred, type of relationships and channels of transfer used, which would also add to the reliability of the network data.

For data analysis, we utilized a range of network metrics to analyze the network from different perspectives and at different levels. The network metrics are described in Table 1, and this also serves as a detailed explanation of the analytical terms associated with network analysis that will be used subsequently in the findings and discussion when describing the characteristics of the Western Australian network. The software packages used for the analyses were UCINET (Borgatti, Everett, & Freeman, 2002), Gephi (Bastian, Heymann, & Jacomy, 2009) and Networkx (Schult & Swart, 2008).

Results: network structure

In the following paragraphs, the topological characteristics of the network are illustrated. This account starts with a general overview of the network, then moves on to focus on the results of whole network level properties, such as degree distribution, scale-free structure and hierarchical structure. Next, the network is analyzed at a deeper level, focusing on the cluster or sectoral level. Finally, the results of the individual level are presented. For clarity and to avoid repetition, network terms and metrics used in this paper are defined in Table 1.

The network is directed: respondents were asked to name the organizations from whom they receive information and knowledge.

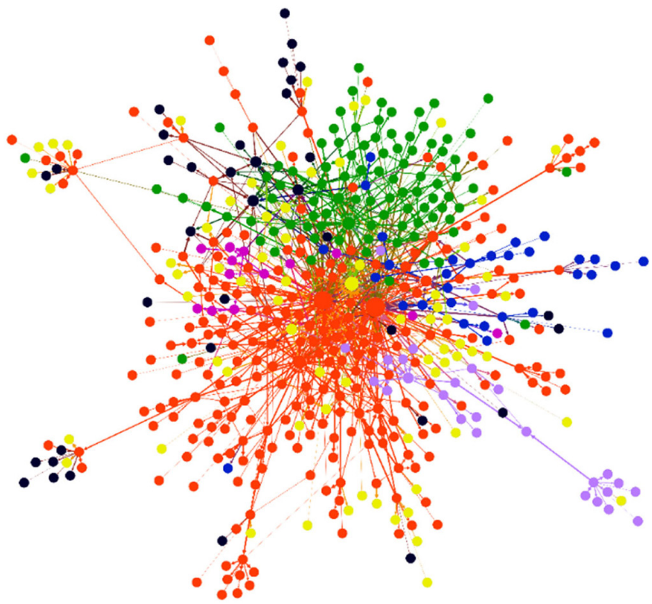

Fig. 1. Western Australian tourism knowledge transfer network.

Table 2
Network global properties.

Network properties	Value
Type of network	Directed
Nodes	510
Edges	1054
Connected components	1
Average degree	2.067
Density	0.004
Average path length	3.079
Diameter	8
Average clustering coefficient	Directed: 0.07 (undirected: 0.25)
Assortativity	In-in: −0.043, Out-out: −0.121
Modularity	0.516
Number of communities	16
Reciprocity	0.032
Small-world property	ω = 0.029

The network is visualized in Fig. 1 and a summary of the network properties is presented in Table 2. The network has 510 nodes and 1054 ties forming one giant connected component. The network is extremely sparse with the density of 0.004, which means out of 1000 potential knowledge transfer ties, only four ties are actually present in the destination network.

Degree distribution shows the probability distribution of nodes' degree over the network. The degree distribution shapes the defining characteristics of network structure and affects the transfer of knowledge (Zhang et al., 2016). Fig. 2 shows the *in-degree distribution* (log–log cumulative plot) of the network. The distribution plot (Fig. 2) is close to a straight line and the in-degree distribution exponent alpha is 2.089. These two components of the evidence confirm the power-law nature of the distribution. Power-law distribution of the network shows that the network follows a *scale-free structure*, which means a large number of organizations receive information and knowledge from a few but highly central organizations. Airline networks and World Wide Network are examples of scale-free networks (Barabási, 2016). In the visualization of the network (Fig. 1), a small number of hubs and the majority of periphery organizations can be easily seen. The scale-free structure was also reported in the hyperlink network of Western Australian tourism (Raisi et al., 2018).

The *clustering coefficient* of the network is 0.25 (undirected). Clustering coefficient is a local density indicator and the result means that on average, 25% of all the links within the neighborhood of an organization in the network are actually present. The coefficient can loosely indicate that the average probability that a Western Australian tourism actor could be involved in some kind of knowledge collaborative group is 25%. Compared with the clustering coefficient of the equivalent random graph (0.009), this network is relatively highly clustered. This means that destination actors tend to collaborate particularly closely with similar actors; their specific formation will be analyzed further in this section.

As part of a scale-free network family, when a network has two structural properties of power-law degree distribution and a high clustering coefficient together, it can also have a *hierarchical* structure (Ravasz & Barabási, 2003). As shown in earlier paragraphs, the network demonstrates these two properties. Fig. 3 provides the plotting of the log–log distribution of clustering coefficient against the

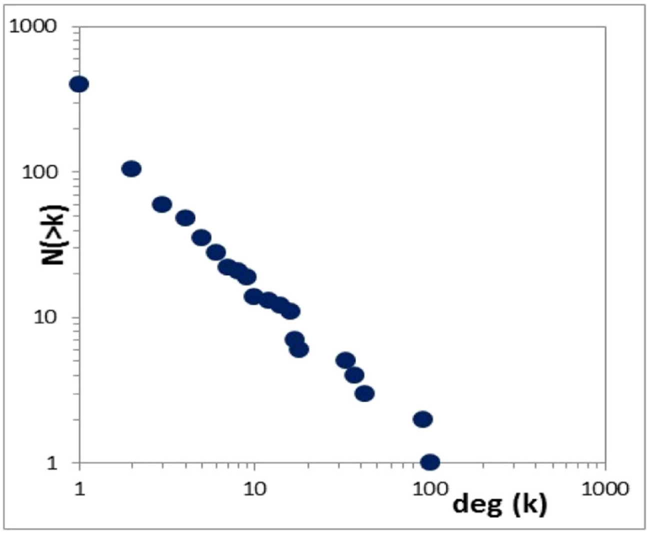

Fig. 2. Log–log cumulative in-degree distribution.

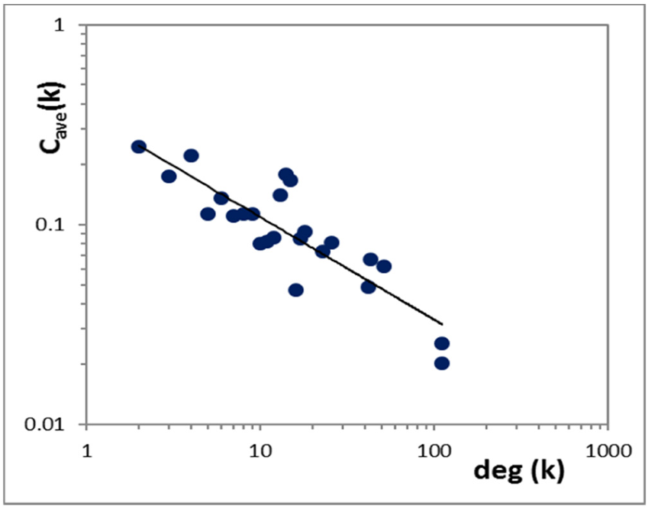

Fig. 3. Hierarchical structure – log–log clustering coefficient distribution by degree.

degrees of nodes. The distribution, drawn on a log-log plot, is close to a straight line, which confirms the power-law shape and thus the hierarchical structure of the network. This suggests that the Western Australian tourism industry is composed of a limited number of highly centralized hubs and a large number of poorly connected actors who receive their knowledge through a hierarchical structure from those hubs.

So far, the results show that the network is scale-free, relatively highly clustered and hierarchical. Another important structural property of an information and knowledge network can be small-worldness (Watts & Strogatz, 1998). The analysis indicates that this network shows high small-world properties ($\omega = 0.029$). Small-world networks are associated with efficient information transfer because, owing to the short distances between actors, knowledge and information can spread quickly in the network.

Further analysis at the global network level was conducted to examine the *assortativity* mixing of the network. Assortativity analysis can show the tendency of nodes to connect to similar degree nodes in the network. The result shows that the assortativity coefficient *r* is close to zero (in-in: -0.043, out-out: -0.121), indicating that the network is non-assortative, which means there is no evidence that similar degree nodes connect each other.

Since this network is directed, we also examined the *reciprocity* of the network to measure the extent of mutual transfers between the organizations. The reciprocity was extremely low: only 3% of actors had reciprocal relationships. Thus, senders and receivers have one-way relationships, and only in 3% of relationships knowledge flows both ways. Reciprocal knowledge transfer collaborations can enhance the trust and strength of relationships and facilitate the knowledge flow within the network (Mu, Peng, & Love, 2008).

So far, the network has been explored at the whole network level. However, real networks are usually formed from smaller communities or clusters. As indicated earlier, the Western Australian network is relatively clustered. We extended this to discover the communities within the network and consider the causes behind the formation of communities within the available data. We used *modularity* (Newman & Girvan, 2004) analysis to detect the communities. Modularity for this network was 0.516, which is relatively high, and 16 communities were detected. We used the Rand index to see if the identified communities were formed based on the tourism sectors or regions of the organizations. The Rand index (Rand, 1971) is a similarity measure, and its results did not show strong evidence that network communities are formed based on these two attributes of tourism regions and sectors (module–region: 0.066, module–sector: 0.053).

Additionally to the modularity analysis, we performed *homophily* analysis to better understand community formation in the network. Results (Table 3) showed that tourism organizations had more tendency to transfer knowledge with organizations in their geographical regions than those in similar tourism sectors. Tendency to connect to geographically proximate organizations was relatively strong in three regions, those being the regions from which we obtained the main data (about 90% of respondents). However, the results based on tourism sectors showed very strong heterophily for all sectors, demonstrating that organizations working in a tourism sector do not prefer to connect and transfer knowledge and information with each other. These results are similar to those found in a recent Western Australian tourism hyperlink network study (Raisi et al., 2018).

Moving forward to the individual level of analysis, we calculated an importance index based on the geometric mean of normalized values of four *centrality* measures of in-degree, closeness, betweenness and eigenvector. In-degree is preferred over the degree and out-degree because the purpose is to show the important organizations that peripheral enterprises contact to receive knowledge. Table 4 shows the top 30 important organizations in the network. The most important organizations of the network are located in the Experience Perth region (20 nodes), as expected, because this is the capital region of the state and it has a larger population in the network. There are also four national organizations in the list, of which three are public tourism bodies. Important organizations of the network in terms of tourism sectors are among the information services (8 nodes), public tourism bodies (7 nodes), tourism associations (6 nodes) and regional tourism organizations (4 nodes).

Table 3
Homophily analysis— external-internal index based on tourism sector and region.

External-internal index based on tourism sector			External-internal index based on tourism region		
Sector	Number of nodes	External-internal index	Region	Number of nodes	External-internal index
Whole network	510	0.715	Whole network	510	−0.149
Accommodation	96	0.558	Experience Perth	240	−0.417
Attraction	48	0.569	Australia's South West	92	−0.212
Event	24	0.770	Australia's North West	27	−0.205
Hire	2	1.000	Australia's Coral Coast	31	0.200
Information services	60	0.670	Australia's Golden Outback	13	0.163
Intermediary	27	0.358	National	71	1.000
Local tourism organization	2	1	International	36	1.000
Others—non-tourism	73	0.921			
Other tourism services	23	0.873			
Public tourism body	21	0.817			
Regional public body	33	0.923			
Restaurant	17	0.444			
Regional tourist organization	4	0.895			
Tour	48	0.691			
Tourism association	23	0.768			
Transport	9	1			

Table 4
Important organizations in the network.

Rank	Organization ID	Importance index	Region	Sector
1	2	0.438	Experience Perth	Public tourism body
2	1	0.411	Experience Perth	Public tourism body
3	3	0.247	Experience Perth	Regional tourism organization
4	18	0.217	Australia's South West	Regional tourism organization
5	16	0.174	National	Public tourism body
6	5	0.141	Experience Perth	Tourism association
7	119	0.125	Australia's South West	Tourism association
8	17	0.121	Experience Perth	Tourism association
9	15	0.110	National	Public tourism body
10	122	0.107	Experience Perth	Tourism association
11	20	0.106	Experience Perth	Regional tourism organization
12	343	0.103	Experience Perth	Public tourism body
13	58	0.097	Experience Perth	Information services
14	13	0.092	Experience Perth	Tourism association
15	75	0.092	Experience Perth	Information services
16	59	0.089	Experience Perth	Regional public body
17	44	0.081	National	Public tourism body
18	90	0.081	Experience Perth	Tourism association
19	42	0.079	Experience Perth	Local tourism organization
20	0	0.078	Experience Perth	Public tourism body
21	21	0.077	Experience Perth	Regional public body
22	196	0.074	Experience Perth	Information services
23	288	0.055	Experience Perth	Information services
24	142	0.053	Australia's South West	Information services
25	121	0.050	Australia's Coral Coast	Information services
26	130	0.048	Australia's Coral Coast	Information services
27	98	0.047	Experience Perth	Tour
28	74	0.046	Experience Perth	Information services
29	43	0.046	National	Others—non-tourism
30	19	0.040	Australia's North West	Regional tourism organization

Boundary spanners

Previously, we showed that the network is homophilous in terms of geographical regions, but heterophilous in terms of tourism sectors. However, at the individual level, those organizations who connect their region, sector or Western Australia to external sources of knowledge can be viewed as boundary spanners. Boundary spanners are those individuals or organizations that link their organization or community to external sources of knowledge.

In this network, we defined two types of boundary spanners: regional boundary spanners, who join the gaps between geographical regions (regions, national, international), and industry sector boundary spanners, who join the gaps between tourism sectors, such as connecting sectors of events and accommodation.

We identified 131 regional boundary spanners, which used 443 ties to link to external regional, national or international actors. Among 443 ties, 41% (182 ties) were inter-regional, with 38% (169 ties) national, while the remaining 21% (92 ties) were international. About 79% of all the regional boundary spanners were in the regions of Experience Perth (50 nodes) and South West Australia (29 nodes). Further, among the regional boundary spanners, the majority worked in the accommodation sector (36%) and tours sector (15.27%). Significant boundary spanning was also performed by operators within both the information services sector (13%) and the attractions sector (8.40%). Regional boundary spanning was thus led by the core regions of the network, and by the accommodation and tours sectors.

When analyzing the tourism sectors, 165 boundary spanners were identified. However, 165 sector boundary spanners held 904 ties, which is very close to the whole number of ties in the network. The reason for this, as shown in the homophily analysis, is that the nodes in this network tended not to link to organizations in their own type of industry actor. Therefore, the majority of links were made with other sectors of the industry; in another words, companies and organizations in the network received their knowledge from other sectors. Most sector boundary spanners (77.5%) were among accommodation, tours, information services and attractions. Thus, an accommodation enterprise was far more likely to network with a tour or catering enterprise than with any other accommodation enterprises; however, this would not occur in another region but within their own region.

Discussion and conclusion

In this paper, we have analyzed the topological characteristics of the knowledge transfer network between tourism actors in Western Australia. The results provide a clear image of how information and knowledge flows within this destination. The first noticeable and significant characteristic of this network was its very low connectivity. According to cohesion theory (Coleman, 1988), dense networks help build trust and improve cooperation. Higher density provides network actors with more opportunities to communicate with other members (Wei, Zheng, & Zhang, 2011) and serves to overcome transfer impediments and ease transfer of knowledge (Reagans & McEvily, 2003). However, too much density can also lead to knowledge redundancy (Uzzi & Spiro, 2005) and cognitive lock-in (Grabher, 1993). A trade-off between structures is needed to secure the cooperation and efficient transfer of knowledge and flexibility (Gargiulo & Benassi, 2000). There is no stablished ideal density cut-off point to advise; however, the current density of Western Australian network is extremely low. Density results indicated that out of 1000 potential links, only four links are existing in the network. It should also be considered that this network does not include all the actors of the destination and increasing the number of nodes would make it even sparser. Thus, it can be safely advised that the connectivity of the destination network needs to be significantly improved. This study also provides more evidence that low density appears to be a feature of tourism networks (Baggio, 2007; Del Chiappa & Baggio, 2015; Grama & Baggio, 2014; Scott, Cooper, & Baggio, 2008). Low density leaves enterprises with limited connections, limited knowledge exchange and therefore less resources for innovation, which weakens the competitiveness of the overall destination.

Despite low connectivity, the network has a relatively short average path length and diameter. Small network distances between the actors increase the speed and efficiency of knowledge transfer in the network (Cowan, 2005). Moreover, the network shows small-world properties, which as indicated in some studies is indicative of a suitable structure for quick transfer and diffusion of information and knowledge (Cowan & Jonard, 2004; Morone, Morone, & Taylor, 2007).

Further analysis showed that the network is highly centralized around a small number of organizations, and the centralization has a hierarchical pattern. The hubs are mainly public tourism bodies and regional destination management organizations. This indicates that destination management organizations have rightly established their positions in the network, and the majority of organizations in the destination relies on them for their knowledge and information needs. However, there is limited knowledge cooperation between other enterprises and organizations (other than destination management organizations). This gap in the Western Australian network is clearly shown in this research, which calls for increasing knowledge collaborations between different actors of the destination. Many real networks exhibit scale-free properties including some tourism related networks such as airport networks (Guimera & Amaral, 2004), inter-firm networks within destinations (Aarstad, Ness, & Haugland, 2013; Scott, Cooper, & Baggio, 2008), tourism flow (Bendle, 2018), websites of a tourism destination (Raisi et al., 2018), and destination's electronic word of mouth network (Williams et al., 2017). Some studies confirm that scale-free structure or existence of highly central hubs in the network accelerate the transfer and diffusion of knowledge within the network (Qiao, Shan, Zhang, & Liu, 2019; Tang, Mu, & MacLachlan, 2008). Hubs have fast and close access to many actors in the network and this can improve the speed of diffusion of knowledge. However, high centralization can impede access to diverse and new sources of knowledge because the knowledge sources are limited to a few hubs. Moreover, centralized networks depend on a small number of organizations, and their loss or lack of functionality can affect the performance of the whole network. In particular, the results indicated that the Western Australian network is not assortative. Assortativity improves the robustness of the network as removing a high degree node will not affect the network dramatically, because hubs can function as back-up to each other (Thedchanamoorthy, Piraveenan, Kasthuriratna, & Senanayake, 2014). Identification of such centralized and hierarchical structures as well as central actors would give Western Australian destination management organizations more realistic insights into the underlying structure of relationships and knowledge flows within the destination. Depending on the goals and policies of the destination, this can help in planning and devising appropriate strategies to change and decentralize the network structure or maintain and strengthen the current centralized structure. In addition to identifying the overall structure of the network, the structural importance of all actors in the destination network was measured and the top 30 important organizations were reported. This can help destination management organizations better identify the important and neglected or potentially vulnerable actors of the destination and plan to improve the structure of the network.

The results showed that tourism organizations and companies in Western Australia tend to create regional clusters and connect to geographically proximate organizations. Considering the large geographical size of the destination, this could be due to local and regional collaborations and partnerships. Creating dense cohesive regional clusters can improve the collaboration, trust and transfer of knowledge between the organizations (Fritsch & Kauffeld-Monz, 2010; Reagans & McEvily, 2003). However, it is often access to external and new knowledge that is believed to improve innovation and competitive advantage. Western Australian tourism needs more links to connect the regional clusters to external sources of knowledge. The destination was found to have few numbers of boundary spanners. A very small portion of knowledge transfer collaborations link Western Australia to international tourism organizations (9%), but more ties connect the destination to national (16%) and regional (17%) organizations. Identifying these boundary spanners can be important for the management of the knowledge network. This can be another important area on which Western Australian destination management organizations can focus to improve. This will help educate, encourage and provide premises for the engagement and collaboration of Western Australian tourism with external partners. Boundary spanners can be source of new knowledge and innovative ideas that can be diffused to the rest of the network. However, despite their significance, boundary spanners might have a poor structural position in the network, and thus their identification could help the destination management organizations to consider them and intervene to improve their involvement in the network.

Western Australian tourism organizations also have few reciprocal relationships. This may be due to the lack of mutual trust or a highly competitive market. Lack of mutual ties may also be partially the result of the hierarchical structure of the network, with most companies receiving their knowledge from a limited number of hubs and relying on these authoritative links. These hubs are mainly tourism public bodies, regional tourism organizations and tourism associations. Most tourism actors in the destination are small and medium-sized enterprises that are not rich enough in knowledge resources to be able to satisfy the knowledge needs of similar organizations. Thus, knowledge flows one way in the destination, from hubs to a large number of less central actors. Therefore, mutual knowledge collaborations and trust need to be encouraged and developed within the destination. Decentralization of the network can also lead to more reciprocal relationships in the network.

In comparison with a previous study of the destination, the knowledge network of Western Australian tourism shows very similar topological properties to the hyperlink network of the destination (Raisi et al., 2018), although not with the same strength, which is probably due to the smaller size of the knowledge network. Both networks have several similar characteristics, with both having low density and reciprocity, both having scale-free, hierarchical and small-world structures, and both having high modularity and homophily based on geographical proximity. Therefore, this study can provide further support to the ideas suggesting that web networks can potentially mirror and represent the real networks (Baggio & Del Chiappa, 2014; Del Chiappa & Baggio, 2015). This is significant evidence to support and confirm these existing assertions in the literature. Results also indicate that Western Australian tourism should pay more attention to the hyperlink network of the destination, since beyond its online significance and usefulness, it can also represent the offline relationships, especially given hyperlink networks are less costly to study. Thus, the findings of this study contribute to theory building in this area by confirming that within tourism networks, web networks mirror, reflect and coexist with the actual relations and knowledge flows between actors within those destinations.

This paper has provided more evidence and support for the usefulness of network analysis application to study tourism destinations. The characteristics of the Western Australian tourism knowledge network, such as scale-free and hierarchical structures, high modularity and small-worldness represent features of complex networks (Baggio, 2008; Boccaletti, Latora, Moreno, Chavez, & Hwang, 2006). These features indicate that formation of the network has not happened randomly and there are some underlying patterns and rationale for the structural characteristics of the network. These structural features require, first, a set of complex methods, such as network analysis, to explore, analyze and understand them, and second, some managerial understanding, approaches and interventions to improve the structure of the destination network. Determining the specific characteristics of the network through network analysis and understanding what they indicate about the tourism network in general and the potential for improving this specific network has been a significant production of this study.

This study has explored structural properties of the network, while recognizing that they are only one of several factors influencing the transfer of knowledge. We acknowledge that this study, in endeavoring to use network analysis to analyze tourism destinations and their knowledge flows, has limitations. A comprehensive study of knowledge transfer needs to examine a broader range of knowledge transfer dimensions, such as the properties and nature of knowledge, the capabilities of organizations to send and receive the knowledge, and the quality of relationships within the network. An ideal comprehensive study would consider all these aspects together and provide a more holistic view of the efficiency of knowledge transfer in a destination. Moreover, the topological analysis that has been completed in this paper clarifies the characteristics and the weaknesses and strengths of the network but does not provide an overall quantified efficiency measurement for the network. Future research could develop new methods to measure the efficiency of a tourism destination network in transferring knowledge.

Another research area that could be deepened and expanded in terms of analyzing a tourism knowledge network is boundary spanners. Beyond identifying these, further analyses can illustrate their structural positions in the network and show how their position could be improved to benefit the network. It should also be noted that in this research static measures were used to assess a dynamic process of knowledge transfer. The results provided a ‘snapshot’ of the current situation in the destination. Future studies are encouraged to examine the dynamics of knowledge transfer networks in tourism destinations, with the option of using a supporting qualitative approach to obtain details of how knowledge flows and is restrained between and within organizations. Finally, the relatively small sample of the study poses some limitations. Although the network encompasses the main actors of the destination and the topological properties of the network proved similar to the hyperlink network of the destination, a larger sample would yield more reliable and robust results.

While there are always opportunities for advancing knowledge with further research, this study is among the first in its depth and scale to use network analysis to study knowledge transfer in a tourism destination. Using an extensive application of network analysis, this paper presents a comprehensive empirical example of how to study the structural properties of the knowledge network in a tourism destination. In addition, the study provides significant information for the enterprises and public bodies within the specific Western Australian network. Practitioners and destination management organizations can apply this method to explore and analyze the knowledge flow of a destination to have a better understanding to improve the policy decisions and management of the destination.

Declaration of competing interest

None.

Acknowledgements

Rodolfo Baggio acknowledges the financial support of the Ministry of Education and Science of the Russian Federation in the framework of the Competitiveness Enhancement Program of the Tomsk Polytechnic University.

Author contributions

Hossein Raisi: Conceived and designed the analysis; Collected the data; Contributed data or analysis tools; Performed the analysis; Wrote the paper.

Rodolfo Baggio: Contributed data or analysis tools; Performed the analysis; Wrote the paper.

Llandis Barratt-Pugh: Conceived and designed the analysis; Collected the data; Wrote the paper.

Gregory Willson: Conceived and designed the analysis; Wrote the paper.

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