Increasing the efficiency of knowledge transfer in Italian tourism system: a network approach

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Abstract
Efficient transferring information and knowledge play a fundamental strategic role in a tourism system. This is especially important in critical times where efficient collaboration practices and a fluid flow of ideas is essential for the performance and the growth of the entire tourism industry. Here we use the methods of network science for increasing our awareness of the different collaborative structures and the potential information and knowledge flows across them. Intermediaries play a fundamental strategic role for the whole tourism domain and the good functioning this system is crucial for the social and economic development of tourism activities. The paper builds on previous research on the subject and takes as unit of analysis the Italian travel agencies and tour operators. Numerical simulations allow to build scenarios that improve the understanding of the Italian tourism intermediaries knowledge network and can be used to devise policies that tend to a more efficient and innovative functioning of the sector. The findings show how even limited structural changes in the system sensibly improve its efficiency and the capability to exchange information and knowledge.

Keywords: Knowledge transfer, network science, network analysis, Italian intermediaries, travel agencies, tour operators.

1. Introduction

A significant number of works involved in the study of network interrelations have agreed in recognizing the knowledge nature of networks and its relationship in terms of competitive success. Networks, in fact, provide firms with access to knowledge, resources, markets, or technologies. The present paper focuses on networks and how firms acquire knowledge through their positions within a network. (Nonaka, 1994; Baum et al., 2000; Dyer & Nobeoka, 2000; Gupta & Govindarajan, 2000; Nishiguchi, 1994).

Knowledge transfer, cultural variables and social embeddedness are fundamental elements of international competitiveness for leading countries and encourage a renewal of capitalism favoring a 'knowledge economy' (Dayasindhu, 2002; Tödtling et al., 2006; Uzzi, 1996). Knowledge is well

established as the most critical resource to create sustained competitive advantage in organizations (Grant, 1996; Quintas et al., 1997; Nieves & Diaz-Meneses, 2018). For a resource to hold the potential of sustainable competitive advantage, it needs to be valuable, rare, imperfectly imitable and non-substitutable. 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). Tourism is essentially a service industry and its administration processes are mainly centered on the ability and capability of the information and knowledge exchanges taking place among the several institutions cooperating to provide composite products (Otto & Ritchie, 1996). In this regard, one could claim that in the international tourism field, the competition to draw a larger number of users is among destinations and not among tourist organizations. (Ritchie & Crouch, 2003). 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 et al., 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; 2019). Some specific features of the tourism industry negatively affect the transfer of knowledge within the destinations, for example, the 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; 2019; Éber et al., 2018).

Although rigorously information and knowledge are to be considered different concepts, well defined in the literature (see e.g. Zins, 2007), in what follows we use the two terms indifferently meaning with them the exchange of concepts, ideas, approaches or methods that refer to the activities of the companies examined. Being mostly interested here in the structural features that affect the transfer process, the actual nature of what is exchanged is relatively inconsequential.

Although a good number of studies have examined these issues in a wide variety of domains (Barrat et al., 2008; da Fontoura Costa et al., 2011; Raisi et al., 2019; van der Zee & Vanneste, 2015), only a very few, to our knowledge, have approached the question of how to modify and improve a given situation for increasing the efficiency of the exchanges in order to provide the whole system and the individual actors a more fluid flow of ideas. here, through the analysis of the case discussed, we mainly contribute with a methodological approach that can allow fulfilling the objective of creating scenarios able to attain the desired level of efficiency.

The aim of this paper, as said, is the system of Italian tourism intermediaries (travel agencies and tour operators). The choice of such a representative unit is due to the strategic role played by travel agencies within the national and international tourist system. The paper builds on previous research on the subject (Valeri & Baggio, 2020a)

The paper is divided in three parts: the first part focuses on a review of previous research on knowledge, knowledge transfer, and networks in tourism. Then, the methods used in the study are described. The following section focuses on a study of the topological characteristics of the knowledge transfer network in the Italian tourism intermediaries sector and on the modifications for improving its efficiency. The study helps illustrate the structural patterns and properties of

this network and clarify how the structural properties of the network can affect the transfer of knowledge. Results, discussion and conclusions close the paper.

2. Literature review

Knowledge transfer

Our interest is focused on the circumstances that facilitate knowledge transfer in networks. In other words, we aim at surveying the path by which the experience of one network participant can affect the experience of another participant.

In a context where the amount of research and studies is continuously increasing and evolving, scholars assert that organizations implementing the knowledge transfer in an effective way across their organizational units are more performing if compared to those that are not able to transfer knowledge (Argote et al., 1990; Almeida & Kogut, 1999; Baum & Ingram, 1998; Hansen, 2002; Kostova, 1999). New knowledge, especially knowledge from outside the firm, represents a significant inspiration for renovation and organizational upgrade. Within the particular framework of network, Kotabbe, Martin and Domoto (2003) recognized that knowledge transfer between network firms could lead to organizational advantages.

According to the vision of Gupta and Govindarajan (1991), the MNC can be considered as a network of financial resources, goods and knowledge transactions among organizations that do not operate in the same country. They also argue that "the primary reason why MNCs exist is because of their ability to transfer and exploit knowledge more effectively and efficiently in the intracorporate context than through external market mechanisms" (Gupta & Govindarajan, 2000, 473).

According to the type of transaction and depending on whether the subsidiaries act as receivers or providers of the transaction, the extent of their engagement in intra-corporate dealings may differ. Gupta and Govindarajan (2000) further maintain that MNCs exist primarily because of their superior ability to transfer knowledge internally, relative to the ability of markets.

In terms of strategic alliance, the transfer of knowledge can be analyzed according to various viewpoints. Firstly, organizations may achieve knowledge able to help design and manage future alliances (Lyles, 1988). Such collaborative expertise may be useful to manage further alliances.

Secondly, organizations may achieve knowledge about an alliance partner that promotes the organization's capability of managing the collaborative activity. Such new knowledge can be fundamental for the progress of the alliance (Arin˜o & de la Torre, 1998; Doz, 1996).

Thirdly, when partners jointly get into a new business sector and acquire new skills, organizations learn from the alliance partner.

Regarding the last point, organizations achieve knowledge from an alliance partner by obtaining admission to the expertise and capabilities the partner offers to the alliance. (Baum et al., 2000; Kogut, 1988). In such framework, alliances bring opportunities to develop reusable knowledge (or private advantage), including for example technical or market knowledge.

According to the aim of our study, we will concentrate on the last two viewpoints that focus on the flows of knowledge among alliance partners.

Many recently released studies about industrial districts have highlighted their ability to promote processes of knowledge achievement and innovation as the keystone for the creation of

a competitive advantage (MacKinnon et al., 2002). Firms in an industrial district have various opportunities to tap into a larger knowledge resource base.

The knowledge of primary interest is usually highly tacit, difficult to replicate, and not easily purchased. Geographic proximity facilitates knowledge flows and technical ex- changes among firms (Marshall, 1920). According to Keeble and Wilkinson (1999), we can distinguish three main techniques for the special transfer of knowledge inside the boundaries of an industrial district: (1) inter- organization mobility of human resources inside the district; (2) relationships between dealers and consumers and makers and users of capital goods; (3) spin-off of new businesses from existing businesses, colleges and public research laboratories. The processes of the transfer of knowledge that take place in an industrial district lead to combined expertise that far exceeds the borderlines of the business but that keeps staying inside the borderlines of the district (Capello, 1999; Inkpen & Tsang, 2005).

Networks

There are to date, only a small number studies on knowledge management across destination networks (Baggio, 2007; da Fontoura Costa & Baggio, 2009; Scott et al., 2008a; Scott et al., 2008b; da Fontoura Costa, 2011; Xiao & Ying, 2011; Kim & Scott, 2018). However, recognition of the significance of the approach is growing as practitioners recognize the value of knowledge sharing not just within the organization, but also through networks, and in particular the encouragement of partnerships within destinations.

Currently a new way of thinking is arising, that recognizes that "sharing is power" and pushes to develop "communities of knowledge" within a destination. Actually, among the various economic fields, tourism is where formal and informal cooperation, partnership and network are the most essential and fundamental to perform. Tourism has emerged as the economic field in which these issues have a high relevance. A significant quantity of tourism literature on these topics is available on the discussion of partnerships and collaboration (Bramwell & Lane, 2000; Hall, 1999; Selin, 2000; Selin & Chavez, 1995; Sarkar et al., 2021) and networking (Copp & Ivy, 2001; Halme, 2001; Tinsley & Lynch, 2001; Tyler & Dinan, 2001; Albrecht, 2013; Ying et al., 2016).

As a matter of fact, one school of thought on tourism analyzes tourism (Leiper, 1990), destinations (Carlsen,1999) and market niches (Scott & Laws, 2004) as an entity of linked elements. Looking at destinations as networks, and more broadly as multifaceted variable structures (Baggio, 2008), makes it possible to carry out studies through tools like the network science (Barabási, 2016; Watts, 2004; Arcese et al., 2020; Elmo et al., 2020).

A social network is a definite set of connections amongst a certain group of actors (whether individuals, groups or organizations), with the extra peculiarity that allows the features of all these connections to be utilized to read the social behavior of the parties concerned (Mitchell, 1969; Hong et al., 2015). Several important results come from network science. It offers a tool of viewing and simplifying the tangled sets of relationships and accordingly helps improve fruitful cooperation in a group, promoting decisive junctures in networks that pass over functional, hierarchical, or geographic borders; and providing integration among groups pursuing strategic reorganization actions (Cross et al., 2002). Lately, this investigation approach has been used for the analysis of tourism industry, contributing with significant observations (Baggio, 2007; Scott et al., 2008a; Scott et al., 2008b; Baggio et al., 2010).

A stakeholder is another key concept that has to be taken into consideration when studying destinations as networks of organizations. Stakeholders are all those subjects who are involved for various reasons in a system. The term refers to any individual, group or entity that plays a role in a development operation, project or plan. This interpretation comprises designated beneficiaries and intermediaries, winners and losers, and those interested or excluded from the managerial proceedings (SDI, 1995). Stakeholder theory, developed by Freeman (1984) states that an organization is outlined by its interrelations with different bodies and single persons, including workers, customers, vendors, citizens and public administrations.

The flows of information and knowledge in a destination system are considered a significant factor for the overall behavior of the network (Ye & Law, 2013; Williams et al., 2017). The progress of innovation, the increase of productivity, and the development of economy are heavily affected by these mechanisms. In addition, how the process of their spreading takes place can influence the pace at which single operators perform and organize their expected actions at the destination. Specifically, the architecture of the network will have an impact in defining the effectiveness of the destination's efforts to innovate and make knowledge available and hence keep being competitive (Argote & Ingram, 2000; Baggio & Cooper, 2011).

In this sector the literature has worked on two main points: the techniques and the methods of gaining knowledge within single stakeholders (e.g. enterprise, society or organization) and the spreading within the destination network composed by more than one group of stakeholder, according to their analogies (e.g. industrial clusters) or their geographical position (Baggio & Mariani, 2019).

Theoretically, network 'structural' and 'relational' properties are the main dimensions of social capital theory (Nahapiet & Ghoshal, 1998). 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. 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; Raisi et al., 2019). The second reason is that tourism is a perfect example of a network industry (Scott et al., 2008a; Scott et al., 2011). 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).

The destination network comprising different stakeholders and their formal and informal interrelations has a topology that has demonstrated its key role when presenting the techniques by which ideas, information and knowledge move, or better yet 'travel', through the elements of the system, from one to another (Chen & Hicks, 2004; Da Costa & Terhesiu, 2005; López-Pintado, 2004; Valente, 1995).

Social networks represent the main means of communication through which these events manifest themselves. Sociologists and economists have repeatedly proven that well-built social networks can promote a stakeholder's orientation to explore new opportunities and share experiences, especially when in mutable uncertain contexts. This translates into a positive impact on the evolution of the community in which they are set (Inkpen & Tsang, 2005; Levin & Cross, 2004; Vega-Redondo, 2006). As a case study, Ingram and Roberts (2000) report how the strong network of interrelations between the managers of Sydney hotels has favored the consolidation of many best practices, resulting in the improvement of the performance of their structures and of their return on investments. The instruments of network science have therefore been utilized to examine these phenomena and have turned out to be useful in describing the common features of networks (Birk, 2005; Cross et al., 2000; Cross et al., 2002).

The rest of this work focuses on an outline of such methods and on the description and discussion of a couple of simple simulation models.

3. Materials and methods

Network science, after a relatively slow start, have acquired a certain popularity in the tourism and hospitality domain and today can be considered as an important methodological tool for the study of the several systems that contribute to the phenomenon (see e.g. the reviews by Baggio & Cooper, 201; Baggio, 2014; van der Zee & Vanneste, 2015; Casanueva et al., 2016; Baggio, 2017; Brandão et al., 2020).

The basic concepts are relatively well known. We can model a system in terms of the actors involved and their relationships abstracting these as nodes and links of a graph. The network thus obtains can be then analyzed by measuring a number of properties that summarize the structural characteristics and the dynamic behavior of the system and of the processes that have the system as environment. Quite a number of these measures have been defined (see (Barabási, 2016; da Fontoura Costa et al., 2007; Chung et al., 2020). They allow to describe the global topological (structural) features and those of the mesoscopic structures that might be present as well as the individual traits of the actors involved.

Among these, the most important for the purpose of our investigation on the possibilities to optimize a networked system with respect to its global efficiency in transferring information and knowledge and in providing a favorable setting for cooperative practices are the following:

- *density*: the ratio between the number of existing links and the maximum possible in the network;
- *clustering coefficient*: a measure of local density in the neighborhood of a node, that provides a measure for the collaborative attitudes of the actors (Baggio, 2007)
- *local efficiency*: measures the capability of a node to exchange information with the rest of the network (Latora & Marchiori, 2001)
- *modularity*: the extent to which the whole network is structures in cohesive communities (Fortunato, 2010)
- *Simmelian brokerage*: a measure introduced by Latora et al. (2013) that provides an indicator of the capability of the whole system to provide an environment that favors creative and innovative practices. The metric is based on the idea that a configuration made of cohesive

communities in which information flows quite rapidly, loosely connected to other communities so that inflows of new ideas can exist is the most effective.

The abstraction used for modeling a tourism system is especially suited for the development of simulations that may help in providing scenarios that depict the conditions and the effects of certain modifications, activity that, for obvious reasons of opportunity cannot be performed in the real world. Here we look for the influence of a modification of the structure of the Italian travel agencies network with the objective of improving the efficiency in transferring information (Inbar & Stoll, 1972; Leiper, 1990; Baggio & Baggio, 2020).

Many possibilities exist to modify, in part or in total, the topology of a network by augmenting or 'rewiring' the connections among the vertices, and this can be done in a wide variety of ways (Bansal et al., 2009; Ferrer i Cancho et al., 2003; Lehmann, S., & Hansen, 2007; Paul et al., 2004; Volz, 2004). Typically, the procedure can be roughly described as an optimization algorithm in which:

- the dynamic process chosen is run on the original network;
- a certain objective is set (e.g. an ideal level of density, clustering, modularity etc.);
- links are added and the network optimized until the desired objective is met;
- the dynamic process is run.

Then the outcomes of the process are compared with the original one and the modification is accepted if an improvement is detected. This procedure is then repeated until the desired level of improvement is reached.

The object of study, as said, is the system of Italian tourism intermediaries (travel agencies and tour operators). The choice of such a representative unit is due to the strategic role played by travel agencies within the national and international tourist system. The system is seen as a network whose nodes are the single organizations and whose links are the connections established among them. Data were collected through a survey conducted on a sample of Italian travel agencies and tour operator industry. This is a common data collection process in the area of network science (Christopoulos & Aubke, 2014; Marsden, 2011). The number of actors surveyed is quite extensive and therefore able to provide significant results from a statistical perspective. In this network analysis process, information was gathered by interviewing managers of Italian travel agencies or tour operators about their interactions with other similar organizations. Operationally, a list of about one thousand Italian travel agencies and tour operators was created. The survey was emailed to the organizations in the list, with two subsequent reminders sent after three weeks. Because the units of the analysis are organizations, but the data were collected from individuals, as representatives of the organizations, it was specified in the information letter and the body of the emails distributed that the respondents needed to be informed about the organization's contacts and connections. In a few cases, for the large organizations, more than one survey was completed that were merged at the end of the collection.

An online questionnaire was used to collect the data from September to December 2019. A list of 1000 tourism companies and organizations working in the Italian tourism intermediaries sector (travel agencies and tour operators) was created. was created. The survey was emailed to the organizations in the list, with two subsequent reminders sent after three weeks

As a result, 350 valid questionnaires were collected, which resulted in a network with 329 nodes and 741 ties. Nodes represent the organizations and ties are the knowledge transfer connections between the organizations. The links asked for in the survey concern the contacts in terms of

information or knowledge exchange, therefore they represent a communication channel established between the companies examined.

The network used has been fully described elsewhere (Valeri, 2016; Baggio & Valeri, 2020; Valeri & Baggio, 2020a; 2020b; 2020c). Here we recall its basic properties. Table 1 shows the main characteristics and the metrics we are interested in (we note here, for the sake of an easy interpretation, that all the relevant measures are normalized). A can be seen the network is rather sparse (low density), with many disconnected groups (components) and with a relatively low clustering coefficient and efficiency.

Tab. 1 Main features of the Italian travel agencies network

Metric	Value
Node count	329
Link count	751
Density	0.014
Nodes in largest component	262 (79.6%)
No. of components	28
Clustering coefficient	0.036
Average local efficiency	0.058

The response of a certain structure to the diffusion of information and knowledge can be measured by resorting to the analogy with the spread of a disease in a population, assuming that receiving a piece of information is similar to being 'infected' by a disease. The similarity between the transmission of disease and the transmission of knowledge, then, sets on the idea that informed actors ('infected') can transfer their knowledge to others ('susceptible') if some kind of connection (e.g. a communication channel) exists between them. The analogy is by now a well-established approach and a wealth of works have analyzed this process using a wide array of networks (Zhang et al., 2016).

Modeling such a process starts with the identification of the population of interest and of the ties existing. Then one of the many epidemiological diffusion models is chosen (Hethcote, 2000). These models consider the population as made of individual that may be, at a certain time in one of the following states:

- susceptible (S): healthy individuals, susceptible to be infected;
- infected (I): those who contract the disease and are infectious for a certain period of time;
- recovered (R): individuals who recover by having acquired some immunity or because removed from the population.

Using a network of relationships as substrate, differently from traditional epidemiological models in which the connections are ignored, changes a number of important parameters of the process and gives results, in terms of duration, spread and conditions for the diffusion, that are different from those obtained in a pure no-link case (López-Pintado, 2008).

The different models are named after the type of individuals they deal with. Therefore, SI models include only susceptible or infected elements; SIS models in which individuals go through a complete cycle: susceptible, infected, then susceptible again; and SIR models that uses consider susceptible individuals that are infected and end their process by being removed (i.e. immunized or eliminated from the initial population).

In our simulations we use two of these models: SI and SIS. They mimic situations in which once the piece of information or knowledge was acquired it remains (SI) or settings in which the information received is 'forgotten' after a certain period of time (or with a certain probability) thus making the individual susceptible again (SIS). The outcomes are measured in terms of maximum extent of the infection (i.e. the maximum number of individuals infected) and of speed of diffusion (i.e. the time to reach the maximum diffusion).

It is known that the topology of the network influences strongly the whole process (Balázs et al., 2005; Iribarren & Moro, 2007; López-Pintado, 2008) (Pastor-Satorras et al., 2015; Zhang et al., 2016), thus we can simulate some modifications in the structure of the network and evaluate the effects these changes have. Over the last years the opportunity to avail of both hardware and software computational instruments has promoted the growth and the use of numeric simulation models. We note here that the reliability and credibility of these numerical simulations are generally considered good, provided some basic requirements are met (for a more extensive discussion see e.g. Baggio, 2015). As recognized in the literature, the most important are the choice of a sound conceptual model in connection with the particular circumstances for which the simulations are run and the accuracy of the software program used. With these conditions they have proved to be effective and efficient in mimicking different systems and processes and may be considered valuable aids in decision making (Klein & Herskovitz, 2005; Küppers & Lenhard, 2005; Mollona, 2008).

Both models employed (SI and SIS) use a probability of infection $\beta = 10\%$ and an initial fraction of infected $init = 5\%$; for the SIS model the recovery $\lambda = 0.5\%$. These values have been arbitrarily chosen, but the choice is irrelevant for the results since they are kept constant across the various runs so that the differences found are due only to the other changes applied.

For understanding how modifications in the topology of the network examined could improve the diffusion process we choose a minimal change and simply connect the whole network re-joining all the isolated components. To do that we add a small proportion of links (14%) in a way that preserves the general topology of the network. The mechanism is that of preferential attachment. As described previously this is a possible mechanism for the formation of this network (see CIT) and consists of selecting randomly some nodes in each disconnected component and attach it to one of the main connected cluster with a probability proportional to the degree of the target node. In this way we carry on with the idea that most popular (in terms of connectivity) actor are the most probable target. This mechanism, as shown in the next section (Fig. 1), does not modify substantially the shape of the degree distribution of the augmented network with respect to that of the original thus retaining the general topology.

4. Results and discussion

The first step in our study is to decide the type of changes to be applied to the Italian travel agencies network in order to verify the effects of this modification on the diffusion of information or knowledge. Fig. 1 and Tab. 2 report the results of this simulation with respect to the main metrics discussed above. The networks (Fig. 1) are shown highlighting their mesoscopic structure with the different communities uncovered by the algorithm proposed by Traag et al. (2019). The cumulative degree distributions (Fig. 1, last panel) have, as designed, practically the same shape. As can be easily seen a modest increase in the overall connectivity of the network (added links = 14.2%) leads, generally, to higher increases of the main metrics that characterize the processes of our interest. Essentially, increasing the density under the mechanism chosen (preferential attachment) leads to the

increase of the other characteristics due the known correlations among these metrics (Vázquez et al., 2003; Bounova and de Weck, 2012).

Tab. 2: Main metrics for the original and the augmented network

	Original	**Augmented**	**Delta**
No. of links	711	812	14.2%
Average degree	5.427	6.527	20.3%
Density	0.021	0.025	20.3%
Clustering coefficient	0.045	0.051	13.5%
Modularity (normalized)	0.571	0.685	20.0%
Average local efficiency	0.073	0.083	13.8%
Simmel brokerage	0.065	0.082	25.1%

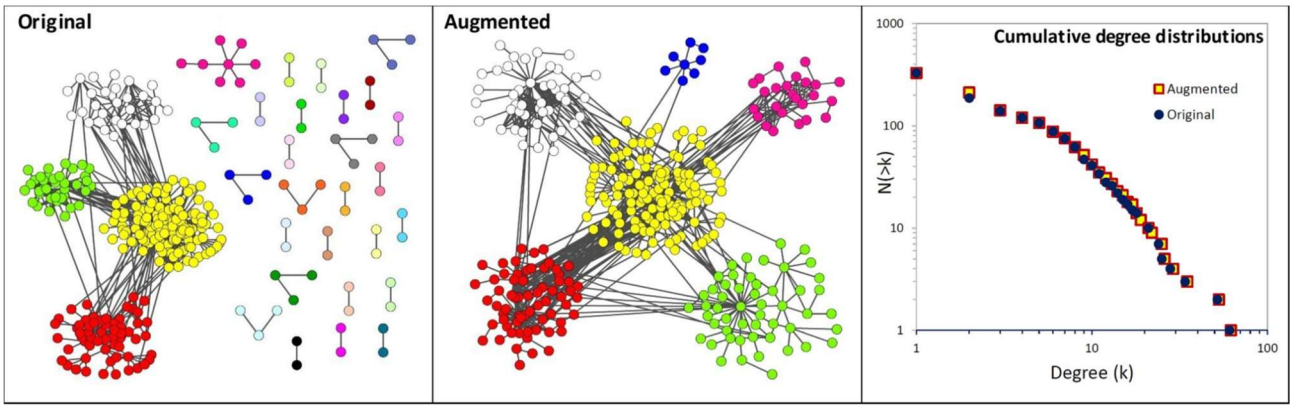

Fig 1: The original and the augmented networks with their cumulative degree distributions

For both networks two diffusion models are run: SI and SIS. The results are shown graphically in Fig. 2 and Fig. 3. They contain both the cumulative and noncumulative curves for the number of infected individuals during the process. Due to the inherent stochastic nature of the simulations the curves result from averaging over 10 realizations.

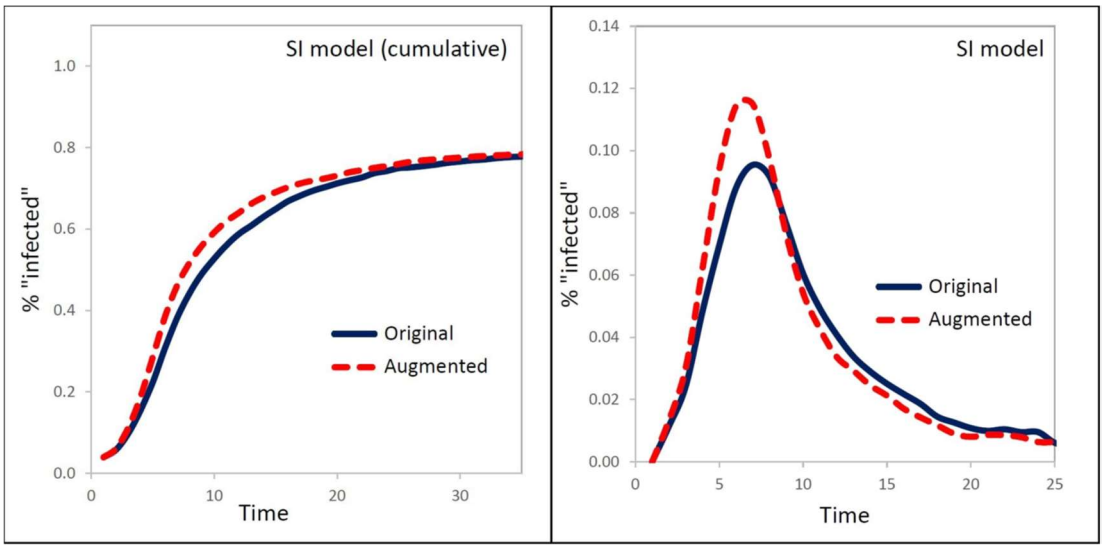

Fig. 2: SI model

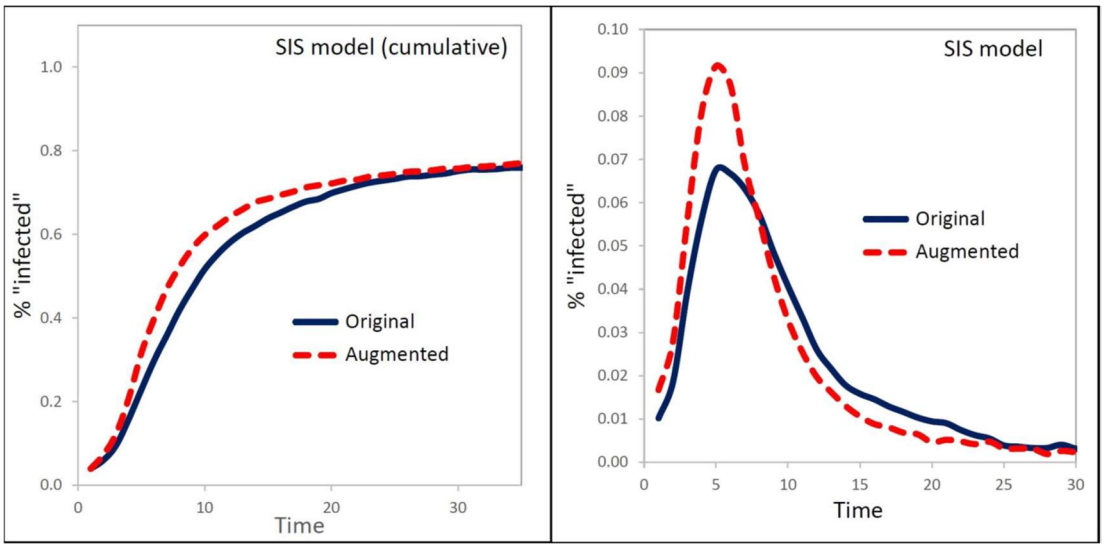

Fig. 3: SIS model

Source: Author's elaboration

It is clear from the figures that the modifications made on the original network allow to obtain a higher extent of the diffusion. In other words, the increase in links, but mainly the removal of isolated components, leads to a more rapid and extensive spread of the piece of information or knowledge. The improvement in the number of *infected* individuals (i.e. those who have received the information or knowledge transferred) at the time corresponding to the peak of diffusion for the original and the augmented networks is in Table 3.

Tab. 3: Values and difference of infected for the SI and SIS diffusion models

	Original	**Augmented**	**Delta**
SI infected at peak	0.105	0.125	18.8%
SIS infected at peak	0.071	0.109	53.2%

In summary our outcomes show that a relatively modest increase in the number of connections and the removal of isolated elements or components from the network produces a higher increase in the capacity of the system to exchange information and knowledge and improves its overall efficiency.

From a 'practical' point of view we note here that many possibilities exist to push towards the desired creation of linkages in a certain setting. A well pondered series of stimuli can be devised by favoring a collaborative and cooperative milieu for the actors considered and a well-designed strategic plan can favor new configurations once their effects are evaluated also considering the necessary balance between the benefits and the related costs.

5. Concluding remarks

This paper has analyzed the topological characteristics of the knowledge transfer network in tourism intermediaries, one of the most important components of the tourism domain. The results

provide a clear image of how information and knowledge flows between Italian travel agencies and tour operators. The first noticeable and significant characteristic of this network was its very low connectivity. The cohesion theory states that dense networks support building trust and enhance cooperation (Coleman, 1988). With a higher density, network actors have more chances to communicate with one another, transfer impediment is more easily overcome, and transfer of knowledge appears facilitated (Reagans & McEvily, 2003; Wei et al., 2011). With a low density, enterprises can access restricted connections, restricted knowledge exchange, and consequently limited means for innovation.

According to the literature, the presence in the network of scale-free structure and highly central hubs speeds up the transfer and spreading of knowledge inside the network (Qiao et al.,2019). The speed of knowledge diffusion can be accelerated by the fact that hubs have a quick and close access to a large number of actors in the network. Nevertheless, high centralization may prevent access to diversified and innovative sources of knowledge, since only a restricted number of hubs are admitted to the knowledge sources. In addition, centralized networks rely on few organizations, and their failure or inefficiency can have an impact on the entire network's performance. Depending on the goals and policies of the organizations, this can help in planning and devising appropriate strategies to change and decentralize the network structure or maintain and strengthen the current centralized structure.

Tourism operators and organizations have been notoriously careless in dealing with information and knowledge management approaches and devise effective policies, partly due to the context of the tourism sector (see our review and Shaw and Williams, 2009). The issues have been analyzed several times, mostly discussing their relevance and the factors that influence more the matters from both an individual and a systemic viewpoint (Cooper, 2018). In this area the role played by the structural characteristics of the network of relationships has been recently approached and examined (Raisi et al., 2020; Zach & Hill, 2017). These studies have centered on relatively well defined tourism systems such as the destinations. Here, instead, we focus on a different level and analyzed a single business system, that of the intermediaries, disregarding geographical boundaries within a country (Santos et al., 2021a; 2021b).

Moreover, this study is particularly relevant in a crisis situation as the recent Covid-19 pandemic. Particularly during crises, an effective transfer of knowledge is essential for an even and uphold performance of the business and for the survival and the growth of the entire tourism sector in each and every destination (Ahmad et al., 2020; Chemli et al., 2020; Toanoglou et al., 2021; Valeri & Katsoni, 2021; Valeri, 2021).

This study has, obviously, limitations. A thorough study of knowledge transfer would require the analysis of a wider variety of knowledge transfer dimensions, such as the characteristics and essence of what is exchanged, the ability of enterprises to transfer and collect knowledge, and the quality and intensity of relationships among the tourism intermediaries. In addition, the topological examination carried out in this work explains the strong and weak points of the network but, however, does not offer a general quantified efficiency measurement for the network. Future research will develop the effects of Covid-19 or other disasters on tourism intermediaries and the cohesion effects on sustainable tourism performance. One more research avenue is to examine whether, and to what extent, the increased information transfer efficiency resulting from the modified structural properties of the system affect the individual components and the whole system, and whether they can be a factor for enhancing members' knowledge generation and management for a competitive advantage.

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