Network science: an interdisciplinary contribution to tourism studies

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ABSTRACT

The study of network representations of physical, biological, and social phenomena has developed rapidly in recent years. The body of knowledge accumulated on the structure and the dynamics of complex networks has offered useful insights on the behavior of many natural and artificial complex systems The paper examines the work done by considering tourism destinations as networks of interconnected organizations. The nature of these networks, both from a structural and dynamic point of view is described and the outcomes of these investigations are presented. The general theoretical framework is described and the implications of this analysis for destination management are discussed.

KEYWORDS

Network science, complex systems, tourism destination, destination management, qualitative and quantitative methods

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INTRODUCTION

Tourism is a complicated field of enquiry. The debate on whether we may consider tourism studies a *discipline* or not is still unresolved and many have discussed and argued both views (Echtner & Jamal, 1997; Leiper, 2000; Tribe, 1997). In any case it is undisputable that many different interventions form the most diverse disciplinary areas have given tourism many interesting and valid contributions and have advanced our knowledge. Economics, geography, sociology, management, to quote only a few, have provided a good set of possible explanations for many of the phenomena observed and delivered a number of tools which, at least to some extent, increase our ability to follow and predict the nature and the behavior of the *tourism phenomenon*.

As tourism scholars, students and practitioners well know, tourism is a *sector* (provided it could be defined as such) with fairly indefinite boundaries. It contains a wide variety of organizations offering diverse products and services and exhibiting very little homogeneity. The relations between the different components are difficult to define and analyze and are of highly dynamic nature. A tourism destination, the place to which travelers aim to spend their time, can be broadly defined as an area that offers a tourist the opportunity of taking advantage of a variety of attractions and services (Jafari, 2000). Many scholars consider it a fundamental unit of analysis for the understanding of the whole tourism sector, even if difficult to define precisely and problematic as a concept (Framke, 2002).

However, as it has been observed in some recent works, the traditional approach to the study of tourism systems is somehow inadequate. One of the most important and crucial remark is that this fragmented set of models, ideas and methods, mostly based on classical analysis methods, is not able to fully describe a complex and dynamic part of our socio-economic environment, and, more importantly, is not able to provide satisfactory insights into the possible development paths of such systems (Farrell & Twining-Ward, 2004; Faulkner & Russell, 1997; McKercher, 1999).

TOURISM DESTINATION SYSTEMS

Putting a destination at the center of the interest means supporting a systemic approach to the study of tourism and considering this *system* as a fundamental unit of analysis. A system, that is to say an organized assembly elements or parts (components) connected to each other with some defined relationship, and having a general objective of accomplishing a set of specific functions. The system approach has its importance in the opportunity to house different perspectives, without necessarily assuming predetermined views. It enables to understand broad issues which affect tourism and to better take into account the relationships between its different components (Page & Connell, 2006).

A tourism destination, as many other socio-economic aggregates, is a complex adaptive system. This means, essentially, that in studying such configurations we expect to find a number of different components (the stakeholders), of different size and functions, connected between them in many possible ways which are typically dynamic and of nonlinear nature. The overall result is a system whose behavior is almost unpredictable. It can show properties which cannot derived by simply composing (linearly) the behaviors and the characteristics of its components. In some cases it is able to resist huge external shocks (natural disasters, for example) without altering too much its evolutionary path, in some other cases a similar system can be completely disrupted by an avalanche created by some seemingly insignificant event. Some stakeholder can act as a catalyst for incredible socio-economic growths in some cases, while in other situations similar behaviors do not have any recognizable effects. A complex system is self-similar, it will look like itself at different scales, if magnified or made smaller in a suitable way. (Baggio, 2008a; Bar-Yam, 1997).

Many scholars believe this approach is able to overcome the difficulties of describing *complex* systems and to give better representations and better tools to handle the issues involved. This approach argues that the reductionist hypothesis born with the origin of modern science is limiting much of our ability to describe the real world. The methods conceived by Galileo, Newton, Laplace, and many others, are not able to return reasonable explanations for a wide number of phenomena.
These ideas have contributed to set a new perspective in our view of nature, a new view which today is known as *complexity science* (Waldrop, 1992). While complex systems ideas are amongst the most promising interdisciplinary research ideas to have emerged in the last few decades, not much has been done so far in the field of tourism studies.

TOURISM DESTINATIONS AS COMPLEX SYSTEMS

An important strand of literature has signaled the necessity to change attitude when studying tourism and tourism systems. In a pioneering work, Faulkner and Valerio (1995), considering the deficiencies and the unreliability of many prediction and forecasting methods, call for the need of unconventional ways to explain tourism facts. They propose the adoption of a chaos and complexity framework. The reductionist paradigm, consisting in the separation of a tourism system into some components while assuming that the relations between them are stable and static is challenged as unable to provide meaningful elucidations of many outcomes (Faulkner & Russell, 1997; Russell, 2005, 2006). Examples of how the chaos and complexity framework is able to provide meaningful explanations of the dynamic behavior can be traced in a number of later works. These discuss issues such as the dynamic and serendipitous development of destinations (Faulkner & Vikulov, 2001; Russell & Faulkner, 1998, 2004; Scott & Laws, 2005; Tinsley & Lynch, 2001). All these are essentially qualitative works discussing and exemplifying the advantages of this way of studying a tourism system. Baggio (2008a) adds to these a quantitative approach by using the toolbox typical of many investigations into complex and chaotic systems.
The concept of tourism destination implies, as said, a systemic approach in tourism studies. An approach in which the main focus is given to the activities and the strategies to foster the development of an area pictured as a system of actors cooperating in order to supply integrated tourist products.
It is a common theme in the tourism literature that a destination management problem exists. In other words, the achievement of the benefits generated by tourism in a particular region requires a process in which some entity takes the responsibility of guiding the activities of the different stakeholders (Buhalis, 2000; Framke, 2002; Kozak, 2004; Ritchie & Crouch, 2003). The literature stresses the idea that the main task of a management entity is to foster the tourism system in an area by looking at the long-term prosperity and wellbeing of the local social community, while maximizing the economic profitability of the operators involved and ensuring a sustainable balance between economic benefits and socio-cultural and environmental costs. Efficient and effective destination management aspects can increase the appeal and improve the quality and value of the resources (Ritchie & Crouch, 2003). Moreover, successful management practices can contribute to the generation of satisfaction among both tourists and the local community by adopting shared marketing strategies. Managing these processes is particularly challenging for the fragmented nature of the tourism industry and for the possible conflicts that may arise from the different views, values and attitudes held by the diverse components of the district. This, as has been noted, indicates the necessity of recognizing common elements and of favoring effective transfer of information among the different stakeholders (Bramwell & Lane, 2000; Font & Ahjem, 1999). Managing the complex system called a destination is quite a challenging task, because it also means finding the way to *direct* a complex system which, almost by definition, is quite unmanageable.

Governing a complex system requires an adaptive attitude, rather than a rigid deterministic, authoritarian style. It may call for the adoption of strong rules, but it definitely needs the capability to change them dynamically, reacting in short times to all the changes that may occur in the system and in the external environment. The proposal of using adaptive management to deal with a system derives from the work of 1970s ecologists (Holling, 1978). It calls for an experimental path to management. The method builds on the idea of exploring alternative possibilities, implementing one or more of them, monitoring the outcomes, testing the predictions and learning which one most effectively allows the achievement of management objectives. The cycle then closes by using the results of the actions to improve knowledge and adjust subsequent management activities. Since then, it has been adopted in different situations, including tourism systems, with encouraging results (Agostinho & Teixeira de Castro, 2003; Farrell & Twining-Ward, 2004).

For a tourism destination, as well as for other types of organizations, it is possible to adopt the idea (Stacey, 1993, 1996) that systems do not only adapt to their environments, but help to create them. Their success can come from contradiction as well as consistency. When contingency (direct and linear cause and effect relationships) loses its full validity, long term planning is almost impossible.

Despite these difficulties, it is still possible to manage and understand complex systems, at least at some level. Large scale behaviors might still be foreseeable if it is possible to describe the overall dynamics of the system including the presence of any preferred evolutionary paths. Once these have been identified, it can be possible to determine whether changes in some specific parameter can produce sudden shifts in behavior, or at least establish a probability distribution for their occurrence (Hansell et al., 1997). Short-term predictions allow identification of the main evolutionary paths and small *corrections* to the system behavior that may be effective in avoiding undesired regimes.

A STATISTICAL PHYSICS APPROACH

When considering a tourism destination, one of its characteristic features is the presence of many different relationships between companies and organizations. Despite this well known evidence, only a few works have analyzed these connections, mainly from a qualitative viewpoint (Michael, 2003; Pavlovich, 2001; Pavlovich & Kearins, 2004) or have used this fact to improve the understanding of some peculiar process (Pearce, 2009).

However, when it is possible to gather a reliable and significant set of data on the destination's stakeholders and their relations, it is possible to apply the methods and the techniques developed in recent years to study a networked system (Börner et al., 2007; Lewis, 2009; Watts, 2004) and derive useful theoretical and practical insights into the structure and the dynamic behavior of a tourism system (Scott et al., 2008a).

A large number of scientists, mainly physicists and mathematicians, have, in the last decade, established a set of tools, methods and theories able to analyze and model a networked system, so that a new discipline is now active: network science (Watts, 2004).

The main theoretical framework in which these investigations are embedded is the set of theories known as statistical physics (or statistical mechanics). This is one of the fundamental fields of physics, and uses statistical methods for addressing physical problems. A wide variety of issues, with an inherently stochastic nature, are treated with these methods. It provides a framework for relating the microscopic properties of individual atoms and molecules to the macroscopic properties of materials observed in every day life. For example, it is possible to explain thermodynamics, and thermodynamic properties, as a natural result of its methods.

The main result, and power, of this approach is in the development of two important concepts: universality and scaling (Amaral & Ottino, 2004). Many systems exhibit universal properties

that are independent of the specific *form* of their constituents. This may suggest the hypothesis that universal laws or results may also show up in other types of complex systems, whether they be social, economic or biological.

The scaling hypothesis, born in the framework of the study of critical phenomena, has provided the idea that a set of relations, called scaling laws, may help in relating the various critical-point parameters characterizing the singular behavior of a system under certain conditions. The concept of universality in statistical physics and complex systems has the basic objective of capturing the essence of different systems and classifying them into distinct classes.

In other words, universality and scaling assumptions give us the basis to justify an approach by analogy. Analogies have been widely used in a number of different disciplines. In physics the method is well known and has a long tradition. One of the best examples is probably the work by James Clerk Maxwell, the father of electromagnetism, who has stated several times the effectiveness of a formal analogy between two systems as a way of increasing and deepening the knowledge of them (Turner, 1955).

When a similarity between different phenomena may be established, it can be assumed that there exists some common underlying law or principle. This may be especially true where such a similarity exists between the functions of elements in different systems or between their structures. Obviously, the usefulness of this approach depends on whether the consequences that can be drawn can be tested or observed and on the correctness of the theoretical framework in which the analogies are set (Gentner, 1983).

If structural relations can be reproduced in a simplified form in a known environment, a mathematical model can be assembled. The effectiveness of this procedure has been proved in innumerable cases and in various disciplines (Gentner, 2002; Krieger, 2005; Wigner, 1960). From an epistemological point of view, although a concept needs to be taken with caution to avoid potential abuses (Daniel, 1955), it has been claimed that theories (stated as a set of postulates) not showing even a formal analogy to some already existing system of abstract relations, would provide no means to understand how the theory could be applied to concrete problems (Nagel, 1961). One recognized use to analogy is its catalyzing function. As has happened many times in the history of science (in physics, for example, with scientists such as Faraday, Coulomb, Helmoltz, Maxwell), it serves as initial help in the development of new disciplinary fields. Known schemes, models and criteria may initially help in finding one's bearings in the vast quantity of data, evidence, phenomena and to start organizing all these into an organic set.

Using the laws and methods of physics applied to social systems can be, and has been, questioned. Here, however, it must be noted that in studying a socio-economic system we are mainly interested in its global behavior and in the possibility of making predictions at this level rather than guessing the conduct of every single element (individual actors). The objective is to understand how regularities may emerge (when they do) out of the apparently erratic behavior of single individuals (Majorana, 1942). In this perspective, the comparison with empirical data has the primary objective of verifying whether the trends seen in the data are compatible with a *reasonable* microscopic modeling of the individuals and whether they are self consistent or require additional factors.

In these circumstances, as Castellano et al. (2009) note, only high level characteristics, such as symmetries, critical transitions or conservation laws are relevant. These, as the principles of statistical physics show, do not depend on the microscopic details of the system. Therefore, as Castellano et al. (2009: 593) state: "With this concept of universality in mind, one can approach the modelization of social systems, trying to include only the simplest and most important properties of single individuals and looking for qualitative features exhibited by models."

The application of statistical physics laws and methods to the study of a socio-economic system such as a tourism destination can be considered justified, mainly if the quantitative techniques rely strongly on a sound and accepted qualitative interpretation of the phenomena described.
A number of tools have been developed in recent years to analyze a complex system. In their review, Amaral and Ottino (2004) identify three main classes of tools belonging to areas well known to physicists and mathematicians: nonlinear dynamics, discrete-space and discrete-time modeling, and network theory. Among these, the techniques belonging to network science are probably the most promising series of methods that can be used to model a complex system.

NETWORK SCIENCE

The topology (its structural characteristics) of a network (a tourism destination network, in our case) is not just a curiosity, but a fundamental systemic property that may greatly influence the overall dynamic behavior of the system and explain and control a number of processes from the diffusion of ideas to the robustness to external or internal shocks, to the optimization of the relationships among the network components. The networked structure of a tourism destination and its importance has been acknowledged by several authors. Considering the set of relationships is deemed a remarkably appropriate approach to describe these systems and to give better insights into the whole industry and its coordination and organizational structures (Tremblay, 1998).
The simple existence of a network in a tourism district is not sufficient to generate effective synergies, it is the structure of such networks that is thought to be a crucial determinant (Michael, 2003). The existing theories and research on the relationships between competing and cooperating firms in a tourism destination support a confirmation of this role. In a tourism environment where many and diverse small companies operate, the overall success of the destination is more often found when firms interact more frequently both at a formal and an informal level. Furthermore, efficient information transfer and cooperation in marketing activities or in sharing the knowledge about the 'paths' their tourist segments take through the destination strongly influence a destination's success (Gnoth, 2004).
Multiple ranges of network types exist; they can be categorized according to type of organization, configuration of interorganizational connections, degrees of formality, or level of intensity of the linkages between members. The success of such networks (in terms of economical and social benefits achieved) depends on a number of different factors: clarity of objectives; organizational structure and leadership; capabilities to manage human, financial and physical resources; and participation of the members. Most of these benefits are difficult to quantify. The evaluation of their qualitative aspects can be very complex, but these benefits are deemed important to fully understand the characteristics and functioning of social groups (Dredge, 2005). All things considered, the many examples studied confirm a clear relationship between the success of a destination and the structure of the network of its stakeholders. This is valid also for *virtual* tourism networks, those that include elements not necessarily geographically close, but spread on an international basis and connected (e.g. via computerized linkages) by a common vision and an efficient exchange of information and knowledge (Morrison et al., 2004).
Many complex systems can be described in terms of networks of interacting elements. A number of researchers have shed light on some topological aspects of many kinds of social and natural networks (Albert & Barabási, 2002; Boccaletti et al., 2006; da Fontoura Costa et al., 2007; Lewis, 2009; Newman, 2003). As a result, we know that the topology of a network is a knowable property of some types of networks. These investigative techniques can be considered a diagnostic method for collecting and analyzing data about the patterns of relationships among people in groups or among organizations. They provide a view into the

network of relationships that may give tourism organization managers leverage to improve the flow of information and to target opportunities where this flow may have a crucial impact on regulatory or business activities.

CONTRIBUTIONS OF NETWORK SCIENCE TO THE STUDY OF A TOURISM DESTINATION

A recent strand of literature has started to apply quantitative network analysis methods to the study of tourism destinations. Methods and techniques have been extensively described and discussed elsewhere (Boccaletti et al., 2006; da Fontoura Costa et al., 2007; Lewis, 2009), also with regard to applications to tourism systems (Baggio et al., 2008; Scott et al., 2008a). Here it is only noted that a number of measurements are used to characterize a network topology: degree (the connections each node of the network has to others) and the statistical distribution of the degrees in a network, density at a local or global level and its non-homogeneities (clustering coefficient, for example), average distance between any two nodes (average path length), efficiency (global and local) in transferring information, correlations between the degree of a node and that of its neighbors (assortativity) and modularity (extent of division in denser subnetworks, also called communities). The literature has also identified broad classes of network topologies based on these measurements mainly on the degree distribution *P(k)* (Amaral et al., 2000):

- *single-scale networks* (or random networks: RND): *P(k)* has exponential or Gaussian tails. This class contains small world (SWN) networks described by Watts and Strogatz (1998), characterized by large clustering coefficients (local densities) and short average path lengths;
- *scale-free networks* (SFN): *P(k)* has a power-law distribution $P(k) \sim k^{-\gamma}$: some (few) nodes act as very connected hubs, having a very large number of connections, while the majority have a small number of links (Barabási & Albert, 1999);
- *broad-scale networks*: *P(k)* has a mixed behavior, a power law regime followed by some tail cutoff (exponential or Gaussian decay).

Both SFN and SWN networks are very common structures among real and artificial systems.

TOURISM DESTINATION NETWORKS: STATICS

The first application of network analysis methods concerns the topological characterization and the identification of the structural peculiarities of a tourism destination. In examining these issues it has been found that a scale-free topology, common to may other systems, is present (Baggio et al., 2008; da Fontoura Costa & Baggio, 2009; Scott et al., 2007).
The destination examined, however, exhibits very low density of connections, low clusterization and a negative degree-degree correlation (i.e. highly connected nodes tend to link low degree elements). These features have been interpreted as symptom of the well known tendency of tourism stakeholders to avoid forms of collaboration or cooperation. The related metrics (clustering and assortativity coefficients) have thus been proposed as quantitative measurements for these characteristics.
This is an important (even if partial) result, because an undisputable identification of strategic weaknesses in the cohesiveness of the destination can be addressed by policy and management approaches. Moreover, as important managerial implication, the network approach emphasize the need for competitive destinations to be collaborative. By highlighting the relationships that form a value-creation system, it is possible to detect differences in measures of inter-organizational cohesion at different tourism destinations (Scott et al., 2008b).
Beside the structural features (e.g. the number of paths of distinct lengths between pairs of nodes, as well as the number of reachable companies), some dynamical characteristics have

been examined. The capability to reach a node from another one and the associated probabilities have been measured and analyzed leading to a series of important findings related to the interactions between tourism companies. Among the several results, it is shown that the type and size of the companies influence strongly these characteristics while their geographical position does not seem to matter (da Fontoura Costa & Baggio, 2009).
A modularity analysis has then unveiled that some form of aggregations exist in a destination, even if it is not very well defined or highly significant. However, this community structure goes beyond preset differentiations (by geography or type) of the agents. In other words, companies of the same type (e.g. hotels), or in the same geographical area, tend to connect with some other company which runs a different business or are located in different localities (Baggio et al., 2008; da Fontoura Costa & Baggio, 2009).
Network analysis methods have been applied also to the virtual network of the websites belonging to destination's stakeholders. The results are similar to those obtained by studying the *real* destination network (Baggio, 2007; Baggio et al., 2007a). This has allowed to gauge the level of utilization of advanced communication technologies among the actors in a destination and measure the extent to which they exploit (or waste) resources universally deemed to be crucial for today's survival in a highly competitive globalized market.
The substantial similarity of the main topological characteristics, coupled with considerations on the mechanisms with which *corporate* websites are interlinked, has suggested an important conjecture. The tourism destination's webspace can be the source to collect a significant sample of the underlying socio-economic network (Baggio, 2008b). In fact, network methods can be difficult to use if the data collection mechanism is not able to provide a reasonable amount of information on tourism organizations and their interconnections. Therefore, the World Wide Web, is argued, can provide an efficient and effective way to gather significant samples of networked socio-economic systems to be used for analyses and simulations (Scott et al., 2008b).
By using this assumption, a comparison between the networks of two destinations considered to be at different development stages (Butler, 1980) has allowed to correlate, although for the time being only at a qualitative level, the topological evolution with the development phase. The idea put forth (Baggio & Antonioli Corigliano, 2009b; Baggio et al., 2007b) is that in early stages of development, existing tourism organizations have not yet connected to others. This happens because they probably do not feel such a necessity or because they have not yet recognized the existence of other stakeholders. Larger organizations or associations, generally responsible for the higher degrees in the network, still have to establish a connection with the newer nodes. In this situation, there exist a limitation in (some of) the nodes' ability to process information about all the other nodes of the network. This information filtering is able to generate (Mossa et al., 2002) the differences in the topologies which have been measured.
One more interesting outcome is the possibility to identify the important members in a destination; those who are reputed to give the most important contribution to the tourism activities. As expected, public stakeholders are more important for both management and marketing activities than private sector (Presenza & Cipollina, 2009). Destination management organizations or actors possessing critical resources have the highest centrality and local government bodies are perceived to hold the greatest legitimacy and power over others in destination development (Timur & Getz, 2008).
More than that, a comparison between the perceived (through a series of interviews) importance of organizations in a destination and their network characteristics has brought to the identification of a set of metrics able to render this feature. It has thus been possible to reliably show that the key stakeholders are located in the core of the network and form an elite that is seen as more salient while peripheral stakeholders are seen as less important. This suggests that destination management is controlled by a limited number of stakeholders

(Cooper et al., 2009). A further confirmation of the necessity of creating cohesive inter-organizational network for the production of integrated tourism experiences.

TOURISM DESTINATION NETWORKS: DYNAMICS

One of the advantages of a network representation of a complex system is that it is possible to perform numerical simulations. They allow *experiments* to be performed in fields where these would not otherwise be feasible for both theoretical and practical reasons. Different configurations can be designed and several dynamic processes simulated in order to better understand how these configurations influence the behavior of the whole destination system. Simulation techniques have a good tradition in social sciences (Inbar & Stoll, 1972). The credibility of these techniques is good, provided some basic requirements are met: a solid conceptual model and the limitation to the particular circumstances for which the simulations are run (Küppers & Lenhard, 2005; Schmid, 2005). With these conditions, simulations can be effective and efficient in reproducing different types of processes may be considered a valuable aid in decision making (Axelrod, 2006; Stauffer, 2003).

Information and knowledge flows in a destination network are relevant determinants of the *health* of the system. Productivity, innovation and growth are strongly influenced by them, and the way in which the spread occurs affects the speed by which individual actors perform and plan their future (Argote & Ingram, 2000). A commonly used way to study the problem is the one based on an analogy with the diffusion of a disease (Hethcote, 2000), but differently from standard epidemiological models, it has been demonstrated that the structure of the network is highly influential in determining the basic unfolding of the process (Da Costa & Terhesiu, 2005; López-Pintado, 2004).

A set of simple simulations have shown these effects (Baggio & Cooper, 2010). Different configurations have been used, based on the single actors' capacities to absorb and retransmit knowledge and on different network topologies. It has been proved that scale-free networks (the tourism destination one) affect the process by speeding it up. A further improvement is obtained by eliminating differences in the capability of tourism stakeholders to transfer knowledge to other members of the community. The best results in terms of process efficiency, however, have been obtained when the network has been reconfigured (rewired) in order to increase the clustering characteristics. It can thus be concluded that a very important determinant for the spread of knowledge in a tourism destination is the presence of a structured topology in the network of relations that connect the different stakeholders, with a well established degree of local cohesion. In other words, destination stakeholders should be encouraged to form cooperative or collaborative clusters to raise the overall competitiveness of the destination. This is an important indication for public sector bodies which can well facilitate these evolutions.

Other important knowledge diffusion mechanisms are crucial for the success of tourism operators. The diffusion of marketing messages through traditional advertising and word-of-mouth, both well known and studied techniques. A simulation has been set up, in which a tourism operator (a hotel manager for example, or a whole destination) wishes to understand the possible effectiveness of traditional advertising as compared to word-of-mouth for promoting the services offered to a target market (Baggio et al., 2009). By comparing the two situations the relative effects of these two methods have been measured in terms of time needed for reaching a certain fraction of the target population and resources spent. The results show the higher effectiveness, at least in the short term, of word-of-mouth. For the classical paid advertising, a more intense effort is needed to reach the same level of informed people.

The virtual network of tourism operators' websites has been examined form a dynamical point of view. The importance hyperlinks connecting different websites is very high due to their ability to provide a visitor with a wealth of good quality information and for the role they play in the ranking by modern search engines. An examination of the webgraph of a

tourism destination has been conducted by simulating the behavior of a visitor. This work has highlighted the effects that the topological structure has on its navigability and on the effectiveness of its positioning in a search engine results screen. A series of simulations performed has also allowed to see how a modest increase in the number of connections (usually very scarce as already shown) may improve the visibility and the navigability of the destination's webspace (Baggio & Antonioli Corigliano, 2009a).

CONCLUDING REMARKS

The general framework of complexity science offers a sound basis for the study of a tourism destination. Within this framework, the structure of a system can be described in terms of its components and of the linkages that connect them. This brief review has shown that, among the many possible approaches, the study of the topological structure of a destination is able to give insights into the functioning of the system both from a static and a dynamic point of view. Modeling a tourism destination as a complex network and using the ideas, the concepts and the techniques of network science to study its topology and its evolution over time is proving to be an interesting and promising line of research. Moreover, beside the intellectual appeal, the implications that can be derived, in terms of capabilities of understanding the general behavior and the dynamic evolution of a destination, may give tourism organization managers a strong leverage to improve the flow of information and to target opportunities where this flow may have the most impact on business activities.

Most studies examined here have, obviously, limitations. Very simplified models and representations of tourism systems have been used, and straightforward simulations have been set up. However, this is only the beginning a new research path, and most works have been conducted with the main goal of proving the applicability and choosing, among the hundreds possible techniques, the most useful and effective for the field. As well highlighted in the works described here, the most important contribution so far is of methodological nature. A combination of models and techniques has been synthesized in order to develop a uniform set of tools for the structural analysis of a tourism destination. As noted several times, this approach must necessarily be coupled with a deep knowledge of the object of study. Both quantitative and qualitative instruments are necessary to fully exploit the potential of the methods presented here.

The use of quantitative measurement for the assessment of network properties has little meaning without a *physical* interpretation which may only come from the outcomes of more traditional qualitative investigations. For the scholar, this can greatly help in confirming these models. For those interested or involved in managing a destination, the combination of both traditional qualitative evaluations and quantitative measurements can give more strength to the decisions made and better inform the actions and policies needed.

As a final point, it is important to note that a more rigorous establishment of methodological tools such as those described here, can be a powerful way to help a transition towards a less *undisciplined* set of theories and models in the tourism arena, and that this can be greatly beneficial for the understanding of the structure and behavior of this system and its components, so important in today's social and economic setting.

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