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WHAT NETWORK ANALYSIS OF THE WWW CAN TELL US ABOUT THE ORGANISATION OF TOURISM DESTINATIONS

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ABSTRACT

This research examines the comparative characteristics of two tourism destinations based on quantitative analysis of the network of hyperlinks among their tourism operators' websites. Methods and techniques of the "science of networks" are used to characterise and compare the static and dynamic characteristics of a tourism destinations webspace. Network metrics are proposed as quantitative assessments of collaboration and cooperation among destination stakeholders. Using two cases, Fiji islands and the island of Elba (Italy), we show that the networks exhibit a topology similar to that characterising many complex social systems which have been studied and reported in the literature. The differences found of these tourism networks from other types appear due to the relatively poor connectivity among the elements of the networks. The structural characteristics are then interpreted in terms of the evolutionary growth of tourism destinations.

KEYWORDS

destination, collaboration, network analysis, websites, Fiji, Elba.

INTRODUCTION

Tourism involves travel and requires the collection of information about a destination and its tourism products prior to travel. The means by which travellers collect this information has changed over the past decade with information on travel products and destinations increasingly being sourced from the World Wide Web (WWW). As a result tourism destinations and tourism product managers are developing sophisticated www sites that provide both information and the ability to purchase a tourism service (Buhalis, 1998).

Individual tourism product sites on the WWW may be associated through hyperlinks. The advantage of a hyperlink is that they make it convenient for users to move from one WWW page to another without having to know the 'address' of the second page. Typically WWW users follow links from one page to another to find information about their potential holiday and these links may connect pages from the site of the same tourism operator or they may connect different organisations. For example, a National Tourism Organisation website may be the first point of contact to which different tourism products in that country are linked.

This set of websites and links may be considered to form a network. Networks are found in many places. The brain is a network of neurons connected by synapses. Food webs and ecosystems may be represented as networks (Barabasi & Bonabeau, 2003; Watts, 2004). A social network is defined as a specific set of linkages among a defined set of persons, with the additional property that the characteristics of these linkages as a whole may be used to interpret the social behaviour of the persons involved (Mitchell, 1969).

In studying networks, researchers from disciplines as diverse as physics, biology, sociology and psychology have applied common tools and techniques to understand their properties. The properties of networks do not apply to individual nodes (neurons, people) but to the network as a whole; the network is the unit of analysis. Thus, network researchers study the density, size, or centrality of the network rather than the properties of individual nodes. For example, the density of human networks has been found to be related to the effectiveness of communication of ideas and innovations (Monge & Contractor, 2003) as well as the spread of disease during epidemics (Barabasi & Bonabeau, 2003).

The literature of network research has shown that the structure (or topology) of a network is a predictable property that greatly affects their overall dynamical behaviour and explains a number of processes from the diffusion of ideas to the robustness of technical networks to external attacks to the optimisation of the relationships among the network components. Network analysis techniques are a diagnostic method for collecting and analysing data about the patterns of relationships among networks such as people in groups or among organisations. In the field of tourism, they provide a novel view of the tourism system and give tourism managers the potential to improve network functions such as the flow of information or the governance of destinations.

The research discussed here uses the science and tools of network thinking to examine the structural properties of the network of hyperlinks between the websites of tourism operators in two destinations: The Fiji Islands and Elba, Italy. Using such network tools to describe the technological ensemble of hyperlinks would not be problematic for most social science researchers. It might be considered an interesting scientific study that has some relevance to the study of social systems.

However, this research is based upon the assumption that the connections among the websites (hyperlinks) may be considered not simply as a technological manifestation but also as a reflection of social processes. The structure of hyperlinks form patterns based on the designs and aspirations of the individuals or organisations who own websites. A growing literature suggests that these networks reflect offline connections among social actors and support specific social or communicative functions (Jackson, 1997; Park, 2003; Park & Thelwall, 2003). The layout of a network of websites for a tourism destination can thus be seen as a reflection of characteristics of the structure of the social network from which it originates. This relationship between cyberspace and the physical world is two-way: on one side, the online linkages represent and complement social relations in the offline world; on the other side, offline interactions can influence how online relationships are established and developed (Birnie & Horvath, 2002; Wellman, 2001).

The paper presented here is exploratory in the sense that it seeks to examine how network thinking can inform our understanding of the interactions between tourism operators within a destination. It uses quantitative network analysis methods to compare the network characteristics of two tourism destination. The main structural characteristics are measured, both from a static and a dynamic point of view. The results show that network topological measurements can be used to illuminate important properties of the destination network and of the underlying social and economic system.

METHODS

The work presented here focuses on the analysis of two tourism destinations: Fiji Islands and Elba (Italy). The destinations share many similarities; in both cases these islands offer “sun and sand” tourism experiences, they both receive tourist arrivals of around 500,000 visitors per year who spend around 3 million visitor nights. Each offers accommodation capacity of the same order of magnitude (approximately ten thousands bed places). Both economies are highly dependent on the expenditure generated by tourism activities. Both have an Internet presence and this analysis was conducted on the network formed by the hyperlinks between websites belonging to core tourism operators in each destination: accommodation (hotels, residences, camping sites etc.), intermediaries (travel agencies and tour operators), transport, regulation bodies, services etc.

A network is mathematically represented by a graph composed of nodes connected by a certain number of links. Among the many parameters used to describe a complex network, some are commonly employed to fully characterise the topology and the behaviour of such systems (Boccaletti et al., 2006; da F. Costa et al., 2005):

- *degree distribution P(k)*: the statistical distribution of the number (and sometimes the type) of the links among the network elements;
- *average path length L*: the mean distance between any two nodes;
- *diameter D*: the maximal shortest path connecting any two nodes;
- *clustering coefficient C*: representing how well connected are the neighbours of a node and giving a measure of the inhomogeneity of local density of links;
- *efficiency* (at a local E_{loc} or global E_{glob} level): which can be interpreted as a measure of the capability of the system to exchange information over the network (Latora & Marchiori, 2001);
- *assortative mixing*: which gauges the correlation between the degrees of neighbour nodes (Newman, 2002). In assortative networks, well-connected elements tend to be linked to each other. This quantity, connected to the clustering coefficient, has been recently shown to influence directly the formation of strongly connected subnetworks or communities and to give an indication of their strength (Quayle et al., 2006; Radicchi et al., 2004).

These parameters can be used to classify the networks into three broad classes (Amaral et al., 2000):

- *single-scale networks*: in which *P(k)* exhibits exponential (Poissonian or Gaussian tails. This class contains the random graphs (ER) described by Erdös & Rényi (1959) and the small world (SW) networks proposed by Watts and Strogatz (1998) which are characterised by large clustering coefficients and short average path lengths;
- *scale-free networks*: *P(k)* has a power-law distribution: $P(k) \sim k^{-\gamma}$. The distribution is largely uneven, there is no characteristic mean nodal degree (the mean of a Poissonian ER distribution), but some (few) nodes act as very connected hubs, with very large number of ties, while the majority of nodes have a small number of links (Barabási & Albert, 1999). The scale-free (SF) topology has been identified in a very wide range of man-made or natural networks;
- *broad-scale networks*: for which the degree distribution has a mixed behaviour, a power law regime followed by some sharp cut-off (an exponential decay) of the tail occurring above a certain degree value k_c: $P(k) \sim k^{-\gamma} exp(-k/k_c)$.

The websites have been analysed considering them as the nodes of a complex network. The elements of the network have been identified by using official lists provided by the Elba Tourism Board and Fiji Visitors Bureau. Links among the websites have been counted by using a simple crawler, complementing the data obtained with a visual inspection of the websites. All links are considered of directed nature. The analysis has been performed with Pajek (Batagelj & Mrvar, 1998) and a set of programs written by one the authors using the Matlab (MATLAB, 2004) development environment.

The sizes of the networks examined are: 468 elements (websites) for Elba and 492 for Fiji. This size can be considered sufficient to show the graph's statistical properties in a meaningful way (Angeloudis & Fisk, 2006; Dunne et al., 2002).

RESULTS

The graphical representation of the two networks are given in Figure 1 (Elba) and Figure 2 (Fiji).

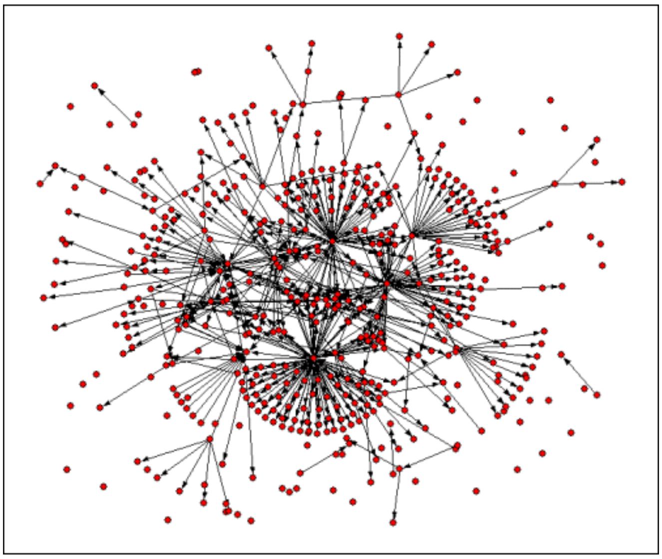

Figure 1. Elba network graph

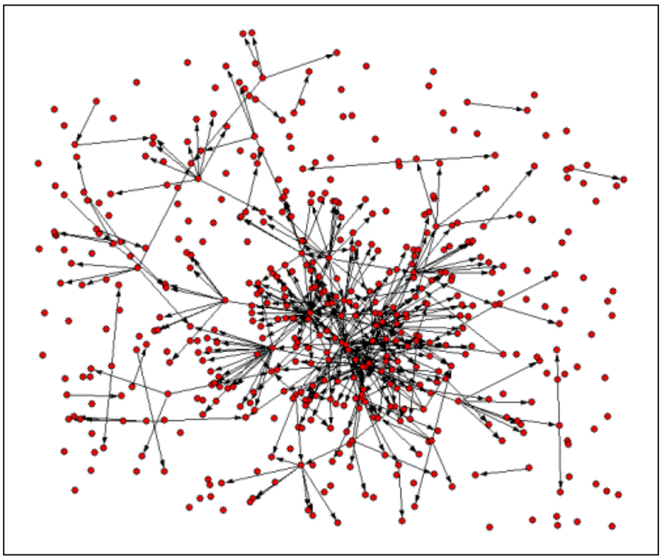

Figure 2. Fiji network graph

As it can be easily seen, both networks exhibit a well identifiable structure. This is more clear if we compare them with the graph obtained by generating a network of a comparable size (500 nodes) and link density (2%), whose links are purely randomly distributed (see Figure 3).

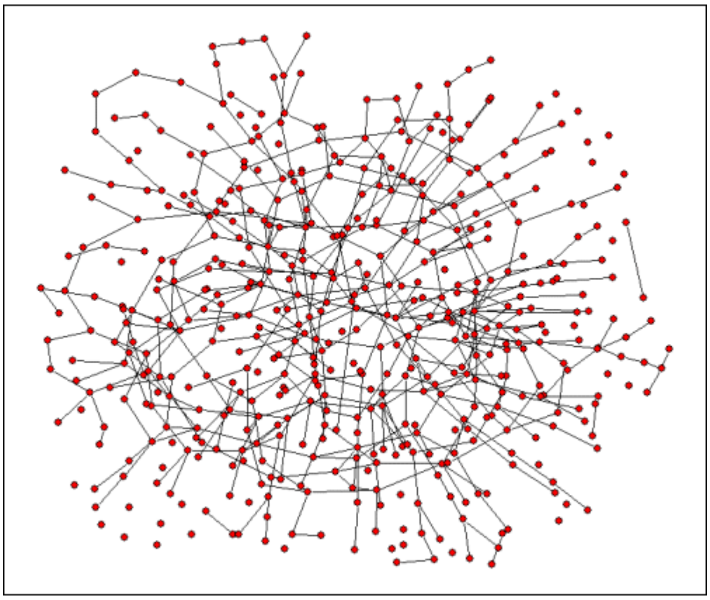

Figure 3. The graph of a random network

The numeric values calculated for the main characteristic parameters of the two networks are given in Table 1.

Table 1. Main characteristics of Fiji and Elba networks

	Fiji	Elba
Size (# of nodes)	492	468
Link density (δ)	0.0016	0.0023
nodes with no connections	35%	21%
Average path length (L)	2.9	4.5
Diameter (D)	6	11
Clustering coefficient (C)	0.024	0.003
Efficiency		
local	0.0275	0.0145
global	0.0710	0.1698
Assortative mixing coefficient	-0.137 ± 0.102	-0.101 ± 0.094

These characteristics indicate that both networks are rather sparse, showing very low densities and high proportions of totally unconnected websites. Diameters and average path lengths are almost in line with those exhibited by similar networks (Albert & Barabási, 2002; Dorogovtsev & Mendes, 2003). The clustering coefficient and the local and global efficiency of the graphs are very low as well. The values are considerably lower than those found for similar systems. The local efficiency value confirms the poor clustering of the network. Finally, it is interesting noting that for both networks, the assortative mixing coefficient is low and, more importantly, negative. This is the opposite of what is commonly found for social networks in which, typically, the most connected nodes tend to link nodes with similar degrees (Newman, 2003).

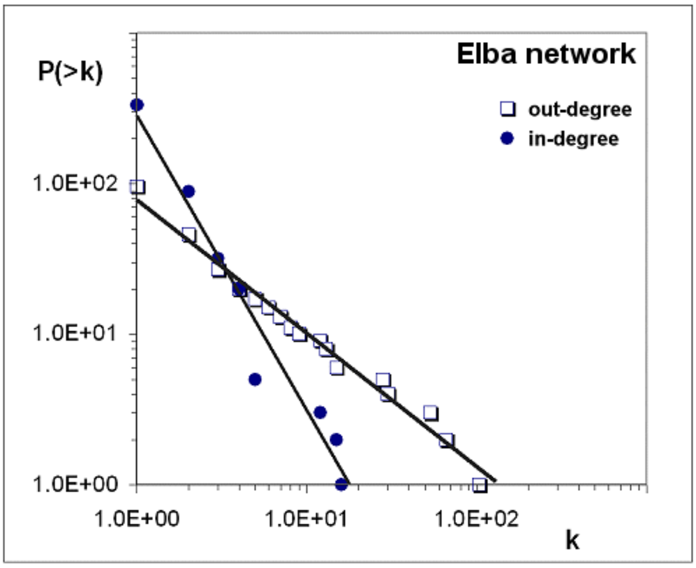

Figure 4. In-degree and out-degree cumulative distributions for the Elba network

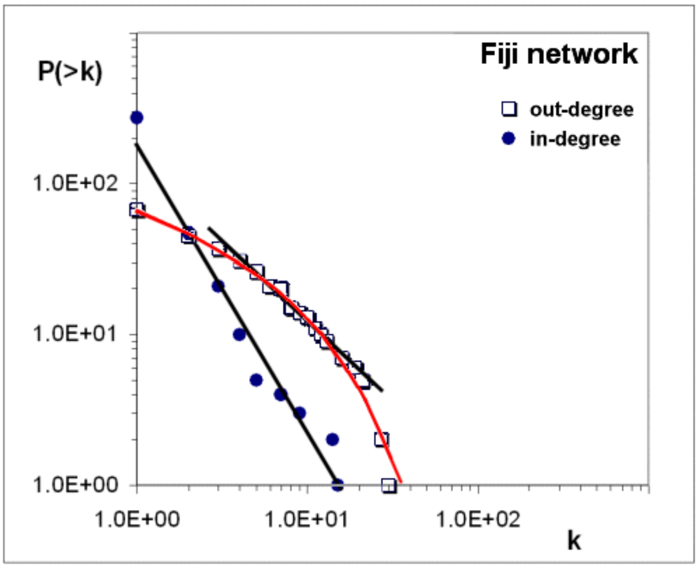

Figure 5. In-degree and out-degree cumulative distributions for the Fiji network

Key parameters characterising the structure of a directed network are the in-degree (k_{in}) and out-degree (k_{out}) distributions (the distributions of the number of links incoming to a node or outgoing from it). The cumulative degree distributions are shown in Figure 4 (Elba) and Figure 5 (Fiji).

For Elba network, both distributions follow a power-law whose exponents are: out-degree: $\gamma_{out} = 1.89$ and in-degree: $\gamma_{in} = 2.96$. In the Fiji network a pure power-law behaviour seems to be attributable only to the in-degree distribution (exponent is: $\gamma_{in} = 2.91$). The out-degree distribution shows a clear cutoff at high k values. The best fit for this distribution is therefore a function of the form: $P(k) \sim k^{-\gamma} \exp(-k/k_c)$, with $\gamma_{out} = 1.4$ (the central part of the distribution scaling as a power-law) and $k_c = 15$.

Both in-degree exponents are higher than those typically measured for the Web: $\gamma_{in} \sim 2.1$ (Broder et al., 2000), indicating a greater concentration of the networks. The values found are consistent with the preferential attachment growing mechanism suggested by Albert and Barabási (2002). Out-degree exponents are, instead, much lower (typical Web value is $\gamma_{out} \sim 2.7$), indication of a much flatter and more spread distribution of the links. A spectral analysis confirms the main topological characteristics of the networks, also acknowledging their scarce connectedness.

DISCUSSION

The results of the network analysis for the two destinations considered can be summarised as follows:

- both networks show a scale-free topology (power-law behaviour of the degree distributions) which is consistent with the one generally ascribed to many artificial and natural complex networks;
- the general connectivity is, however, very low (link density) with large proportions of disconnected elements.
- clustering is quite limited, as is the efficiency both at a local and at a global level;
- moreover, a very small and negative correlation among the degrees of the nodes has been found (assortativity coefficient), i.e.: nodes with high degree tend to connect with nodes with low degrees. This behaviour is the opposite of that typically found for social networks.

If we consider the data presented here purely as a technological network, we must conclude that such low connectivity and modularity (i.e.: low and sparse number of connected communities or clusters) is of low efficiency and a waste of resources both from a technical and an organisational point of view. While the benefits of cooperating and collaborating by networking resources and functionalities have been emphasised several times (Barua et al., 2000; Hackathorn, 2003; McLaren et al., 2002; Walker, 2002), in the destinations examined here this is not evident. These destinations appear to be missing out on the advantages of cooperation mechanisms on the Internet that could greatly ease the organisation and the management of the destination and its efficiency in facing a globalised and highly competitive market.

One more technical consideration is in order. From a strategic development perspective, it should be noted that future search engines and recommendation systems will be based on dynamic agents whose task will consist in identifying connected communities on the web (Adamic & Adar, 2003; Adomavicius & Tuzhilin, 2005; Baggio, 2006; Lawrence, 2000). The websites of destinations not forming an identifiable "community" through high network interlinkages will be hard to reach by a casual user, with unfavourable consequences for the effectiveness of the marketing and communication activities and their economic outcomes.

As discussed above we may also assume that the network of destination websites represents more than an artificial technological network and the web space of a tourism destination is a representation of the underlying economic and social network. In this context, our analysis can provide interesting insights. The clustering coefficient and the assortativity index may then be used as quantitative assessments of the degree of collaboration or cooperation among the tourism destination's stakeholders. In this case, the clustering coefficient can be thought of as a *static* measurement of cooperation, and representing the formation of cohesive communities inside the destination, while the assortativity measure can be interpreted as representing the tendency to form such communities.

Under this assumption, the general low connectivity and low clustering characteristics of both networks are a clear indication of very limited degree of collaboration or cooperation among the stakeholders. The negativity of the assortative mixing coefficient also reinforces this reading. A confirmation of this interpretation comes from previous studies on Elba (Pechlaner et al., 2003; Tallinucci & Testa, 2006) where it has been argued that a low propensity to connect to the external world exists. The stated reason is the strongly independent way small family-run enterprises (the vast majority of the tourism businesses on the island) are conducted. In the case of Fiji, the structure of Fiji's tourism industry is mainly based on "all inclusive" resorts that are self-sufficient and have little collaboration with other organisations besides the very basic supply chain relationships.

As seen above (Table 1), some differences in the values of the network parameters exist. Fiji values show a lower connectivity, higher degree of disconnected elements, lower efficiency and lower assortativity. Its relatively higher clustering coefficient can be explained by the smaller size of the "giant component", the largest connected component in the network.

Let us consider now the degree distributions (Figure 4 and Figure 5). The out-degree distribution of Fiji network exhibits a marked cutoff at high k. This characteristic, for a complex network, is usually interpreted as the result of some kind of constraint on the evolution (growth) process of the network. Constraints can be in the form of cost limitations in forming connections, of aging of nodes who stop creating links after a certain period of time, of spatial confinements of the network or of finite lifetimes (Boccaletti et al., 2006; Dorogovtsev & Mendes, 2000; Dorogovtsev et al., 2000; Jin et al., 2001; Rodgers & Darby-Dowman, 2001).

Before being able to give a meaning to these characteristics, we need to consider the tourism characteristics of both destinations. Elba is considered a "mature" tourism destination (Tallinucci & Testa, 2006). It has a long history and has gone through a number of different expansion and reorganisation cycles. The stakeholders are mainly small and medium companies and there are a number of associations and consortia who try to overcome the "independence" of the companies by implementing different kinds of collaboration programs. Geographic, economic and political factors have not favoured a full development of tourism in Fiji (Harrison, 2004). The destination is divided into a number of different geographical locations such as the Coral Coast, Mamanucas and Yusawas and, as noted above, the supply structure is highly fragmented. Only comparatively recently are central tourism policy organisations designing and implementing coordinated development plans.

With this scenario, and if we accept the idea that a tourism destination has some kind of evolutionary path (Butler, 2005a, 2005b), we may legitimately say that Fiji is at an earlier stage of development, as a tourism destination, than Elba. In an early stage of development, tourism organisations exist, but they have not yet connected to others. This happens because they do not feel the necessity or because they have not yet realised the existence of other companies. Larger organisations or associations, generally responsible for the higher degrees, still have to establish a link with the newer nodes in the network. In other words, there seems to exist a limitation in (some of) the nodes' ability to process information about all the other nodes of the network. This filtering of information is able to generate (Mossa et al., 2002) the exponential truncation found in the degree distribution of Fiji websites. Moreover, as these authors say, concluding their paper:

> 'In the context of network growth, the impossibility of knowing the degrees of all the nodes comprising the network due to the filtering process – and, hence, the inability to make the optimal,

> rational, choice – is not altogether unlike the "bounded rationality" concept of Simon (1997). Remarkably, it appears that, for the description of WWW growth, the preferential attachment mechanism, originally proposed by Simon (1955), must be modified along the lines of another concept also introduced by him – bounded rationality (1997).'

This kind of relationship between the modifications in the network topology and the evolution of a destination has also been described, if only at a qualitative level, by Pavlovich and Kearins (2004) in their analysis of Waitomo (NZ). They note a significant structural change, with an increase in number and heterogeneity of the interconnections, connected with the evolutionary growth of the destination.

CONCLUSIONS AND IMPLICATIONS

In the last few years, the techniques and methods of analysis of complex networks have developed significantly. An increasing number of research works have studied a great variety of theoretical and empirical aspects of networks of many types. Tourism systems, in spite of the recognised "networked" characteristics, have been almost absent from these investigations. Only a handful of papers have employed basic social network analysis methods, and generally only at a qualitative level, in this sector. This work, which is part of a wider research project, is one of the first attempts at using quantitative network analysis models in the study of tourism destinations.

We have considered two such tourism systems and, by examining their web spaces, have provided an assessment of the main characteristics of the two networks. With the hypothesis that the technological system represents the economic and social group that originates it, we have derived a series of characteristics of the structure and the cohesiveness of the system, emphasising the aspects connected with the issues of collaboration and cooperation. Moreover, by assuming the existence of an evolutionary growth for a tourism destination, we have connected the basic topological characteristics of the networks with such evolution.

Clearly, the exploratory nature of the analysis and the limited number of examples examined put a limit on the generalisation of our results. However, even such limited results, show, in our opinion, the validity of the methods used. The possibility to give quantitative assessment to structural characteristics of the network of stakeholders in a destination can prove extremely useful for the organizations responsible for the management of the system. Till recently only qualitative measurements of network characteristics were possible, with all the reliability limitations such investigations have. The approach used here provides a quantitative confirmation of the level of collaborative phenomena, and may better help in directing planning activities. Moreover, the usage of computer simulations models, which may be easily implemented once the basic structure of a system is known, can provide useful tools to study different possible optimisation schemes and allow the building of more reliable development scenarios.

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