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Opinion and consensus dynamics in tourism digital ecosystems

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Abstract

A tourism destination is a social network, with a group of interacting stakeholders, jointly producing the experience that the travellers consume. The harmonisation and coordination of stakeholders' views and the development of a consensus-based strategy are essential elements for destination competitiveness and growth. Despite that, there is still scarce research aimed at analysing the mechanisms through which consensus can be achieved and how such a process can be assessed and monitored. This paper aims at contributing to fill this gap applying a spectral analysis to three destination network with the objective of analysing the mechanisms through which information flows across the connections that link the different stakeholders and those that rule the establishment of a common opinion. Contributions to the body of knowledge and managerial implications are discussed and suggestions for further research are given.

Keywords: digital ecosystems, tourism destinations, opinion dynamics.

1 Introduction

A tourism destination is a cluster of interrelated stakeholders embedded in a socio-economic milieu that strive to meet visitor needs and produce the experience that travellers consume (Baggio, et al., 2010; Del Chiappa and Presenza, 2013). As a consequence, successful tourism marketing requires all the components to work together (Uysal et al., 2000). Specifically, contributions relating to tourism destination planning do stress the need for involving public and private players in order to reach a consensus so that the strategies of companies and institutions converge towards the same goals and worldviews (Burstein, 1991; Pforr, 2006). Achieving a consensus-based collaboration within the network is essential for destination competitiveness and growth (Beritelli, 2011; Nordin and Svensson, 2007) and allows exploiting several benefits. In particular, it allows to reduce the costs involved in solving conflicts among stakeholders, it may bring legitimacy to collective actions when stakeholders are involved in the decision-making processes, and, finally, it may enhance the coordination between policies and related activities (Bramwell & Sharman, 1999).

Recent research argued that a tourism destination can be considered to be a digital business ecosystem (DBEs). In other words, a destination is a networked system of stakeholders delivering services to tourists, complemented by a technological infrastructure aimed at creating a digital environment which supports cooperation, knowledge sharing and open innovation (Baggio and Del Chiappa, 2013a, 2013b).

In such a system two main components are taken into account: a *real* one, composed of the business stakeholders in a certain economic or industrial sector and its *virtual* complement formed by the technological equivalents of these stakeholders. The real part generates the virtual one, but, given the strong coupling between the two, all modifications, changes or perturbations originating in one of them rapidly propagate to the whole system. That said, it was argued that the relationships between the real and the virtual components are so tight that it will be difficult, if not impossible, to consider them separately any more (Baggio and Del Chiappa, 2013a, 2013b). In such a context ICTs, information systems and social media can be considered as important coordination mechanisms (Bregoli and Del Chiappa, 2013) that allow information to flow more easily across the destination (Fyall, 2011) and through the stakeholders facilitating processes such as consensus-based tourism planning (Micera et al., 2013). Broadly, it can be stated that the Web has become the medium that enhances the interaction and collaboration between stakeholders and the sharing of information and opinions among them, in an attempt to converge toward a common vision (Funilkul and Chutimaskul, 2009; Micera et al., 2013). In other words, ICTs allow "more contextual data to be transmitted and opinions to be shared and discussed" (Breukel and Go, 2009: 188).

Tourism literature has widely recognised that collaboration, harmonisation and coordination of stakeholders' views working within the destination are pivotal for an effective and competitive tourism development (Moscardo, 2011, Del Chiappa and Bregoli, 2012). However, there is still scarce research aimed at explaining the mechanisms through which consensus can be attained (Ryan, 2002) assessed and measured.

The present study was carried out to investigate how the network structure of a tourism destination can affect the process of consensus development among stakeholders. To do that, a spectral analysis of the network was conducted. The analysis was also used to reaffirm the tight integration between real and virtual components in a DBE. The cases examined are those of three Italian tourism destinations already object of a previous study (Baggio and Del Chiappa, 2013a; 2013b). In this way we derive a very strong and documented argument in favour of the digital ecosystem approach to the study of tourism destinations.

The paper is organised as follows. Section 2 briefly reviews the issue of consensus based strategies, section 3 describes the methods and the cases used. Results of the analysis, and discussion follow. The concluding remarks close the paper with a brief discussion of the main implications of the outcomes presented.

2 Consensus based strategy in tourism destinations

A substantial body of empirical and theoretical research has accumulated on the subject of strategic consensus, especially adopting a micro-level perspective (i.e. the one of a single firm, see e.g. Amason, 1996). Consensus received several definitions.

According to Priem (1990: 469), consensus can be defined as a "general agreement in the opinions held by all or most". Interestingly, Kellermans et al. (2005: 721) defined it as simply "the shared understanding of strategic priorities among managers". The concept of strategic consensus has been discussed also in the tourism literature where it has been recognised explicitly to be an essential element for destination competitiveness and growth (Beritelli, 2011). According to Jamal and Getz (1995: 200) "in the fragmented tourism domain, perceived interdependence and key stakeholder involvement are not adequate for achieving success; methods must be devised for finding common grounds for facilitating consensus and for implementing the collaboration's results (if required)". Prior works in the field of strategic management showed that temporal issues should be considered in strategic-consensus research (Wooldridge and Floyd, 1989) and that the achievability and desirability of consensus is likely to vary over time (Markóczy, 2001). Based on this idea, Kellermanns et al. (2005) argued, for example, that consensus might be highly desirable during the implementation of a strategy whereas the process of formulation might benefit from a lower level of consensus (which comes earlier in the decision-making process). Indeed, the lower level of consensus in the process of formulation could help to prevent premature closure and encourage the expression of diverse views and opinions, thus increasing the decision quality and improving organisational performance. Kellermanns et al. (2005) maintains that the construct of strategic consensus consists of the following dimensions: scope (who participates in the process of decision making), content (what decision makers agree about) and commitment (managers' involvement and willingness to collaborate in order to implement the decisions taken).

In the strategic management literature only an handful number of papers deal with the topic of measuring consensus. For example, Bowman (1991) measured it as an index of consistency, expressed as the average correlation between the organisational members' responses. Iaquinto and Fredrickson (1997) used multiple scenarios and ask respondents up to 43 questions for each scenario. Another approach consists of measuring consensus as a product of commitment to and understanding of a specific strategy (Wooldridge and Floyd, 1990), where understanding is measured as a forced-choice distribution by respondents against a set of strategic priorities. Another interesting approach assesses consensus comparing the managers' mental models or mental maps that can be used to represent how they do perceive the relationships among different organisational success factors (Markóczy, 2001).

Among the variables that might influence knowledge sharing and consensus development, the literature in strategic management and organisational behaviour considered ICTs and leadership (Yang, 2010). Following this strand of research it could be argued that an effective leader is able to play the role of facilitator aiming to foster social interactions and to emphasise group harmony and consensus, thus invigorating interpersonal relationship among stakeholders, minimising conflicts and involving them in the strategic planning.

Here we consider an important aspect of the issue, the one that considers the mechanisms through which information is passed along the connections that link the different stakeholders in a destination and those that rule the achieving of a common opinion, accepted by the majority of them. In this case we disregard the qualitative traits of the single actors and concentrate on the role played by the topology of the destination network in the unfolding of the processes. This is not a limitation because the structure of the substrate has been found in numerous recent studies to be by far the major (and in many cases the only) factor affecting the speed and the extent of the diffusion or the time for reaching a stable *consensus state* (Baggio & Cooper, 2010; Castellano et al., 2009).

3 Materials and methods

The ecosystems examined in this study are those of the Italian destinations of Elba, Gallura and Livigno. These are three well-known destinations. Elba is an island off the coast of Tuscany (central Italy), Gallura-Costa Smeralda is the north-western region of Sardinia and Livigno is a mountain district in northern Italy, close to the Swiss border. The destinations are quite typical of their sort. Elba and Gallura are marine areas, while Livigno is an Alpine zone. Each destination, for the purpose of this study, is considered bounded by the respective administrative borders. The size of the three destination, in terms of tourism firms operating, is similar, about one thousand companies, as similar is their tourism intensity. They receive about half a million visitors per year, with a strong seasonality. The ecosystem networks considered have been described elsewhere (Baggio & Del Chiappa, 2013). For all the systems we consider the whole network and the two subnetworks formed by the real firms and the one made of their virtual representations (websites).

The main characteristics are reported in Table 1.

Table 1. Main characteristics of the destination networks

Destination	Type	Nodes	Edges	Density
Elba	Ecosystem	1156	2712	0.0041
	Real	713	1636	0.0064
	Virtual	443	494	0.0050
Gallura	Ecosystem	3712	9718	0.0014
	Real	2235	6077	0.0024
	Virtual	1477	2165	0.0020
Livigno	Ecosystem	751	2740	0.0097
	Real	468	1388	0.0127
	Virtual	283	566	0.0142

For all destinations the networks of core tourism stakeholders (accommodation, travel agencies, restaurants, associations, consortia etc.) were assembled from lists provided by the local tourism boards together with those formed by their websites. In these networks the links between the different actors were uncovered following the methods extensively described in Baggio et al. (2010b). In short, connections due to commercial agreements, co-ownership, partnerships, membership in associations or consortia as uncovered by consulting publicly available sources (listings, management board compositions, catalogues of travel agencies, marketing leaflets and brochures, official corporate records, etc.). All data have been also validated via in- depth interviews to knowledgeable informants (directors of tourism boards, directors of associations, tourism consultants).

It is straightforward to think that there is a qualitative difference in the links between real and virtual elements of the network and that, when information diffusion is concerned, this translates into a difference in transmission speed. To render this difference a weighted version of the networks was prepared in which we arbitrarily assign value 1 to a link between two real nodes, 2 to a link between a real and a virtual node and 3 to a link between two virtual nodes.

Here we continue the preliminary analysis presented in Baggio and Del Chiappa (2013a; 2013b) and discuss two topics, the structural integration of the real and virtual components and the diffusion and synchronisation of opinions. The methods used belong to the class of spectral methods. The rest of this section discusses briefly the methodological bases for this analysis.

3.1 Opinion diffusion and synchronisation

Spreading an opinion is a process that has been studied in innumerable ways. For what concerns our cases we can use an epidemiological modelling approach (Danon et al., 2011; López-Pintado, 2008). Such models consider the individuals in a group (population) as susceptible (S) to an infection. They could then be infected (I) and finally recover (R) from infection when acquiring some form of immunity or simply become susceptible again. The infection can well represent the acceptance of an idea or a message. For what concerns information or opinions suitable models are those that consider the S and I. A first one (simple) is termed SI model. It posits that susceptible individuals, when exposed to a piece of information accept it and become infected. They remain in this state until the end of the process. A second one, more elaborated, is the SIS model. Here individuals, once accepted what transmitted, have a probability to *forget*, which can mimic the case in which news become uninteresting, or information obsolete, or some other event induce a change in an opinion previously accepted. This model has a well-known threshold τ_C which depends on the (average) capacity of individuals to infect others. The infection process dies when the infectivity $\tau < \tau_C$. All these processes are obviously also depending on the number and the distribution of the relationships existing in the population.

Another proposal for understanding the spreading of opinions is to treat consensus as a peculiar form of synchronisation, a phenomenon which has been very well studied in different contexts by means of simple and effective models. The most popular is the one of Kuramoto (1984). Here the elements of a system are thought of as collection of oscillators coupled to each other. Each oscillator has an intrinsic frequency and a characteristic phase that might be seen as representing the individual’s opinion. Linkages between individuals are given a value which constitutes a coupling between the oscillators. Here too it is shown that when the coupling K is greater than a critical coupling K_C, which depends on the system configuration and characteristics, the whole system synchronises and all elements oscillate with the same phase, that is: a general consensus is reached and opinions are aligned (Arenas et al., 2008; Pluchino et al., 2005).

3.2 Elementary spectral graph theory

Spectral graph theory is a branch of algebraic graph theory that studies graph properties such as connectivity, centrality, and clustering by using the methods of matrix analysis. Moreover, spectral graph theory has proved quite effective for the investigation of network dynamic processes such as epidemic diffusion or synchronisation (Van Mieghem, 2010).

Let us consider an undirected network. Usually it is rendered as a geometric abstract object called graph made of points (nodes, vertices) and lines connecting them (links, edges). More formally a graph is a pair $G = (V,E)$, where V is the set of vertices and E is the set of links: ordered couples (V_a, V_b) of vertices. Such a graph can also be identified by a symmetric $n \times n$ matrix A_G, called adjacency matrix, whose elements are defined as:

$$A_G(i,j) = \begin{cases} w & \text{if } \{i,j\} \in E \\ 0 & \text{otherwise} \end{cases} \tag{1}$$

w is the weight associated to the link. For an unweighted network $w = 1$.

For a square symmetric matrix, given a non-null vector x, if it is possible to find a scalar λ such that $Ax = \lambda x$, λ is called *eigenvalue* for A and x is the corresponding *eigenvector* (Lang, 1970). The eigenvalue satisfies the equation: $(A - \lambda I)x = 0$ which has nontrivial solutions if and only if: $det(A - \lambda I) = 0$. The latter is known as the characteristic equation of A (and the left member characteristic polynomial). There exist exactly n roots (not necessarily distinct) for this polynomial therefore an $n \times n$ matrix has n eigenvalues and n associated eigenvectors (each one having n elements). If the matrix is real (i.e. all its elements are real numbers) and symmetric (undirected network), its n eigenvalues $\lambda_1, \lambda_2, \ldots, \lambda_n$ are the real roots of the characteristic polynomial. The ordered set of the eigenvalues for A is called the *spectrum* of A: $sp(A) = \lambda_1, \lambda_2, \ldots, \lambda_n$ *with* $\lambda_1 \geq \lambda_2 \geq, \ldots, \geq \lambda_n$. The largest eigenvalue λ_n (also principal or dominant) is termed spectral radius.

A second matrix can be defined. Let D be the degree matrix, a diagonal matrix associated to the adjacency matrix A_G, whose elements are defined as:

$$D_G[i,j] = \begin{cases} \sum \deg(i) & \text{for } i = j \\ 0 & \text{otherwise} \end{cases} \tag{2}$$

Then it is possible to define the Laplacian matrix: $L = D - A$. L is a symmetric $n \times n$ matrix (n = order of the graph G):

$$L_{ij} = \begin{cases} \deg(i) & \text{if } i = j \\ -w_{ij} & \text{if } i \neq j \end{cases} \tag{3}$$

(w_{ij} = weight of the edge *ij*, for an unweighted graph: $w=1$ for all the edges; in all weighted cases *deg(i)* is the sum of the weights for the nodal links).

L is a real and symmetric matrix, therefore all its eigenvalues (μ_i) are real. If the network is not fully connected, the multiplicity of the null eigenvalue equals the number of the connected components in *G*. The spectrum of *L* is called the *Laplacian spectrum* of the network (Mohar, 1991).

Eigenvalues and eigenvectors (both adjacency and Laplacian) of a graph are closely connected to its structural characteristics; they *summarise* its topology (Restrepo et al., 2006). More precisely, eigenvalues contain global information about the network, while eigenvectors contain local (nodal) information. This is the case, for example, of a number of nodal metrics such as eigenvector centrality (Bonacich, 1987), Katz centrality index (Katz, 1953) or PageRank (Brin & Page, 1998), all calculated from the principal (largest) eigenvector of the adjacency matrix. The spectral analysis of the adjacency and the Laplacian matrix of a network can be a useful, and in many cases computationally more efficient, method to derive its main parameters. Among the many interesting conclusions of the wide body of studies in spectral graph theory we use here two results.

The first one deals with the identification of communities in a complex network. This is done by using the eigenvector associated to the second smallest eigenvalue of the Laplacian spectrum μ_2. This is called Fiedler vector (after Fiedler, 1973), and renders, through its visual plot, the algebraic connectivity of the network. In essence, when sorting the vector in increasing order and plotting its values along with their rank index number, well separated modules, that are weakly linked between them, can be identified by looking at the gaps in the plot (Fortunato, 2010). An example is given in Fig. 1 where an artificial network with two well defined components have been generated.

The second important result concerns the spectral radius, the largest (principal) eigenvalue of the adjacency matrix λ_N. This plays a crucial role in controlling the two dynamical processes described above: diffusion and synchronisation. In fact, it is found that the critical threshold for a SIS epidemic diffusion τ for an undirected graph is $\tau = 1/\lambda_N$ (Chakrabarti et al., 2008). For what concerns synchronisation a similar result holds for the critical coupling that turns out to be: $K_C \propto 1/\lambda_N$ (Restrepo et al., 2005).

No matter how we model the spreading of opinion and the establishment of a consensus, the largest eigenvalue of the adjacency matrix shows the properties of these processes on a complex network: the higher its value the lower their critical thresholds, or: the higher its value, the easier is to inform and *convince* the actors in a complex social network.

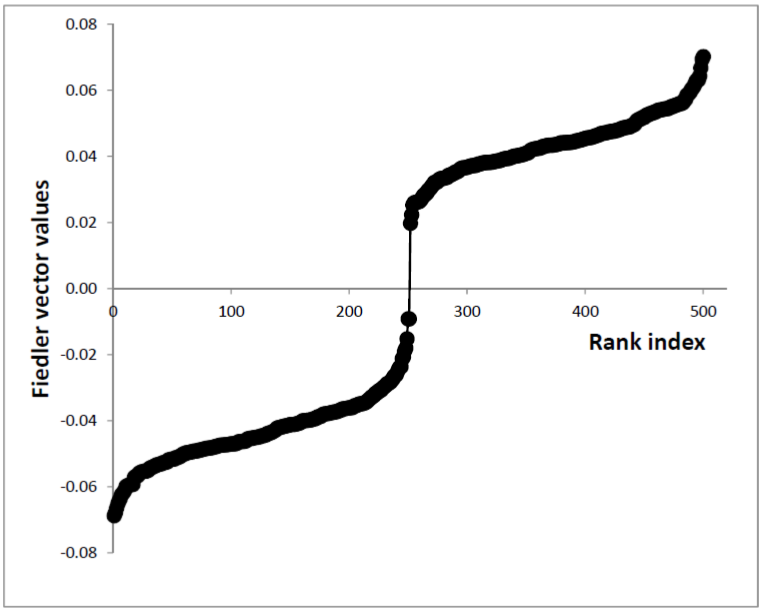

Fig. 1. Fiedler vector plot of an artificial network composed of two well defined communities

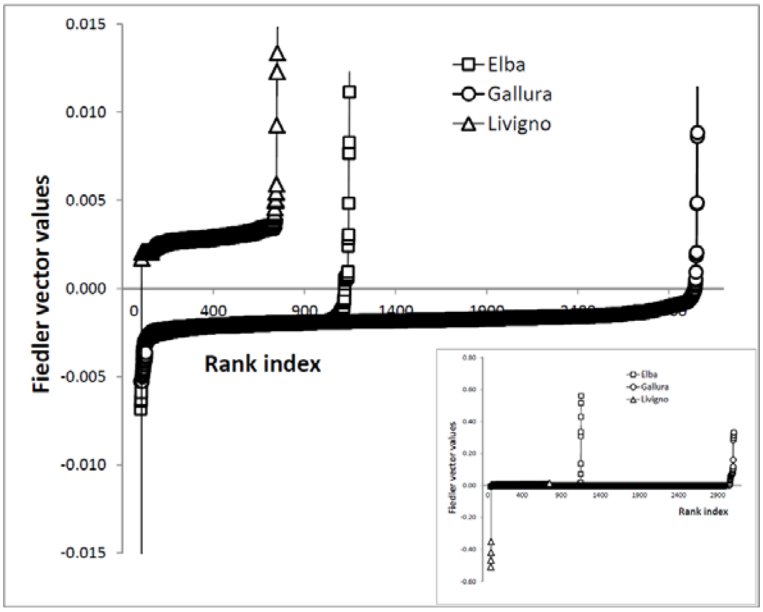

Fig. 2 Fiedler vector plot of the three digital ecosystems (for better readability only the central parts of the spectra are shown, inset contains the full graph)

4 Results and discussion

Fig. 2 shows the plot of the three ecosystems' Fiedler vectors with respect to their rank index when sorted in ascending order (for the sake of simplicity only the values for the unweighted networks are shown, those for the weighted versions follow the same shape).

The comparison with Fig. 1 is quite clear. No trivial division in modules can be made. This reconfirms the results reported in Baggio and Del Chiappa (2013a; 2013b) and gives a stronger argument to the idea that there is a strong coupling between the real and the virtual component of the systems examined. In fact, those results were obtained by employing a stochastic algorithm that, even if know and proved, is subject to statistical fluctuations thus containing a certain margin of error. Here the spectral analysis renders full information about the structural characteristics of the network. Therefore, the method (and this analysis) may be considered more reliable and trustworthy.

Table 2 contains the values for $1/\lambda_N$ (the inverse spectral radius) calculated for all the networks examined.

Table 2 The inverse spectral radius for all the networks examined

	Weighted Ecosystem	**Ecosystem**	**Real**	**Virtual**
Elba	0.0292	0.0430	0.0434	0.0899
Gallura	0.0167	0.0433	0.0437	0.0503
Livigno	0.0194	0.0354	0.0428	0.0776

The values for the whole ecosystems are lower than those of their components and the minimum is attained by the more realistic model given by the weighted networks. This reconfirms the idea already put forward that the combination of real and virtual elements in a single well integrated system provides a more efficient substrate for the spreading of ideas or the reaching of a common agreement on some issue.

If we combine the results presented here with those discussed previously (Baggio & Del Chiappa, 2013a; 2013b), we have a stronger indication of the crucial and central role of the technological manifestations of tourism firms in a destination in shaping its characteristics.

5 Concluding remarks

The idea that today, in a group of organisations, and even more when these are parts of a system such as a tourism destination, the real and the virtual aspects play together in a fully integrated way is not new. Up until now many studies have shown this strict relationship, but only recently the concept of digital business ecosystem has been formally examined in a tourism context.

Here we have examined again the structural characteristics of a tourism digital ecosystem by using a different method. The spectral characteristics of the networks examined confirm the idea of structural strong cohesion between the real and the virtual components of a destination.

In these systems, as known, the diffusion of information and the reaching of a consensus on opinions that may be derived from policy measures devised by the destination governance entities is a crucial process. Here, with the aid of established algebraic methods we have shown how the ecosystem is more efficient in this regard, in agreement with the general results already obtained (Baggio & Del Chiappa, 2013a; 2013b).

Besides the theoretical interest, these results are important for anyone interested in the life and the development of a tourism destination. In fact, our study suggests that the setting of a good strategy needs effective communication channels that can be exploited when the basic mechanisms for achieving the desired level of knowledge and agreement are well understood. Moreover, as already discussed in other works (see e.g. Baggio & Cooper, 2010), numerical simulations can be employed in order to find the most efficient configurations for ensuring an optimal *persuasion* dynamics.

This is important because while active participation and involvement of stakeholders in a strategic planning process is beneficial, a wide consensus does not necessarily translate into positive organisational results. In fact, in dynamic environments, higher levels of consensus may lead to lower levels of organisational performance. Thus, in such dynamic environments, it is more appropriate to allow stakeholders good autonomy in their strategic decisions to face the diverse situations and circumstances that might arise. Pressing for full consensus across functional strategies in dynamic environments can be costly and actually result in poor overall organisational performance (Kellermanns et al., 2005).

In this regard we think it would be quite interesting and useful to investigate more deeply the inter-organisational information, opinions and knowledge transfer and the relationship between the role and level of strategic consensus in a tourism destination and how this can affect its overall performance.

Aside from the theoretical and managerial contribution of the study, as with all research, there are limitations. The present study argues that the higher is the value of the eigenvalue of the adjacency matrix the easier is to inform and convince the actors in a complex social network. However, it should be noted that many further mediating elements may work in order to link those actors. Further research, would be needed to deepen investigate the nature of such elements and their influence on the process of information sharing and consensus development.

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