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The value of collaboration in the tourism domain has been highlighted in numerous works. Coordination of joint activities in tourism destinations is a prerequisite for enhancing the value creation process and providing a good basis for the attractiveness and development of the destination. Destination managers are called to design efficient and effective strategies for improving collaboration in their areas. To do that, they need reliable ways to measure the phenomenon. Traditional methods are reputed to be relatively ineffective for their intrinsic biases. However, network science can provide, instead, trustworthy ways for this task. This paper describes some of the most relevant network analytic techniques and discusses the most important precautions to achieve reliable outcomes.

Key Words: collaboration, cooperation, tourism destination, network science

Introduction and Background

Collaboration, cooperation, coopetition, in short, any form of working together in general or on specific projects or activities is a fundamental determinant for the success particularly in a tourism destination. No wonder, then, that the scientific literature on this subject has been quite vast and has produced a wealth of studies, investigations analyses, both theoretical and empirical on the significance and the effects of such phenomena (Fyall *et al*., 2012; Nguyen *et al*., 2022; Wang & Krakover, 2008). The issue is even more relevant when islands are considered. Their generally small size and the relative ‘isolation’ produce some peculiar characteristics for social groups and their relationships.

An island, in a sense, is a world by itself; a miniature universe comprising some special kind of community, society, ecology, and economy. It promotes a profound sense of identity among its peoples, different from others across the sea. Research has shown that island communities have distinct characteristics derived from their spatial nature. Insularity, isolation, and peripherality give rise to some peculiarities in the composition and the behaviour of the social system. As literature has described, among the most relevant we find; cultural homogeneity and social community cohesion due to limited space and population; interdependence of individuals for the relative isolation and scarcity of resources; strong environmental awareness due to the limited space and the impact of geography, traditions and rituals tied to the local history or cultural practices that shape social interactions. The strong social bonds and interrelations are also the reasons for the often-exhibited good resilience of small island societies (Fernandes & Pinho, 2017; Vogt *et al*., 2016).

Additionally, when the impact of tourism activities is relevant there may be contrasts between local community and the temporary population of visitors. Moreover, geographical features like low accessibility and small size strongly affect economic and social progress, calling for a careful consideration of key socioeconomic indicators to gauge the degree of insularity. Insularity, thus, transcends a mere geographical status, involving the interplay between geographic conditions and the reactions of political, social, economic, and cultural peripheralisation. These factors shape the attractiveness of islands, influencing their economic and social development. Insularity also influences local governance. Robust social ties and community engagement often facilitate rapid and effective decision-making, involving people in both policy formulation and implementation even if, sometimes, the proximity between institutions and stakeholders may lead to clientelism and conflicts of interest (see Deidda, 2016; Nel *et al*., 2021; Grydehøj & Hayward, 2014).

Independently from the environment in which a destination is embedded, assessing the extent of collaboration is, as said, of paramount importance for an effective examination of the strategic planning and policy setting. In the past, and today, this assessment is mainly conducted by using a series of methodological approaches that can be defined as predominantly qualitative in nature (a typical example is that of Palakshappa & Ellen Gordon, 2006). The most common instruments are surveys, of different forms, but all essentially asking the interviewees to judge the level and the quality of collaboration among the different stakeholders thus collecting their *perceptions* about the topic at hand. This typically involves asking respondents about their firm's involvement in various collaborative activities, such as joint research and development, co-marketing, and supply chain partnerships. Respondents are usually also asked to rate their level of agreement with statements about their organisation's collaboration activities or to provide quantitative estimates of the frequency or intensity of these activities.

However, as is well known, this way of analysing the issue is subject to a strong bias, even if respondents honestly believe they are giving objective answers (Pronin *et al*., 2002; Pronin *et al*., 2004). A quantitative and impartial way of assessing collaborative characteristics is thus needed (Qiu *et al*., 2024). This may come, as recent literature well shows, from the use of network analysis methods, justified by the fact studies of relational connections have provided numerous ways to fulfil satisfactorily the task.

The aim of this paper therefore, is to describe several possible ways to study collaboration in a tourism destination system.

Network Analysis in A Nutshell

When dealing with a complex dynamic system such as a tourism destination, the study of its structural and dynamic properties is of great importance for understanding the composition and the behaviour of the different parts and how they influence and are influenced by the different dynamic processes that are at play (Baggio & Sainaghi, 2011; Baggio, 2008). Since such systems are made of several elements that interact, often in nonlinear and sometimes unpredictable ways, it is natural to resort to a network representation.

By mapping the network of interactions between the components of a system, a topological network (structural) analysis can reveal patterns and relationships that would be difficult to discern by analysing the individual elements. Network analysis has been applied to a wide range of fields, including social networks, transportation networks, and biological networks. In the context of destination management, network analysis can be used to provide several outcomes such as:

- identify key players and stakeholders.
- understand information and knowledge flows, highlighting areas where information is being shared effectively and identifying potential bottlenecks.
- design and evaluate management strategies, by simulating the potential impact of different management strategies, allowing destination managers to make informed decisions about resource allocation and policy development.

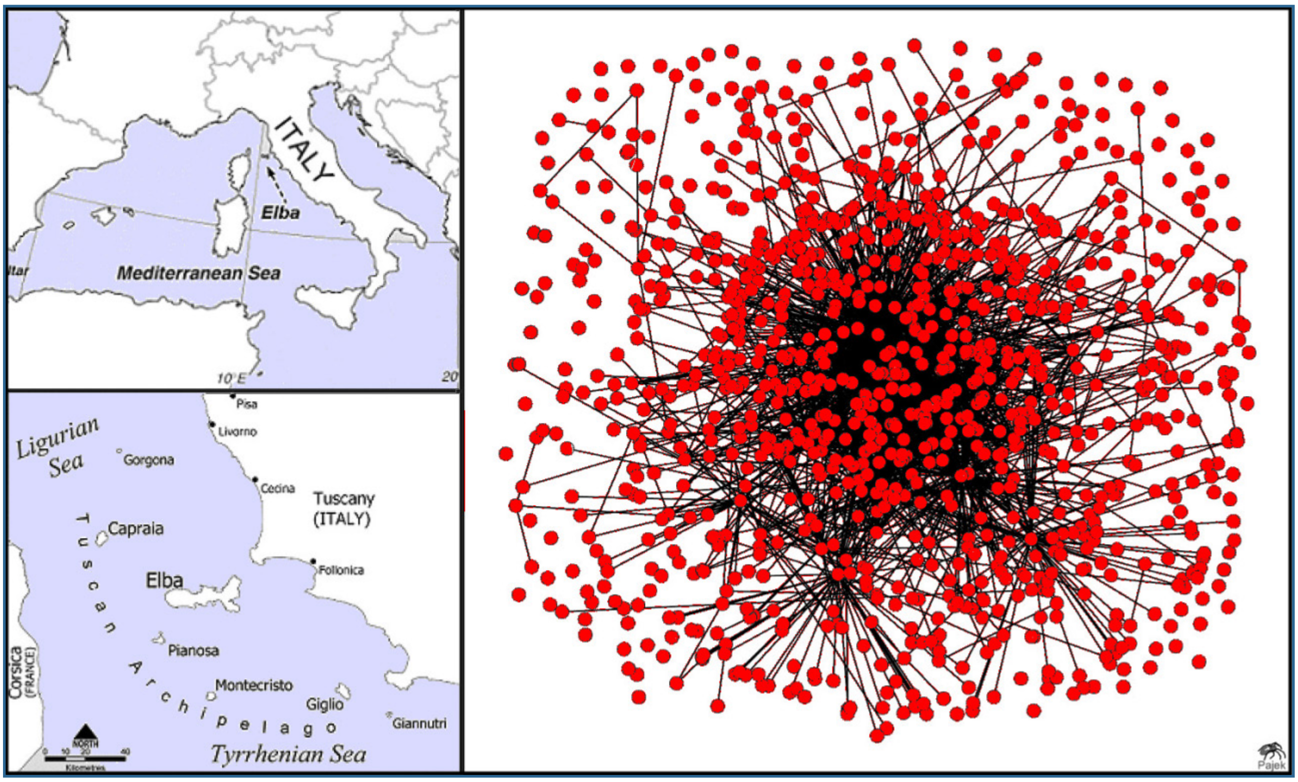
And, to focus on what interests us here, network analysis can assess levels and quality of collaboration, helping to reveal patterns and relationships that would be difficult to discern by analysing the perceptions of individual elements (Baggio, 2011).

A thorough network study evaluates the system at three levels (Baggio, 2020):

local (microscopic): This level focuses on the properties of individual components (nodes) in the network. Relevant metrics include degree (number of links), clustering coefficient (density of links between neighbours), closeness (ability to reach other nodes), betweenness (role as connector between different areas of the network), and overall influence (derived from the principal eigenvector of the adjacency matrix).

intermediate (mesoscopic): This level examines sub-structures such as modules (groups of nodes with high connectivity) and hierarchies in the network topology. Other mesoscopic structures are motifs or

Figure 1: The Italian Elba Island and the Network of its Tourism Destination
(network picture adapted from Baggio *et al*., 2010)



graphlets, patterns of connections involving small subsets of nodes.

global (macroscopic): This level focuses on large-scale topological characteristics such as the statistical distributions of local metrics and the degree distribution, which describes the ability of the system to react to dynamic processes. Many real and artificial networks exhibit a power-law degree distribution, indicating that a few nodes have many connections, and many nodes have few connections. Other global measures include average path length (average distance between any two nodes), diameter (longest distance between any two nodes), correlations between different metrics, and the average values of microscopic metrics over the whole network.

The many measurements defined for quantifying the various network features offer rigorous quantitative evaluations that describe the characteristics and the dynamics of the systems. Their detailed definitions can be found in the vast literature of network science (Coscia, 2021; Cimini *et al*., 2019; da Fontoura Costa *et al*., 2007).

Network science, as it is known today, relies on the strong and rigorous theoretical framework of statistical physics, which uses quantiative methods and probability theory for analysing large assemblies of microscopic entities and to derive the macroscopic properties of these assemblies. Most of the techniques used for the analysis of a network are rooted in the mathematical branch of graph theory.

Measuring Collaboration: The Network Analytic Approach

The first step, obviously, is to prepare a suitable network model for a destination(Figure 1). The data can be collected in several ways, usually the start is a survey in which the different stakeholders are asked to list their main contacts and, possibly, the importance or intensity of the relationship. Another more valid source is the virtual representation of the destination, the websites of the various entities (operators, associations, public bodies, etc.). Hyperlinks connecting such stakeholders have been shown to be a reliable and significant sample. To all this we can add membership listings from associations or consortia, official records on co-ownerships, and so on (see e.g. Baggio, 2022).

Measuring Collaboration: Method 1

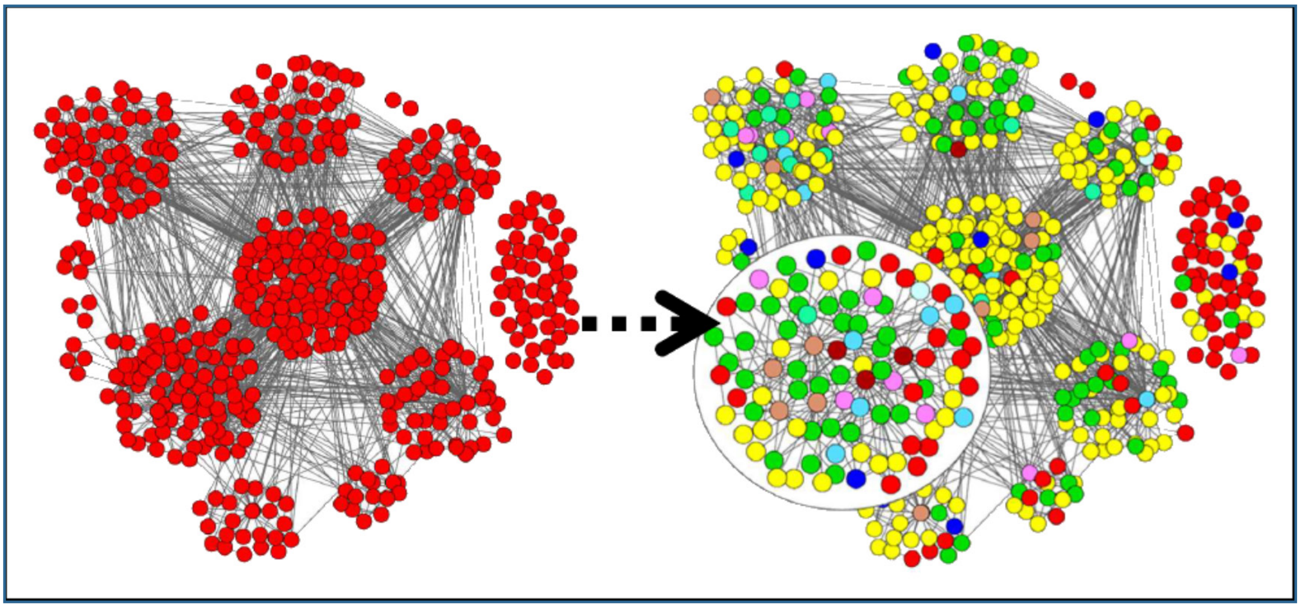
The first, simple, assessment can be made by using two global network metrics: clustering coefficient and assortativity. The clustering coefficient is essentially a measure of how densely connected the network is around any node, the average of these values provides a quantitative evaluation of the extent to which the destination stakeholders work together forming cohesive communities. Assortativity or assortative mixing, is a preference for a network's nodes to attach to others that are similar in some way. In other words, nodes with many connections (high degrees) tend to connect to one another; the same occurs for nodes with low degrees. The assortativity coefficient is the Pearson correlation coefficient of degrees between each node and its neighbours. A positive value (assortative network) is common in many social and socio-economic networks, although it also appears sometimes in different systems. It is easy to see then that high-degree nodes in assortative networks tend to form a core group. Among other things such core groups provide robustness to the network. For their nature, the clustering coefficient can be thought of as a static measurement, while the assortativity coefficient can be interpreted as expressing the tendency to form collaborative communities (Baggio, 2007).

Measuring Collaboration: Method 2

A collaborative group is a community of entities (people, companies, businesses etc.) who join their efforts and knowledge around a specific issue to achieve some predetermined goal(s). When it comes to unveil these communities, network science has developed quite a few methods for this task.

In many instances, a complex network displays a certain form of internal structure. Local subgroups may exhibit a denser connectivity among their elements (nodes) while maintaining less dense connections with nodes outside the group. The examination of this modular organisation of communities has garnered scholarly interest, as communities are a prevalent feature in numerous real-world networked systems and play a pivotal role in comprehending their structure and behaviours. Numerous approaches have been proposed for identifying these subgroups (also called modules, clusters, or communities). These approaches rely on numerical algorithms capable of detecting topological similarities in the local linking patterns. Regardless of the specific method employed, all of the approches utilise a metric known as the modularity index to assess the effectiveness of the outcomes. In essence, the modularity index (denoted as Q) represents the fraction of all links

Figure 2: Modularity Analysis of Livigno Destination Network
(From Sainaghi & Baggio, 2014 - showing how different communities are composed (right picture) of entities of different types of business: hotels, services, restaurants, cultural establishments etc. identified by colours)



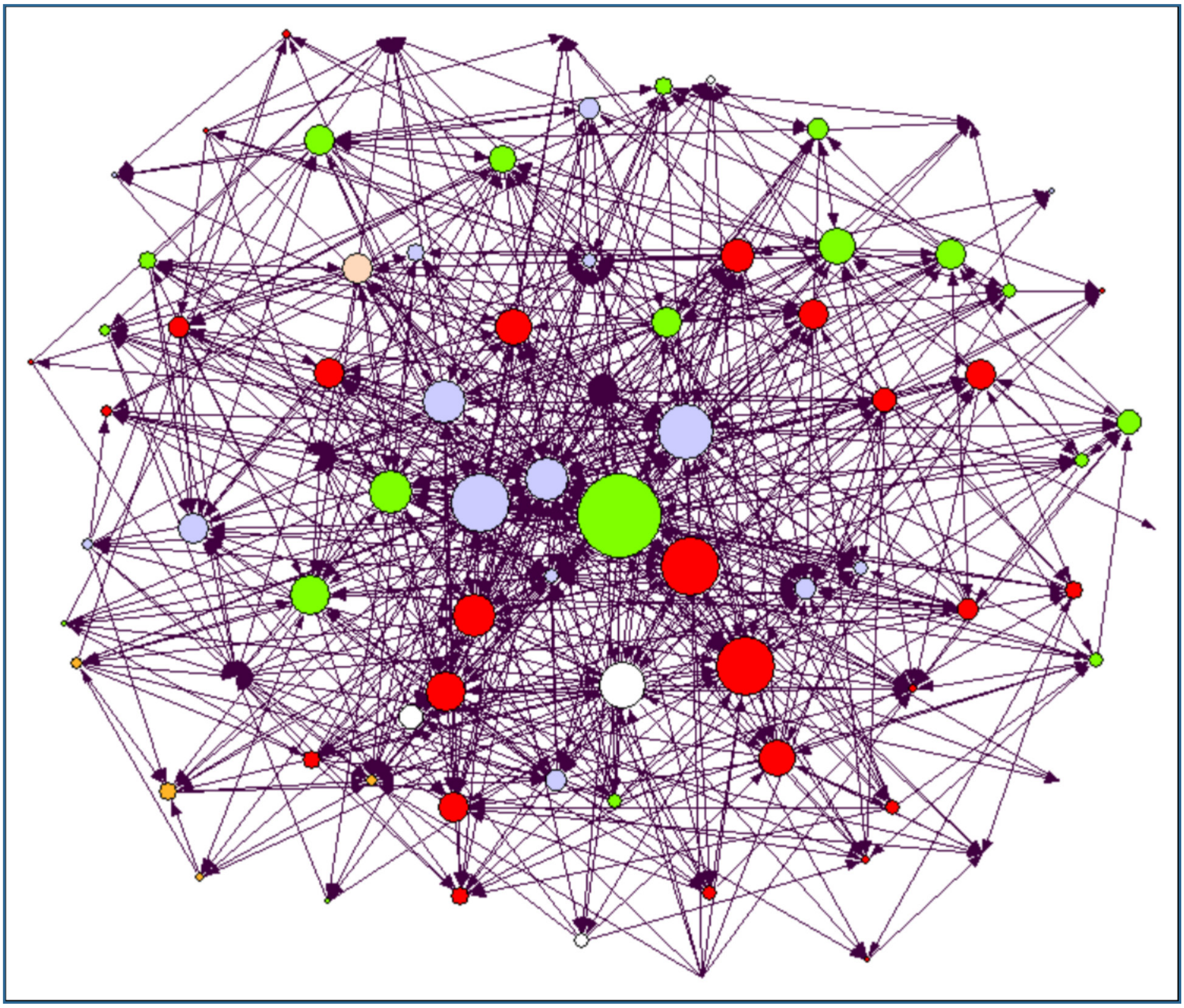
within a community minus the expected value of the same quantity that would be observed in a graph with nodes possessing the same degrees but featuring a random distribution of links (Souravlas *et al*., 2021; Javed *et al*., 2018; Fortunato & Hric, 2016).

In a destination, traditionally, we divide the stakeholders into communities by type of business (hotels, restaurants, attractions, intermediaries etc.) or by geographic location. If we calculate the modularity index with such a subdivision, we typically find very low values and, moreover, the inspection of one of these modules can result in very low levels of connectivity. Instead, tourism destinations, as complex adaptive systems, exhibit significant self-organising properties, leading to the emergence of informal communities that can efficiently and effectively be unveiled by using one of the stochastic modularity analysis algorithms. A quantitative assessment thus, provides a way to better and more reliably understand the natural internal structure (Figure 2).

Complex tourism destination systems are inherently challenging to manage. Rigid deterministic attempts to control them are likely to fail due to the strong self-organising tendencies, so that an adaptive approach, characterised by flexibility and responsiveness to internal and external changes, emerges as the most effective strategy for managing tourism destinations.

In summary, traditional classification methods for defining communities within tourism destinations prove inadequate due to the self-organising nature of these systems. Instead, a network-based approach, allows

Figure 3: San Vito Lo Capo network
(Size represents the brokerage degree of the node while different colours mean different business types)



capitalising on the spontaneous characteristics of these complex systems and offers a more effective governance paradigm.

Measuring Collaboration: Method 3

Besides the considerations made so far about the assessment of the collaboration level in a destination we might think of looking at the role each actor plays in fostering collaborative practices, acting as brokers for this function. A recent paper (Ruggieri *et al*., 2022) suggests a possible way of performing this analysis. The network studied is a directed network built by enumerating the commercial links between the companies present in a small Italian destination (San Vito Lo Capo in Sicily). A company is a broker when it facilitates the flow of resources or information between two other companies that are not directly connected. To analyse the brokerage activity, two nodes (*a,b*) are considered together with the minimum flow (Z_{ab}) between them. A third node (*c*) connected to them is a broker if the flows between *ac* or *cb* is greater than the one between *ab*, that is if $min(Z_{ac}, Z_{cb}) > Z_{ab}$.

Combining all the instances in which a node acts as a broker it is possible to calculate a brokerage degree that allows identification of the most relevant contributors to the destination's collaboration level (or those who contribute less, see Figure 3), thus providing useful information for designing policy actions.

Measuring Collaboration: Issue 1

Collaborating with one another has, obviously, a cost, related to the efforts and the resources needed to establish and maintain the relationship. An understandable question then arises. Do we need to work towards a complete set of linkages among the stakeholders of a destination or is there an optimal configuration? It is possible to answer the question by considering two computable quantities starting from the network model of the destination under study. The links can be assigned a weight representing this cost (even arbitrarily, provided there is a consistency in its definition) and combining these costs gives a measurement of the efficiency, at a global and individual level. This efficiency represents the capacity of the actors (or the whole network) to exchange knowledge or information. We then calculate these quantities for different configurations starting from networks with disconnected communities to a completely connected one and can find the region in which there is an optimal solution (see an example in Figure 4).

Measuring Collaboration: Issue 2

In what is written thus far, the term collaboration has been used, but, as known and as said at the very beginning of this paper, stakeholders of a destination can assume many different forms and can be of different intensities. The quantitative analysis methods described so far can only signal the level to which the phenomenon exists but cannot provide the type - that can only come from an independent, qualitative investigation.

This consideration takes us to a second, important, issue: the necessity of not relying exclusively on the quantitative analyses discussed so far. Network analysis is an area in which, as already well demonstrated by **much** literature, purely qualitative or purely quantitative

Figure 4: Optimisation of Costs/benefits as Function of Separation Between Communities in a Synthetic Network

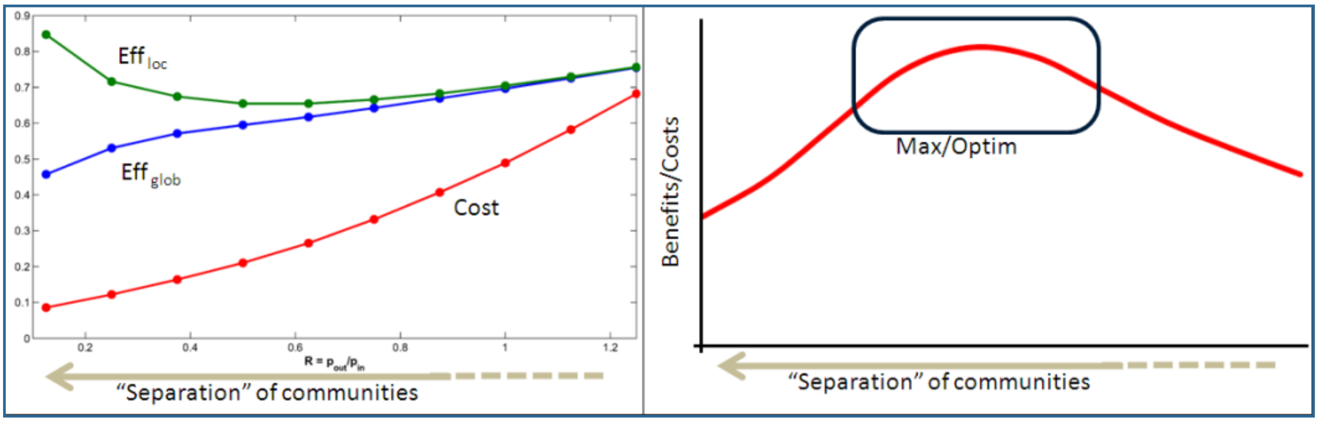
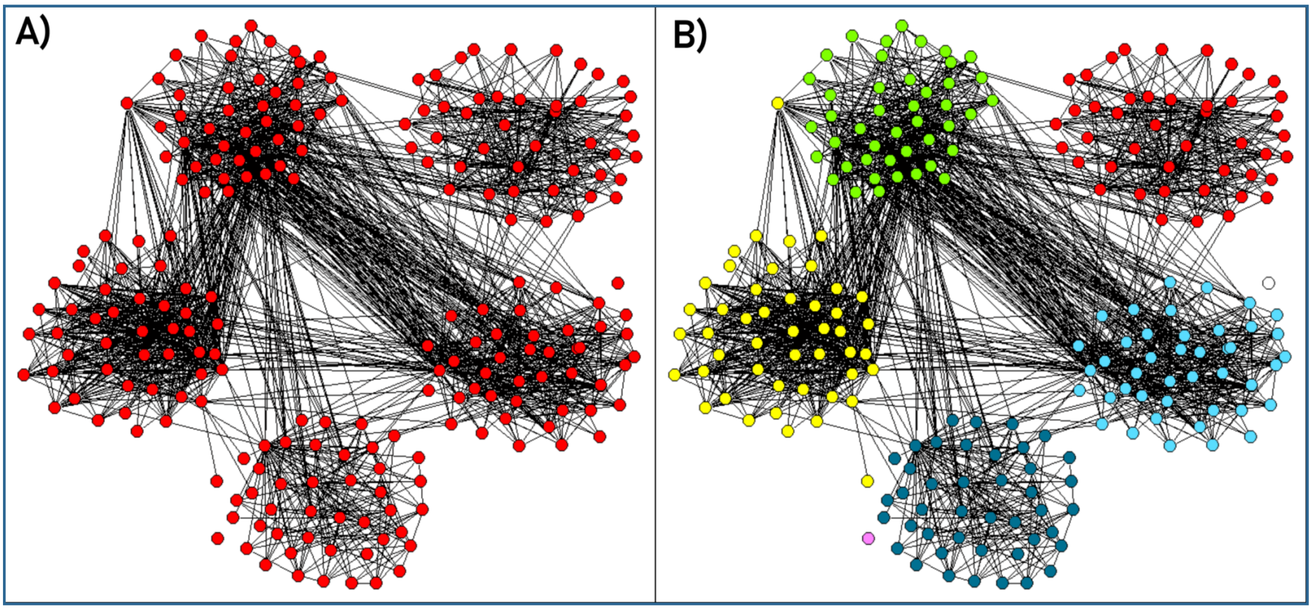


Figure 5: Communities of the Beskid Five Network (A) as Identified, and Coloured (B) by municipality



studies may display strong limitations, suggesting the need for a mixed-method approach (Mariani & Baggio, 2020; Williams & Shepherd, 2017; Varga, 2018).

One more example comes from a study of the hospitality sector in the city of Rimini, one of the most popular Italian tourisms destinations (Mazza *et al*., 2021). The survey reported, among other elements, a general perception of limited or poor collaborative atmosphere. However, analysis of the network built by using the same survey shows a relatively good connectivity. A largest connected component containing 85% of the nodes and a modularity index Q = 0.662 tell us that at least the system possesses a good communication infrastructure and that the collaboration among the hospitality organisations might be much higher than what is perceived by the hoteliers.

Great care must be taken when interpreting the results of a network analysis, which should always be confirmed by a careful investigation of the case studied. The following example is enlightening; an examination of Beskid Five, a group of five municipalities located in southern Poland (Czernek-Marszałek & Majewska, 2019). The five areas joined their efforts with the aim of integrating their tourism industries to achieve the greatest possible benefits and create the best offer for tourists. The quantitative analysis of the combined networks shows a relatively appropriate configuration. The network is well connected (the largest component contains 99.1% of the nodes), the average clustering coefficient is a good value: 0.524 as is the modularity index Q = 0.578, within the five communities. However, when looking more closely at the composition of these communities we find them coinciding, almost exactly, with the five oritinal municipalities (Figure 5).

In other words, the inter-destination (inter-municipal) cooperation, although relatively noticeable, mainly concerns entities located within each municipality, with very little interactions with the others, despite the intentions and the claims. This should give destination managers some indications of the need for a more effective design of common strategies.

The measures and the issues discussed above are summarised in Table 1.

Simulations and Optimisation

One of the benefits of representing a complex system as a network is the possibility to run numerical simulations. These allow experiments to be performed in situations where they would not be feasible otherwise for theoretical or practical reasons. Different arrangements can be devised, and several dynamic processes tested to

Table 1: Network Analytic Measures and Issues		
Network Level	**Measure**	**Issues**
Local	brokerage degree	
Intermediate	modularity analysis	cost/benefit optimization of communities
Global	average clustering coefficient and assortativity	quantitative and qualitative analysis of internal structures

better understand how the configurations influence the processes. Simulation techniques have a good tradition in social sciences (Axelrod, 2006; Baggio & Baggio, 2020). Their credibility is good provided some basic requirements are met: a solid conceptual model and a thorough consideration of the settings within which they are run (Graebner, 2018; David *et al*., 2017). With these conditions, simulations can easily reproduce different types of processes and may be regarded as a valuable aid in decision making or scenario planning (Stauffer, 2003).

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 (Ferrer I Cancho & Solé, 2003; Paul *et al*., 2004; Lindquist *et al*., 2009). Typically, the procedure can be roughly described as an optimisation algorithm in which:

- the 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 optimised until the desired objective is met.
- the dynamic process is run.

The outcomes are compared with that of the original configuration and the modification is accepted if an enhancement is detected. This procedure is then repeated until the desired level of improvement is reached.

These optimisation techniques can be of great value for a destination manager allowing the exploration of different possible scenarios and informing high-quality rational response strategies that balance economic and societal considerations.

Policy Remarks

This paper uses the network analytic approach to evaluate collaborative practices within the intricate web of a tourism system and underscores the relevance of such an undertaking. As the tourism industry evolves and becomes increasingly complex, effective collaboration among diverse stakeholders emerges as a linchpin for ensuring a balanced and uninterrupted development of tourism activities. An interesting finding from this exploration is recognition of the limitations inherent in traditional methods of measuring collaboration. These conventional approaches have a natural tendency that is a clear signal to switch to more reliable and objective methodologies. Through a review of network analytic techniques, the article presents a promising alternative that identifies and attempts to overcome the constraints embedded in conventional measurement approaches.

The expectation in this discussion extends beyond the academic sphere, with the hope that this innovative approach will permeate the broader community of practitioners. Integrating network analytic methods into the intricate tapestry of real-world tourism scenarios requires a total synergy between theory and practice.

In support for integrating network analytic concepts and methodologies into academic programs, this article suggests an educational framework that ensures the upcoming generation of tourism professionals is well-versed in applying these approaches in practical settings. Cultivating collaborative initiatives within the tourism industry encourages stakeholders to forge partnerships and engage in joint projects, fostering a culture of openness and shared insights. An iterative approach to policy optimisation using network analysis is endorsed, encouraging policymakers to regularly reassess and adjust collaborative strategies based on continuous monitoring and evaluation of network dynamics. This adaptive methodology ensures that policies remain responsive to the evolving landscape of tourism. Through policies and methodologies, destinations can encourage a collaborative ecosystem that identifies and actively addresses the complexity of the tourism industry. The seamless integration of evidence-based insights and adaptive policies contributes to developing more resilient, sustainable, and successful tourism systems.

Concluding Remarks

The objective of this paper was to describe the network analytic approach to the assessment of collaborative practices in a complex tourism system. The issue is of great relevance, as is well known, for the role played in ensuring a balanced and uninterrupted development of tourism activities. It has also been shown that there are many traditional ways for measuring this phenomenon which cannot be completely trusted for their intrinsic biases. Several techniques have been discussed along with some warnings necessary for a correct and reliable use of these techniques. The hope is that this way of approaching the problem could spread among academic and practitioner communities, and provide the possibility of designing more rational and effective means for the difficult task of setting good strategies and policy measures.

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