The effects generated by events on destination dynamics and topology

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Abstract

This study investigates the effects generated by a mega-event (the World Expo 2015) on a destination (Milan), using network analytic methods. The horizontal visibility graph was used to transform the time series into a network. Two hypotheses are tested: first, the ability of the Milan Expo to generate a turning point; second, the ability of this event to increase the system's stability. The findings are based on a longitudinal analysis (2004–2017) of three widely used metrics: occupancy, average daily rate, and revenue per available room. The empirical pieces of evidence confirm both hypotheses. The Milan Expo has generated a positive turning point increasing the system stability. In the conclusion section, some theoretical and practical advancements are proposed, along with the implications for future research, and the main study limitations.

Keywords

Milan Expo; complex theory; network topology; system dynamics; horizontal visibility graph; turning points.

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1 INTRODUCTION

The destination is a relevant system for tourism researchers and practitioners (Buhalis, 2000). Pearce (2014) identified five different theoretical streams contributing to defining the destination concept: industrial districts, clusters, networks, systems, and social constructs. The presence of so many different theoretical streams is related to the complexity of the constituent elements of a destination and the presence of different governance mechanisms (d'Angella, De Carlo & Sainaghi, 2010) able to create some destination capabilities (Sainaghi, De Carlo, d'Angella, 2018). In a supply-side perspective (Leiper, 1990; Smith, 1988), a tourism destination is composed of hundreds of actors and organizations, described as co-producers of the destination product (Sainaghi, Phillips & d'Angella, 2019). The destination creates a favorable context for the start-up of new firms (Campopiano, Minola & Sainaghi, 2016). This complexity is well reflected by some theoretical streams used to analyze the destination, such as the industrial district approach (Dredge, 1999) and, more recently, social network analysis (SNA) (Casanueva, Gallego & García-Sánchez, 2016). In the industrial district approach, the destination is described as a well-defined geographic area, sharing a common culture and populated by many small-to-medium enterprises, widely interconnected (Sainaghi, 2006). The tourism district presents the typical traits of industrial districts as the five elements proposed by Hjalager (2000) – the interdependence of firms; flexible firm boundaries; cooperative competition; trust in sustained collaboration; and a "community culture" with supportive public policies. In the SNA, the destination is a network, where nodes are the local organizations – mainly firms, associations, destination management organizations (DMOs), and other relevant local actors – and links represent the relationships among these actors (Erkuş-Öztürk, 2009; Erkuş-Öztürk & Eraydın, 2010). This paper adopts this last definition of destination. However, the SNA approach is not far from the tourism district. In fact, both suggest the presence of many local firms (Haugland et al., 2011), the interconnections between them (interdependence) (Baggio & Sainaghi, 2011), the ability to cooperate and compete (Beritelli, 2011), the relevance of trust (Sainaghi & Baggio, 2014), and the presence of a community culture (Sainaghi, 2006). For this paper, the destination is a network of firms and organizations operating in a well-defined geographical area. Looking at the destination as a network, some interesting traits of this system emerge, such as the presence of non-linear relationships among actors (Laws & Prideaux, 2005), the ability of this system to organize itself (Kauffman, 1995; Nicolis & Prigogine, 1977), reacting to many external events, as well as showing both robustness and fragility (Lorenz, 1963).

This paper contributes to the SNA research stream analyzing three gaps. The first is related to the *limited amount of quantitative papers*. Despite the SNA using some technical measures derived from the graph theory (Baggio, Scott & Cooper, 2010), the majority of tourism studies adopting the network approach are based on a qualitative approach (Albrecht, 2013). In fact, Sainaghi and Baggio (2017) review 47 papers published after 2010 and show that only 17 (36%) are quantitative, while the remaining 64% are qualitative. As discussed below in the literature review, the quantitative approach is able to perceive the system as a whole, avoiding the reducing of the network to a mere concept (van der Zee & Vanneste, 2015). The present study contributes to developing quantitative studies using time series analysis (as later discussed and presented).

The second gap focuses on the ability of the tourism SNA papers to represent the *destination structure (topology)* and the *network evolution over time* (dynamics of networks). A network interacts with many external and internal events and is able to influence its structure (topology) and its evolution over time (dynamics) (Pavlovich, 2014). Some events modify the system, generating a "breaking through" or a "turning point" in the destination evolution (Coshall, 2000) and changing the destination structure (topology) (Baggio & Sainaghi, 2011). The internal causes are mainly related to the variability of ties among actors (Glückler, 2007). The external factors include a wide set of events, such as macroeconomic forces (Wang, Li & Wang, 2012), technological advancements (Baggio & Del Chiappa, 2013), competitive dynamics (Enz, Canina & Liu, 2008), and new consumer behaviors (Torres, Singh & Robertson-Ring, 2015). A relatively small number of papers have measured the system structure (or topology) and its evolution over time (system dynamics) (i.e. Baggio & Sainaghi, 2016; Pavlovich, 2014; Sainaghi & Baggio, 2017; Zehrer & Raich, 2010).

The third limitation concerns the *topic analyzed*. The current quantitative studies have explored a number of topics, such as knowledge transfer and diffusion (Del Chiappa & Baggio, 2015; Scott, Cooper & Baggio, 2008), the complexity traits of tourism destinations (Baggio, 2008; Baggio & Sainaghi, 2011; Baggio, Scott & Cooper, 2010), the evolution of international tourist arrivals (Miguéns & Mendes, 2008), and more generally, the forecasting of tourism (Palmer, Montaño & Sesé, 2006). Other authors have highlighted the ability of relationships among local actors to generate social capital and to mitigate the negative effects of seasonality (Sainaghi & Baggio, 2014) or the extent to which the technological connection has affected the structural configuration of the tourism system (Baggio & Del Chiappa, 2013). Any quantitative paper has explored the impacts generated by a tourism event on the system structure and on the network dynamics. In practice, many DMOs use event management to increase the destination's competitiveness (Getz, 2012).

Considering together the three identified gaps, the present study aims to explore quantitatively the impact generated by the event management on the dynamics and topology of a destination network. Therefore, the following research question is proposed.

RQ 1. Are major events organized by a destination able to generate a quantitative turning point and to affect the network structure (topology)?

The paper develops an empirical case study represented by the World Expo 2015, hosted by Milan (Italy). The remainder of the paper is organized as follows. The next section positions the study within the broader SNA literature, exploring the three gaps included in our research question and developing two hypotheses. The methods and the data used in the empirical study are examined in Section 3. Then, a discussion of the outcomes and implications is presented, along with some limitations and possible future developments.

2 LITERATURE REVIEW

This paragraph presents and discusses the three limitations (gaps) reported in the introduction. The first Section (2.1) illustrates the main advantages related to the quantitative approach applied to the SNA and how it is possible to transform the time series into a network using the horizontal visibility graph (HVG) methodology. The second Section (2.2) depicts the distinction between network structure (or topology) and network evolution (or dynamics) and explains how it is possible to measure the degree of stability/instability (topology) and identify a "breaking through" or a "turning point" (dynamics) using the network approach. Finally, the third Section (2.3) reviews the main published papers using the SNA, showing the absence of studies focused on tourism events organized at the destination level.

2.1 SNA: Toward a quantitative approach

In their literature review of SNA, Casanueva, Gallego, and García-Sánchez (2016) note: "these previous studies in tourism research have used theoretical concepts that are related to networks. However, the use of SNA as a mathematical tool for analyzing relational data is not found among the most widely used methods in tourism [...], although it has a degree of general usage in similar fields" (p. 1191). Said differently, the SNA has a limited quantitative application in the tourism field. Similar to this is the conclusion proposed by Sainaghi and Baggio (2017). But what is the real advantage of approaching a network quantitatively rather than qualitatively? Van der Zee and Vanneste (2015) offer an interesting answer: "departing from a mathematical conceptualization of the network as a collection of network nodes and ties with a distinguishable structure, this field of studies [network configuration] for the first time departs from *the network as an entity and not a mere concept*" (p. 53, italics added). The qualitative studies, as usual in each area of inquiry (Yin, 2009), had the advantage of discovering some pros and cons of the SNA. The quantitative approach helps researchers to analyze the network as an entity and not as a mere concept.

But how is it possible to illustrate a destination network, given its complexity? The HVG is a useful methodology for analyzing a tourism destination, starting from its performance data (Nuñez et al., 2012; Ravetti et al., 2014). These latter are usually represented by tourist flows, such as arrivals or overnights (Baggio & Sainaghi, 2016), or hospitality metrics, such as occupancy, average daily rate (ADR), and revenue per available room (RevPAR) (Sainaghi, 2010; Sainaghi, Phillips & Corti, 2013; Sainaghi, Phillips & Zavarrone, 2017). The basic idea of this method is very simple: consider a time series as the monthly overnights of a tourism destination. Each value can be reported in a graph. Each and every bar is linked to all those that can be connected with a horizontal segment without intersecting any other intermediate bar. A network is then built where nodes are the data points and links (undirected) are the horizontal segments (i.e. two nodes are connected if they are "in view", whence the name, visibility graph). Many previous papers have created some examples that explain the functioning of this methodology and how it is possible to transform a time series into a network (Ahmadi, Besseling & Pechenizkiy, 2018; Lacasa & Toral, 2010; Liu, Zhang & Zhang, 2018).

The advantage of the HVG is its ability to capture the complex nature of the system and to support quantitatively the measurement of the chaos degree in a time series (Wang et al., 2018). The HVG has attracted the interest of many researchers, since it has been proved that series correlations are captured by the algorithm and translated in the associated graph, opening the possibility of building fruitful connections between time series analysis, non-linear dynamics, and graph theory (Baggio, 2014; Lange, Sippel & Rosso, 2018; Wu, Shang & Xiong, 2018). In the methodology section, some additional technical information is reported concerning how the research team has transformed the Milan time series in a graph and what kinds of analyses were developed to measure the network structure (topology) and its evolution over time (dynamics).

2.2 The network dynamics

The SNA supports the tourism research with a set of methods and tools able to discover the patterns and the structures of the network, which in this paper is called the network structure or topology (Casanueva, Gallego & García-Sánchez, 2016), on one side, and its evolution over time (network dynamics), identifying the turning point or breaking through (Coshall, 2000), on the other.

Focusing on the first topic (*topology*), researchers agree that a tourism destination is a complex system (Baggio & Sainaghi, 2011) characterized by non-deterministic (McKercher, 1999) and non-linear relationships (Zahra & Ryan, 2007). For this reason, some researchers in the field of tourism and hospitality agree to use the complex theory in exploring the functioning of a tourism destination (Miguéns & Mendes, 2008; Palmer, Montaño & Sesé, 2006; Pavlovich, 2014). The complexity is mainly related to the high number of components (nodes) and the nature of the relationships (links), which are not always simple or linear (Baggio, Scott & Cooper, 2010). The evolution of this system is usually unpredictable and can move quickly from an ordered state to some complex behavior or even to completely chaotic conditions (Baggio, 2008).

This last characteristic (the movement from order to chaos) introduces the second area of inquiry, represented by *the network dynamics*. It is a crucial field of investigation and it has a long tradition in the tourism literature. In fact, studies such as the life cycle model (Butler, 1980, 2005a, 2005b) and more generally the longitudinal studies exploring the destination development (Pavlovich, 2003; Russell & Faulkner, 2004) confirm the relevancy of this topic. In general, this evolution generates some structural break in the time series (Baggio & Sainaghi, 2016).

Despite the importance of this area of inquiry, the number of published studies is very limited and they are predominantly based on a qualitative approach. Bhat and Milne (2008) explore the dynamics of inter-organizational cooperation in destination marketing and identify two development stages. Pavlovich (2003, 2014) analyzes the evolution of the Waitomo Caves (New Zealand). The study represents the local network distinguishing between four periods. Rodger, Moore, and Newsome (2009) used network theory to explore a natural program (wildlife tourism research). Some stages are proposed and for each phase, the key actors were identified. Russell and Faulkner (2004) researched the destination development by applying the complexity and chaos theory. They proposed a revision of the Butler life cycle model. Zehrer and Raich (2010) combined the SNA and the life cycle model, developing some propositions related to each stage of the destination development.

These qualitative studies – usually based on a single case study – have supported the second wave of research that is more quantitative. In particular, Baggio and Sainaghi (2016) applied the SNA and identified some turning points in the evolution of an Alpine tourism destination (Livigno). A second study by these authors (Sainaghi & Baggio, 2017) has enlarged the sample, including eight Italian destinations plus the total of the two analyzed Provinces. The multi-destination approach reveals that diverse places show different or very different turning points. The quantitative evidence of the destination's development is very limited and focuses mainly on Alpine tourism. The present study enlarges the research focus, exploring the network topology and the destination dynamics of a large city (Milan), mainly positioned in the business segment (Sainaghi & Mauri, 2018; Sainaghi, Mauri & d'Angella, 2018).

2.3 The event management approach

As presented and discussed in the previous Section (§2.2), the actual research of the destination's development is very limited. Furthermore, the limited quantitative literature "does not explain the factors influencing both exponent [destination topology] and turning points [destination dynamics]" (Sainaghi & Baggio, 2017, p. 378). Said differently, the previous studies have identified some different phases or stages, but the factors of origin are unknown. For this reason, the present article is based on a different approach. It analyzes whether or not a precise tourism event (the World Expo 2015) has generated a turning point in a large tourism destination (Milan) and whether the Expo has changed the network structure (topology). Based on the published studies, we know that turning points are relatively few and are triggered by significant changes, such as economic crises (Baggio & Sainaghi, 2016) or an important shift in the segment composition (Sainaghi & Baggio, 2017). Therefore, it is not common that a turning point is registered. The turning point tends to change the system's structure, increasing or reducing its order (instability) (Horion et al., 2016).

Event management is a crucial activity for many tourism destinations (Getz, 2008). In fact, these special occasions are able to modify the attracted targets, develop new products, improve the destination performance, and reduce the seasonality (Baum & Hagen, 1999; Commons & Page, 2001; Connell, Page & Meyer, 2015; Getz & Nilsson, 2004; Getz & Page, 2016). Some recent studies confirm the positive effects generated by the Milan Expo on local firm performance (Sainaghi & Mauri, 2018; Sainaghi et al., 2018), and the ability of this mega-event to reduce the destination's seasonality (Sainaghi, Mauri & d'Angella, 2018).

As described in some previous papers (De Carlo et al., 2009; Sainaghi & Canali, 2009, 2011; Sainaghi & Mauri, 2018; Sainaghi, Mauri & d'Angella, 2018; Sainaghi et al., 2018), Milan is the leading Italian economic capital and it is located in the Lombardy region. Lombardy (one of the 20 Italian regions) alone produces more than one-fifth of the national GDP. The strong link between this destination and Italian economic life is reflected by the pivotal role played by the business segment and the trade-fair customers (Milan is the second trade-fair destination in Europe). By contrast, the leisure segment is more marginal. This market structure generates some implications on the Milan seasonality, epitomized in higher performance during midweek – especially midweek covered by trade-fair events, and a significantly lower hotel occupancy during weekends and non-working days.

The World Expo 2015 represents an important occasion to reposition the destination in the leisure segment. The focus of this event on food ("Feeding the Planet; Energy for Life") reinforces this relationship. Based on the strong number of attracted travelers (Guizzardi, Mariani & Prayag, 2017), the positive impact generated on the hotel sectors (Sainaghi & Mauri, 2018), and the reduction of the Milan seasonality (Sainaghi, Mauri & d'Angella, 2018; Sainaghi et al., 2018), the following hypothesis is proposed:

Hypothesis 1. The World Expo 2015 has generated a turning point in the Milan tourism evolution (network dynamics).

The first hypothesis will test whether there is a breaking through in the network dynamics of the Milan time series. However, it is reasonable that the effect of this mega-event can change not only the evolution but also the destination structure (topology). As previously discussed, tourism destinations are complex networks, swinging between order and chaos. The positive effects generated by the World Expo 2015 are expected to reinforce the Milan tourism system, thus, increasing its order. Therefore, the second hypothesis is stated:

Hypothesis 2. The World Expo 2015 has increased the order of the Milan network structure (topology).

3 METHODOLOGY

3.1 The destination choice

As previously discussed in the literature review, there are few papers focused on destination development and the analyzed cases are mainly isolated, small, and Alpine places. Some examples clarify this statement. Pavlovich (2003, 2014) explored the evolution of the Waitomo Caves (New Zealand); Russell and Faulkner (2004) studied the evolution of Coolangatta and Southport (Gold Coast, Australia); Bhat and Milne (2008) illustrated the website of New Zealand; Baggio and Sainaghi (2011) focused on an Alpine destination (Livigno, Italy); Sainaghi and Baggio (2017) identified patterns in a sample of leading destinations related to Alpine tourism. These choices are coherent with the aim of reducing the destination complexity and limiting the size of the local network. It is now time to take an additional step in the research by exploring a more complex destination and focusing the attention on a large city such as Milan. Italy is ranked fifth for international arrivals and Milan, with roughly 10 million overnights, represents the second most popular national destination after Rome.

3.2 The data

The HVG transforms the time series into a network (Ahmadi, Besseling & Pechenizkiy, 2018). The Milan time series was operationalized using the Smith Travel Research (STR) data. This company records the daily data of a large sample of rooms (more than 30,000 for each year). The STR sample represents a large part of the Milan hotels (Sainaghi & Mauri, 2018). Consequently, this performance data can be considered as a valid surrogate for the real data in the area (Pan & Yang, 2017). Furthermore, STR data allows for longitudinal analysis; in fact, the research team received daily selling information from 2004 to 2017.

Many previous studies have used STR data (e.g. Enz, Canina & Lomanno, 2009; Pan & Yang, 2017). The present paper considers three operating measures: occupancy, the ratio between rooms sold and rooms available; average daily rate (ADR), the ratio between room revenue and rooms sold; and RevPAR, the ratio between room revenues and rooms available. All these indices have been widely used in many previous studies focusing on tourism (e.g. Lado-Sestayo, Vivel-Búa & Otero-González, 2016; Raguseo & Vitari, 2017; Sainaghi, 2011).

While nominal data relies on the face value of currency over the years (2004–2017), real values are corrected for inflation by adjusting them to the same monetary value as of January 2004 (the beginning of the sample), using monthly Consumer Price Indexes (CPIs) reported by the Italian Institute of Statistics (ISTAT). Such a method has been proposed in some similar previous studies (e.g. Kosová & Enz, 2012).

3.3 Methods

An analysis of the time series characteristics allows determining its overall evolutions and, consequently, the dynamic evolution of the system. For this purpose, we test the stationarity of the series in order to check for the existence of structural breaks. These are the symptoms of sensible changes in the series trend or level and are the evidence of dynamic modifications of the system's behavior. For this purpose, we used the test developed by Lee and Strazicich (2003), based on Lagrange multipliers, which is considered especially powerful and robust (Ambartsumyan et al., 2018; Colajanni et al., 2018). The identification of one or more structural breaks in a time series, however, does not tell us anything about the dynamic conditions of the system. It only signals that something has changed.

To better understand what type of change happens we used the HVG technique (Luque et al., 2009). The general idea is that it is possible to build a network from time series data. The nodes of the network are the times at which the measurement was taken. Then, two nodes are connected with a link if they can be drawn in a way so that there is a straight "visibility line" that joins the points without crossing any other intermediate data bar (see Figure 1).

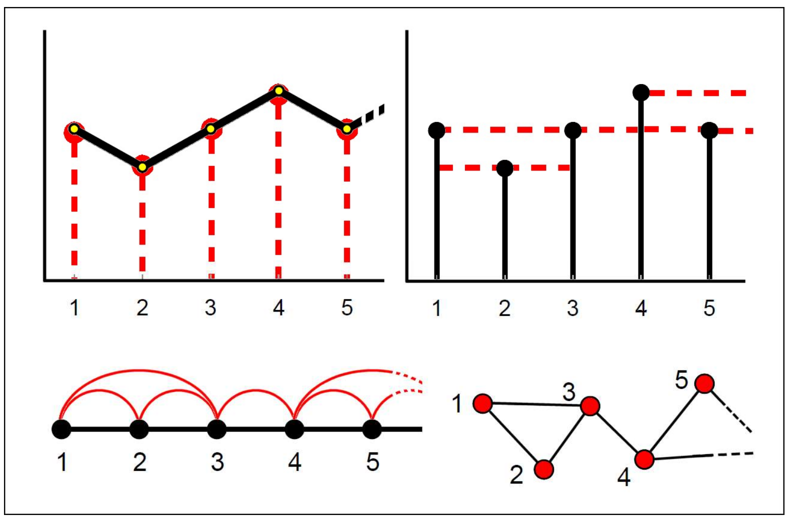


Figure 1. The transformation of a time series into a network using a HVG method

An interesting result of the studies in this area (Lacasa & Toral, 2010; Luque et al., 2009) is that it is possible to distinguish between a stochastic (correlated or uncorrelated) and a chaotic time series. In other words, this method allows us to determine whether the system has a chaotic, deterministic or stochastic dynamic behavior. The analytic results obtained in some previous studies show that, when an exponential degree distribution is found – when the number of nodes having degree k, N(k) follows a relationship such as $N(k) \sim e^{-\lambda k}$ – there is a threshold value $\lambda_C = \ln(2/3) = 0.404$ that separates the different dynamics. A correlated stochastic series maps into an HVG with an exponential degree distribution that slowly tends to λ_C. A chaotic series, instead, converges to the limiting value from the opposite direction (i.e. for exponent lower than λ_C). Thus, we can use this result as an indicator for the dynamic characteristics of a system that i) will be chaotic for an exponent lower than λ_C; ii) will show an edge of chaos (complex) behavior in the region around λ_C; iii) will be more stable for an exponent degree higher than λ_C.

The HVG transformation was applied to all the series considered (RevPAR, Occupancy, and ADR) in their entirety and after splitting them into the before and after EXPO periods. For a better appreciation of the results, similar to what has been reported elsewhere (Baggio & Sainaghi, 2016), we used a random series as null models, a random Brownian motion, a white noise representing uncorrelated stochastic dynamics (generated with Hurst exponent H=0.5), and one obtained from the well-known chaotic system described by the Lorenz equations (Lrnz) (Parker & Chua, 1989). For each of these, a set of values of the same lengths of the Milan series were created. The process was repeated ten times, thus considering the randomness of the generation, and all results were averaged. Finally, allowing for the confidence levels of all the values calculated, we can reasonably assume that values within ±5% of λc denote systems with a prevalent complex or random behavior.

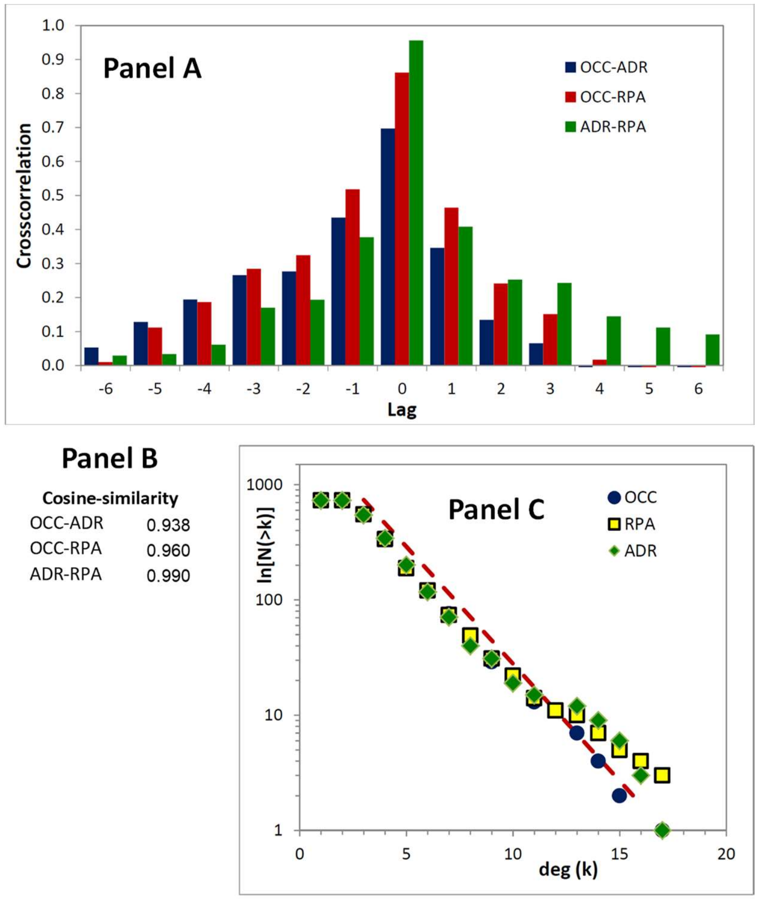
4 FINDINGS

This paragraph is structured in three sections. First, a correlation analysis is done in order to depict the correlations among the operating indices used in the study (occupancy, ADR, RevPAR) (§4.1). Second, the longitudinal time series is analyzed and the turning points are identified (§4.2). Third, the degree of distribution is analyzed and the effects generated by the Milan Expo to the level of chaos are reported (§4.3).

4.1 The metrics in use

The three indices used in the present study present some evident problems of correlations. In fact, RevPAR is the product between ADR and Occupancy (Mauri, 2012). Furthermore, the level of occupancy influences the rates and vice versa. Panel A of Figure 2 confirms the existence of a high correlation. Therefore, the dynamics generated by these indices tend to be very similar. The quantitative analysis (Panel B) reveals a cross-correlation coefficient always higher than 0.9. The two highest values are those registered by the RevPAR, given its relationship with occupancy (0.96) and ADR (0.99): they occur at lag 0 (i.e. there are no time lags between them).

Despite the high correlations among the three metrics in use, there are also some differences. The occupancy is usually the main determinant of hotel operating performance (González-Rodríguez et al., 2018). In fact, the ability to saturate the capacity (inventory) influences the rates (ADR) and the whole hotel performance (Yang & Cai, 2016). Said differently, in the revenue management systems, the occupancy is the starting point for defining the level of ADR (Mauri, 2012). If the forecasted occupancy is very high, the hotel can apply rack rate while the opposite occurs when the expected capacity saturation is very low. The rate (ADR) is the second strategic lever and has an effect on occupancy (Zakhary et al., 2011). A strong reduction in the ADR can reduce the inventory, augmenting the capacity saturation (Mauri, 2016). The RevPAR has the advantage of epitomizing the variation of both occupancy and price and therefore is widely used in the hospitality and tourism industry (Slattery, 2002). As with every performance indicator, RevPAR has some limitations, well described in the hospitality literature (Brown & Dev, 1999; Chen, Koh & Lee, 2011), while other authors have proposed new measures, such as the Gross Operating Profit Per Available Room (GOPPAR) (Tarí et al., 2010).



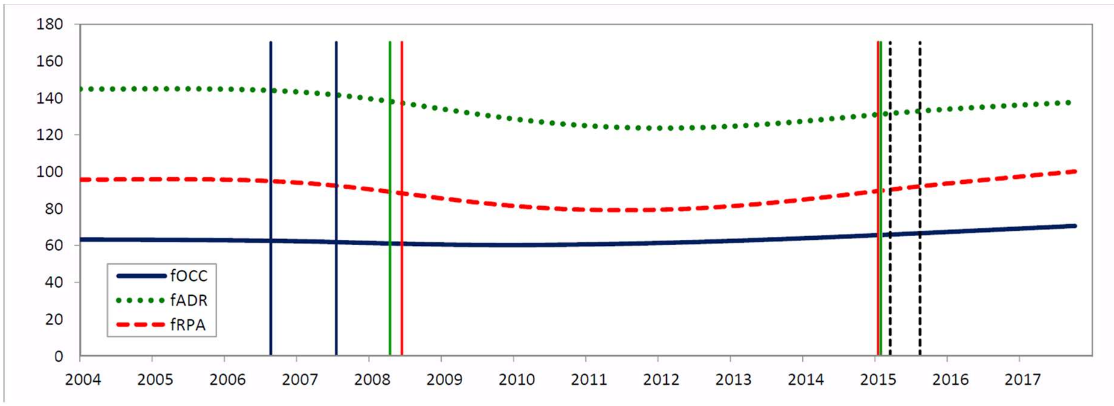
Legend: RPA = RevPAR; OCC = Occupancy; 1 = before Expo; 2 = after Expo

Figure 2. Metrics in use: correlation and degree distribution

Panel C reports the distribution degree of the three metrics. As said, considering the main central part of the curves, the three distributions show a very similar structure (for this reason, some points are perfectly overlapped). This analysis, therefore, confirms that for our purposes, the three indices can be used interchangeably.

4.2 The Milan turning points

This paragraph tests the first hypothesis. Figure 3 reports the breaking through in the Milan time series and identifies two turning points. The series shown in the picture is a filtered version of the data. The filter applied is a Hodrick-Prescott filter and is used in order to show the main behavior of the series (Hodrick & Prescott, 1997). The first change that can be seen is related to the international economic crises and dates 2007–2008. As reported in the graph, the different metrics in use show some small time lags. The second phase is located in March 2015, very close to the opening of the Milan Expo (1 May).



Legend: RPA = RevPAR; OCC = Occupancy; 1 = before Expo; 2 = after Expo

Figure 3. Filtered series with structural breaks

The first break is related to the international financial crises, which began in 2007, and is in line with a previous study conducted by Baggio and Sainaghi (2011). Figure 3 reports two evolutions registered by the occupancy. A first signal dates back to the end of 2006, while a second variation is reported in the middle of 2007. Generally speaking, this first turning point is characterized by a reduction in the city's performance. It is interesting to note that for some months, the Milan hoteliers had supposed that this shock (occupancy reduction) was only a short-term effect and for this reason, they had not changed the ADR. Only in the middle of 2008 do the rates show a turning point (see green lines). This second effect suggests that the Milan companies had understood the disruptive impact generated by the economic crises and therefore the need to adjust the average ADR. The combined effects – reduction in occupancy and on the ADR – finally also caused an adjustment in the RevPAR (see the red lines).

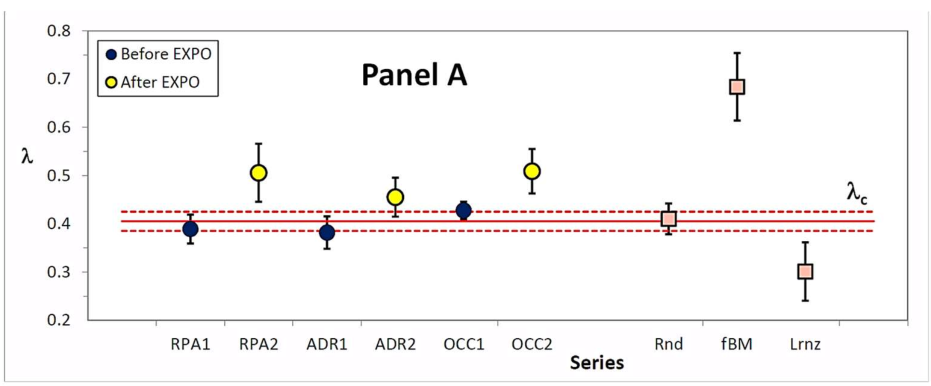
The second turning point is collocated at the beginning of 2015 (March). The indicators involved, however, are different (only the ADR and the RevPAR), and they show a diverse order, compared to the financial crises. To explain the different sequence – a double variation in the occupancy followed by the ADR and finally by the RevPAR during the financial crises; only the ADR and the RevPAR during the Expo – it is important to remember the market position of Milan before the Expo event. The city is the second trade-fair destination in Europe. When Milan hosts an important trade fair, the hotels adjust their rates (Sainaghi & Mauri, 2018). Therefore, the hotel managers are familiar with dynamic price and modify the ADR according to the expectations in terms of capacity saturation (occupancy). In the case of trade-fair events, it is relatively easy to make these previsions. In fact, many events are repeated each year or are biennial. The results achieved in the past and especially the level of occupancy orient the level of price.

In the case of Expo, the hoteliers have no previous experience. The expected number of attracted visitors were estimated at 20 million (Guizzardi, Mariani & Prayag, 2017). Of course, an important segment is represented by residents and schools and therefore these clients do not generate any impact on hotels. However, there are also non-residents and in particular international leisure clients. Based on these forecasts, the hoteliers have increased the price (ADR). This is confirmed in the study by Sainaghi and Mauri (2018). For this reason, the first turning point in 2015 is registered by the ADR and consequently by the RevPAR. By contrast, the occupancy does not display a turning point, despite its increase during the Expo periods. A recent study reveals that the increase of the ADR considerably outperforms the rise of the occupancy (Sainaghi et al., 2018). This can explain why Figure 3 does not indicate any breaking through in the occupancy.

These findings confirm the first hypothesis: The World Expo 2015 has generated a turning point in Milan's tourism evolution (network dynamics). The empirical findings add an important detail: the breaking through affected the ADR and the RevPAR, but not the occupancy.

4.3 System stability before and after the Expo

The previous Section (§4.2) has confirmed the system dynamics triggered by the World Expo 2015. This mega-event has created a breaking through in the time series. Now the second hypothesis is tested, focusing the attention on the effects generated by the Expo on the tourism structure (topology). The analysis of exponent degree distribution allows the calculating of the level of order (chaos) in the system. As explained in the methodology section (see §3.3), there are some benchmarks able to evaluate the network stability (fractional Brownian Motion: fBm), the edge of chaos (random function: Rnd), and the instability (Lorenz function: Lrnz). Figure 4 Panel A reports the analysis, distinguishing between pre- and post-Expo, and shows in the right side the three benchmarks previously introduced. Finally, the ±5% band around λ_C is also shown (dotted lines).



Panel B

	RPA1	RPA2	ADR1	ADR2	OCC1	OCC2	Rnd	fBM	Lrnz
Coeff	0.39	0.51	0.38	0.46	0.43	0.51	0.41	0.68	0.30
95%CI	0.03	0.06	0.03	0.04	0.02	0.05	0.03	0.07	0.06

Legend: RPA = RevPAR; OCC = Occupancy; 1 = before Expo; 2 = after Expo. Rnd = random; fBM = fractional Brownian Motion; Lrnz = Lorenz map. Horizontal line = critical value = 0.405±0.020 (down = chaotic, up = stochastic; line = random/complex)

Figure 4. Visibility networks degree distribution exponents

Before the Expo, the operating indicators illustrate relative network instability. In particular, the two metrics related to the rates (ADR and RevPAR) are located at the chaos threshold, while the exponent of occupancy shows a higher value and therefore is more ordered. These results are coherent with the network dynamics previously illustrated (§4.2). In fact, the relative ADR instability has generated a turning point during the Expo and the same for the RevPAR. By contrast, the higher stability of occupancy avoids any turning points for this metric.

The exponent degrees show significant variations after the Expo. All coefficients move up towards the area typical of systems whose dynamics is a correlated stochastic process. We can thus deduce that the system has transitioned towards a more stable and predictable setting. The occupancy and the RevPAR register the highest value (both 0.51), while the ADR moves from 0.38 to 0.46 and therefore up to the chaos threshold. These findings confirm the second hypothesis: The World Expo 2015 has increased the stability of the Milan network structure (topology).

Now some possible explanations about the values pre- and post-Expo are proposed for each metric in use. The line of occupancy depicted in Figure 3 shows relative stability. Based on this representation, after the economic crises, the saturation degree increases slowly but constantly. This evolution is coherent with the highest (compared to ADR and RevPAR) exponent degree pre-Expo (0.43). As reported in other studies, the mega-event was able to increase the occupancy, especially during Milan's most fragile seasonal periods (Sainaghi & Mauri, 2018; Sainaghi, Mauri & d'Angella, 2018; Sainaghi et al., 2018). This quantitative and qualitative goal has triggered an increase in the exponent degree (0.51). Considering that the time series includes 2016 and 2017, the short-term evidence confirms the ability of this event to raise occupancy stability.

The ADR registers the lowest coefficient (0.38), revealing a complex structure – the exponent is at the chaos threshold. This situation can be related to the high variation of the daily price comparing Milan's different seasonal periods, as well illustrated in the previous studies. Furthermore, as reported in Figure 3, the ADR shows a progressive reduction since 2011 and then a small rise. This information is coherent to a random or complex coefficient, close to the chaos threshold. The Expo triggered an important price increase, reducing the instability of this indicator. The exponent degree, therefore, is augmented. Finally, RevPAR is the product between occupancy and ADR. If occupancy shows a relatively stable trend, the RevPAR evolution is strongly related to the ADR. For this reason, the initial amount of exponent (0.39) is very close to the ADR (0.38), while the final value (0.51) is positively influenced by the augmenting of the occupancy (from 0.43 to 0.51) and the ADR (from 0.38 to 0.46).

5 CONCLUDING REMARKS

This study investigates the effects generated by a mega-event (the World Expo 2015) on a destination (Milan) using the SNA. The HVG framework was used to transform the time series into a network. Two hypotheses are tested: first, the ability of Expo to generate a turning point; second, the ability of this event to increase network stability. The findings are based on a longitudinal analysis (2004–2017) of the three metrics in use (occupancy, ADR and RevPAR). The empirical pieces of evidence confirm both hypotheses. This Section traces the theoretical (§5.1) and the practical (§5.2) implications, and insights for the future research agenda (§5.3). Finally, the main study limitations are reported (§5.4).

5.1 Theoretical implications

At the theoretical level, this study sheds light on the following: i) the system dynamics; ii) the network structure or topology; iii) the HVG methodology. For each of these three points, there are some confirmations of previous studies and some new insights.

Focusing on the *system dynamics* (first hypothesis), the findings confirm the strong impacts generated by the economic crises that have created a first turning point in the Milan network. This is in line with the study by Baggio and Sainaghi (2011). A second confirmation is the ability of the proposed methodology to identify a few breakings through. The time series of 14 years (2004–2017) shows two turning points. The empirical evidence also supports some new advancement in our knowledge. First, the analysis reported in Figure 3 shows that the three different metrics have different sensibilities to catch the change. For example, the occupancy has not perceived the turning point generated by the Expo, while it is the contrary for ADR and RevPAR. Second, there are some temporal lags between the different indicators. During the economic crises, the occupancy has captured the first and the second breaking through, followed by the ADR and finally by the RevPAR. Third, the change of these indicators is different when comparing a negative turning point (economic crises) and a positive breaking through (the Expo). During the negative dynamics, our findings first suggest a decrease in the occupancy, second in the rates, and then in the RevPAR. During a positive trend (the Expo), only the ADR and the RevPAR have recorded a variation. Fourth, a big event is able to generate a turning point; this confirms the first hypothesis tested in this study.

Focusing on the *system structure or topology*, our findings confirm the evidence traced in some previous studies. The destination is a complex system and tends to operate close to the chaos threshold. When the system is in this area, it can change suddenly from stable to unstable, from order to chaos. This study enlarges our knowledge concerning the system structure. First, the three metrics in use show a different degree of stability. For example, during the pre-Expo period, the occupancy accounts for a higher value than the ADR and the RevPAR, while after the Expo the ADR reports a lower value compared to the occupancy and the RevPAR. The RevPAR has recorded the highest increase. Second, there is a strong connection between system dynamics (a turning point) and system stability. Said differently, after a turning point, the network topology can change significantly. In our study, after the Expo, the system moved from the chaos threshold to a more stable area. Third, a successful event (in our case the Expo) is able to raise the system stability. This finding enlarges the pros of event management, adding a new important perspective. Fourth, the positive effects generated by the Expo have improved the three metrics in use. The Expo event was able to raise the stability of occupancy, ADR, and RevPAR.

Finally, our study allows us to identify some confirmations and advancements concerning the *methodology* used. The HVG has identified two turning points, signaling the efficacy of this methodology for mapping the phases of the destination development. Furthermore, the proposed indicators are able to describe the system topology and its evolution over time (dynamics). But our study also introduced some new insights. First, while previous studies have identified phases and stages using different approaches (both qualitative and quantitative) and later the authors have proposed some possible explanations, the present paper has reversed the process. The research team has analyzed the Milan time series with the aim of revealing the presence or absence of a breaking through and a different system topology triggered by the Expo. Therefore, the possible cause was defined as ex-ante and not ex-post. This approach can orient future research in this field, exploring other relevant phenomena – other types of events, new product development, changes in the market segments, and external shocks. Second, the first part of this study (§4.1) shows that the three metrics in use are very similar. Therefore, if in conducting some new case studies the three indicators (occupancy, ADR, RevPAR) are not available, the researchers can interchangeably use one of the three measures. However, the ability of every single indicator to capture both the system dynamics and the network topology is different, as previously discussed. Third, the three indicators present a very similar structure of the exponents, as reported in Figure 2. However, this similarity coexists with the different ability of every single metric to be stable or chaotic in a precise period of time, as reported in Figure 4. Fourth, the RevPAR indicator is able to epitomize the structural topology and the dynamics accounted by the ADR and the occupancy. Therefore, future studies can focus directly on this indicator.

5.2 Practical implications

In accordance with the structure proposed for the theoretical implications, the empirical advancements are also threefold and distinguish between system dynamics, network structure or topology, and methodological improvements.

Focusing on the *system dynamics*, our study confirms the efficacy of the proposed methodology to identify the destination turning points. These findings can develop the measures used at the destination level both for monitoring the performance and identifying the diverse efficacy of different destination strategies. Concerning this last point, Milan has decided to host the Expo. In other contexts, the destination's managers can opt between different investments, such as event management, new product development, new market segments, counter-seasonal strategies, and so on. The proposed methodology can support DMOs in measuring the effects generated by the destination strategy on network dynamics. The study also introduces some new insights. First, the three metrics in use show a different sensibility to catch the change in the system dynamics. Second, our findings suggest that not all turning points affect occupancy. Therefore, a destination *tableau de bord* focused only on the occupancy can avoid perceiving some positive change in a cycle. Third, the events and, in particular, the mega-events can generate some positive discontinuity in the system dynamics.

Concerning the *system structure or topology*, the findings confirm the tendency of a destination to operate close to the chaos threshold (such as Milan before the Expo period). This situation can generate sudden instability and difficulty in forecasting the future scenario. Therefore, DMOs should monitor the system structure. The empirical evidence permits us to state some new practical advancements. First, an event can significantly increase the system stability, moving the network away from the chaos area. Second, an event is able to improve the stability of both the occupancy and the ADR and therefore it positively affects the RevPAR. Third, given the ability of an event to increase the system stability, event management can be preferred to other types of investments realized at the destination level. Fourth, the indicators related to the revenue (ADR and RevPAR) show higher chaotic behaviors. In fact, both before and after the Expo, ADR records the lowest exponent degree. The RevPAR accounts for the second lowest value before the Expo.

Finally, our study opens up some insights in applying the proposed *methodology*. This article confirms the necessity to integrate the traditional linear indicators with some non-linear tools, such as those presented in this paper, able to measure the system dynamics and topology. The proposed methodology can create a new destination *tableau de bord*, enlarging the traditional indices and measures. The evidence suggests the advantage of integrating the traditional tourism statistics centered on arrivals, overnights, and lengths of stays with the three metrics in use (occupancy, ADR, and RevPAR). Some new methodological insights emerge from this article. First, the three metrics in use present a very similar structure (§4.1) but, by contrast, they offer some different perspectives in catching both the system evolution and the network structure. Second, the three metrics show a different speed and sensibility in mapping the system (dynamics and topology).

5.3 Implications for future research

This study discovers some new research questions for future studies in this field. The following possible areas of inquiry are identified, distinguishing between system dynamics and topology, on the one hand, and methodology on the other.

The proposed advancements have an impact on both the *system dynamics* and *topology*; for this reason, these two levels are analyzed together. Future research should verify the ability of the Expo, realized in other countries, to generate a strong impact on the destination evolution and structure, comparing the results with the Milan case. Second, other big events can be analyzed in order to understand the impacts on the network structure and evolution. Third, this methodology can be applied to other destination management processes (such as new product development, new market segments, repositioning strategies, counter-seasonal policies, and so on) in order to measure their ability in creating new breakings through and/or changing the topology. This comparative analysis can help DMOs to discover the comparative efficacy of different strategies. Focusing on turning points, it would be interesting to verify whether there are other cases where a breaking through has no effect on the occupancy, as registered in this paper.

Focusing on *methodology*, some open questions remain. First, the development of new cases should verify the sequence between the three metrics in use, recorded in this article, and verify the ability of occupancy to perceive the stagnation phase and the sensitivity of ADR to map the expansive cycles. Second, new pieces of evidence can verify the different chaotic degree of the three indices. In particular, in this study, ADR is the most unstable measure, while the opposite is the case for occupancy. Third, the exponent evolution of the Milan case shows the highest increase recorded by the RevPAR. Future studies can test this evidence.

5.4 Limitations

Three main limitations (sample size, time, and single case study) reduce the generalizability of this study and open up possibilities for further research. The first weakness refers to the *sample*, which includes only hotels affiliated to STR data; despite being authoritative, some hotels' units will not be included in the sample, which could, therefore, generate sample selection bias. However, as stated in the methodology, STR collects data from a large percentage of Milan hotels. Furthermore, this source has been used in many previous studies. The second limitation refers to *time*. This study only explores the short-term effects generated by the Milan Expo. When new data becomes available, future research could analyze mid- and long-term effects, with the aim of verifying whether the outcomes previously described have been capitalized on by the destination or whether they only represent an important but time-limited effect. The third limitation relates to the use of a *single case study*. The results can be influenced by the specific competitive positioning of Milan. For this reason, as suggested in the future research agenda (§5.3), new evidence should be produced in order to generalize the findings.

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