Destination attractions system and Strategic Visitor Flows

An exploratory study

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Abstract. Spatial based tourism behavior shows the relationship between visitors with the land and services environments. In the 1990s a *tourism attraction systems* model was proposed as a theoretical framework to answer this research question; this concept has been then enriched and updated by employing *travel network* concepts after the eruption of users of mobile IT (Information Technology). The description of general or aggregate patterns of tourism movements in a given area and their underlying network structures are central for these characterizations, they are referred to as *Strategic Visitor Flows* (SVF). This research uses data recorded during a test carried out in collaboration with Swisscom-the major Swiss mobile company and consists of an anonymized and highly aggregated mobile phone data set. The aim of this exploratory study is to show there is link between the relative importance level of attractions within a tourism system network and the length of stay of the visitors.

Keywords: spatial movement patterns of travelers, network models; travel networks, tourism attraction systems.

1 Introduction

Tourism behavior has been considered as one of the most important aspects of tourism research in the XXI century. There is a general agreement that network structure is an appropriate tool to describe such behaviour [1, 2]. In the 1990's Tourism attraction systems [3, 4] focused on attractions as touch points or nodes mostly identified by their special locations.

During this century, the generalized use of smart phones and the spread of free access to wi-fi facilities enriched tourism experiences [5]. The visitor interacts not only with service infrastructures in the destination but retrieves and shares information before, during and after the vacation experience [6, 7]. As a result, the Travel networks concept [8, 9] added a new characterization level to Tourism attraction systems' touch points: they could be either physical or virtual and, therefore, experiences and informational elements are included. The use of smartphones not only shapes the tourism experience [10] but, has facilitated in visitors more opportunistic behaviours: they are increasing willing to change the planned itinerary on the spot, due, for example to such things as bad weather forecast conditions [11] .

Nevertheless, describing general spatial patterns of travellers' movements or visitor flows (VF) is an important part of the story and it is the main part of this research project [12].

The aim of this research is to show a link of relative importance of attractions (such as being a nucleus, central or marginal) within a tourism attraction system network and the length of stay using VF network analysis on highly aggregated mobile data.

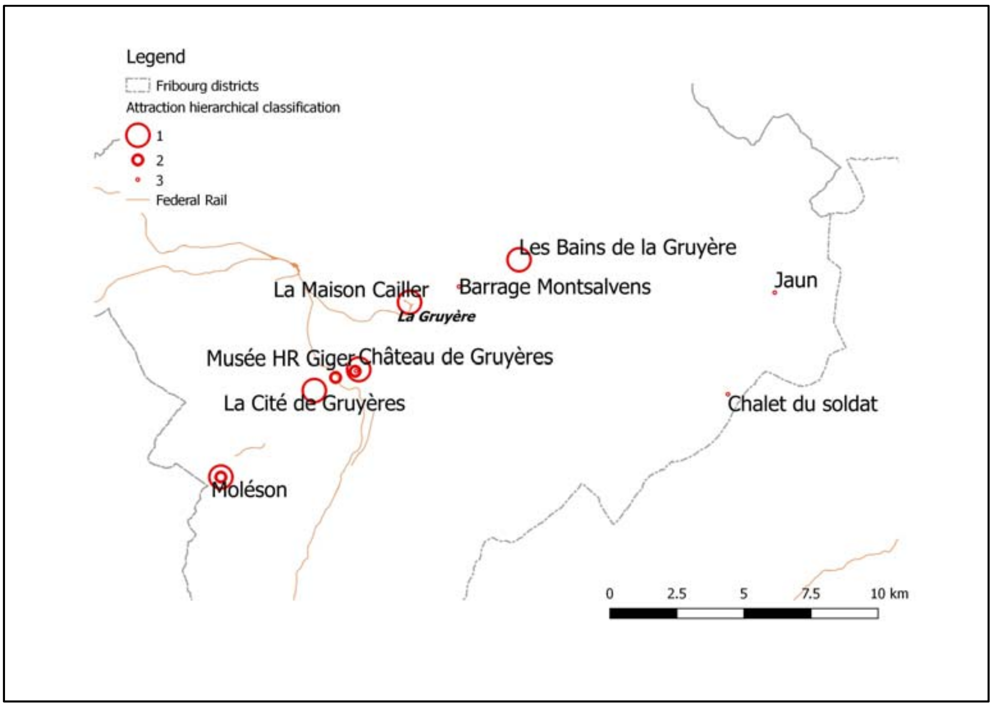
The paper is organized in the following way: the literature review discusses different theories about tourism system elements and relevance of the planning vacation process (PVP) timing. The second section contains the description of the data and network methodology analysis. The third section presents the results. The fourth section analyses the results. The final section discusses the results in terms of scientific and management dimensions and implications for future research.

2 Literature review

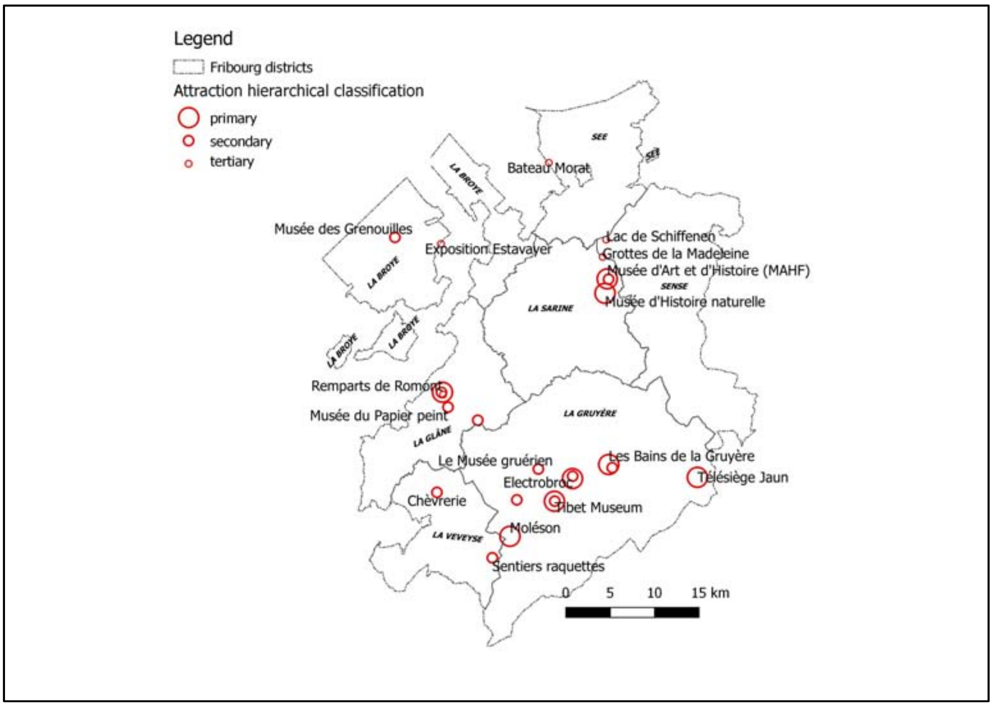
The aim of describing the spatial tourism behavior is central not only for land-planners and policy makers but also for destination management organizations [13-16].

Such descriptions of spatial behaviour's paradigms can be either focused on nodes or flows when they are based on the Network structure theory

Tourism attraction systems [3, 4] focused on attractions as touch points or nodes may be mostly identified by their spatial locations. As it was pointed out above, the attraction systems approach has been modelled as networks in both theoretical [i. e. 17, 18] and empirical [19 ch. 5, 20] researches. Leiper defined the tourist attraction system as "an empirical connection of tourist, nucleus and markers" [17 p. 367]. The nucleus is the central element of a tourism attraction system, and it could be any feature or characteristic of a place that travellers visit. A marker is the link, namely an item of information that links the human and the nuclear element of an attraction system and allows one to distinguish the nucleus from other similar phenomena [op. cit. p. 8]. The centrality of the nucleus in the attraction system does not mean that such attractions are isolated elements; the expression nuclear mix was coined by Leiper [17] as a combination of nuclei which are significant in the experiences during the trip. Nevertheless, there is a hierarchical classification of nuclei: primary, secondary and tertiary. This classification mainly relies on the traveller's knowledge of their existence before they arrive at the site or destination. Tourists could suspect the existence of the secondary attraction but probably not of the tertiary ones. Figure 1 (a) and (b) illustrate these theoretical concepts.



(a)



(b)

Fig. 1. : Examples of system attractions maps in Fribourg canton in Switzerland. Panel (a) an example of a cluster of attraction obtained for tourists, (b) a cluster obtained for day trippers.

The maps in Figure 1 has been obtained after the analysis of 803 valid observations gathered by survey carried out on the field, during the summer season: 2016 for La Gruyère district and 2017 for all the others [21]. Each district is a regional tourism destination. In the survey the following questions were raised: “Please name the attractions you’ve already visited”, “Please name the attraction you are planning to visit”, and the name of the attraction where the survey was taken place was also gathered as data. The observations have been classified as tourists, people spending at least one night in the canton or day-trippers.

Each obtained cluster shows the set of the attractions to be visited, regardless of the trajectory followed. Panel (a) shows one of the clusters belonging to tourists whereas Panel (b) concerned only day-trippers. Both clusters have attractions of three distinct levels: primary, secondary and tertiary. Panel (a) shows a whole attraction system contained within one destination (*La Gruyère*). Panel (b) includes 3 attraction systems located in three different destinations (*La Gruyère*, *La Sarine* and *La Glâne*). The three sets deserve the definition of attraction system because each of them contains primary attractions. Other districts such as *La Veveyse* and *La Broye* have not any primary attractions but some places are included in day-tripper circuits thanks to the relevant primary attraction situated nearby.

Another paradigm, based on flows instead of nodes, consists on the study of the most generalized itineraries, namely SVF. Some researchers pointed out its importance in market segmentation [4, 19, 22] others are interested in describing general or aggregate patterns of movements in a given area [23] and their underlying structure has been characterized as a network [17]. The basic structure of the travel itinerary pattern is origin-destination-origin where lines are routes in between, but there are other kinds of tourist itinerary models as shown in [24]. Therefore, itineraries could have different patterns among destinations / attractions, including single destinations, hub and tour patterns with their representations having a network shape. Two new concepts have been added to this flow approach: gateway (the first destination / attractions) reached before beginning a multiple destination itinerary) and egress (the last destination / attraction visited before going back home).

In a study of Swiss residents travel behaviour, Hyde and Laesser [25] combined the two approaches namely itinerary and attraction system point of view. Hyde and Laesser individualized three typical behaviour patterns: “stay-put”, “arranging”, and “freewheeling” touring vacations. In the first case, “stay-put”, this is very close to the traditional concept of a single destination vacation; the second, the “arranging” touring consists of a visit of several destinations with overnights in multiple locations that could be self-arranged by the traveller themselves prior to the departure; finally, the “freewheeling” vacationer has pre-arranged only a few places of accommodation and has a high flexibility and spontaneous choice of vacation elements. These three patterns show different choices and timing of the macro-level frame such as travel routes and accommodation. Moreover, the increasing flexibility during travel allows the selection of secondary destinations that were not planned prior to the departure.

Scholars inspired by Leiper [17], classified attractions taking into account the time that the visitor decides to expend on each of them once they decide the destination in the PVP. Therefore, this classification states as primary and secondary attractions those whose length of visit can be evaluated. Tertiary attractions are those that the visitors are not aware of their existence when they made the destination decision [26].

The aim of this research is to show that within a geographical area, namely Fribourg canton in Switzerland, the importance of attractions (nucleus, gateway and egress) varies depending on the length of stay of the visitor trajectories. In order to fulfil this objective, mobile data are used to demonstrate generalized patterns of tourist movements in the canton.

2.1 Passive mobile positioning data

The use of smartphones has increased in the everyday life of consumers such as when using social networks on mobiles phones [27] and the same during vacation periods [5]. The capabilities of mobile phone positioning data have therefore become an interesting and pertinent tool for monitoring VF. Advantages include the following: “data can be collected for larger spatial units and in less visited areas; spatial and temporal preciseness is higher than for regular tourism statistics” [28, p. 469].

The term passive mobile positioning data refers to automatically stored information that are kept in log files by mobile operators. The mobile geo-localisation information relies on the position of the cell network. A cellular network is physically placed at base stations which are usually towers supporting one or more directional antennae. The localisation of the cell network is determined by the base station (in the case of only one antenna) or several antennae. The size of the cell network is not fixed, therefore, and depends on the average load or number of phones connected. When the network is crowded, phones cannot switch to the nearest base station but connect to another one in the neighbourhood. The optimal distance from handset to antenna is less than 60 km [28]. There have been two major projects running contemporaneously in Europe focusing on passive mobile data use and tourism. The first one was a Eurostat project named “Feasibility Study” on the use of mobile positioning data for Tourism Statistics [29]. The second was a feasibility project named Monitour [30], which was financed by Swiss research funds. Both projects used the coordinates of the base station as proxy of the location of the mobile, thus geo-localising anonymised visitor data [cf. 29, p. 18]. The studies showed that the method is quite beneficial and able to provide many useful insights.

Reliability evaluation of passive mobile positioning data was one of the aims of the European project. In the estimation of tourism frequentation, the results show that the quality and exhaustivity of those data is not inferior to other alternative methods such as surveys, moreover, their estimations are in coherence and well fitted with the official data gathered by Eurostat [29]. One of the main difficulties that passive mobile positioning data faces is the identification of “natural environment” or “residence place” for the anonymised visitor and this concept is central in tourist identification. The European project solved this issue by the analysis of extended anonymous user’s data in order to follow the anonymous subscribers over “a longer period than the one under study in order to establish their residency and/or usual environment" [29, p. 18]. In the same manner, anonymised visitors can be categorized as day-trippers or overnight tourists, the first category is difficult to grasp with traditional frequentation data gathering techniques [31], even though bias in the classification between these two categories cannot be excluded.

3 Data and methods

3.1 Data description

Swisscom, which is the major Swiss mobile provider having 60% of the market is a partner of this research and provided a set of test data.

The data consists of 18,138 anonymized mobile users belonging to one of the top European incoming countries in Fribourg canton tourism. The period under study is 11 days, from 17 and 28 August 2014. For confidentiality purposes, Swisscom has anonymized the users using Hashing-Algorithm techniques and shifting of the date; no characteristics of the users are given. From hereafter we will refer to the anonymized mobile users as AMU. It is worth noting that this anonymization process does not affect the results of this research, whose aim is to show the inference of SVF using mobile data.

The data is comprised of 2G A Interface data, 2G IuPS Interface data, 3G IuCS data and 3G IuPS data, technology which does not allow accurate geo-localization of the mobile position, i.e. it was not possible to associate the data to specific tourist attractions. Thus, the authors used the position of the cells (namely antennas) as proxy for the geo-localization of AMU, and it is acknowledged that this is a limitation of this research. There are approximately 1,500 cells.

In order to identify SVF, the authors programmed a customized routine in Java which was run by the computer centre of Swisscom in order to yield a file consisting of trajectories. The structure of that file has the following fields: AMU, trajectory identification, time stamp, duration and cell identification. The time stamp field indicates the moment when AMU was captured by the cell identified in the observation. The duration indicates the period of time that the AMU remained captured by the latter cell, but this data was not used in this first analysis.

The data includes 18,138 trajectories having a mean duration of 3 days and 15 hours and a standard deviation of 2 days 14 hours. The median number of trajectories per AMU is 13.

The dataset was then split into three segments containing the trajectories with overall duration of one hour, less than one day, and more than one day. From these three networks were built using the same procedure. Tracks were extracted that contain the different points (antennas) that recorded a single AMU.

3.2 Methodology: Network analysis

The literature review gives some evidences about the relevance of network analysis as a toolbox for the analysis of spatial patterns of movements (VF). This approach provides several metrics useful for describing different aspects of the structural and dynamic characteristics of the object of study [32, 33]. Some of the main measurements that allow the characterisation of topology and behaviour of actors, such as VF, are used in our analysis: the distribution of each node connection (degree distribution), the length of the paths connecting any two nodes (in number of links), and the mesoscopic structure of the network (number and type of clusters of nodes).

The 18,138 trajectories were then combined into a network *G(V,E)* in which the set of vertices (nodes) *V* is composed of the antennas, and the set of links *E* is made of the directed paths connecting the nodes. The paths are directed (from node *x* to node *y*) and are the cumulated tracks followed by AMUs moving from one antenna location to another. The links have also a weight value representing the number of AMUs that followed that particular segment from one antenna to another. The networks were then analysed using standard methods (the interested reader can find all methodological details for this analysis in [2, 33] and [34]). In particular we use the degree distribution *N(k)* (the statistical distribution of the number of links each node has) as an indicator of the overall structural characteristics of a network (see e.g. [35]). All measurements were calculated by using the Python Networkx library [36]. Network visualizations were obtained in Pajek [37] .

4 Results and discussion

The results will be focus on the metric first of nodes and of paths.

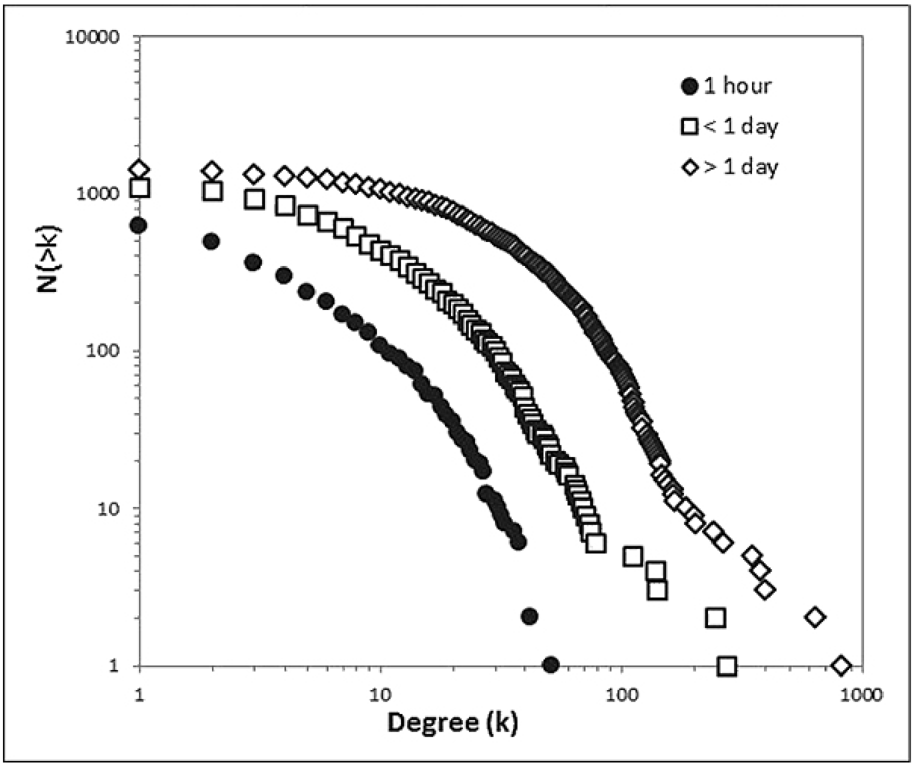


Fig. 2. The cumulative degree distributions of the networks

Among the different metrics, the degree distribution (the statistical distribution of the links between nodes) is commonly used as an indicator of the overall structural characteristics of a network. They are shown in figure 2.

Apart from a scale factor (the three networks have different sizes), the distributions show a substantial similarity that translates into a similarity in the visitors' mobility behaviours. The power-law shape of these distributions signals a great heterogeneity in the choices of the places to visit.

In a directed network, it is possible to identify a so-called bow-tie structure. The network can be considered as composed of a large strongly connected component (SCC), and an IN and OUT component with a unidirectional connection to SCC; the network can also exhibit a TUBE connecting IN and OUT directly, and a disconnected (DSC) component [38]. The results for the three networks are shown in figure 3 and table 1.

With this view interesting differences appear. The bow-tie analysis shows a high concentration of the paths in a certain area and the very high proportion of nodes in the SCC of longest stays networks, signal some kind of repetition in the tracks. Tourists seem to visit repeatedly the same locations, while for the shortest stays the walks are more dispersed.

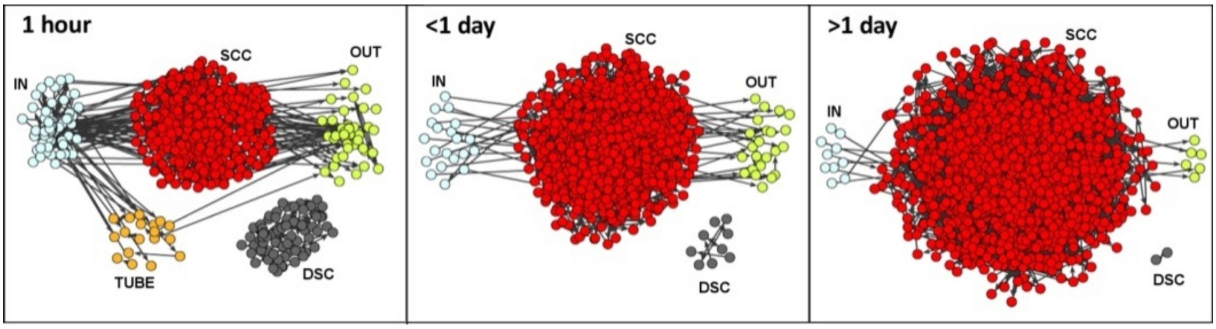


Fig. 3. The bow-tie schematic structure of the three networks

Table 1. The bow-tie components (fraction of nodes in the different components)

Bow-tie component	1 hour	< 1 day	> 1 day
SCC	59.0%	95.2%	98.7%
IN	16.6%	1.8%	0.7%
OUT	8.9%	2.1%	0.4%
TUBE	3.0%		
DSC	12.5%	0.8%	0.1%

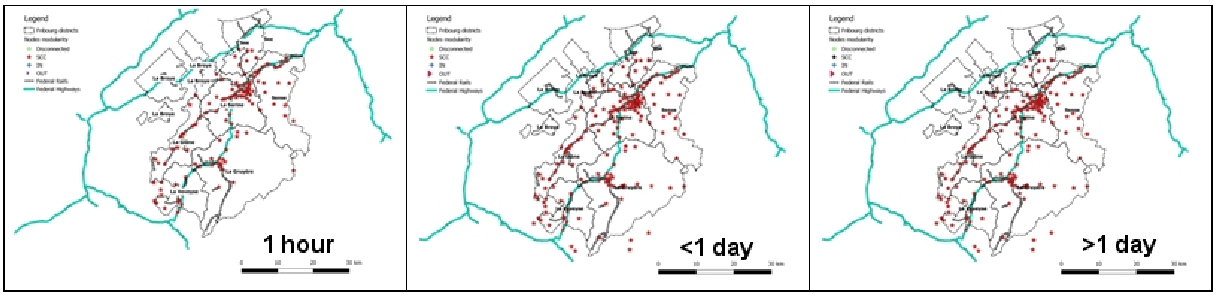


Fig. 4. The geographic rendering of SCC component yield by the bow-tie analysis by length of stay.

The geographical locations of the SCC is shown in figure 4. As can be seen, the differences are much less clear than what the network representation provides, which is a further evidence of how multiple descriptions greatly increase the comprehension of a system and how network analytic methods are able to highlight characteristics otherwise difficult (if not impossible) to recognize.

Another interesting result comes from the analysis of the lengths of the paths travelled by the visitors. The cumulative distributions are shown in figure 5.

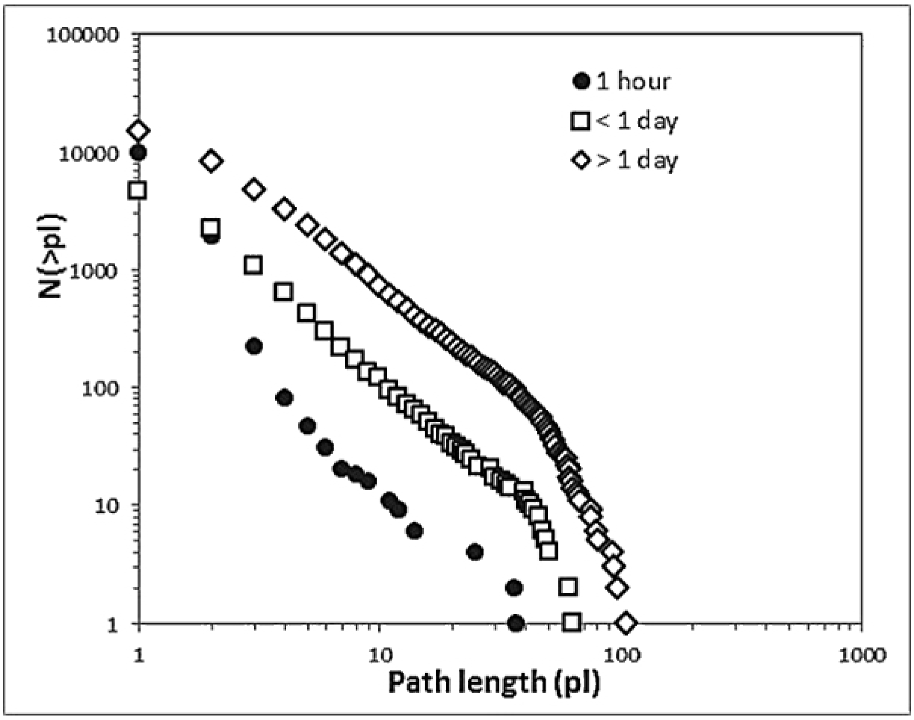


Fig. 5. The path lengths cumulative distributions

They are all consistent with a power-law with exponents (calculated according to [39]): 2.95±0.22 (1 hour), 2.70±0.13 (< 1 day), and 2.62±0.07 (> 1 day). Shape and exponents are consistent with the distribution obtained by an ensemble of Lévy random walks. These random walks are characterized by having step-lengths with a heavy-tailed probability distribution (a power-law $p(L)=L^{-k}$ with exponent $1<k<3$). Essentially, they consist of 'walk clusters' in which within-cluster movements are relatively short, while between-cluster transfers are of a longer displacement. They are considered to be a common characteristic of human mobility [40, 41].

It may be that human intentions more than geographical features play a key role in producing these patterns. Moreover, this could be coupled with the popularity of the locations and the human habits of tending to return to previously visited places. Obviously, the accessibility, or the ease of movement, especially for the longer displacements, strongly affects the patterns of visit. Therefore, a logical conclusion for an attraction, would be to use promotional activities for increasing its popularity but also keeping in mind the possibilities of physical reachability.

5 Conclusion, limitations and future research

The limitations of the work presented here are basically due to the lack of richer information that was not made available about the tourists (due to the anonymization procedure). Little to no information is available about the qualitative aspects such as socio-demographic characteristics (excluding country of the company mobile provider), expenditure, purpose of the trip, etc. This does not permit a more in-depth analysis and verification of the interpretations that were supported by recent literature. Moreover, this research is restricted to AMUs of only one European country and limited in time.

Some other limitations are more difficult to overcome such as related to coverage issues, or with the telecommunications market itself, such as the cost of calls or texting or roaming fees that could affect the use of mobiles especially in the case of international tourists [29]. Another limit is the nature of this research which is exploratory.

However, there are two important outcomes from the study: firstly, from a methodological point of view, network analytic methods have provided some interesting and not easily predictable results on the visitors' behaviours. Secondly: the relative ease in obtaining these results (once data are available) results in destination and attraction managers having a powerful set of tools for the evaluation of tourists' actual movements. If these are combined with some more traditional surveys this can complement and better frame the results obtained, thereby giving a deeper understanding of the behavior of travelers and, therefore, more effective and better planning and promotional activities can be devised.

Future research will increase the number of similar studies in order to better assess the characteristics of visitors' mobility behavior, possibly combining the techniques discussed here with specific surveys.

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