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# ANALYSING TOURIST MOBILITY: CURRENT ISSUES AND FUTURE CHALLENGES

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## *Abstract*

*Tourism statistics are generally based on data collected only at one point of the travel, which, depending on the perspective of interest, can be the originating region or the destination one. Indeed, many tourism trips imply the visit to more than a single destination, since tourists move to visit several attraction to several destination or within the same destination. The analysis of tourist mobility presents several issues which are related both to the collection of information on multidestination trip behaviour and to the analysis of complex information such as the ones related with tourist itineraries. The present work aims at reviewing the main issues related with the analysis of tourist mobility among several destinations and within the same destination to several attractions. The problems related with the collection of information and with their synthesis are explored by reviewing the main works in academic literature which face with these issues. Moreover, the potential given by the use of tracking technologies to collect information on tourist mobility are described and the main methodological approaches for the analysis of such complex data are introduced. More in particular, some analytical tools for the analysis of multidestination trips and of travel itineraries are critically analysed by providing examples of empirical applications on these topics. The final aim is to provide a set of problems related with the analysis of tourist mobility and of the practical solutions in relation to several specific research aims are provided by highlighting merits and pitfalls of each approach.*

***Keywords: tourist mobility, tracking tourists, tourism statistics***

# 1. INTRODUCTION

Tourism implies a movement of people in time and space, from their place of usual residence to a destination (or destinations). Surprisingly, the analysis of tourist mobility within one single destination and among several destinations has not been taken into account adequately, even though a deeper knowledge of tourists' movements is an essential prerequisite for logistics and for the management of the economic, social, and environmental impacts of tourism. Indeed, most of the models of pleasure trip behaviour are based on the hypothesis that tourists visit a single destination, even if this premise is rather unreliable. Tourism statistics are usually related to two places in the restricted space: the region of origin and the destination, thus disregarding the possibility, for the tourist, to make multi-destination trips. According to a simplified model of tourist mobility, official statistical sources use the concept of "main destination" in order to obtain the correspondence between where tourists come from and their destination. However, many pleasure trips imply visiting more than one single destination (inter-destinations) or several "attractions" within the same destination (intra-destination). Although the importance of knowing travel itineraries has been recognized for a long time (Leiper, 1989; Dietvorst, 1995; Fennell, 1996), relatively few studies have made an attempt to model spatial movements among several destinations and within the same destination. The main reasons for this lack are attributable to both the difficulties associated with the collection of information on multi-destination trips (Lew and McKercher, 2002), and on the lack of clarity on what is meant by "multi-destination" trip. As regards the collection of information, official statistics on tourism do not provide any kind of information on multi-destination trips and on trip itineraries, either from the supply side (statistics on guest arrivals), or from the demand side (which focus their attention mainly on the main destination visited). This means that in order to analyse the phenomenon, ad-hoc surveys need to be carried out. Indeed, many of the issues related to the analysis of tourism demand and of its segmentation should not ignore the number and the types of destinations visited during a single trip by tourists.

This work aims at analysing the main consequences of multi-destination trips on tourism statistics, and of describing both the "classical" and the emerging solutions in order to collect information and analyse multi-destination trips and travel itineraries. Some analytical measures and technological solutions are presented in order to face with the issue of tourist mobility, and the main implications under the empirical and methodological perspectives are finally discussed.

## 2. MULTIDESTINATION TRIPS AND TOURISM STATISTICS: MAIN ISSUES AND EMPIRICAL FINDINGS

As concerns the definition of multi-destination trip, the lack of clarity is attributable to the definition of the destination itself (Hwang and Fesenmaier, 2003). For example, whereas some authors (Mings and McHugh, 1992; Stewart and Vogt, 1997) focus their attention on the visits to the attractions within a destination, other authors (Oppermann, 1995) define the term destination in a wider sense, by including the whole region. In addition, Leiper (1989) points out that in order to qualify a stop as a visit it is necessary for the tourist to spend some time in that destination, or that there is some specific tourist interest in that stop. Moreover many studies have considered the overnights as a discriminating factor. Particularly, by referring to one of the most used aggregates to quantify tourist flows, that is the datum related to arrivals in accommodation facilities, the aggregation process by summing arrivals referred to different places (e.g. municipalities) determines a bias (Parroco, Vaccina 2005). Data related with guest arrivals, since they are derived from the sum of all the guests of official accommodation establishments will produce an oversized aggregate, if referred to the number of tourists who visited a specific area (province, region, country, etc.), and this bias will be greater the more extensive will be the territorial level and the greater the presence of overnight trips in several accommodation establishments. Indeed, the higher the territorial level (e.g. country) and the greater the propensity of tourists to take multi-destination trips, the greater will be this "double counting" effect. Parroco and Vaccina (2005) have underlined the matchlessness between data on arrivals of guests in collective accommodation establishments in a given region and the number of tourists in the same region. The main reasons are related to: a) the use of unofficial establishments (e.g. relatives' or friends' houses, unregistered rented houses and rooms, boats, etc.) for tourist purposes, which determines the so-called "unobserved tourism" (Vaccina et al., 2011), considering that information on this kind of flow is not included in official statistics on guest arrivals; b) the lack of information regarding guests' motivations, which does not allow the distinction between tourists and other guests; c) the so-called "double counting" effect of arrivals which occurs every time a tourist changes an accommodation establishment during a single trip, thus being registered more than once.

Given the above mentioned problems, it follows the impossibility of measuring tourism demand through supply-side statistics. For example, Lickorish (1997) highlights that although the World Tourism Organization (UNWTO) report brought back, for 1990, a total of 15 millions of visitors in Europe coming from United States, the European Travel Commission (ETC) using the data of the U.S. Government showed a total under 7 million. Both values were correct but while the ETC was referring to the individuals who carried out a trip in Europe, the UNWTO reported the total number of border crossing registered in Europe, by determining the possibility of counting more than once the same individual.

This double counting effect has implications also in the meaning of the datum related with touristic presences, given by the number of nights spent by guests in the accommodation facilities of a given locality. Indeed, it is common practice to analyse the average length of stay, given by the ratio between presences and arrivals as an indicator of the overall duration of the trip. This interpretation not just is incorrect because of the problem generated by the replication effect, but it can also lead to totally misleading interpretations. In fact, if it is true that it exists a direct relationship between duration of the trip and number of stops (with overnight stay) carried out during the same trip, the increase of the overall duration of the trip could imply a reduction of the average length of stay rather than an increase. To overcome these problems, same authors (Pearce, Elliot 1983, Leiper 1989) proposed the use of some indexes for the analysis of the so-called "tourist circuits" at international level, some of which are described in section 4. However, a great potential for the analysis of tourist mobility is given by the use of new technologies.

## 3. NEW TECHNOLOGIES AND TOURIST MOBILITY

Nowadays, it is possible to overcome some of the above described problems thanks to the development of new technologies as monitoring systems, since they could provide a significant contribution to data collection. New technologies – such as mobile phones, Global Positioning Systems (GPS) and Geographic Information Systems (GIS) – could offer new opportunities, not only in terms of services and information available to tourists, but also in terms of opportunities for collecting, analysing and visualising geo-referenced data related to tourism and for tracking touristic movements. The recent development and spread of small, cheap and reliable tracking devices has favored an increasing volume of spatial research in general and in tourism fields more peculiarly. The efforts made in order to develop commercial applications for tourists, including georeferred mobile information systems or electronic guidebooks, are in progress by the end of the 1990s (Shoval and Isaacson, 2010).

The most famous and commonly used GPS is that of the U.S. Department of Defense (DOD). Fully operational since 1994, it was originally conceived as a military navigation system and only in 2000 the DOD opened up the system for individual and commercial applications across the globe. At the same time, the private sector finished establishing infrastructure for the operation of cellular phones. The commercial use of these devices started at the beginning of the 1980s but it was limited primarily to business purposes because of the high price. Cellular phones prices began to drop drastically in the mid 1990s and today they are owned by everyone in the developed countries. GPS and other tracking technologies are used in a wide variety of fields aside from tourism, such as environmental health, medical field like physiology and cardiology, as a tool to assist in navigation for visually impaired and blind pedestrians. However, most of the research conducted has been in the field of transportation studies, while the collection of data and the study of the spatial activities of pedestrians using

advanced technologies have been less common. One possible explanation for this is that gathering data from pedestrians is more difficult than doing so from motor vehicles. This, however, has now changed thanks to the technological advances that enabled the manufacturing of small, cheap, lightweight and highly sensitive devices.

Existing tracking technologies are classifiable into two large categories: terrestrial and satellite (GPS). The first type consists of a series of antennas - radio frequency sensors (RF) - located throughout the area and it is based on the principle according to which, electromagnetic signals travel at a known speed along a known path. According to the received signal from the antennas, it is possible define the position of the observed object. The widespread use of cellular phones, based on terrestrial radio systems which permit localization, has enhanced the importance of these technologies in order to track tourists' movements, both at an individual level and at an aggregate level (Shoval and Isaacson, 2010). On the other hand, GPS is a satellite positioning and navigation system that, through a dedicated network of artificial satellites in orbit, provides to a terminal (or GPS receiver) information about its geographical and time coordinates, in every weather condition, everywhere on earth or in its nearby area, where there is an unobstructed contact with at least four satellites of the system. This occurs through a radio signal transmission from each satellite and processing the received signal from GPS receiver (Biagi, 2009).

Recently some studies were carried out through the use of new technologies in order to obtain more detailed data about tourist flows and to fill the gap left by traditional surveys. These researches represent a new way to approach space-time analysis of mobile population such as tourists. Some examples of these studies are those of Edwards et al. (2009) and Shoval and Isaacson (2007) about GPS tracking, Reades et al. (2007) and Ahas et al. (2011) about cellular phones as tracking devices, Van der Spek and Nijhuis (2010) about GPS and GIS, but also the study made by O'Connor (2002) on the Alge Timing System, a technology used in sport field that consist of sensors spread along the path and of sensors placed on the ankles of pedestrians, which represents a useful tool – especially in closed areas (such as parks) – for monitoring visitors' behaviours. Moreover, in 2010, Shoval and Isaacson (2010) wrote the first book about the implementation of advanced tracking technologies for the analysis of tourists' outdoor movements in time-space and their activities.

## 3.1. Data coming from Global Position System (GPS) devices

International literature searches out the opportunities offered by new technologies to statistical survey on tourism. Particularly, GPS appears a simple and at the same time detailed tool of detection for tourist flows in a space-time dimension. It permits to visualise on a geo-referenced map the paths and the stops at the various times of the day. These devices, indeed, are able to record time, speed, direction, distance, position and height. They also permit to note the dwell time at each site and the travel time of the various routes, also distinguishing the

different means of transport used. This allows to identify the characteristics of tourism into a specific destination and so the tourist behaviour in terms of mobility. Another relevant aspect under the information collection perspective, is given by the fact that the device doesn't affect tourists' behaviour. Unlike other techniques such as direct observation, tracking through GPS is less invasive. Data collected through these devices are subsequently more reliable than those collected through traditional methods which are usually based on retrospective and administrative surveys, which can be affected by several problems (e.g. recall bias). In other words, constant tracking realised in real time allows to delete or however greatly reduce several biases, generating reliable and detailed data. These remarks also derive from the feedback received, in the different studies analysed, by comparing the data collected through GPS tracking and those ones observed by questionnaires and interviews (e.g. Edwards et al., 2009; Shoval and Isaacson, 2010). The degree of accuracy of space-time data collected is such as to permit the creation of an extensive database from which implement further analysis, such as the study of the sequences of alignment of the events in terms of sequences of tourist activities in time and space and the identification of the prevailing routes (Shoval and Isaacson, 2010)

Some authors consider the relationship between the choice of accommodation and the travel itineraries at the destination or, more generally, between the space-time data and some categorical variables, as well as the differences between domestic and international tourists in terms of characteristics of movements (e.g. Edwards et al., 2009). Other authors (e.g. Shoval and Isaacson, 2010) analysed the creation of touristic groups according the features (sequence) of the activities made by tourists being detected.

In a nutshell, the integration of GPS technology within mobile phones (smart phones) feature which concerns the latest devices (past 5 years), makes it easier, thanks the large diffusion of these devices over the world, to use this technology like a system to collect data related to touristic movements. To give an idea of the magnitude of the phenomenon, a study of "Strategy Analytics" (Shah, 2012) finds that the number of smartphones in use in the world passed from 708 millions in September 2011 to 1.038 billions in September 2012: one person in seven owns it. This number will double from now to 2015.

## 3.2. Data coming from mobile phone traffic

Mobile phones can be used to carry out aggregate analyses on customer movements in the space-time dimension. Particularly, they are suitable for two kinds of analysis. On the one hand for statistical analysis about the activities which concern the antenna in a specific time, and, on the other hand, for the localization of a group of devices in a specific period and its movement among the antennas of the network.

The degree of detail is less than that one achieved through GPS and the tracking is possible only in small areas characterized by the presence of antennas. Through investigation of the so-called "Erlang data" it is possible to analyse

urban dynamics within the boundaries of space-time. These data are a measure of the use of the network bandwidth at level of antenna. The data collected can be linked to urban distribution of activities and also to different time bands in which it is possible to divide the day, to identify the ways of use of the city. It is still important to highlight that it is not simple to distinguish the tourists from the residents. An example of this application is the Estonian experience (Ahas et al., 2011) concerning the use of mobile positioning data for studying the time-space behaviour of people and tourists in the country since 2001. Since then these data have been used in various projects, research and art (Ahas et al., 2011).

## 4. MEASURES AND TOOLS FOR THE ANALYSIS OF TOURIST MOBILITY

In order to analyze multi-destination trips, some indexes have been used in tourism literature. Among the first indices used we find the Trip Index (TI) (Pearce and Elliott, 1983; Uysal and McDonald, 1989):

$$TI = \frac{D_n}{T_n} \times 100 \quad (1)$$

where: $D_n$ is the number of nights spent at the destination considered, and $T_n$ is the number of total nights spent during the trip.

This index represents a measure of the relative importance of the considered destination and its usage is recommended for tourists' segmentation (Uysal and McDonald, 1989), for marketing and destination promotion purposes, as well as additional information useful in order to distinguish tourists' characteristics and to analyse the itineraries undertaken.

A second index is the so called Main Destination Ratio (MDR) (Leiper, 1989) which analyzes the features of multi-destination trips at an international level. It is based on data collected in the region of origin and at the destination and it is defined as the ratio between the trips for which the region observed is the only one visited or the main and the total arrivals:

$$MDR = \frac{V_{ij}}{A_{ji}} \times 100 \quad (2)$$

where: $V_{ij}$ is the number of trips which have had as main destination the *i*-th destination (information derived from the survey on the demand side provided by the *j*-th country generating tourism), whereas $A_{ji}$ is the total number of border crossing made by tourists coming from the *j*-th country (measured through the surveys at the frontiers carried out by countries hosting tourism).

According to the author (Leiper, 1989), by mean of this index it is possible to provide a more complete picture of international tourism and to classify the different countries in predominantly main destination or secondary destinations.

Still, Oppermann (1992) proposes the use of a composite index to characterize touristic travel behaviours. The Travel Dispersal Index (TDI)

incorporates five variables characterizing domestic touristic behaviour and it is defined as:

$$TDI = LS + OD + A + T + TO \quad (3)$$

where: *LS* is the total length of stay in the considered country, *OD* represents the number of visited destinations with at least one overnight, *A* and *T* indicate respectively the number of the different types of accommodation facilities and means of transport used by tourists during their trip, and *TO* is a variable measuring the type of travel organisation.

The use of *TDI* is recommended to identify those tourist segments which have a greater impact on the different economic sectors of a country (Oppermann, 1992). However, this index presents several limits. First, its strong dependence by the average length of the trip in a specific country doesn't allow a direct comparison among different countries based on the values of the index. Moreover, further limits derive from the arbitrary definition of the weights, and from the aggregation criterion by sum which, implicitly, assumes the independence among the different elements. This hypothesis seems quite unlikely.

More recent studies (Hwang et al., 2006; Asero et al., 2011) have framed the phenomenon of the multi-destination trips within the network analysis framework. Different destinations visited are related to the nodes of a network and the routes made by tourists are seen as the links between the nodes of the network. Hwang et al. (2006) in the analysis of multi-destination trips in USA used the concepts of *centrality*, *connectivity* and *cohesion* and that of *structural equivalence.* If referred to a specific node of the network, the *centrality* denotes the degree of prominence within the network. On the other hand, if centrality is referred to the whole network, it describes the structural features of the whole net (Wasserman and Faust, 1994). In the field of network analysis, several measures for centrality have been proposed. The notions of *connectivity* and *cohesion* are related to the degree of density in the network structure and, in tourism field, they can be used to identify the presence of subgroups of destinations strongly connected to each other (Monge and Contractor, 2003). Finally, the notion of *structural equivalence* is referred to the comparison among different networks and to the degree of similarity among their structures.

On the other hand, the detailed and accurate trip data collected through GPS or Mobile Phones need to be opportunely analysed. Some authors suggest the use of techniques derived from others approaches rather than traditional statistical tools. Asakura and Iryo (2007), for example, proposed a simple index for describing and analysing a tour route in order to study tourists' travel behaviours. The authors start from the consideration according with which one of the simplest shapes of a tour route is a circle. When a circular route is observed at a specific point in the area, there are three possible relations between the circular route and the observation point:

1. the direction of the circular route is in a clockwise direction around the reference point;

2. the direction of the route is in an anticlockwise direction around the reference point;
3. the reference point is not located within the internal area of the circular route.

To identify these cases, the authors propose a Route Topology Index (RTI) which is defined respectively being equal to +1, -1 or 0, for each of the above three cases and so the corresponding RTI vector. In order to describe a more complex tour route, the RTI can be evaluated at multiple reference points. The *i*-th element of the RTI vector denotes the RTI for the *i*-th reference point. When the route does not make a circuit, the RTI could be defined as the cumulative angle of a tour rotating around a reference point. (Asakura, Iryo, 2007).

The RTI can be used to study the similarity of tour routes among different tourists through an index called "distance". The difference between tourist A and B is defined as:

$$D^2 = \| R_A - R_B \| = \sum_i \left( r_{Ai} - r_{Bi} \right)^2 \quad (4)$$

where $R_A = \{r_{Ai}\}$ and $R_B = \{r_{Bi}\}$ are the RTI vectors of two tourists.

The element of the vector is the RTI of the *i*-th reference point. The distance defined by the previous equation is used for the clustering method of a certain number of tourists. In this way it is possible to identify similar sightseeing pattern among tourists.

Another method to study the data collected by the devices previously presented is introduced by Shoval and Issacson (2007) and it is based on the sequence of alignment as a tool for analysing the sequential features of the temporal and spatial dimensions of human activities. This method was originally developed during the 1980s and employed to analyse DNA sequences, but at the end of the 1990s it was adapted for use in the social sciences (Shoval, Issacson 2007). In the traditional quantitative methods of sequence comparison, the distance between two sequences of activities is calculated through the Euclidian-based geometry, like Euclidian distance, city block distance or Hamming distance. The sequence alignment analysis, instead, computes the distance between two sequences on a "biological" basis. This method considers an algorithm based on three elementary operations: insertion, deletion and substitution (switching the places of two elements). By applying these operations to one of the sequences, that string is made identical to the other string. The more operations are needed to make the sequences identical, the longer is the distance, and so the greater is the difference between the sequences. Thus the method measures the degree of difference between two sequences in terms of their elements composition and sequence and it is more useful than traditional tools in order to recognise similar patterns that appear within tourists' activity sequences.

## 5. CONCLUSIONS

Over the years tourism has become increasingly important for the economy of many countries and it often represents one of the key sectors for development and growth. This raises the interest by politicians and scholars, engaged to learn the dynamics of the sector in order to implement an effective and efficient management, and it determines the need for data and techniques able to support a real comprehension of the phenomenon. The importance of analysing multi-destination trip behaviour is related, among the other things, to the relevance of this phenomenon for regional tourism development. The multi-destination vacation experience will require more time than the average stays and will attract mainly those who have active lifestyles and more discretionary time and income. Individual destinations will have the opportunity to explore new markets in a cost-effective manner and to develop a more competitive product. At a regional level, local tourism organizations can exploit the potential of profitable diversification and the rebranding of a destination/region.

Despite a number of studies has been made by official statistical institutes and by research groups in order to increase the knowledge of the factors affecting tourists movements (McKercher, Lew, 2004), the empirical evidences on these topics are still too limited to provide a complete picture of the phenomenon. As highlighted in this work, the actual system of official statistics it is not able to provide adequate information which allow for the analysis of tourist mobility (within a single destination and among several destinations). On the other hand, internet and new communication technologies have changed tourism industry in many aspects and now we can speak about a revolution in the tourism products' distribution system. The development of information technologies in tourism has affected the dynamics of tourism products prices, the destination image creation and communication, the increase of transportation security, the structure of market competition, the tourism product personalization, and so on (Zelenka, 2009). Consumers are more directly involved in the production process and they are increasingly often self producer of their own travel, thanks to Internet technology.

Regarding the potential use of ICT information for the analysis of tourists' behaviour we concentrate our attention on the possibility offered by ICT tools for the implementation of ad-hoc surveys. It is acknowledged that sampling tourists is not an easy task, both under the methodological, economic and practical perspectives. From this point of view, the solutions provided by ICT can represent an important tools for the analysis of tourists' space-time behaviour. The availability of a big amount of data characterised by a high degree of accuracy, if integrated with more traditional survey instruments (e.g. questionnaire) can strongly reduce the costs of the survey and increase its quality. On the other hand, there are still several problems which needs specific solutions. First, the determination of the specific sampling design which need to be adequate to the nature of tourist population, which is, by definition a mobile population. From this point of view the Time Location Sampling (TLS) technique can represent an interesting theoretical framework (Kalton, 1991; Parroco, et al.

2012). Second, the implementation of a probabilistic sampling scheme requires the determination of the solutions for a set of practical and methodological problems, such as: the way in which select tourists, the places in which the tourist has to be interviewed, the moment in which the information have to be collected (before, during or after the trip), the determination of the temporal and territorial level of the information, etc. All these problems have important implications on the possibility of implementing a probabilistic sampling scheme which would allow for the application of the classical inferential statistical techniques.

Summarizing, the changing nature of tourism demand and the increasing segmentation of the holyday market are raising the need for more accurate information – which integrate quantitative information on the magnitude of tourism with other more specific aspects of tourism behaviors – whose analysis requires appropriate methods and models.

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