



Exploring the travel behaviors of inbound tourists to Hong Kong using geotagged photos



Huy Quan Vu ^{a,1}, Gang Li ^{a,2}, Rob Law ^{b,3}, Ben Haobin Ye ^{c,*}

^a School of Information Technology, Deakin University, Vic 3125, Australia

^b School of Hotel & Tourism Management, The Hong Kong Polytechnic University, Hong Kong

^c School of Business, Sun Yat-sen University, No. 135, Xin Gang Xi Road, Guangzhou, China

HIGHLIGHTS

- A novel approach to travel behavior analysis is introduced, based on geotagged photos.
- A dataset comprises photos on Flickr by Hong Kong inbound tourists is built.
- The spatial and temporal information of photos infers tourists' movement trajectories.
- The advantage of the approach is shown by analyzing inbound tourist travel behavior.
- The study benefits destination development, transportation planning, and impact management.

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ABSTRACT

Insight into tourist travel behaviors is crucial for managers engaged in strategic planning and decision making to create a sustainable tourism industry. However, they continue to face significant challenges in fully capturing and understanding the behavior of international tourists. The challenges are primarily due to the inefficient data collection approaches currently in use. In this paper, we present a new approach to this task by exploiting the socially generated and user-contributed geotagged photos now made publicly available on the Internet. Our case study focuses on Hong Kong inbound tourism using 29,443 photos collected from 2100 tourists. We demonstrate how a dataset constructed from such geotagged photos can help address such challenges as well as provide useful practical implications for destination development, transportation planning, and impact management. This study has the potential to benefit tourism researchers worldwide from better understanding travel behavior and developing sustainable tourism industries.

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1. Introduction

The tourism industry plays a major role in economic development for many countries and regions, helping to improve the livelihoods of residents (Ashley, Brine, Lehr, & Wilde, 2007). Both public and private sector tourism operations are highly dependent on sustainable development planning, which aims to create appropriate employment, maintain the natural environment, and

deliver a high-quality visitor experience. Due to the perishable nature of the tourism industry, an accurate understanding of travel behaviors is crucial (Edwards, Griffin, Hayllar, Dickson, & Schweinsberg, 2009).

Tourism managers have long been seeking insights into travel behavior for the purposes of destination management, product development, and attraction marketing (Li, Meng, & Uysal, 2008). For instance, good transportation planning enables tourism providers to meet tourists' needs and coordinate their travel with local transportation flows. However, it requires planners to know about tourist preferences, daily itineraries, and the factors that influence them. Movement information can also be used to identify bottlenecks and unnecessary barriers in the flow between accommodation and attractions, or any other tourist destinations (Prideaux, 2000). In tourism location development, knowledge about travelers' location preferences can be used to redefine existing

* Corresponding author. Tel.: +86 84114091; fax: +86 84036924.

E-mail addresses: hqv@deakin.edu.au (H.Q. Vu), gang.li@deakin.edu.au (G. Li), hmroblaw@polyu.edu.hk (R. Law), yehb3@mail.sysu.edu.cn, demonyhb@hotmail.com (B.H. Ye).

¹ Tel.: +61 432 411 359.

² Tel.: +61 3 9251 7434; fax: +61 3 9251 7604.

³ Tel.: +852 3400 2181; fax: +852 2362 9362.

attractions, plan new ones, and market both more effectively (Lew & McKercher, 2006). The identification of the actual routes taken by tourists during their trips can help define the boundaries of districts and nodes, as well as the most appropriate gateways. This information can be used to develop new attractions and products along common routes as well as in district and destination nodes (Chancellor, 2012). In terms of impact management, it is important for tourism managers to identify the time and space characteristics of the routes and destinations which tourists visit most frequently in order to develop appropriate plans to prevent capacity overload, which has the potential for negative social, environmental, or cultural impacts (Lew & McKercher, 2006).

Some prior research focuses on developing techniques for analyzing tourist travel behaviors. For instance, Xia, Spilsbury, Ciesielski, Arrowsmith, and Wright (2010) introduce a method for tourist market segmentation based on dominant movement patterns in a case study of Phillip Island, Australia (Xia et al., 2010). Deng and Athanasopoulos (2011) utilize an anisotropic dynamic spatial lag panel Origin–Destination (OD) travel flow model to understand Australian domestic and international inbound travel patterns. Leung et al. (2012) use content and social network analyses to examine online trip diaries and map overseas tourist movement patterns during the Beijing Olympics. Such growing academic attention being paid to travel behavior indicates that this is an interesting topic which is important in the planning and decision-making processes of tourism managers.

Despite these efforts, both researchers and managers still find it difficult to fully capture and understand the travel behavior of international travelers. The difficulties are due to the following barriers:

Information Capture: Survey and opinion polls are popular methods to collect travel data from tourists (Asakura & Iryo, 2007; Lew & McKercher, 2006; McKercher & Lau, 2008). However, these approaches are usually time consuming and limited in terms of the number of responses as well as the scale of the information captured. The data are normally unable to reflect actual travel patterns closely (Zheng, Zha, & Chua, 2011). There is considerable need for a more efficient method of capturing comprehensive travel behavior data from tourists.

Travel Preferences: It is a natural assumption that travel behavior will vary among different groups of tourists (Batra, 2009). For instance, tourists from different countries may have different preferences for their length of stay and the attractions they want to visit, and this will, in turn, affect their travel activities (Leung et al., 2012). There have been limited attempts to analyze travel behaviors in a way which takes these preferences into consideration.

Recently, advances in multimedia and mobile technologies have allowed large volumes of user-generated data, such as travel photos, to be created and shared. Many photo-capturing devices, like smartphones and tablets, now have built-in global positioning systems (GPS) technology which enable geographical information (latitude and longitude coordinates) to be stored as metadata with each photo a user takes. Those geotagged photos, with time and geographical information embedded, allow the spatial–temporal movement trajectories of the user to be inferred. One of the most popular online resources for people to share their travel experiences by uploading photos is Flickr (www.flickr.com). Containing millions of geotagged photos, Flickr is a rich data source for mining tourist travel patterns (Lee, Cai, & Lee, 2013; Zheng, Zha, & Chua, 2012). Research into the nature and applications of georeferenced multimedia is an emerging topic in Computer Science (Zheng et al., 2011), with many attempts having recently been made to develop tools and techniques for data mining (Kalogerakis, Vesselova, Hays,

Efros, & Hertzmann, 2009; Yanai, Kawakubo, & Qiu, 2009; Yanai, Yaegashi, & Qiu, 2009). It will, therefore, be advantageous for tourism researchers to adopt these advanced technological developments when studying travel behavior.

In this paper, we attempt to address the shortcomings in the existing literature on tourist travel behavior by utilizing the geotagged photos that are available on social networking sites. Firstly, we present a method for constructing the data collection process which captures travel information from geotagged photos on Flickr. Then, we describe two relatively new data-mining techniques for processing and analyzing these data to yield information about the travel behaviors of tourists. This case study focuses on inbound tourism in Hong Kong, a major tourism destination in the Asia Pacific region. The study aims to discover the locations in which tourists are most interested and the routes they take when visiting Hong Kong. This method and the associated findings are of potential benefits to tourism researchers worldwide who are interested in travel behavior, and will also help tourism managers in Hong Kong and likely elsewhere to construct plans for sustainable development.

Having thus set the context for undertaking this work, the rest of the paper is organized as follows. In Section 2, we review existing work, which uses global positioning technology such as Geographic Information Systems (GIS) to analyze travel behavior. We then provide a summary of the techniques developed for processing geotagged photos in travel analysis, and define our research objectives. Section 3 presents the methods for extracting and analyzing geotagged photos. We demonstrate their effectiveness in a case study presented in Section 4. Finally, Section 5 concludes our paper and offers future research directions.

2. Related work

2.1. Travel behavior analysis using geographical information

Since GIS was firstly introduced, many studies have used it to explore the movement patterns of tourists (Lau & McKercher, 2006). For instance, Wu and Carson (2008) use GIS to identify multiple destination travel behavior for travelers in South Australia. McKercher and Lau (2008) apply it to examine the movements of tourists within an urban destination in Hong Kong, and identify 78 discrete movement patterns. Other researchers use GPS to explore tourists' experiences and mobility (Zakrisson & Zillinger, 2012), or to chart visitor movement patterns in natural recreational areas (Orellana, Bregt, Ligtenberg, & Wachowicz, 2012). Additionally, McKercher, Shoval, Ng, and Birenboim (2011) compare and contrast travel behaviors between first-time and repeat visitors in Hong Kong using both GPS and GIS.

Attempts have also been made to study tourist travel behaviors using these methods. For instance, Hwang, Gretzel, and Fesenmaier (2006) examine international tourists' multi-city trip patterns within the United States. A large-scale study of the spatial pattern of tourist flows among the selected Asia–Pacific countries over a 10-year period is presented by Li et al. (2008). Asakura and Iryo (2007) look at tourist travel behavior in Kobe, Japan using tracking data collected via mobile instruments. Smallwood, Beckley, and Moore (2012) explore the movement patterns of visitors traveling within protected areas using various modes of travel through a case study of the Ningaloo Marine Park, in north-western Australia. Masiero and Zoltan (2013) analyze the factors influencing both the spatial extent of the destination visited and the selected transport mode.

2.2. Geotagged photos for travel analysis

Advances in information technology, especially the introduction of GPS technology and mobile photo capturing devices, now allow

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