EVALUATING MUSEUM VISITOR EXPERIENCES BASED ON USER-GENERATED TRAVEL PHOTOS

Huy Quan Vu[a], Jian Ming Luo[b], Ben Haobin Ye[c], Gang Li[d] and Rob Law[e]

[a]Center for Applied Informatics, Victoria University, Vic 3011, Australia;

[b]Faculty of International Tourism and Management, City University of Macau, Macau;

[c]Department of Hospitality and Service Management, School of Business, Sun Yat-sen University, 510275, China;

[d]School of Information Technology, Deakin University, Vic 3125, Australia;

[e]School of Hotel & Tourism Management, The Hong Kong Polytechnic University, Kowloon, Hong Kong

Abstract

This research introduces online travel photos published on social media platforms as a complementary data resource to examine the behavior and experience of museum visitors. The practical value of online travel photos is demonstrated through a case study of popular Hong Kong museums, particularly by using the photo content and metadata available from the Flickr platform. The proposed approach is a generic method for understanding museum visitor behavior and preferences, and supports museum practitioners in developing improved products for visitors. The case study findings are particularly beneficial for tourism managers, especially those in Hong Kong, in promoting and attracting tourists to visit local museums.

Keywords: museum; visitor experience; Flickr; geotagged photos; visiting pattern; user generated content

1. Introduction

Museum visits constitute an important and popular element of tourism (Jansen-Verbeke & Rekom, 1996). It also provides distinctive forms of attraction, which generate jobs, growth, income, and economic development for tourist destinations (Kotler & Kotler, 2000). Certain museums, such as the British Museum, are "must-see" attractions (Throsby, 2001; Burke et al., 2010). In the UK, the contribution of museums to the economy outweighed that of the automobile industry, and museums have provided over 190,000 full-time jobs (Heritage Lottery Fund & VisitBritain, 2010). In Hong Kong, the Leisure and Cultural Service Department (2012) reported that over four million people visited major museums in 2011.

Researchers have focused on investigating visitor interest and experience to attract more visitors to museums and tourist destinations considering their economic benefits. Sheng and Chen (2012) studied visitors' diaries to identify the experiences, expectations, and preferences of different groups. The expectations and experiences of visitors from Thailand toward tourist and museum guides were examined by Kamolpattana et al. (2014). Vaz, Fernandes, and Veiga (2016) investigated the experience of visitors in Brazil regarding tangible user interfaces installed by museums, such as interactive kiosks, multi-touch surfaces, interactive projects, and human–machine interfaces. Brida, Meleddu, and Pulina (2013) analyzed the motivation for visiting different types of museums. Recently, Pallud (2017) studied the effects of technology on visitors' affective and cognitive reactions in a French museum. Finally, Siu, Zhang, Dong, and Kwan (2013) assessed the role of newness and the meaningfulness of new services from museums to improve the visitor experience in customer relationship management.

Despite existing efforts, tourism managers continue to face challenges in gaining a comprehensive and insightful understanding of visitor experience considering the variety of museum types and group preferences for such visits (Sheng & Chen, 2012). For example, tourists may visit a museum because of the beautiful scenes of surrounding areas or its convenient location, and not entirely because of the displayed artifacts. Other tourists may also be more interested in the historical and cultural aspects of the destination. Moreover, tourists may be drawn by different artifacts at the same museum. Traditional approaches in the literature often rely on surveys and questionnaires as means of data collection (Vaz et al., 2016; Siu et al., 2013; Kamolpattana et al., 2014); however, these approaches fail to capture all aspects of museum visitors' experience and motivation.

Fortunately, most tourists take photographs to record their visits and to ultimately prove that they consumed the experience offered by the city destination (Urry, 1990). Numerous social media platforms currently allow individuals to share their travel

photos with their friends and the public (Önder, Koerbitz, & Hubmann-Haidvogel, 2016). Examples of popular social media sites that allow the posting of photos include Facebook, Twitter, Instagram, and Flickr. Lo, McKercher, Lo, Cheung and Law (2011) reported that 89% of overnight tourists took photographs, and 41.4% of them posted some of these pictures online. User-generated travel photos were found to be effective in reflecting visitor experience at tourist destinations (MacKay & Couldwell, 2004; Balomenou & Garrod, 2014). Apart from visual content, social media platforms also include metadata associated with posted photos, such as location, time, and user profile (i.e., Flickr), which provide valuable insights into the behavior of museum visitors. To the best of our knowledge, travel photos have not been employed in the study of museum visitor experience.

This research aims to support tourism managers in gaining insights into the experience of museum visitors by utilizing user-generated travel photos made available publicly through social media sites. Flickr, a photo-sharing site, is used as the data source because it provides free access to an entire database of photos, locations, and timestamps. We demonstrate the practical value of travel photos in revealing tourist interests, experiences, and visiting patterns through a case study of popular Hong Kong museums with a data set of 406 museum visitors and 2,843 photos. The methods and findings are particularly valuable for tourism managers, especially those in Hong Kong, toward promoting and attracting tourists to local museums.

The rest of the paper is organized as follows. Section 2 provides a literature review on the role of museums in attracting tourists to destinations, an overview of extant studies on visitor behavior, and a critical analysis of existing limitations to the investigation of the behavior and preferences of visitors. Section 3 describes our methods for analyzing user-generated travel photos on Flickr. Section 4 presents a case study on museum visitors in Hong Kong and its practical implications. Section 5 concludes the paper and offers future research directions.

2. Literature Review

2.1 Museum as Tourist Attraction

A museum is a non-profit permanent institution in the service of a society, which is developed for and open to the public; it also acquires, conserves, identifies, communicates, and exhibits material evidence of people and their environment for the purpose of study, education, and enjoyment (Robins, 1992). Traditionally, museums focus on the materials they contain. Thus, museum managers are expected to protect museum materials while making them available for public viewing (Forgan, 2005). Previously, museum visits were mainly for viewing and education; nowadays, it

involves intense sense perception and intellectual, participatory, and social interaction (Kotler, 2001). Since the 1990s, museums have also gained attention from local visitors and tourists (Sparacino, 2002).

Given the increasing importance of museums, either as a part of clustered attractions or concerns related to sustaining business revenues, recent literature has focused on the attractiveness and value of museums to the mass population. Bedate, Herrero, and Sanz (2004) used travel cost to estimate the value of museums to customers in Spain. Similarly, Fonseca and Rebelo (2010) applied the Poisson econometric model to estimate the value of museums in Lamego. Participatory experience has also become a growing element of cultural experience that has increased museum visits (Kotler, 2001; Kotler & Kotler, 2000). Several works also emphasized the importance of socially oriented values (such as fun, entertainment, close relationships with other visitors, philanthropy, and social recognition) which influence the value of visiting museums (Brida et al., 2012, Thyne, 2001; Van Aalst & Boogaarts, 2004; Paswan & Troy, 2004). Other types of social experience involved shows, musical performances, films, and lectures of current artists. Burton, Louviere, and Young (2009) further showed that visitors' active participation in social and cultural activities could enhance their experience and prompt repeated visits to museums.

2.2 Studies on Museum Visitor Experiences

Tourism researchers realized that to offer exhibitions and services suitable for visitors, museums must conduct visitor studies and systematically acquire knowledge related to planning and decision making (Liu, 2008). Several studies emphasizing the demographic profile of visitors found that education, income, occupation, race and ethnicity, and age are positively correlated with museum visitation. Doering and Bickford (1994) revealed that, relative to average citizens, museum visitors are better educated, more affluent, and hold better paying jobs. According to DiMaggio (1996), museum visitors tend to be somewhat secular, trusting, politically liberal, racially tolerant, and open to other cultures and lifestyles. Museum visits, when treated as historic and artistic trips, are often associated with persons of higher education (Chieh-Wen, Shen, & Chen, 2008)

Other studies focused on visitor preference and expectation when visiting museums (Harrison, 1997), how they choose to visit each museum, and the attractiveness of different types of museums to various people (Jansen-Verkebe & Rekom, 1996; Harrison, 1997; Thyne, 2001; Brida et al., 2012). Gil and Ritchie (2009) examined visitor motivation and information to compare the process of museum image formation between residents and tourists. Burke et al. (2010) found that most

visitors prefer dynamic museums, as well as those that offer new experiences and regularly update their permanent displays. According to Sheng and Chen (2012), visitors who enjoyed museums usually expect luxurious and fun shows. In recent years, among the museum attraction elements, the external appearance of renovated buildings and exhibition aesthetics has become highly regarded by visitors (Nowacki, 2005).

The behavior patterns of museum visitors have also attracted the attention of tourism researchers (Falk & Dierking, 1992; Hooper-Greenhill, 2006). Various groups of visitors tend to visit different museums at different times. For example, during weekdays, student groups are the main visitors; whereas during holidays, small groups (such as parents and children) are the most common. Sookhanaphibarn and Thawonmas (2009) classified visitor styles by using the average and variance of their stopover times in museums. Yoshimura et al. (2014) discovered that the visiting styles of short- and long-staying visitors are relatively similar. In addition, long-staying visitors might be much more diverse given that they could spend additional time in museums. Harrison and Shaw (2004) and Hume (2011) also established the relationship between consumer satisfaction and intention to visit or revisit museums.

2.3 Literature on Visitor Experience Using Travel Photos

Travel photos are an important component of travel, and photographs are a common means of communicating travel experience and the perceived image of the destination (Schmallegger, Carson, & Jacobsen, 2010). Such photos serve as vacation evidence, and vacations may feel incomplete without photographs (Munir & Phillips, 2005). Analyzing the content of travel photos is an effective strategy for gaining in-depth insights into the experiences and interests of visitors on their destinations. Tudor (2012) examined travel blog photography and found that local specificity and cultural attractions are elements most attractive for Romanian tourists. Stepchenkova and Zhan (2013) analyzed tourists' travel photos on Flickr and identified strong interests regarding the daily lives of Peruvians. Pan, Lee, and Tsai (2014) also examined travel photos to gain insights into the motivation and affective quality of places relative to the experiences of tourists.

The proliferation of social media platforms has made it straightforward for tourists to share travel photos with friends and the public. Apart from the actual photos, diverse metadata, such as location and time, are also made available. Metadata could also provide further understanding into tourist behavior. For instance, the geotagged data of travel photos posted on Flickr were used to infer tourist movement and travel patterns in the case of Hong Kong inbound tourists (Vu et al., 2015) and Australian outbound travelers (Vu et al., 2017). Önder et al. (2016) employed both

location and time metadata to build a model for estimating tourism demand in the urban and regional areas of Austria. Overall, utilizing travel photos and their metadata on social media could complement the analysis of museum visitor behavior and experience.

2.4 Summary

In the past decades, the role of museums has changed from protecting cultural and historical materials to promoting tourist attractions. Tourists no longer visit museums simply because of the artifacts on display, but for many other motivations (Kotler, 2001). Understanding museum visitor behavior and experience is important for tourism managers in promoting museums to attract more tourists to specific tourism destinations. Prior studies focused chiefly on visitor profiles (Sheng et al., 2008), preferences and expectations (Burke et al., 2010; Sheng & Chen, 2012), and temporal visiting patterns and revisits (Sookhanaphibarn & Thawonmas 2009; Hume, 2011). Existing research methods that rely mostly on surveys, questionnaires, and travel diaries are often costly because they require direct contact with visitors. Moreover, travel is a unique visual experience. Given that collected data using traditional approaches are often in text, they may fail to capture fully the visitors' personal experiences. Furthermore, tracking new visitors and revisits is a challenging endeavor when using conventional data collection techniques. By contrast, online travels photos could provide extra insights due to available visual content and metadata. Nevertheless, such materials have not been utilized in prior studies on museum visitor experience. Hence, this research aims to demonstrate the practicality of using online travel photos to study tourist behavior and experience, particularly through a case study of Hong Kong museum visitors.

3. Methodology

Flickr, a popular photo sharing platform, is considered the data source for this study. We selected Flickr platform because it provides full access to its database, unlike other social media platforms such as Facebook, Twitter, and Instagram, which have quota limit for free accounts. Thus, retrieving data from Flickr at any time is convenient. Metadata, such as geotags and photo timestamps, are also available on Flickr, which provide valuable information about visitor behavior. Recent studies have shown that Flickr is a reliable data source for determining tourism demand (Barchiesi, Moat, Alis, Bishop, & Preis, 2015) and ascertaining the travel patterns of tourists (Önder et al., 2016; Vu et al., 2017). No prior information has been gathered from Flickr on visited and photographed popular Hong Kong museums, we first presented the process of identifying popular museums (i.e., those that tourists usually

visit and share photos of on photo sharing sites). All photos taken inside the identified museums were extracted. Finally, we described several methods to process and analyze the dataset.

3.1 Popular Museum Identification

We conducted the initial data collection process for photos with tags containing the keyword "museum." Data were extracted using Flickr's application programming interface (API), which allowed programmers to generate a query on Flickr's server to retrieve specific data. The full documentation of the Flickr-API could be obtained from flickr.com/services/api. The *photo search* function of Flickr-API allowed users to specify the geographical area and collect photos using a bounding box with coordinates denoted as la_{min} (minimum latitude), lo_{min} (minimum longitude), la_{max} (maximum latitude), and la_{max} (minimum longitude). Users could also specify the photo timestamp to limit the search further. Given that museums are not a top tier attraction in Hong Kong, we did not set the time limit to allow for the retrieval of all available photos.

Once the photos with the "museum" keyword were retrieved, we applied a density clustering technique, the P-DBSCAN (Kisilevich, Mansmann, & Keim, 2010), to identify the most visited museums automatically. P-DBSCAN could calculate the number of visitors, a key criterion for determining the popularity of a location. In this process, suppose the collected data are denoted as M. Then, two parameters are required when performing the clustering (α for neighborhood radius threshold and β for owner number threshold). For each photo $p \in M$, its neighbor photos p_n with locations within the radius threshold α from p are identified. If the neighbor photos p_n of p are owned by at least β number of owners, photo p is selected and added to a current cluster; otherwise, p is discarded. The process is iterated for all photos $p \in M$, and the result is determined by a set of clusters $C = \{c_1, c_2, \dots c_m\}$. Subsequently, each cluster is examined to determine the corresponding museum and its geographical extent.

3.2 Museum Photo Data Collection

The initial data collection discussed in the previous section focused on photos with the keyword "museum." However, some museum photos may be taken within the administration area without the "museum" keyword tag. Thus, a second round of data collection was necessary to retrieve all available information for the identified museums. For each museum $c_i \in C$, its geographical area is determined using Google Maps (www.google.com/maps). The *photo search* function is executed with a bounding box designated specifically to cover the targeted museum. Its coordinates

are denoted as $la^{c_i}_{min}$, $lo^{c_i}_{min}$, $la^{c_i}_{max}$, and $lo^{c_i}_{max}$. In case the geographical area of a museum is not rectangular, multiple bounding boxes are used to cover the area as closely as possible. All geotagged photos taken at the identified museum are retrieved together with their metadata, such as *GPS coordinates*, *time taken, UserID,* and *user's location of origin*. *UserID* is vital in our analysis because it facilitates the identification of specific visitors who went to multiple museums.

3.3 Data Analysis Method

Our study aims to utilize travel photos and their metadata to gain detailed insights into visitor behavior and experience. We adopted several techniques to analyze different data types:

- *Spatial Analysis:* We integrated *GPS coordinates* onto a map to examine the spatial distribution of visitors for each museum. Subsequently, the location of photos indicates the museum area of interest (including inside, outside, or nearby area).

- *Descriptive Statistics*: We examined museum visitor profiles by counting the number of visitors of each museum according to their *location of origin*. The numbers of photos taken at the museums were also considered because they indicate the degree of interest in the museums.

- *Temporal Analysis*: We utilized *time taken* and *userID* of photos to determine temporal visiting patterns for different groups. The number of unique *userID*s for any given time unit (i.e., day, week, or month) is also calculated and later represented in a graph.

- *Photo Content Analysis*: Photo content was crucial for reflecting the perception of visitors regarding the destination (Hao, Wu, & Morrison, 2015). We examined the photo collections to determine the common scenes captured in the photos. Proportional analysis of the categories was performed with respect to different museums and visitor groups, which could reveal the interests and preferences of different groups for each museum.

- *Multiple Visit Analysis:* We examined the entire photo collection of each visitor and identified the photos taken in the museum. This method helped to identify whether an individual visited the same museum or different museums at various times, which could then provide insights into their multiple visitation patterns.

4. Case Study

This section explores the behavior of museum visitors in Hong Kong. First, the process of collecting geotagged photo data posted by museum visitors is presented.

Second, detailed analysis is performed on the results regarding visitor behavior and experience. Finally, the practical implications of the findings are discussed.

4.1 Museum Photo Data Collection

The first step in our data collection was to identify popular museums that tourists visited frequently and shared photos of on Flickr. Initially, we collected the travel photos relevant to the Hong Kong museums, as discussed in Section 3. We then set the bounding box for the photo function using the parameter values of $la_{min} =$ 113.887603, $lo_{min} = 22.215377$, $la_{max} = 114.360015$, and $l0_{max} = 22.51446$ to cover the entire geographical area of Hong Kong. The main keyword entered into the search function was "museum." The search period covered 10 years (2007–2016). All photos with tag fields containing the provided keyword and taken within the specified time frame were included. The search returned 2,352 photos from 273 visitors. The locations of the collected photos are shown as yellow dots on the satellite image depicted in Figure 1a.

We applied the P-DBSCAN clustering technique on the initially collected dataset. "Museum" was set as the attraction-of-interest, although they are uncommon in Hong Kong. Accordingly, we set a small value for the radius threshold r at approximately 50 m. The minimum number of owners was set to $\alpha = 5\%$ of total owners. The returned number of clusters is shown in Figure 1b. After examining the locations, the clusters were marked using the names of corresponding museums: *Space Museum, Museum of Art, Museum of History, Science Museum,* and *Heritage Museum.* Four out of these five museums are located close to one another and are near the Tsim Sha Tsui area of Hong Kong.

a) Locations of museum photos   b) Clustering result of P-DBSCAN

Figure 1: Museum photo location and clustering result.

In the case study, we assumed that not all photos taken within or near the museum grounds were tagged with the "museum" keyword. Thus, a second round of data collection was conducted for all photos taken within the geographical areas of the museums. We designed multiple bounding boxes that complement each other to collect photos of museums with nonrectangular geographical areas. No keyword was used in this round, hence all photos were returned. The collected data comprise 2,843 photos posted by 406 visitors, which is a sizable dataset because museums are not among the top attractions in Hong Kong. The metadata for the photos include *GPS coordinates*, *time taken,* and *user's location of origin*.

A statistical summary of the collected museum photo dataset is presented in **Table 1**. We assumed that a visitor could visit more than one museum. Therefore, the total visitor number does not add up to 406. Moreover, because no clear boundary between the *Museum of History* and the *Science Museum* exists, we treated these two museums as a single attraction (i.e., *History & Science Museum*). Based on the findings, the most popular museum is the *Museum of Art*, which attracted 163 visitors, whereas the least popular is the *Space Museum* with 79 visitors. Although the museums were in close proximity to one another, tourists appeared to favor the *Museum of Art*. Additionally, although the *History & Science Museum* ranked second with 138 visitors, more photos were taken at this location (i.e., average of 11.87 photos per visitor) compared with the other museums.

Table 1: Museum Visitors Photo Datasets

Museum	No. of Visitors	No. of Photos	No. of photos per visitor
Space	79	122	1.57
Art	163	608	3.73
History & Science	138	1628	11.79
Heritage	85	485	5.71
Overall:	406	2843	7.00

4.2 Findings and Analysis
4.2.1 Spatial Analysis

Figure 2 shows the location of photos taken at the museums. The distribution of photos differs for the museums. Majority of the photos taken at the *Space Museum*, *Museum of Art*, and *Heritage Museum* were inside the museums. Some photos were taken outside, but were still shot close to the museum buildings. Photos with the

highest density at the center of the building were observed for the *Heritage Museum*, whereas photos spread widely within museum grounds were observed for the *Space Museum* and *Museum of Art*. Few photos were taken at the north area of the *Heritage Museum* building, likely because of museum restrictions or the low interest of visitors regarding the artifacts displayed in this area. For the *History & Science Museum*, numerous photos were taken inside the building; however, many photos were also shot at the open space between these two buildings. Such finding suggests that visitors showed high interest in the area between those two structures. In the latter section of this paper, actual photos taken in the *History & Science Museum* area are examined to determine the theme of visitor interests.

a)   Space Museum (top) and   b)   Museums of History (top)
     Museum of Art (bottom)   and Science (bottom)   c)   Heritage Museum

Figure 2: Location of museum photos

4.2.2 Visitor Profiles

This section explores the demographic profile of visitors. Some users did not provide information because location of origin is not required by Flickr. Subsequently, 211 visitors (approximately 52%) with location information were considered for the present study (Table 2). Among those visitors, 76 were local residents and 135 were international tourists from 27 countries. The top three tourist groups who visited the identified Hong Kong museums were from the United States of America (USA), the United Kingdom (UK) and China with more than 10 visitors each. Table 2 lists the number of visitors from each country for each of the museums. Note that the numbers in brackets are the average numbers of photos per visitor. As a visitor can visit more than one museum, the figures in the "Total Visits" column are higher than those found under "Number of Visitors".

The *Museum of Art* and *History & Science Museum* were visited most by US tourists with 12 and 11 visits, respectively. UK tourists were most interested in the

Museum of Art (10 visits). Chinese tourists favored the *History & Science Museum* with seven visits. In addition, tourist groups were interested mostly in taking photos at the *History & Science Museum,* with more than 11 photos per visitor. Hong Kong residents were equally interested in visiting the *Art*, *History & Science*, and *Heritage Museums* with nearly 30 visits each. *Space Museum* was the least popular, having only 12 visitors. In particular, visitors took more photos at the *History & Science* and *Heritage Museums* compared with the other museums.

Empty cells in Table 2 indicate that no tourists from the listed countries visited the identified museums according to our data collection method. However, the no-count outcome does not necessarily indicate that tourists from the listed countries did not visit the museums. For example, a tourist might have visited the museum but did not take photos or did not share the photos on Flickr. Nonetheless, the statistics could still present some general visiting and photo sharing patterns of tourist groups.

Table 2: Number of Museum Visitors by Country of Origin.

Country	Space	Art	History & Science	Heritage	Total Visits	No. of Visitors
United States of America	6 (2.3)	12 (5.9)	11 (14.3)	2 (5.0)	31	27
United Kingdom	3 (1.3)	10 (2.5)	6 (11.1)	2 (1.5)	21	21
China	3 (2.3)	5 (3.2)	7 (11.7)	1 (5.0)	16	13
Australia	4 (1.5)	4 (4.5)	2 (5.0)	1 (4.0)	11	9
Taiwan	3 (1.0)	4 (4.5)	1 (2.0)	1 (1.0)	9	9
Canada	2 (1.5)	3 (1.0)	4 (12.5)	-	9	8
Japan	2 (1.0)	2 (11.0)	2 (5.0)	1 (4.0)	7	7
Germany	1 (1.0)	3 (4.6)	1 (5.0)	2 (4.0)	7	6
Indonesia	-	4 (1.7)	-	-	4	4
Ireland	3 (2.6)	1 (1.0)	-	-	4	4
France	-	2 (2.5)	1 (21.0)	-	3	3
Thailand	1 (1.0)	-	-	2 (1.5)	3	3
Italy	-	1 (1.0)	1 (1.0)	-	2	2
New Zealand	-	2 (7.5)	-	1 (2.0)	3	2
Singapore	-	1 (1.0)	-	1 (2.0)	2	2
Spain	1 (1.0)	1 (2.0)	-	-	2	2
Switzerland	-	1 (1.0)	1 (1.0)	-	2	2
Netherlands	-	2 (2.0)	2 (7.5)	-	4	2
Belgium	-	1 (1.0)	-	-	1	1
Finland	1 (2.0)	-	-	-	1	1

Holland	1 (1.0)	-	-	-	1	1
Jordan	1 (2.0)	-	-	-	1	1
Korea	1 (1.0)	1 (1.0)	-	-	2	1
Philippines	-	1 (1.0)	-	-	1	1
Qatar	-	1 (2.0)	-	-	1	1
Russia	-	1 (2.0)	-	-	1	1
Sweden	-	-	1 (3.0)	-	1	1
Hong Kong Residents	12 (1.7)	27 (3.8)	29 (19.1)	29 (10.2)	97	76
Total Location Stated	45	90	69	43	247	211
Location Not Stated	34	73	69	42	218	195

**Note:** *numbers in bracket indicate the average number of photos per visitor*

4.2.3 Temporal Visiting Patterns

We further examined the temporal information of the photos for additional insights into the tourists' visiting patterns of museums. Visitors were grouped based on their continents (i.e., *Asia*, *Europe*, *North America*, and *Oceania*) for the purpose of analysis and interpretation. Hong Kong residents were retained as a separate group to distinguish their visiting patterns from international visitors. Tourists from the *Asia* group are from Asian territories except for Hong Kong. We calculated the number of visitors for each museum according to month and visitors' origin (Figure 3). Our findings are summarized as follows:

- The *Space Museum* was visited often during the second half of the year, with visits peaking in July (Figure 3a). Half of the visitors in July were Hong Kong residents. From September to December, international tourists were more likely to visit the *Space Museum* in comparison to Hong Kong residents. Fewer visitors were noted in March, May, and June compared with the other months.

- The *Museum of Art* was more likely to be visited at the early parts of the year (January–April) than the latter months (November–December) (Figure 3b). Majority of the visitors in December were from Asia and Europe. Museum visitors peaked in July, but they were mostly Hong Kong residents. International visitors were more likely to visit the *Museum of Art* (Figure 3b) than the *Space Museum* (Figure 3a) at the beginning of the year, even if the museums are in close proximity to each other.

- The *History & Science Museum* was visited most days of the year except during March and December, the months with minimal visitors (Figure 3c). Hong Kong residents and tourists from North America were the main groups of visitors in July and August. November is the peak time for the *History &*

Science Museum, as shown by the highest number of visitors for most groups except for North American tourists.

- Figure 3d shows that the peak period for the *Heritage Museum* is the middle of the year (April–June), although majority of the visitors were Hong Kong residents. The limited number of international visitors might be because of the museum's location, which is far from the metropolitan area where tourists usually stay when visiting Hong Kong.


(a)

(b)

(c)

(d)
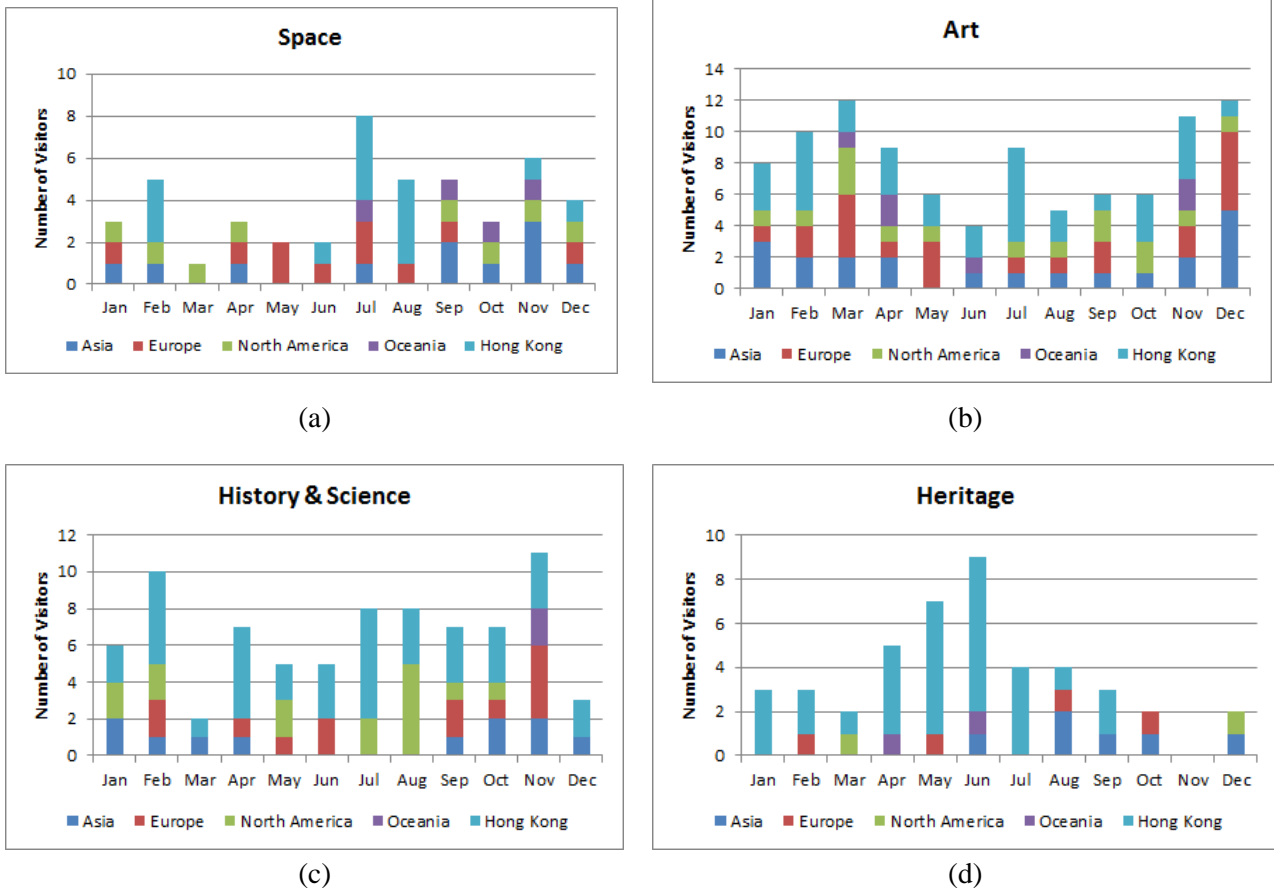
Figure 3: Museum visits by month

4.2.4 Photo Content Analysis

This section presents an analysis of the actual content of the photos, which implicitly indicates the visitor interests and perception toward museums. Manual content analysis was adopted to examine the photos taken at the museums. This approach is acceptable because the photo data collection is small in terms of scale. Three graduate students were employed to examine and label the photos individually into a number of categories, such as *indoor scene & artifact*, *outdoor,* and *selfie.* Examples of *indoor scene & artifact* are shown in Figures 4a, 4b, 4c, and 4d. Photos taken indoors in the *Space*, *Art,* and *Heritage Museums* focused on specific objects

displayed, whereas photos shot at the *History & Science Museum* showed multiple objects. Among the outdoor scenes at the *Space Museum,* we found a number of photos focusing on the museum building, whereas the others were general scenes without a specific theme. We grouped the outdoor photos as *outdoor museum building* and *general outdoor*. Figure 4e shows an example of a museum building photo at the *Space Museum* that includes the building and water pond. Similarly, for the *Museum of Art*, we classified the outdoor photos under *general outdoor* and *Victoria Harbor scene*. A sample photo of Victoria Harbor taken from the *Museum of Art* is shown in Figure 4f**.** The *selfie* category contained photos with contents focusing on human beings, either the tourists themselves or other people. A photo was classified into one of the aforementioned categories only if all three graduate students reached a consensus regarding the label. Otherwise, the photo was labeled as *others* because it cannot be grouped into any category.
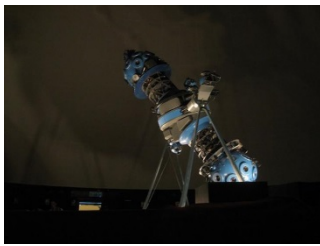
| (a) Indoor Artifact at the Space Museum	(b) Indoor Artifacts at the Art Museum	(c) Indoor Artifacts at the History & Science Museum
(d) Indoor Artifacts at the Heritage Museum	(e) Building Scene of the Space Museum	(f) Victoria Harbor Scene from the Art Museum

Figure 4: Sample photos at the museums

We calculated the proportion of photos according to the categories (Figure 5). Based on Figures 5a and 5b, approximately half of the photos taken at the *Space Museum* and *Museum of Art* contained outdoor scenes. Less than 40% of the photos were of the indoor scenes and the artifacts displayed in these museums. Around half of the outdoor photos at the *Space Museum* focused on the museum building, and half

of the outdoor photos at the *Museum of Art* centered on the Victoria Harbor scene. Thus, tourists were interested in taking photos not only of the indoor exhibition items of the museums, but also of their surrounding environment. This finding was consistent with those for the two museums located at a tourist hotspot in Hong Kong where other attractions were situated. By contrast, the main attraction at the *History & Science* and *Heritage Museums* were the indoor scenes and the museum artifacts, as indicated by a large percentage of photos (85%) (Figures 5c and 5d), and very few photos focused on the outdoor scene. Selfie photos were taken more often at the *Art* and *Heritage Museum*s (around 8%) compared with the other museums.


(a)

(b)

(c)

(d)
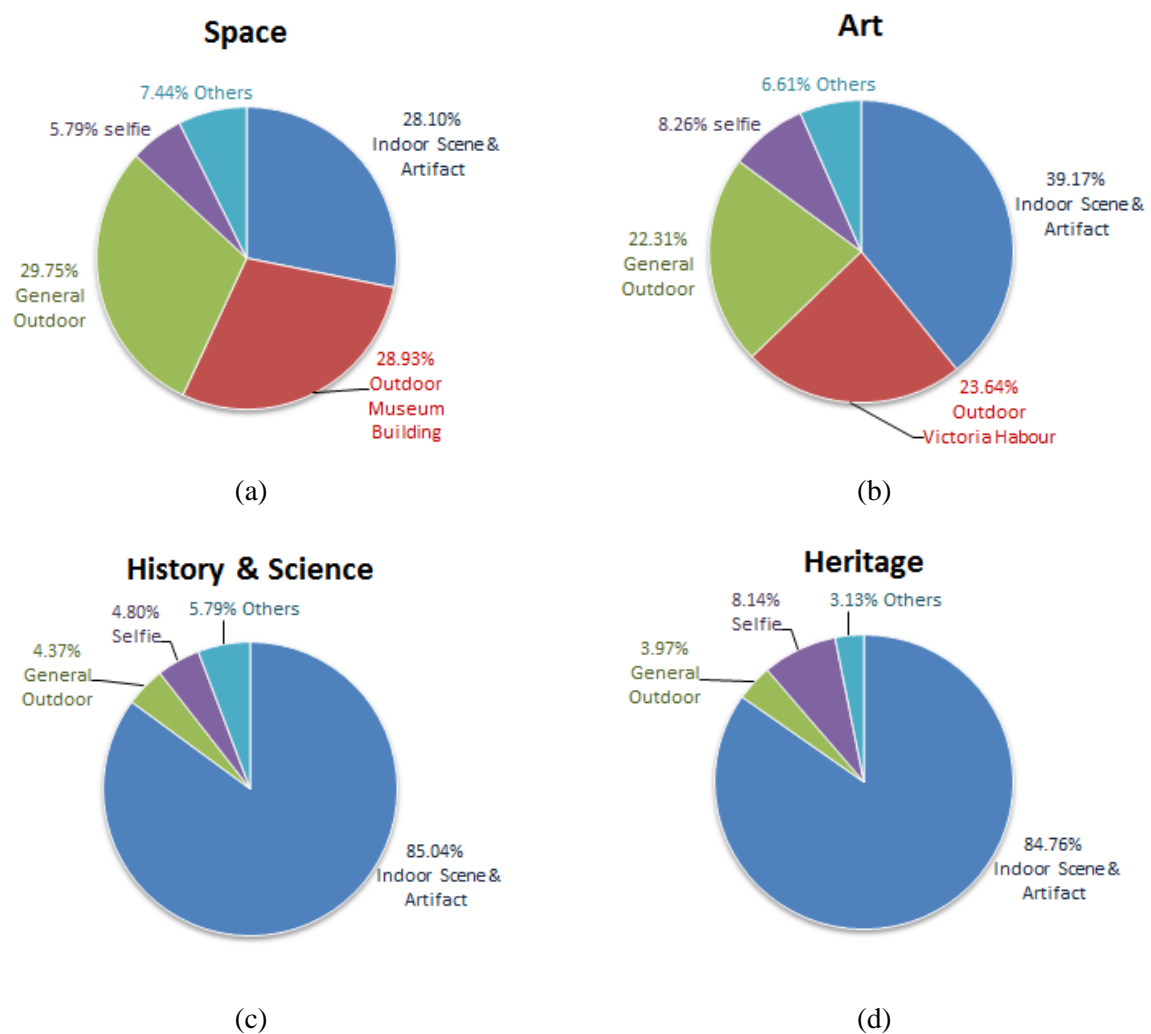
Figure 5: Proportion of the photo scenes by museum

We further examined the photo categories with respect to the demographic profile of photo-takers for deeper understanding of visitor interest. In this analysis, the photos were grouped as *indoor scene & artifact*, *outdoor,* and *others*. The *indoor scene & artifact* group was similar to that of the previous case. The *outdoor* group contained photos taken outdoors, and the *others* category contained selfies or other

unlabeled photos. The numbers of photos in these categories are shown in Figure 6 with respect to different visitor groups. Hong Kong residents were most interested in *indoor scene & artifact,* as shown by nearly 90% of their photos. Visitors from North America highly favored *indoor scene & artifact,* with more than 80% of their photos under the said category. Meanwhile, the *outdoor scene* represented a considerable proportion of the photo collection of visitors from Asia and Oceania (more than 30%).
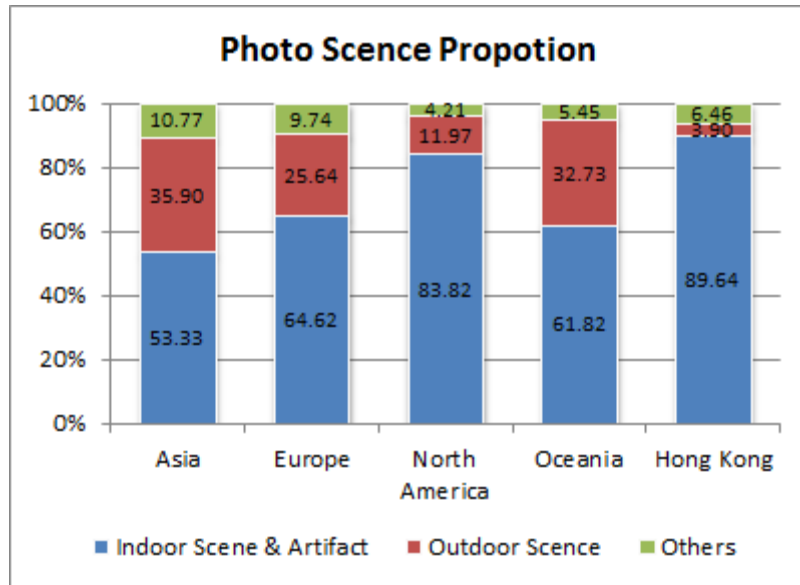
Figure 6: Proportion of photo scenes by visitor group

4.2.5 Multiple Visit Analysis

This section examines the visiting patterns of museum visitors based on the travel history reflected in their photo collections. Table 3 provides a summary of the visiting frequency for one, two, or three museums. In total, 361 individuals visited at least one museum, 35 individuals visited at least two museums, and 10 individuals visited at least three museums. For individuals who visited at least one museum, they were twice as likely to choose the *Museum of Art* over the *Space Museum*, even if the two buildings share the same location. The *History & Science Museum* was also likely chosen by individuals who made one visit to the museum.

Table 3: Frequency of Museum Visits

	Space	Art	History & Science	Heritage	**No. of Visitors**
Visited one	60	131	112	58	361

museum					
Visited two museums	13	23	16	18	35
Visited three museums	5	8	9	8	10

We further examined the profile of visitors who visited more than one museum to obtain a detailed understanding of their visiting patterns. In our dataset, 46 visitors visited multiple museums, but only 26 provided location information (Table 4). *UserID* refers to the account ID of the photo-takers on Flickr, with the last digits omitted for privacy. Visits according to month and year are shown by the columns for the corresponding museums. Shaded cells indicate museums visited in the same period. Among international visitors (rows 1 to 13), many visited multiple museums during the same month, likely during the same trip to Hong Kong. Conversely, Hong Kong residents were likely to visit multiple museums at different times spanning multiple years. This finding was consistent with common concerns such as time constraints. In other words, international visitors used their trip to Hong Kong to visit multiple museums, whereas Hong Kong residents visited museums whenever they liked. None of the Flickr users visited the same museum twice in our data collection.

Table 4: Multiple Museum Visits by Year

Row ID / User ID	Visitor Location	Museum			
		Space	Art	History & Science	Heritage
1 / 20256721@xxx	Australia	-	Apr 2010	-	Apr 2010
2 / 64810392@xxx	Australia	-	Nov 2011	Nov 2011	-
3 / 25426000@xxx	Canada	Feb 2010	-	Feb 2010	-
4 / 49034914@xxx	China	Apr 2011	-	Apr 2011	Aug 2011
5 / 82955071@xxx	China	-	Dec 2008	Mar 2008	-
6 / 13651714@xxx	Germany	Dec 2014	Dec 2014	-	-
7 / 97502594@xxx	Korea	Jan 2011	Jan 2011	-	-
8 / 40288584@xxx	New Zealand	-	Jun 2015	-	Jun 2015
9 / 10895714@xxx	Netherlands	-	Nov 2008	Nov 2008	-
10 / 43334562@xxx	Netherlands	-	May 2009	May 2009	-
11 / 49503142513@xxx	USA	Mar 2015	Mar 2015	-	-
12 / 8435962@xxx	USA	Oct 2007	Oct 2007	Oct 2007	-
13 / 93452482@xxx	USA	Apr 2010	Sep 2011	-	-
14 / 13984624@xxx	Hong Kong	Aug 2006	Oct 2006	-	-

15 / 27318550@xxx	Hong Kong	-	Feb 2014	-	Jul 2016
16 / 29142598@xxx	Hong Kong	Feb 2013	Jul 2010	Jul 2010	-
17 / 34919198@xxx	Hong Kong	-	Jun 2007	Nov 2006	May 2007
18 / 43069313@xxx	Hong Kong	-	Dec 2012	Feb 2013	Jan 2014
19 / 44844382@xxx	Hong Kong	Feb 2010	Feb 2010	-	Jul 2013
20 / 60395108@xxx	Hong Kong	-	Nov 2008	Sep 2015	Feb 2015
21 / 66883888@xxx	Hong Kong	-	-	Jul 2008	Jun 2011
22 / 69921425@xxx	Hong Kong	Jul 2015	-	Jun 2016	May 2016
23 / 7512041@xxx	Hong Kong	-	Jul 2008	Jul 2007	Jun 2007
24 / 86736023@xxx	Hong Kong	-	-	Feb 2013	Apr 2013
25 / 8938232@xxx	Hong Kong	-	-	Apr 2014	Apr 2014
26 / 99708700@xxx	Hong Kong	-	Aug 2012	-	Apr 2011

4.3 Discussion

The analyses presented how travel photos and their metadata could be used to capture the behavior and experience of museum visitors in Hong Kong. Several implications were drawn from the findings. First, according to Figure 5, only 39.17% of the photos for the *Museum of Arts* were taken indoors, particularly of the museum artifacts. Similarly, 28.10% of photos taken at the *Space Museum* were of the same theme (i.e., indoor scene and artifacts). Both percentages of the photos taken at the *History & Science* and *Heritage Museums* for the indoor scene and artifacts categories were over 80%. Hence, we conclude that visitors find the content in the *History & Science* and *Heritage Museums* to be more attractive compared with those of the *Museum of Arts* and the *Space Museum*. Another reason could be that the *Museum of Arts* and the *Space Museum* are located in central locations in Hong Kong, whereas many other attractions are located in other places. In addition, visitors were interested in taking photos of other scenes, such as the Victoria Harbor, rather than focusing only on the artifacts displayed inside the museums. Many outdoor photos of the Victoria Harbor were also taken from the top of the *Museum of Arts* building. Thus, managers of the *Museum of Arts* may consider incorporating photo shoots into their promotional materials or museum guides to attract more visitors. Moreover, as shown in Table 1, the *Museum of Arts* was the most visited and photographed museum, whereas the *Space Museum* was the least visited and photographed, despite these two museums being located close to each other. As mentioned, many visitors were interested in taking harbor view photos from the *Museum of Arts*, which was not possible from the *Space Museum* (i.e., the harbor view photos could be the main reason for the lower

number of visitors and photos). Consequently, the *Space Museum* managers may consider improving their collection, enhancing their artifacts, or incorporating new activities and promoting visitor participation and attraction sites (Van Aalst & Boogaarts, 2004; Paswan & Troy, 2004; Burton et al. 2009).

As shown in Figure 3, for the *Space Museum, Museum of Art, History & Science Museum,* and the *Heritage Museum*, the highest number of visitors is recorded during July, March/December, November, and June, respectively; whereas the lowest number of visitors arrive on March, June, March, and November. This finding shows that museum visitors have different preferences in terms of timing of museum visitation, thereby complementing previous studies (Falk & Dierking, 1992; Hooper-Greenhill, 2006). Another possible reason could be the products offered by different museums at different months of the year. For example, the *Heritage Museum* has six permanent exhibitions (the Orientation Theatre, New Territories Heritage, Children's Discovery Gallery, Cantonese Opera Heritage Hall, T.T. Tsui Gallery of Chinese Art, and Chao Shao-an Gallery). More importantly, the permanent exhibitions are supplemented by special events and exhibitions held at specific times, but mostly every May (Hong Kong Heritage Museum, 2017). From the government's perspective, it can capitalize on museum events to balance tourist arrivals throughout the year.

Table 2 and Figure 6 show the photo-taking behavior according to visitors' places of origin. Most Asian visitors to Hong Kong were from mainland China and Taiwan, but they displayed low interest in museum visitation compared with European and North American tourists. This outcome suggests that Chinese cultural tourists are not attracted to Hong Kong museum products. By contrast, visitors from North America were interested in indoor scenes and artifacts compared with visitors from Asia, Europe, or Oceania. Asian and Oceanian tourists prefer taking outdoor scene photos. Hence, visitors from North America can be classified more easily as cultural tourists in comparison to those from other destinations. Therefore, the corresponding recommendation to tourism product providers is that they should enhance promotion related to cultural tourism product to North America. Alternatively, for visitors from Asia and Oceania, the museum can be a simple tourist attraction for the mass market. For example, the government can promote museums to the Western market as cultural tourism and promote museums to other Asia Pacific markets as one of the attractions.

Despite the findings on museum visitors, this study is not without limitations. Different tourists have different social networks, and Flickr might not be their only choice for photo posting. Moreover, individual profiles on Flickr might be self-selected, making the results of this study subject to sample bias. In the study, we

assumed that tourists visited a museum but did not take or upload photos on Flickr. Accordingly, the visiting patterns established by this study should be understood as based on the minimum visits only. Furthermore, our data collection method relied on geotagged data to identify photos taken within the geographical area of the museums. If a museum visitor used photo capturing devices without a GPS function, their uploaded photos on social media sites are not geotagged. Consequently, our method was unable to identify or extract non-geotagged photos. Nevertheless, an increasing number of geotagged photos have become available online because of advanced technologies, making photo capturing devices with GPS functions increasingly popular. In the case study, only the visitors' places of origin were considered because of the limited demographic information on Flickr. Although other social media platforms may have more demographic data, they are usually treated as private, hence such data would be difficult to obtain. Therefore, the introduction of online travel photos in this study does not aim to replace traditional data collection approaches (e.g., survey and questionnaire) but rather to provide added data sources to complement the insights into visitor experience. One major advantage of online travel photos is the availability of metadata attached to the photos, which provide additional information on visitor behavior at the destination. The GPS data of the geotagged photos provide microscopic information on the spatial distribution of visitors at museums. The visual content of the actual photos provide information on specific scenes and artifacts that attract visitors' attention, which could be helpful in examining the attractiveness of different museums to different visitors, as noted in prior studies (Thyne, 2001; Brida et al., 2012). The user ID helps identify the profiles of visitors, who visited multiple museums, which may contribute in expanding our knowledge of museum visiting patterns (Hooper-Greenhill, 2006). Other social media platforms such as Facebook, Twitter, and Instagram may provide other types of metadata, including comments, discussions, and sentiment indication (i.e., like and dislike), which may also be useful in the further study of museum visitors.

5. Conclusions

Museums have become an important component of tourism because they generate economic benefit to tourist destinations. Hence, understanding the behavior of museum visitors is crucial for museum managers to construct strategic plans. Existing approaches on museum visitor experience and behavior rely mainly on textual data (e.g., surveys, questionnaires, or visitors' diaries), which cannot fully

capture information regarding a visitor's own experience. In this research, we introduced online travel photos available through a social media platform as a complementary data resource. We also demonstrated the practical implications by presenting a case study of Hong Kong museum visitors. A visitors' own experience was reflected through the analysis of photo content, whereas other metadata provided by Flickr allowed the consolidation of insights with regard to spatial and temporal visit patterns. The proposed approach and findings are likely to benefit tourism researchers and practitioners in understanding visitor behavior and preferences and allow museum practitioners, especially those in Hong Kong, to provide better products to museum visitors. Given that travel photos made available on social media platforms are available globally, analysis may also be conducted for other types of museums in different tourist destinations. Various social media platforms may be considered jointly to develop a comprehensive understanding of visitor experience. Moreover, the photo content analysis was accomplished manually in this study because of the relatively small number of photos. Future studies may consider adopting a computational technique for photo processing to facilitate the analysis of photo content for substantial photo collections.

References

Balomenou, N., & Garrod, B. (2014). Using volunteer-employed photography to inform tourism planning decisions: A study of St David's Peninsula, Wales, *Tourism Management,* 44, 126-139. doi:10.1016/j.tourman.2014.02.015

Barchiesi, D., Moat H. S., Alis C., Bishop S., & Preis, T. (2015). Quantifying International Travel Flows Using Flickr. *PLos One, 10*(7): e0128470. doi:10.1371/journal.pone.0128470

Bedate, A., Herrero, L. C., & Sanz, J. Á. (2004). Economic valuation of the cultural heritage: application to four case studies in Spain. *Journal of Cultural Heritage*, *5*(1), 101-111. doi:10.1016/j.culher.2003.04.002

Brida, J. G., Meleddu, M., & Pulina, M. (2012). Understanding Urban Tourism Attractiveness: The Case of the Archeological Otzi Museum in Bolzano. *Journal of Travel Research,* 51(6), 730-741. doi:10.1177/0047287512437858

Burke, P. F., Burton, C., Huybers, T., Islam, T., Louviere, J. J., & Wise, C. (2010). The Scale-adjusted Latent Class Model: Application to Museum Visitation. *Tourism Analysis*, *15*(2), 147-165. doi:10.3727/108354210X12724863327605

Burton, C., Louviere, J., & Young, L. (2009). Retaining the visitor, enhancing the experience: identifying attributes of choice in repeat museum visitation. *International Journal of Nonprofit and Voluntary Sector Marketing*, *14*(1), 21-34. doi:10.1002/nvsm.351

Chieh-Wen, S., Shen, M. J. & Chen, M. C. (2008). Special interest tour preferences and voluntary simplicity lifestyle. *International Journal of Culture, Tourism and Hospitality Research,* 2(4), 389-409. doi:10.1108/17506180810909005

DiMaggio, P. (1996). Are art-museum visitors different from other people? The relationship between attendance and social and political attitudes in the United States. *Poetics,* 24(2-4), 161-180. doi:10.1016/S0304-422X(96)00008-3

Doering, Z.D., & Bickford, A. (1994). *Visits and visitors to the Smithsonian Institution: A summary of studies.* (Institutional Studies Report No. 94-1). Washington, DC: Smithsonian Institution. Retrieved July 16, 2017, from: https://www.si.edu/content/opanda/docs/Rpts1997/97.04.VisitorsSummary.Final.pdf

Falk, J.H. (1998) Visitors: Who does, who doesn't, and why. *Museum News*. 77(2), 38-43.

Falk, J.H. & Dierking, L.D. (1992). *The museum experience.* Washington, D.C: Whalesback Books.

Fonseca, S., & Rebelo, J. (2010). Economic valuation of cultural heritage: application to a museum located in the Alto Douro Wine Region–World Heritage Site. *Pasos*, *8*(2), 339-350. Retrieved July 16, 2017, from http://www.pasosonline.org/Publicados/8210/PS0210_07.pdf

Forgan, S. (2005). Building the Museum: Knowledge, Conflict, and the Power of Place, *History of Science Society*, 96(4), 572-585. doi:10.1086/498594

Gil. S. M., & Ritchie, J. R. B. (2009). Understanding the Museum Image Formation Process. *Journal of Travel Research*. 47(4), 480-495. doi:10.1177/0047287508326510

Hao, X., Wu, B., & Morrison, A. M. (2015). Worth thousands of words? Visual content analysis and photo interpretation of an outdoor tourism spectacular performance in Yangshuo Guilin, China. *Anatolia*, 27(2), 201–213. doi:10.1080/13032917.2015.1082921

Harrison, J. (1997). Museums and Touristic Expectations. *Annals of Tourism Research*, 24(1), 23-40. doi:10.1016/S0160-7383(96)00037-0

Harrison, P., & Shaw, R. (2004). Consumer satisfaction and post-purchase intentions: An exploratory study of museum visitors. *International Journal of Arts Management*, 6(2), 23-32. Retrieved July 16, 2017, from http://www.jstor.org/stable/41064817

Heritage Lottery Fund, & VisitBritain. (2010). *Investing in success: Heritage and the UK tourism economy.* London: Heritage Lottery Fund. Retrieved from: https://www.hlf.org.uk/investing-success-heritage-and-uk-tourism-economy

Hong Kong Heritage Museum. (2017). *Exhibitions*. Retrieved July 16, 2017, from: http://www.heritagemuseum.gov.hk/en_US/web/hm/exhibitions/past_exhibitions/past2015.html

Hooper-Greenhill, E. (2006). Studying visitors. *A companion to museum studies,* S. Macdonald (Ed.), Malden, MA: Blackwell Publishing Ltd..

Hughes, H. L. (1998). Theatre in London and the Inter-Relationship with Tourism, *Tourism Management*, 19(5), 445-452. doi:10.1016/S0261-5177(98)00041-7

Hume, M. (2011). How do we keep them coming?: Examining museum experiences using a services marketing paradigm. *Journal of Nonprofit & Public Sector Marketing*, *23*(1), 71-94. doi:10.1080/10495142.2011.548759

Jansen-Verbeke, M., & Rekom, J. (1996). Scanning Museum Visitor. Urban Tourism Marketing, *Annals of Tourism Research*, 23(2), 364-375. doi:10.1016/0160-7383(95)00076-3

Kamolpattana, S., Chen, G., Sonchaeng, P., Wilkinson, C., Willey, N., & Bultitude, K. (2015). Thai visitors' expectations and experiences of explainer interaction within a science museum context. *Public Understanding of Science*, 24(1), 69-85. doi:10.1177/0963662514525560

Kisilevich, S., Mansmann, F., & Keim, D. (2010). P-DBSCAN: a density based clustering algorithm for exploration and analysis of attractive areas using collections of geo-tagged photos. In *Proceedings of the 1ˢᵗ international conference and exhibition on computing for geospatial research & application.* Article no. 38, Bethesda, Maryland, USA.

Kotler, N. (2001) New ways of Experiencing Culture: The Role of Museums and Marketing Implications, *Museum Management and Curatorship*, 19(4), 417-425. doi:10.1080/09647770100801904

Kotler, N., & Kotler, P. (2000). Can Museum Be All Things to All People? Missions, Goals, and Marketing Role. *Museum Management and Curatorship*, 18(3), 271-287. doi:10.1080/09647770000301803

Leisure and Cultural Services Department of HKSAR. (2012). Statistics report. LCSD, Retrieved July 16, 2017, from http://www.lcsd.gov.hk/en/ppr_statistic_cs.php#Museums

List of museums in Hong Kong. (n.d.). Retrieved April 26, 2016, from https://en.wikipedia.org/wiki/List_of_museums_in_Hong_Kong

Liu, W. C. (2008). Visitor study and operational development of museums. *Museology Quarterly,* 22(3), 21-37. Retrieved July 16, 2017, from: http://web2.nmns.edu.tw/PubLib/Library/quaterly/200807_21.pdf

Lo, I. S., McKercher, B., Lo, A., Cheung, C., & Law, R. (2011). Tourism and online photography. *Tourism Management,* 32(4), 725-731. doi:10.1016/j.tourman.2010.06.001

MacKay, K. J., & Couldwell, C. M. (2004). Using Visitor-Employed Photography to Investigate Destination Image. *Journal of Travel Research,* 42(4), 390-396. doi:10.1177/0047287504263035

Munir, K. A., & Phillips, N. (2005). The Birth of the "Kodak Moment": Institutional Entrepreneurship and the Adoption of New Technologies. *Organization Studies*, *26*(11), 1665–1687. doi:10.1177/0170840605056395

Nowacki, M. M. (2005). Evaluating a museum as a tourist product using the Servqual method. *Museum Management and Curatorship,* 20(3), 235-250. doi:10.1016/j.musmancur.2005.03.002

Önder, I., Koerbitz, W., & Hubmann-Haidvogel, A. (2016). Tracing Tourists by Their Digital Footprints. *Journal of Travel Research*, 55(5), 566-573. doi:10.1177/0047287514563985

Pan, S., Lee, J., & Tsai, H. (2014). Travel photos: Motivations, image dimensions, and affective qualities of places. *Tourism Management*, 40, 59–69. doi:10.1016/j.tourman.2013.05.007

Paswan, A. K., & Troy, L. C. (2004). Non-profit organization and membership motivation: an exploration in the museum industry. *Journal of Marketing Theory and Practice*, *12*(2), 1-15. doi:10.1080/10696679.2004.11658515

Pallud, J. (2017). Impact of interactive technologies on stimulating learning experiences in a museum. *Information & Management*. 54(4), 465–478. doi:10.1016/j.im.2016.10.004

Robins, R. (1992). *A Manual for Small Museums and Keeping Places*. Brisbane, Australia: Queensland Museum. Retrieved July 16, 2017, from http://trove.nla.gov.au/version/24827966

Schmallegger, D., Carson, D., & Jacobsen, D. (2010). The use of photographs on consumer generated content websites: practical implications for destination image analysis. In N. Sharda (Ed.), *Tourism informatics: Visual travel recommender systems, social communities, and user interface design*, Information Science Reference, Hershey, PA, pp. 243–260.

Sheng, C., & Chen, M. (2012). A study of experience expectations of museum visitors, *Tourism Management*, 33(1), 53-60. doi:10.1016/j.tourman.2011.01.023

Siu, N. Y., Zhang, T. J., Dong, P., & Kwan, H. (2013). New service bonds and customer value in customer relationship management: The case of museum visitors. *Tourism Management,* 36, 293-303. doi:10.1016/j.tourman.2012.12.001

Sookhanaphibarn, K., & Thawonmas, R. (2009, December). A movement data analysis and synthesis tool for museum visitors' behavior. *In Pacific-Rim Conference on Multimedia,* pp. 144-154, Bangkok, Thailand.

Sparacino, F. (2002, April). Real-Time Sensor-Driven Understanding of Visitors' Interests for Personalized Visually-Augmented Museum Experiences. In *Proceedings* of *Museum and the Web*, pp. 1-27, Boston, Massachusetts, USA.

Stepchenkova, S., & Zhan, F. (2013). Visual destination images of Peru: Comparative content analysis of DMO and user-generated photography. *Tourism Management*, 36, 590-601. doi:10.1016/j.tourman.2012.08.006

Throsby, D. (2001). *Economics and culture*. Cambridge: Cambridge University Press.

Thyne, M. (2001). The importance of values research for nonprofit organisations: The motivation☐based values of museum visitors. *International Journal of Nonprofit and Voluntary Sector Marketing*, 6(2), 116-130. doi:10.1002/nvsm.140

Urry, J. (1990). The consumption' of tourism. *Sociology*, 24(1), 23-35. doi:10.1177/0038038590024001004

Van Aalst, I., & Boogaarts, I. (2002). From museum to mass entertainment the evolution of the role of museums in cities. *European Urban and Regional Studies*, 9(3), 195-209. doi:10.1177/096977640200900301

Vaz, R. I. F., Fernandes, P. O., & Veiga, A. C. R. (2016). Proposal of a Tangible User Interface to Enhance Accessibility in Geological Exhibitions and the Experience of Museum Visitors. *Procedia Computer Science*, 100, 832-839. doi:10.1016/j.procs.2016.09.232

Vu, H.Q., Li, G., Law, R., & Ye, B.H. (2015). Exploring the travel behavior of inbound tourists to Hong Kong using geotagged photos. *Tourism Management*, 46, 222-232. doi:10.1016/j.tourman.2014.07.003

Vu, H.Q., Li, G., Law, R., & Zhang, Y. (2017). Travel diaries analysis by Sequential Rules Mining. *Journal of Travel Research*, In Press. doi:10.1177/0047287517692446

Yoshimura, Y., Sobolevsky, S., Ratti, C., Girardin, F., Carrascal, J. P., Blat, J., & Sinatra, R. (2014). An analysis of visitors' behavior in the Louvre Museum: A study using Bluetooth data. *Environment and Planning B: Planning and Design*, 41(6), 1113-1131. doi:10.1068/b130047p