THE RELEVANCE OF NEWLY AVAILABLE BIG DATA AND URBAN HERITAGE TOURISM

INVESTIGATING THE POPULARITY OF URBAN HERITAGE AREAS IN AMSTERDAM USING FLICKR DATA

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COLOPHON

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PREFACE

This thesis is written in the context of graduation project for Construction Management and Engineering (CME), followed at Eindhoven University of Technology (TU/e). This report is a completion mark of my master study. Studying at TU/e as an international master student has been a very important experience for me. It was a real learning process and challenge to carry out the complete research. I would like to express my gratitude to people who helped me during my master graduation thesis.

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SUMMARY

The Netherlands is a popular destination among tourists and especially Amsterdam is the first choice for vacations. Tourism is one of the major sources of income in the Netherlands and it is rapidly growing over the last ten years (CBS, 2019). Total tourist expenditure was nearly 75.9 billion euros in 2016 and approximately 6.7 million foreign hotel guests prefer to visit Amsterdam (CBS, 2019). Amsterdam is home to unique cultural-historical values, parks, and canals and it offers various hidden gems. Each people have different motivations when they visit the city. However, some locations are visited more than others within the urban core. Overcrowding is accepted as one of the major issues by local residents and tourists. Therefore, Amsterdam has undergone rising pressure from visitors. Although tourism industry benefits from total turnover, residents and municipality tend to take some precautions regarding the tourist numbers. Due to the mass tourism and popularity of some areas, tourists are unevenly distributed in cities, resulting in inequality of service distribution, traffic, noise and so on. Amsterdam has been pursuing a distribution policy within the city for some time (CITYLAB, 2019). The target is to decentralize the visitors' flow and to balance the distribution of people within the city.

In recent years, the growth of social media that allows photo uploads has been influential on the increase of tourism trips. Due to that influence, researchers have investigated the tourist distributions by using different data sources. Today, social media generates newly available big data which is an important component to access human generated information for researchers. It provides big data that contains different aspects of urban values. Uploaded photographs on social media (i.e. Flickr, Panoramio, Instagram, Facebook) have effect on visitors' destination choice, therefore popular destinations have been affected widely by word-of-mouth. The goal of this research is to investigate the behavior of tourists and local residents within the historical urban core in order to find the most attractive/popular locations for them by using geotagged photographs. As a result, the underlying reasons for the popularity of these locations can be explored and similar but less attractive/popular heritage locations can be proposed to evenly distribute the visitors in the city.

There are existing studies that use different user generated content (UGC) data in order to find solutions to urban problems, also in the field of urban heritage tourism. However, these studies usually use only UGC data and do not combine it with city data on heritage. Moreover, there is no study yet to utilize the newly available datasets for urban heritage tourism problems such as overcrowding in Amsterdam. This thesis attempts to explain how can big data be utilized to understand the overcrowding in Amsterdam in relation to urban heritage tourism and it is designed as a case study in order to investigate most popular heritage points and explains in time stamps hourly, daily, weekly and yearly regarding division of tourist and local using different datasets in Amsterdam. Also, the influence of urban facilities on the attractive spots are explored, and recommendations are given by considering the preferences of local residents and tourists.

In this research, user generated contents (UGC) from Flickr which consists of volunteered geographic information is used. Flickr dataset is divided as local and tourist to understand temporal differences between them. Geotagged photographs are processed using density-based algorithm (DBSCAN) to find the overcrowded areas in Amsterdam. This algorithm provides cluster in order to analyze dense points; therefore, the most concentrated areas (POIs) are assumed as the most crowded places. The results of POIs are used to find the most

attractive urban heritages in Amsterdam. In order to find the relation between heritages and the spatio-temporal patterns of Flickr users for local and tourist, the results of POIs are processed with National Monuments data. Each heritage object has its own attributes including, coordinates, function, CBS category (building, church, monument, object), postcode, street name, municipality and so on. Heritage types are assigned to certain groups regarding their functions in order to perform the analysis. The heritages which place fall under the buffer of POIs are assumed as the most attractive/popular ones, because they are photographed by both tourists and locals. The results from POI analysis and heritage analysis are tested by chi-square distribution. Chi-square goodness of fit values are calculated both manually and in R to test the independence of a significant relation between variables. Moreover, Amsterdam city datasets including eating-drinking points and tram-metro stops are processed to investigate the influences of urban facilities and accessibility of heritages. The result from detailed heritage analysis is presented as a map; therefore, the influences of accessibility and urban facilities are analysed visually.

The analysis results in 9 locations for tourist photographs and 12 locations for local photographs. For instance, the majority of tourist photographs are taken around the well-known popular places such as Museumplein, Centraal Station, Eye at 2.00PM; locals' photographs are clustered around such as the Zoo Artis, Centraal Station, Vondelpark and they are not taken and specific period. Considering the heritage types, for tourists, the majority of photographs are taken around the houses, culture-sport buildings, and storages/warehouses; for locals, the majority of photographs are taken around houses, culture-sport building and industrial buildings. Common heritage types are found as house buildings and culture-sport sites. The main reason is that, narrow canal houses are registered as national monument and they attract visitor's attention. Not surprisingly, majority of photographs are taken on weekends, and indoor places such as museum and exhibition areas are photographed in fall seasons, and outdoor areas are photographed in spring and summer season. Considering urban facilities and accessibilities, the most photographed locations have appeared around the eating-drinking facilities and tram-metro stops.

Considering these findings, this thesis attempts to understand the validity of the used datasets and give recommendations to policy makers to evenly distribute the tourists in the city. As a result of this thesis, it can be said that newly available big data provides meaningful understanding for spatio-temporal patterns of people within urbanscapes.

ABSTRACT

This thesis presents an exploratory approach to identify the most popular/attractive urban heritage areas with their temporal distribution. For this research, geotagged photographs from Flickr are used. 285.130 geotagged photos are harvested from Flickr and the most photographed locations are defined using a density-based algorithm (DBSCAN). A method is processed to define the most concentrated areas in Amsterdam. The temporal distribution of tourists and locals is analysed per POIs and per heritage types to define differences regarding time stamp. Clusters generated by DBSCAN are used to find heritage distribution by using geoprocessing tools in QGIS. The results from POI analysis and heritage analysis are evaluated by comparing promoted tourist map. Also, eating-drinking points and tram-metro stops from Amsterdam City Data are processed to investigate the relation between urban facilities and the most attractive/popular urban heritage areas. It is concluded that newly available datasets are useful sources to investigate spatio-temporal pattern of tourists and locals in the urban heritage areas. It provides a better understanding of distribution of people in time and space.

Keywords: Flickr, DBSCAN, Spatial Clustering, POI, Heritage, Urban Heritage Tourism

List of Abbreviations

API	Application Program Interface
CBS	Centraal Bureau voor de Statistiek
DBSCAN	Density Based Spatial Clustering of Applications with Noise
ESRI	Environmental Systems Research Institute
EU	European Union
GPS	Global Positioning System
ICT	Information and Communication Technologies
POI	Point(s) of Interest
RCE	Rijksdienst voor het Cultureel Erfgoed
UGC	User Generated Content
UNESCO	The United Nations Educational, Scientific and Cultural Organisation
URL	Universal Resource Locator

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1. INTRODUCTION

1.1. PROBLEM DEFINITION AND OBJECTIVE

Tourism is one of the major sources of income in the Netherlands and it is rapidly growing over the last ten years (CBS, 2019). Total tourist expenditure was nearly 75.9 billion euros in 2016 and approximately 6.7 million foreign hotel guests prefer to visit Amsterdam (CBS, 2019). Therefore, Amsterdam has undergone rising pressure from visitors. Although tourism industry benefit from total turnover, residents and municipality tend to take some precautions regarding the tourist numbers. Mass tourism is an important issue around Amsterdam, because total number of visitors almost exceed carrying capacity in some places (OIS, 2019). Berge & Jacobs (2013) performed a survey among the residents and visitors in Amsterdam and they found that overcrowding, tourism and parking are the least attractive characteristics among the residents; while overcrowding, parking and garbage are the least attractive characteristics among the visitors (Figure 1.1). It can be concluded that both the residents and visitors of Amsterdam are aware of the overcrowding issue in Amsterdam; therefore, it can be accepted as a major problem for Amsterdam.

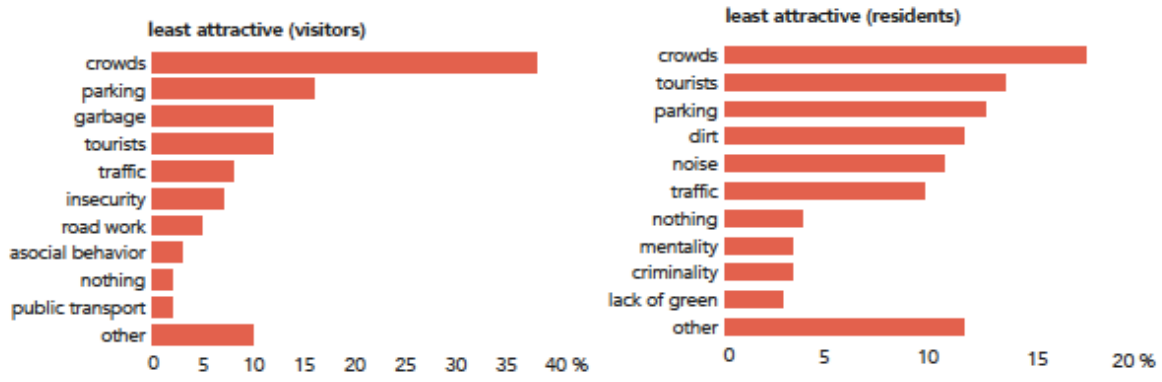


Figure 1. 1 Least attractive points of visitors and residents (Berge & Jacobs, 2013, as stated in Elsinga, 2017)

Amsterdam is not only home to canals and parks, but also the historical core is one of the important components within the region. The historical city center is surrounded both by the tangible heritage destinations and by tourist products such as restaurants, hotels which are essential factors for the preference of tourists. (Ashworth & Page, 2011). In Amsterdam, cultural heritage landmarks such as canals, museums and exhibition locations are the main attraction spots for tourists and they are usually located in the city core (Rijksmuseum and Van Gogh Museum). It can be seen that culture is one of the driving force for the urban tourism (van Loon & Rouwendal, 2017). However, the increasing number of tourists can be socially and physically harmful to the historical district because heritages are delicate and vulnerable. Over tourism might have destructive effect on tangible heritage such as socio-cultural; vandalism, damage the monuments (Kuščer & Mihalič, 2019). Due to the mass tourism and popularity of some areas, tourists are unevenly distributed in cities, resulting in inequality of service distribution, traffic, noise, etc. For instance, in 2018, the famous “I Amsterdam” sign had to be removed outside the Rijksmuseum, because it was drawing a large number of tourists within a limited space. Consequently, the “I Amsterdam” sign was located to a less known neighborhood by the municipality of Amsterdam. In order to give more

"space" to its residents by introducing other attractive places (less popular places) to tourists, Amsterdam has been pursuing a distribution policy within the city for some time (CITYLAB, 2019). The target is to decentralize the visitors' flow and to balance the distribution of people within the city.

In recent years, the growth of social media that allows photo uploads has been influential on the increase of tourism trips. Due to that influence, researchers have investigated the tourist distributions by using different data sources. Today, social media generates newly available big data which is an important component to access human generated information for researchers. Such data sources are utilized to transform information into knowledge that is derived from visitors' flows, comments and uploads (Litvin, Goldsmith, & Pan, 2008). With the help of digital technologies such as web services, GPS, WiFi and IoT, people can be considered as sensors as they generate and also use the data. For example, people's cell phones usually have GPS, and it enables users to quickly connect their photos to locations. As a result, there is a large amount of public geotagged photos, comments and reviews. The data generated by humans through GPS, social media and web use (Flickr, Instagram, Twitter, TripAdvisor) can be used by developers or planners for providing better urban services (Thakuriah, Tilahun, & Zellner, 2017).

Social media plays important role to understand people's behavior. In the current technological era, social media is accepted as a tool by various researchers (Garduño Freeman, 2010). Social media provides big data that contains different aspects of urban values. Uploaded photographs on social media have effect on visitors' destination choice, therefore popular destinations have been affected widely by word-of-mouth. Visitors have a tendency to take into account the other people, who have already visited the place (Bak, Min, & Roh, 2018). Geotagged photographs could make specific locations more popular. Therefore, social media and geotagged photos, comments and reviews have influenced the polarization of tourism demand in specific locations and resulted in mass tourism.

During or before their trip, tourists decide which places they will visit during their stay. Historical urban core is surrounded by tangible aspects, such as monuments, buildings, objects, natural features and intangible aspects, for instance, practices, activities, knowledge and so on (Ginzarly, Pereira Roders, & Teller, 2018). When tourists decide to visit well-known or popular places, they have different motivations and expectations. The attributes which are derived from urban facilities such as accessibility, eating-drinking locations and accommodation have also influence on tourist distribution around heritages. These attractions can be accepted as secondary products and that can motivate travelers, because they can create lively and attractive atmosphere for visitors. (Ashworth & Page, 2011; Kádár, 2014). Tourist destinations and supporting facilities have also influence on the temporality of the visitations. For instance, some areas might be more visited during the day due to the opening times of facilities and some areas might be more attractive during evening due to the characteristics of a destination.

In that sense, newly available big data sources can be helpful to understand people's behavior is space and time, because it reveals people's activities and experiences in time. The most visited locations can be found by tracing geotagged data and better distribution can be provided using such big data. Investigating the preference of visitors and residents in Amsterdam could be helpful to better understand which locations, as well as heritages that are located within the urban core, draw visitor's attention to specific areas in time. This thesis

will attempt to investigate relation with big data and urban heritage tourism using Flickr data set. With the contributions of Flickr, urban heritages areas and their popularity in Amsterdam will be discussed following chapters.

1.2. RESEARCH QUESTION(S)

The rise of social media provides a wide range of digital footprints. In recent years, Amsterdam has suffered from overcrowding as well as overtourism. Tourists have tendency to visit well-known places, which are usually urban heritage locations, because of the popularity of these places. As a result, unbalanced distributions of visitors/tourists occur. Although local people benefit from tourist's monetary expenditures, high number of tourists create pressure in the city core such as crowding, traffic, noise, waste. The goal of this research is to investigate the behavior of tourists and local residents within the historical urban core in order to find the most attractive/popular locations for them by using geotagged photographs. As a result, the underlying reasons for the popularity of these locations can be explored and similar but less attractive/popular heritage locations can be proposed to evenly distribute the visitors in the city.

Following that, the main research question is: How can big data be utilized to understand the overcrowding in Amsterdam in relation to urban heritage tourism?

Sub questions:

- What are the newly available datasets and how are they used for urban and heritage studies?
- What are the most attractive/popular areas within Amsterdam historical urban core?
- What are the differences between local residents and tourists in terms of their spatio-temporal distribution within Amsterdam historical urban core?
- Which heritage types contribute to the attractiveness and popularity of certain areas within Amsterdam historical urban core? and What are the spatio-temporal differences between heritage types for local residents and tourists?
- How do urban facilities and accessibility impact the popularity of urban heritage areas within Amsterdam historical urban core?

1.3. RESEARCH DESIGN

The study area is located in the municipality of Amsterdam. Tourist and local behaviours around the urban heritage areas observed within the UNESCO boundary, since most of the cultural values such as, Dam Square, Museumplein, Anna Frank House and canals are clustered in this area (Figure 1.2). Each person has different motivation when they decide to visit Amsterdam. Existing studies focus on which places were most visited and why by following the human trace. User generated contents have various information such as location, time, personal data and so on. With the help of user generated content, different spatial and temporal patterns of tourists in the UNESCO boundary will be explained by using clustering analysis. The purpose of this work is to explore newly available big data from the online photo sharing website in the context of urban heritage tourism to extract information about visitors in the urbanscape.

Exploratory data analysis techniques are used in order to define most photographed points in Amsterdam. It starts with Flickr data collection using Flickr API. After, data is visualized in QGIS.

Point of interests are determined by using DBSCAN method. R programming language is preferred to process DBSCAN. The places of interests within the urban core are found by applying clustering methods on the geolocation data of Flickr (Koutras, Nikas, & Panagopoulos, 2019). Next, the correlation of national monuments and POI's are analysed and most photographed locations are found with help of geoprocessing tool in QGIS.

Figure 1. 2 Study area (Google Maps and Open Street Map)

1.4. READING GUIDE

Chapter 2 of this research describes existing state-of-the-art. The newly available big data and urban studies are used as an umbrella term. Table 1 shows breakdown of studies with data sources, data types and methods. Therefore, different branches of big data and review of existing literature explain within this chapter. Chapter 3 explains data collection from different sources and data process including cleaning raw data and visualizing tools. The results of data analysis including, temporal distribution, point of interest (POI) analysis and heritage relations, and comparisons between maps are explained in chapter 4. General overview and conclusion are presented in chapter 5.

2. LITERATURE REVIEW

The purpose of this research is to investigate how can big data be utilized to understand the overcrowding of Amsterdam in relation to urban heritage tourism. Within the scope of this chapter, the current state-of-the-art is explained. The first part focuses on the relation of newly available big data and urban studies. Following that, big data and urban heritage tourism are discussed by explaining data types. Also, heritage and urban tourism problems regarding to overcrowding are discussed. Existing studies are explained in the last part.

2.1. THE NEWLY AVAILABLE BIG DATA AND URBAN STUDIES

It is well known that, Information and Communication Technology (ICT) and Internet of Things (IoT) face rapid growth in recent years. There are many definitions of big data. Batty (2013), describes big data as "any data cannot fit into Excel spreadsheet". It is not only produced automatically by using different forms of sensors but also created by humans. In that sense, big data delivers many rows and columns which are full of information. This type of data always includes many features and it presents data-driven evidence on the basis of numbers instead of anecdotes, stories or experiences (Song & Liu, 2017). Another definition is that big data consist of volume, velocity, and variety "3V's" (Laney,2001). Later, this definition was updated by adding Veracity (Beyer & Laney, 2012) and Value (Mao, Zhang & Leung, 2014). Such data flow with various information and therefore it is becoming an important tool for urban studies and planning practices. Big data initiatives, which are openly accessible by the public, presents various data sets including mobile phone activities, geotagged photographs, travel trajectories and so on. These types of data allow researchers to observe the dynamic changes in urban environments at very fine spatio-temporal scales (Long & Liu, 2016). For instance, smart transportation cards can reflect the dynamic changes in real-time and through the records, the current state of stations and the number of users can be monitored and visualized; therefore, further measures can be proposed to prevent the crowd in certain locations.

Urban big data fall into five categories namely; sensor systems (environment, transportation), user generated content (social media, GPS), administrative data (education records, taxes), private sector data (loyalty cards) and hybrid data (census administrative records). User generated content (UGC) consists of volunteered geographic information and data from social media that generates valuable information regarding urban environments. In general, UGC supplies real-time big data for researchers (Ginzarly et al., 2018; van Zanten et al., 2016). For instance, Twitter, Facebook, and Instagram have a wide range of user generated information. Moreover, users can leave their footprint through TripAdvisor, Flickr, Airbnb. These types of location-based services provide powerful data on the urban services and such data can allow monitoring of events, emotions, and preferences of users (Thakuriah et al., 2017).

UGC data is at individual level and collected at fine levels of spatio-temporal scale, therefore, it allows understanding and modelling the human behaviour dynamics in the urban environments. Investigating the human behaviour dynamics gives information about the interaction between cities and people. As urban planning is as a process that focuses on the improvement of urban environment for its citizen; planners can utilize the newly available big data sources together with the observations and surveys in order to understand the interaction between citizens and urbanscape. In that sense, newly available big data can be used as an supportive and alternative way to access information related to human and

urbanscape interaction (Frias-Martinez, Soto, Hohwald, & Frias-Martinez, 2012). For example, cell-phones are accepted as one of the sensors of human behaviour and if users add geolocation to their Tweets, their activity pattern could be identified. Another example is that photos on Flickr can be used to visualize human behaviour on urbanscape, therefore different types of interactions such as most photographed locations, user's origin, and time-stamped pattern can be identified.

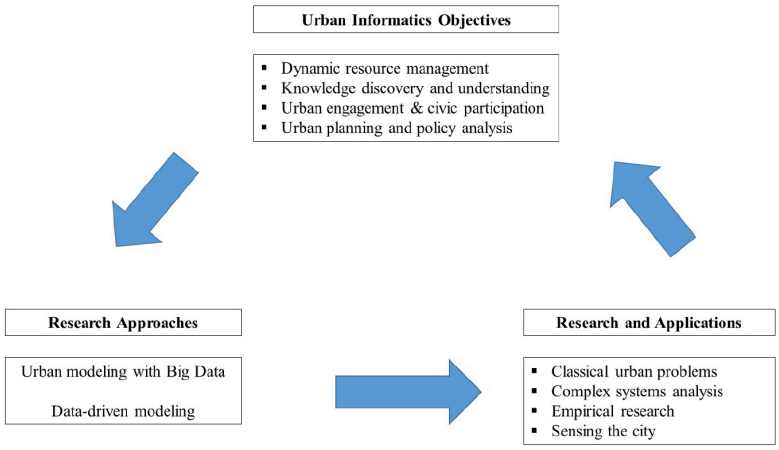


Figure 2. 1 Relation between urban big data and research areas (Thakuriah et al., 2017)

Urban big data such as UGC can be applied to investigate classical urban problems, complex system analysis, empirical research and sensing the city (Figure 2.1). The usage of big data is diverse regarding the urban context. Some scholars are inclined to obtain data in order to create a better environment, while others use data to preserve existing environment better. Batty (2013) suggest that cities are plannable using crowdsourcing data over different time stamps, because data sets are generated by human and they are produced automatically from sensors. For instance, a study by Batty (2013) used a smart travel card in London by collecting passenger data, which consists of check-in and check-out time, therefore it is possible that make assumptions about their temporal positioning system. Experts are able to recommend alternative ways in rush hours. Another study by Kádár (2014) explains measuring tourist activities in cities using geotagged photography and it focuses on tourist movement within urban contexts. He reveals that comparing the most photographed locations in consideration of most visited areas could lead to better tourism planning and destination management. All in all, newly available big data, especially when combined with existing data sources, allows researchers to bring solutions to variety of urban problems such as transportation, overcrowding, waste.

2.2. BIG DATA AND URBAN HERITAGE TOURISM

As far as urban fabrics are concerned, heritage sites are an essential part of the cities. According to the Cambridge dictionary, heritage is described as "features belonging to the culture of a particular society, such as traditions, languages, or buildings, that were created in the past and still have historical importance" (Cambridge, 2018). Cultural heritages are divided into two categories by UNESCO; tangibles cultural heritages such as movable, immovable and underwater; intangible cultural heritages including oral traditions and rituals (UNESCO, 2018). Within the urban level, immovable cultural heritages incapsulate monuments and archeological sites. Also, historic places are assessed in the context of cultural heritage and

they are the supporting zone of urban. These destinations attract the visitors and are the core areas for the daily life of the public (Zhang et al., 2017).

Visitor influx is inclined to be clustered in the urban centers and it mostly intersects with historic centers. Visitors are usually motivated by the cultural factor and their interest focus on heritages as well as activities that are related to heritages. They could be involved in cultural activities which overlap with local's activities (García-Hernández, de la Calle-Vaquero, & Yubero, 2017). Cities are becoming consumption places and it can be accepted that urban cores are usually transformed into tourism destinations. Although, this has economic advantages for cities, it has also resulted in overtourism and overcrowding in which causes congestion pollution and overuse of heritage assets in heavily touristified areas (Barrera-Fernandez, Hernández-Escampa, & Vázquez, 2016). One of the causes of tourism booming is that people make several trips instead of extended holiday. Also, the increase in literacy level can be related to the growth for curiosity in heritage values (Eurostat, 2007). Urban tourists can be concentrated in certain areas such as urban cores, heritage sites on specific days and hours; therefore, it can result in pressure within certain places and intensive usage of services (Allan M. Williams, 2010). Moreover, the unbalanced distribution of tourists and locals can deteriorate hospitality as well as visitor experience (Barrera-Fernandez et al., 2016). If heritage destinations cannot be managed carefully, heavy tourist activities and tourist flows can lead to distortion of historical districts and urban cores (van der Zee, Bertocchi, & Vanneste, 2018).

The connection to the past is an important part of heritage tourism, since heritages reflect the value of history, art, and culture (Dela Santa & Tiatco, 2019). In that sense, the visitor experience is an important factor between visitors and heritage sites. A study by Vong & Ung, 2012 focusses on heritage attributes by dividing four groups that have influence on visitor patterns. First group consists of heritage types; gardens, museums, castles, and historical buildings, the second group is heritage resources; country's history and culture, traditional festival and events, another group is heritage interpretations; memorable experience and last group is that related to attractions; tour attraction and shopping attraction (Vong & Ung, 2012). In the view of such information, the location of heritages, type of heritages and events can be taken into consideration as influential factors for the degree of attractiveness and popularity.

Newly available big data such as UGC allows researchers a better understanding of tourist behaviour from three sources, as shown in Figure 2.2, user, device and operation and each source has different categories. User data is related to the content of data and is collected via online textual data and online photo data; device data is related to the location and derived from such as, GPS, Bluetooth, and RFID; lastly transaction data is collected by using web search data, loyalty card and so on (Li, Xu, Tang, Wang, & Li, 2018). Looking at the UGC data, most of the time, online textual and photo data has also location and time stamp information due to the GPS of the devices that are used for generating such data.

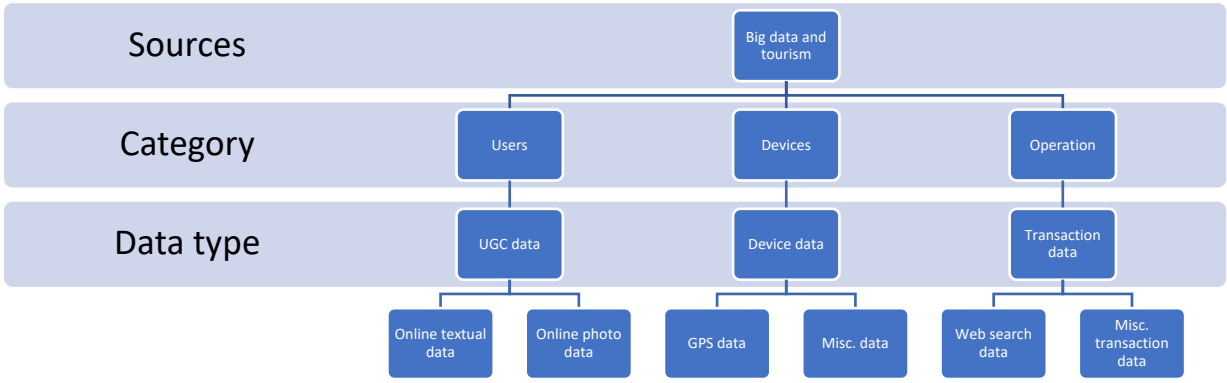


Figure 2. 2 Graphical representation of big data in tourism research (Li et al., 2018)

Tourism has different segments that cover different components, for instance, activities, online booking and webpage visiting and so on. Big data analysis can provide adequate data without any bias and it helps to develop better understanding of tourist and products (Thakuriah et al., 2017). When comparing big data and traditional data, big data is more structured and contains different data types; therefore, researchers can focus on specific target groups.

Recently, global positioning systems (GPS) tracks are used to understand tourist flow (Shoval & Ahas, 2016), and combining GPS and survey method also provide accurate information about tourists (Kádár, 2014). UGC has been used to support tourism research, since it can be considered low cost and easy access to online data sets (Li et al., 2018). It divides into two categories; online textual data, for instance, reviews, and rankings; online photo data on photo sharing websites such as, Flickr and Panoramio. With rapid increasing social media usage, it offers a voluminous platform for tourists to leave their digital footprint on the web.

This research attempts to investigate the newly available big data and urban heritage tourism using the Flickr data set. For this reason, user generated content derived from online textual data and online photo data are explained more detailed below.

2.2.1. Online textual data

Travelers or tourists can take full advantage of social media by sharing their personal experience in different forms, such as blogging, Tweeting and these contribute to special big data from different sources, and they contain reviews, opinions, recommendations. The data from the review's express tourists' approach toward the products and they include their own opinions. The online textual data mainly focus on users' comments, for instance, TripAdvisor, and Expedia (Fang, Ye, Kucukusta, & Law, 2016), Booking (Xu & Li, 2016) are popular among the researchers. All relevant data are collected by data mining technologies and they are downloaded via URL. Researchers focus on different methods in order to interpret datasets such as Latent Dirichlet Allocation (LDA), sentiment analysis, statistical analysis, clustering and categorization, text summarization and dependency modeling (Li et al., 2018). Another technique for analysing online textual data is statistical analysis. For example, descriptive statistics and correlation matrix (Racherla & Friske, 2012); correspondence analysis (Költringer & Dickinger, 2015); multivariate regression (Ioannides, Röslmaier, & van der Zee, 2018) methods are used to interpret such data. In addition, researchers benefit from text summarization that is used to describe the most valuable sentences of hotel or restaurant reviews (Hu, Chen, & Chou, 2017). These types of data are commonly analysed in order to

improve tourism management, provide better services and describe tourism potential in neighbourhood.

2.2.2. Online photo data

Another type of UGC is online photo data which could be obtained by utilizing of social media. The geographic positioning of each photo represents important information. It consists of photos, geolocation, and tags; therefore, locations are kept by geotagging along with space and time. Therefore, researchers are able to explain relations with people and specific locations. For instance, UGC could be exploit to describe popular tourism destination (Lee, Cai, & Lee, 2014), to discover cultural heritage locations (Bujari, Ciman, Gaggi, & Palazzi, 2017), to understand distribution of tourists around the heritages (van der Zee et al., 2018), to measure tourist activities (Kádár, 2014), and to derive cultural heritage values by using social media (Ginzarly & Teller, 2016). Generally, online metadata is divided into four sections; user related information (photo ID and user ID), temporal information (taken and uploaded dates), geo-information (coordinates) and textual information (description and tags) (Li et al., 2018). One of the popular websites Flickr.com stores around 200 million geotagged photographs (Kádár, 2014). Dataset is obtained by using the Flickr API that is very popular among the researchers (Crandall, Backstrom, Huttenlocher, & Kleinberg, 2009; García-Palomares, Gutiérrez, & Mínguez, 2015; Ginzarly et al., 2018; Ginzarly & Teller, 2016; Girardin, Vaccari, Gerber, & Biderman, 2009; Terras, 2011; van Zanten et al., 2016). Also, geolocated Tweets (Frias-Martinez et al., 2012; Ginzarly & Teller, 2016) and Panoramio (Ginzarly et al., 2018; van Zanten et al., 2016) are used to better understanding human behaviour in the urbanscape.

Flickr has dominated most of the researches, since it was established in 2005 and it is considered a trustable photo sharing website among the users. In order to obtain valuable information, several steps are followed; data preprocessing, metadata clustering and trajectory discovery (Li et al., 2018) (Figure 2.3). First, raw data is collected and prepared to data cleaning steps, after valuable metadata is left for analysis. For example, textual metadata in photos is used for mapping tourist behaviour around the heritages via tags (Ginzarly et al., 2018). Second, clustering analysis is performed on the derived data from the previous step and this method can be diverse including, centroid based (k-means), density-based (DBSCAN) and connectivity based (hierarchical clustering). Regarding literature, density based clustering is dominated to existing studies (Lee et al., 2014; Oku, Hattori, & Kawagoe, 2015; Zhou, Xu, & Kimmons, 2015). Last, travel chains of tourists are investigated by route generation methods.

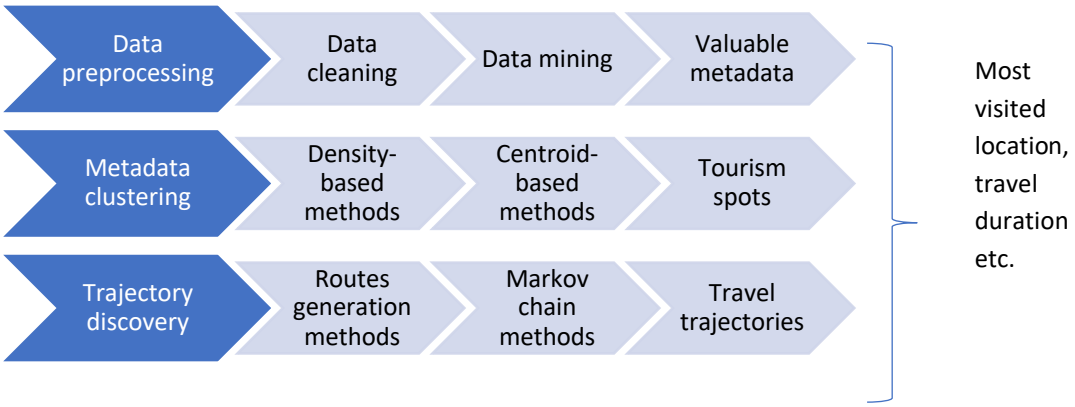


Figure 2. 3 Graphical representation of online photo data process (Li et al., 2018)

2.3. EXISTING STUDIES AND RELEVANT WORKS

Over the last years, researchers have published articles related to tourism and heritage. In this part, existing works are reviewed. Table 1 classifies the distribution of literature regarding subject, data source, data type, method and research questions.

As far as data types are concerned, the first group consists of online textual data such as TripAdvisor and AirBnb. Current studies are explained below:

- Van der Zee et al. (2018), focus on distributions of tourists within urban heritage using user generated content (UGC). This study has two levels; starts with spatial analysis of UGC, which is collected from TripAdvisor in Bruges, Antwerp and Ghent to create hot spots and cold spots, and continue with validation of result with policymakers. Their purpose is to transform UGC into knowledge for tourism decision makers. Three different categories are selected from TripAdvisor and the total number of reviews is correlated with bed-night statistics in order to understand relations. Therefore, they are able to make interpretations and it is found that they are well-correlated regarding R^2. Spatial correlation and cluster mapping are done using Getis-Ord hot spot analysis. A hot spot is a cluster with high attribute (more reviewed) and the cold spot is cluster with less reviewed. As a consequence, tourists' reviews therefore the visitations tend to cluster in Bruges, Antwerp and Ghent city centre. According to this study, if the visitations are not managed properly, overcrowding could lead to deterioration in heritage location.
- Ioannides et al. (2018), investigate Airbnb as an instigator of tourism bubble expansion in Utrecht and they analyse where Airbnb activity clustered and influences of tourist infrastructure. They prefer to avoid heavily touristified areas in order to observe less attracted region. Multivariate linear regression analysis is done in order to define the relative presence of online textual data (Airbnb) per neighbourhood with support of CBS data. In this study, variables are divided into a different group such as distance to the city center, average housing value, presence of families with children and so on. As a result, the factor influencing the distribution of Airbnb over the city is found, and heavily concentrated areas are located in the city center, because most of the attractions and tourist products are also situated in the core.
- Ganzaroli et al. (2017), analyse the efficiency of TripAdvisor on the quality of a restaurant as part of the cultural heritage of Venice. They correlated reviews and position of rankings, and use GPS visualizer for mapping. They conclude that the ranking of restaurants is strongly related to visitors' expected quality in Venice.

The second group comprises of online textual and photo data including, Flickr, Ctrip, Qunar, Panoramio and AT&T. Existing studies are detailed below:

- Kádár (2014), proposes a quantitative method to define tourist movement within the urban level. Flickr dataset and bed-night statistics from 16 European historic cities are analysed, and behavioural differences between tourists and locals are explained. 3D bar maps are created by using Google Earth for better understanding of differences between tourist and local. After, tourism statistics and geotagged photos are compared for verification. In the urban level, tourist patterns are compared with the morphology of historical centres to identify tourist movement. It is found that visible patterns are correlated with historical structure. Therefore, the urban core is the main

attraction and tourists mostly prefer to visit historical route instead of less appealing streets.

- Zhang et al. (2017), investigate the protection and utilization of historic districts using big data analysis. They use different datasets including, Dazhongdianping's POI, Tencent location Big Data, Mafengwo, Ctrip, Qunar, Dazhongdianping, and Baidu. Index system is created regarding "Disciplines and Guidelines for Social Impact Assessment" and this study carried out in ten core indexes such as richness of heritage resources, the most popular season for visiting famous streets, the influence of famous streets, public praise from users and so on. They find out famous streets attract more attention and the higher ratio of cultural facilities more suitable for the development of cultural industries.
- Ginzarly et al. (2018), create a historical urban landscape (HUL) using social media. Flickr data is retrieved from 2003 to 2016 and divided into two groups as a tourist and local using users' real name and country. They benefit from tags and create maps. Hot spot maps are created to further analysis. As a consequence, locals are distributed over the city, while tourists are mainly interested in historical core. They reveal that different landscape preferences occur among locals and tourists, because it depends on visitors' political and religious backgrounds. Tag crawling has various component, researchers are able to transform datasets into knowledge using a predefined threshold.
- García-Palomares et al. (2015) focus on identification of tourist hot spot based on social networks. The Panoramio dataset is used to analyse tourist movement, and results are visualized using ArcGIS. They use 30 days threshold to define local and tourist photographs. If this period exceeded 30 days, the photographs are attributed to residents, otherwise, they are accepted as local. In order to analyse the spatial distribution of photographs different methods are used such as 200 meters hexagons are created to produce density map, spatial autocorrelation is analysed to identify clusters. As a consequence, uploaded photos are concentrated around monuments, tourist attractions, and museums. Tourist photographs are clustered in the city center; however, local movements are extended such as parks and recreational areas.
- Girardin et al. (2009), carried out quantifying urban attractiveness using digital footprints. They analyse two types of data AT&T (cellular network) and Flickr. Phone calls are aggregated number of calls, text messaged and telephone traffics using AT&T antenna. They use 30 days threshold to define local and tourist photographs, therefore they create a density maps and flows of the footprint. As a result, they are able to make a comparison among six landmarks from different cities regarding local and tourist distribution. For example, waterfront attractiveness is shown positive growth over the summer or the majority of phone calls are made by locals.
- Koutras et al. (2019), focus on tourist behaviour using social network data in Athens. Flickr dataset is used to analyse, since they are carrying spatio temporal characteristics. They use exploratory data analysis on photographs, therefore they prefer to density-based clustering method (DBSCAN). Also, Koutras et al. (2019) use 30 days threshold to divide tourist and local. Different values are tested and the best parameters are selected to define POIs. Seven clusters are found by inspection Flickr and the temporal distribution of tourists is explored. They revealed that DBSCAN algorithm works well, because these POIs are also registered ancient monuments and important sites of Athens.

Table 1. Distribution of existing studies

Author(s)	Subject	Data source	Data type	Method	Research question
(van der Zee et al., 2018)	Tourism and heritage tourism	TripAdvisor Tourism statistics	Online-textual	Hot spots and cold spots analysis, correlation between nights spend in destination	How do tourists move around the heritages and how can spatial analysis of UGC patterns contribute to destination management?
(Ioannides et al., 2018)	Tourism	Airbnb	Online-textual	Multivariate regression	What effect does the distance from existing tourist bubbles have on Airbnb activity and to what extent does proximity to tourist infrastructure influence Airbnb activity?
(Ganzaroli, De Noni, & van Baalen, 2017)	Heritage tourism	TripAdvisor The number of hotel arrivals	Online-textual	Correlation between judgements and concentration ratio GPS visualizer	Does TripAdvisor contribute to strengthening the popularity of already known restaurants in spite of their rating?
(Kádár, 2014)	Tourism and heritage tourism	Flickr, arrival and bed-night statistics	Online-textual and photo data	Correlation of data sets from Flickr with statistical data, morphological constraints and the attributes of attractions	How do tourists move in the urban context and how do they consume spaces?
(Zhang et al., 2017)	Heritage tourism	Dazhongdianping's POI, Tencent location Big Data, Mafengwo, Ctrip, Qunar, Dazhongdianping, Baidu	Online-textual and photo data	Index system	How can historic districts be protected and utilized using big data?
(Ginzarly et al., 2018)	Heritage	Flickr	Online-textual and photo data	Hotspot analysis	How can people's movement be identified around the cultural heritage by mapping the historic urban landscape?
(García-Palomares et al., 2015)	Tourism	Flickr	Online-textual and photo data	Density map and correlation regression	How can the popular attractions be identified by using photo sharing services?

(Girardin et al., 2009)	Tourism	Flickr and network data (AT&T)	Online-textual and photo data	Density map and spatio-temporal distribution	How do locals and visitors share the space?
(Koutras et al., 2019)	Tourism	Flickr	Online-textual and photo data	Density based algorithm	How can GIS analysis be used to identify tourist behavior in the city of Athens?

2.4. CONCLUSION

Emerging ICT, notion of IOT and resulting high resolution spatio-temporal data are changing the way cities function and can be managed. In-line with that, people also become data source as they generate textual and photo data by means of GPS and WiFi enabled devices and social network platforms such as Flickr, Twitter, TripAdvisor. Such data usually consists of location, time and some user characteristics data that enable researchers and city planners to investigate the human dynamics in urban environments. Current literature already emphasizes the importance of utilizing such newly available data sources for citizen-centred and data-driven management of cities.

UGC data is used for urban problems in variety of domains and one of the domains is urban heritage tourism. UGC is quite suitable for investigating urban tourism and urban heritage tourism problems as such data is usually produced by people when they are doing leisure activities i.e. touristic visits, going out activities, visiting events. Table 1 shows how different data sources and data types could be used to identify tourist distribution within the urban scapes. Subjects fall into three categories; heritage, tourism, and heritage-tourism with regard to how tourists consume the cities. Tourist movements are traced using different data sources, for instance, Flickr, Airbnb, Trip Advisor, and relevant tourism statistics. Data types are divided into two parts as online-textual and photo data. Online textual data includes recommendations, rankings and reviews, whereas photo data contains geolocation and tags which are embedded in photographs metadata. Mapping people's movements regarding tourist and local, are traced using different methods, such as hot-spot and cold-spot analysis, density maps and multivariate regression. Researchers are able to explain their questions using different methods and data types.

From this point of forward, it can be said that overcrowding has a negative influence on heritages (van der Zee et al., 2018) and historical urban core is exposed to tourist pressure (Ioannides et al., 2018; Kádár, 2014). Also, the distribution of tourists and locals has followed different patterns within the city; while tourists tend to cluster within the urban core, locals have tendency to visit over the city (García-Palomares et al., 2015; Ginzarly et al., 2018). In addition, famous and well-known locations can attract visitors attention (Zhang et al., 2017) and time-frame has effect on the choice of destination (Girardin et al., 2009).

There are existing studies that use different UGC data in order to find solutions to urban problems, also in the field of urban heritage tourism. However, these studies usually use only UGC data and do not combine it with city data on heritage. Moreover, there is no study yet to utilize the newly available datasets for urban heritage tourism problems such as overcrowding in Amsterdam. This thesis attempts to explain how can big data utilized to understand the

overcrowding in Amsterdam in relation to urban heritage tourism and it is designed as a case study in order to investigate most popular heritage points and explains in time stamps hourly, daily, weekly and yearly regarding division of tourist and local using different datasets in Amsterdam. Also, the influence of urban facilities on the attractive spots are explored, and recommendations are given by considering the preferences of local residents and tourists.

Based on the literature, Flickr is found to be the most suitable data source for this study. Because, when people are in popular and attractive places, they tend to make photographs and upload on social media to show others. Flickr is such a social media platform among others (i.e. Facebook, Instagram). Considering data sources, Facebook is one of the social network sites where members can add friends, update personal information and post pictures. Instagram is another social media source and it is used for instant photo sharing and social network. Although Flickr also allows to add friends, it is mainly used to photo sharing by professional and amateur users. In terms of photo feature, Flickr users can arrange their photos in album using title feature and photos can be kept in full resolution, for this reason Flickr dataset is mostly used in urban research. In the literature review, Flickr is found the most trustable photo sharing website regarding time and location. Therefore, it is possible to separate the Flickr dataset for different user groups such as local residents and tourists and look into details of spatial and temporal differences per groups. Finally, it is possible to combine this dataset with city and heritage data.

3. METHODOLOGY

This chapter describes the methodology in order to find the answers of research questions that are explained in the chapter 1. First, the method of data collection from different sources, namely the Flickr, Amsterdam City Data and National Monuments (Rijkmonumenten) are explained, and also the division of local residents and tourist are explained. Second, the data process is defined by explaining the DBSCAN method. For the data analysis, it is explained that R software package is used for the processing of DBSCAN algorithm, and chi-square analysis which is used to test the independence of a significant relation between variables, and QGIS is used to visualize the maps of attractive locations and comparisons with facilities such as transportation and eating/drinking.

3.1. DATA COLLECTION

The purpose of this research is to determine attractive/popular areas in order to define overcrowding in time and space around urban heritage areas in relation to urban heritage tourism in Amsterdam, and to understand the relation between heritage areas, facilities in urbanscape and people. To achieve these aims, different datasets are processed. Flickr is used to determine the attractive/ popular areas for local residents and visitors in time and space. Amsterdam City Data is used to understand influences of urban facilities to heritage points. City data consists of accessibility such as tram and metro stops; catering facilities such as eating and drinking points. National Monuments data is used to analyse relation of the point of interests and urban heritage areas. This chapter elaborates the data collection from different sources and their process to find answers of research questions.

3.1.1. FLICKR DATA COLLECTION

Flickr is a web based photo sharing platform that is introduced in 2004 (Ginzarly & Teller, 2016) and it provides quite structured environments to users in which people can easily upload photos, and they can leave comments. Until 2018, it was free to use and each user had 1 terabyte of space. However, the user agreement was changed and since 2018 users can upload maximum of 1000 photographs in their accounts (Flickr, 2019). As far as data protection is concerned, the data privacy of Flickr allows it to open for friends or everyone. Within this research, only the users' location and the photo taken time are used. Personal information such as gender, country, occupation, and city are not processed. The final results do not reveal any personal information of the Flickr users.

Flickr Application Programmers Interface (API) contains photo data for commercial and non-commercial users. Datasets can be downloaded by means of different methods, such as HTTP-GET and GO that are based on codes. The HTTP-GET method works with codes and different parameters. In order to obtain metadata, users need to have a unique and personal API key that could be demanded from Flickr. Afterwards, users determine other parameters such as location, an accuracy that can vary regarding needs. Another method is that "The GO Programming Language" and it is open source and supported by Google (Go Language, 2019). Within the research, GO language is used to download Flickr data and an example of codes are given below in figure 3.

```
{
  "flickr": {
    "key": "941799d2a8ac864ef7804f9c0323b99e",
    "secret": "ff21160ac8ca0c72"
  },
  "minx": 4.867080,
  "miny": 52.357924,
  "maxx": 4.933176,
  "maxy": 52.390259,
  "zoomlevel": 14,
  "output": "results_noid.csv",
  "description": true
}
```


Figure 3. 1 Example of GO request

A user could request metadata filling different parameters. Key is a personal API which is required and taken from Flickr and the secret is required to acquire the additional metadata of photos. Minx, Miny, Maxx and Maxy are coordinates of the location where a user would like to download the Flickr metadata. The zoom level is data granularity that related to the accuracy of the photo location such as the World level, country level, region level and so on. The output is a final result that gives as csv format Flickr metadata.

Flickr database mainly contains photos, and time, location (latitude and longitude), description (tags) of photos. Time is divided into two parts; taken time and uploaded time. The location of photos can be uploaded automatically from the camera or manually assigned on the map. Table 2 shows attributes and explanations which retrieved from Flickr. Each photo has a unique owner number and geolocation (latitude and longitude) that are assigned to obtain further metadata of the photo. The date taken is the timestamp of a photo's capturing time, date uploaded is a photo's uploaded time on Flickr. The timestamp of Flickr photos is a very useful source of data for tourism research, since timestamp is the powerful information to understand the relations between location and user. User information contains eight data fields; first name, last name, join date, occupation, hometown, city, country, and website. Registering these data to Flickr is optional for its users, therefore not all users fill in these data fields or give their exact data. Also, the title is another attribute as users can assign special title for their photos. Tags is an optional attribute that allows to label photographs with the special descriptions. Lastly, URL is the unique link of each photos and it makes photographs downloadable from web browsers.

Table 2. Flickr attributes per photo

Attribute	**Explanation**
latitude (optional)	Latitude of taken photo (coordinate)
longitude (optional)	Longitude of taken photo (coordinate)
owner	Photo identifier – unique number
date_taken	Photo taken time
date_unknown	Unknown photo taken time (true-false)
date_uploaded	Photo upload time
title (optional)	Title of photo
description (optional)	Description of photo

tags (optional)	Photo description tags
url	URL of the photo
join date (optional)	User join time to the Flickr
occupation (optional)	User occupation of photographer
hometown (optional)	User hometown of photographer
first_name (optional)	User name of photographer
last_name (optional)	Last name of photographer
website (optional)	Personal website of photographer
city (optional)	City of the photographer
country (optional)	Country of the photographer

Flickr is the base dataset for this research to define the most attractive locations in Amsterdam. It provides valuable information on photos such as their latitude, longitude, date taken URL and so on. Location and temporal information are the most important points in order to define spatio-temporal distribution within the defined location. Most photographed locations are accepted as POI among the users. As mentioned before in literature review, the dataset from Flickr is one of the common photographs sharing website according to researchers.

3.1.2. NATIONAL MONUMENT (RIJKMONUMENTEN) DATA

Culture Heritage Agency is one of the branches of the Ministry of Education, Culture and Science. It was established for the protection and conservation of national heritage sites in 1918 and this organization was renamed Rijksdienst voor het Cultureel Erfgoed (RCE) – National Service of Cultural Heritage in 2009. Approximately 63.000 heritage sites and buildings are registered throughout the Netherlands in the National monuments dataset which can be downloaded from the Cultural Heritage Agency website. All data is presented Environmental Systems Research Institute (ESRI) shape format, therefore it is possible to use it directly within a GIS software environment (Rijksmonumenten, 2019). Each heritage object has its own attributes including, coordinates, function, CBS category (building, church, monument, object), postcode, street name, municipality and so on.

Heritage types are assigned as certain groups regarding their functions to make further analysis (Table 3). Similar heritage types such as government building, military, and court as governmental building; housing part, memorial, fortress are placed under the remains, so main heritage types are clustered in order to do meaningful analysis. Otherwise, research results in a lot of groups and they could lead to vague analysis to understand relation most popular areas and heritages. Therefore, heritage types are categorized for further analysis in order to investigate popular urban heritage areas.

Table 3. Heritage classification

Heritage Type	Group	Heritage Type	Group
Catering	Catering	Industry	Industry
Church	Church	Meeting points	Office building
Art and Culture	Culture-Sport	Trade office	Office building
Sport and recreation	Culture-Sport	Work-home	Office building
Education	Education	Fort, fortress	Remains
Garden and park	Garden and Zoo	Housing Part	Remains
Zoo	Garden and Zoo	Memorial	Remains
Administration building	Governmental building	Remains	Remains
Court	Governmental building	Street furniture	Remains
Government Building	Governmental building	Store	Shopping
Military	Governmental building	Storage	Storage
Service home	Governmental building	Transportation	Transportation
Social care	Governmental building	Uncategorised	Uncategorised
House	House		

The purpose of the usage of national monument data is to define the most popular heritage locations that fall under the most popular areas in Amsterdam. The most attractive heritage buildings and sites are found by processing Flickr data with national monument data together that will be explained in data analysis section.

3.1.3. AMSTERDAM CITY DATA

The city data consists of a wide range of themes, including, public spaces, tourism, culture, infrastructure, energy, population. Dataset is presented with different formats, for instance, csv, docx, json, pdf, and established in collaboration with Amsterdam Municipality and their partners. All data is open and suitable for researchers, and it is kept up-to-date (City data, 2019). An example of a tourism dataset is presented below. As it can be seen that sub-categories such as museums, marketing, monuments are located under the title of tourism and culture. Data description, data formats and uploading time are also given on the website, as can be seen in figure 3.2.

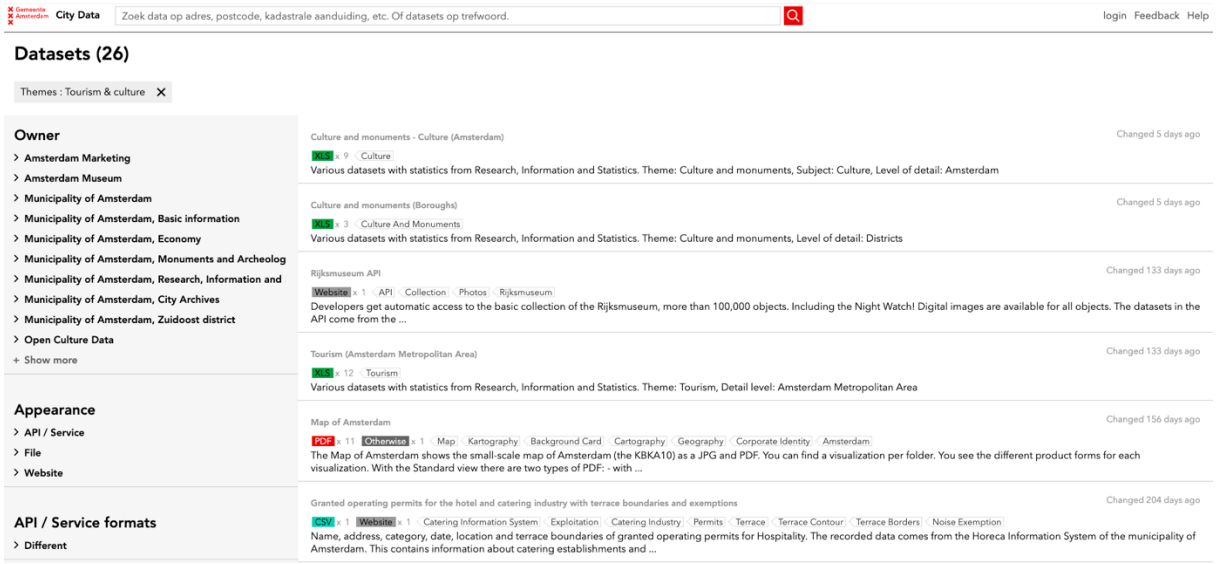


Figure 3. 2 Tourism dataset

For this research, Amsterdam city data is utilized to understand the influence of accessibility and urban facilities to heritage points and their popularity/attractiveness. For that purpose, UNESCO heritage boundary, tram-metro stops, and eating-drinking locations are downloaded from Amsterdam city data. They will be processed in the QGIS environment with geoprocessing tools. Intersection locations between national monuments and city data will be explained by mapping techniques in the data analysis chapter.

3.2. METHOD

In this section, the cleaning of raw data, division of users into local residents and tourists and processing and analysis methods of data are explained.

3.2.1. CLEANING FLICKR DATA

The downloaded Flickr dataset contains a wide range of invalid records. Data request code for Flickr is run many times in order to increase the number of responses and therefore it gives repeated results for some locations. For instance, some photographs appear 9-10 times in the downloaded dataset. Due to that, duplicate records should be cleaned before the analysis. First, duplicate records are cleaned and invalid records are removed. After that, regarding the temporality of photos, new columns (hour, day, month and year) are added to each record based on the “date taken” column. The date taken is considered as the main date and it is processed for further analysis, instead of its uploading date of photos. This assumption is made because some users prefer to take photographs and upload their photo at a different time; therefore, it could be misleading for the data analysis. After this step, unnecessary columns are removed from the data file. The final data file consists of latitude, longitude, owner, hour, day, month, year, date taken and URL columns per photo record. The basic cleaning process is illustrated in figure 3.3.

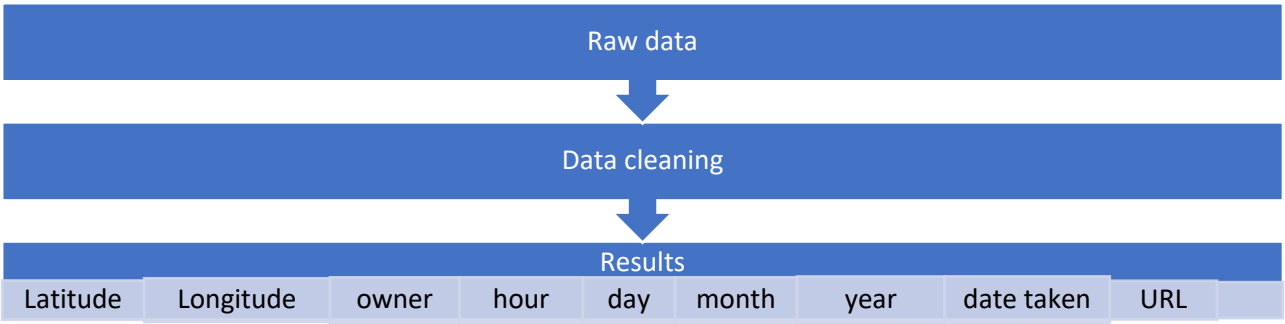


Figure 3. 3 Data cleaning

After the cleaning process, the Flickr dataset is ready for further analysis to define the most photographed areas in Amsterdam. It will be used to understand the most attractive points within the urban core by a clustering method. The time stamps will be used to divide the users into tourist and local residents by considering photographs' taken time. This will enable to understand the most attractive locations per user group.

3.2.2. PROCESSING OF THE DATA SETS

Before the data is processed, cleaned data needs to be divided into two user groups as local and tourist; therefore, temporal characteristics of photos are utilized within this step. Photograph taken time is split by days and 30 days threshold is selected to define tourists as suggested in the literature by Girardin et al.,2009 and Koutras et al., 2019. If the same user uploads more than one photograph within 30 days, it could be assumed as a tourist, since shorter periods are preferred by tourists (Kádár, 2014). Following that assumption, users are divided into two groups. Tourists are coded as 0 and locals are coded as 1. As a result of this, two data files are created, one for tourists and one for local residents. All the data processing steps that will be explained below are applied to both data sets. At the beginning, 285.130 photographs are downloaded from Flickr API and these are divided into tourist and local. 93.752 photographs belong to tourists and 191.378 photographs belong to local. After cleaning process, 12.766 photographs remain from 1808 tourists, and 25.445 photographs remain from 654 locals. A flow chart with the different steps of data processing is presented in figure 3.6. The flow chart is conducted both for tourists and locals separately.

Step 1 of the process is transforming the data coordinate system to a national coordinate system. All cleaned data is uploaded as csv format in QGIS and it is saved as shape file. After that, the coordinate of point geometries is transformed into the Netherlands coordinate system (EPSG:28892). Longitude and latitude are also recalculated using field calculator, because they are presented in degree format and they need to be converted EU (European Union) metric system. After that, they are processed in R which is a programming environment for statistical research such as linear and nonlinear modelling, classification, clustering and also graphs, maps and tables can be produced in the program. It was established in 1993 and it is a free software (R project, 2019). An Example of csv file that is used in R is presented below in table 4.1.

Table 4. 1 Example of tourist data

x	y	lat	lon	Group	owner	day	days	month	year	hour	tourist
121845.049	487288.644	52.372472	4.90035	1	100085119@N03	10	Monday	9	2018	21	0
122786.007	486628.714	52.366597	4.91423	1	100085119@N03	11	Tuesday	9	2018	10	0
122786.245	486633.942	52.366644	4.914233	1	100085119@N03	11	Tuesday	9	2018	10	0
122907.352	486519.437	52.365622	4.916022	1	100085119@N03	11	Tuesday	9	2018	11	0
123203.836	486464.666	52.365147	4.92038	1	100085119@N03	11	Tuesday	9	2018	12	0
122894.272	486665.728	52.366936	4.915816	1	100085119@N03	11	Tuesday	9	2018	13	0

As it can be seen in table 4.1, x and y represent coordinates in the EU metric system, lat and lon are the same coordinates with degree format. The group number is numerical code that is used to divide local and tourist with time stamp, these numbers are associated with the owner number, which is considered as ID key per user. The day is the numerical format of the day, and days is an alphabetical representation of the related date. Month, year and hour are presented as a numerical format. The last tab is the result of 30 days algorithm either tourist (0) or local (1). The output of the first step will be used to process the cluster algorithm.

Step 2 is the calculation of clusters that will be analyzed to determine the most popular locations. Each cluster represents the points of interests and it could be found using the most photographed locations. Using clusters on geotagged photograph data enables to determine the Point of Interests (POI's) within an urban core that show the concentration of most photographed locations (Koutras et al., 2019).

Researchers are able to use different clustering methods such as K-means, fuzzy C-means, DBSCAN and so on. K-means is one of the popular clustering methods that was introduced in 1967 (Macqueen, 1967). It sets the mean value of objects in a cluster as a cluster centre, also it is a simple method that computes complexity O(nkt), where n is the number of objects, k is the number of clusters, and t is the number of iterations (Lee et al., 2014). However, k-means does not calculate noise outliers and it has to run many times to find the best algorithm; therefore, it is not efficient to use with such large a dataset in this research. Another method is fuzzy C-means, it was developed in 1973 (J.C. Dunn, 1973) and it is mainly used to pattern recognition. Both methods k-means and fuzzy c-means demonstrate nearly the same strategy. They are based on the Euclidean distance in order to determine the similarities between the considered objects and cluster centroids (Dinh Sinh Mai & Long Thanh Ngo, 2015). Fuzzy c-means is sensitive to the initial cluster centers selection, slowness of convergence, and it has tendency to become stuck in the local optimum value (Winkler, Klawonn, & Kruse, 2012). In the thesis, clusters are not determined previously; therefore, the method of fuzzy c-means is not suitable for experiment. Another method is density based spatial clustering method (DBSCAN) which is widely utilized in urban planning studies with big data (Kisilevich, Krstajic, Keim, Andrienko, & Andrienko, 2010; Koutras et al., 2019; Lee et al., 2014). It is a simple algorithm and it searches for the areas of high density. DBSCAN is run with two parameters; areas of neighborhood (Eps) and minimum points (MinPts) within these areas. When comparing the methods, k-means appeal to researchers who focus on a location optimization problem, while DBSCAN is better to find geospatial aggregation (Lee et al., 2014). Also, noise points are calculated in DBSCAN and these points can be assumed as less interested areas for further analysis.

Koutras et al. (2019) run the DBCAN algorithm in their research and they are tested the best parameters. Seven clusters are found by inspection Flickr and the temporal distribution of tourists is explored. They revealed that the DBSCAN algorithm works well, because these POIs

are also registered ancient monuments and important sites of Athens. Lee et al., (2014) are other researchers who prefer DBSCAN. They run the clustering algorithm dataset in two levels, first global level and local level. They investigated that large clusters could be further segmented into locally attractive POI in Queensland Australia. Their research reveals that geospatial concentrations could be used to understand interesting places for local businesses and policy makers.

For the experiment in this research, density based spatial clustering method (DBSCAN) is selected (Ester, Kriegel, & Xu, 1996). This research focuses on to understand the most popular urban heritage tourism locations that fall under the most photographed areas and find solutions regarding overcrowding in Amsterdam; therefore, geospatial concentrations of geotagged photographs from Flickr will be processed in order to find the clusters. DBSCAN algorithm can be used to find clusters with different shapes and sizes, that can be produced using different parameters. Clusters are shared common properties and noise points can be described as low density regions (Batra Nagpal & Ahlawat Mann, 2011). The algorithm starts with picking a core point and it continues to enlarge it until for all density reachable points from the core point. The points that do not belong to any clusters (not reach density reachable point) assigned as noise points and it continue to search until no points remain. Clusters depend on different criteria that are core, border, noise, directly density reachable, density reachable. The core point is in the center of density based clusters and it is array within Eps and MinPts. Border point lies within the neighborhood of the core point. Noise is the point which is neither the core point or border point. Directly density reachable (DDR) is a point r is directly density reachable from s. Eps and MinPts are belonged to NEps(s) and |NEps (s)| >= MinPts. Density reachable (DR) is a point r is reachable from point s. Eps and MinPts if there is a sequence of points r1….rn, r1 = s, rn = s such that ri+1 is directly reachable from ri (Batra Nagpal & Ahlawat Mann, 2011). The algorithm finds dense areas and creates arbitrarily shaped clusters (Götz, Bodenstein, & Riedel, 2015).

Algorithm is processed by two parameters Eps; the search radius and MinPts; the minimum points within the search radius. The larger value of Eps results in the larger POI and the larger MinEps value gives a higher significance, smaller value results in more clusters. However, very large POI's result in more noise points and therefore the results could be falsified (Koutras et al., 2019). The concept of DBSCAN is illustrated below in figure 3.4. Data from the previous step is opened in the R and DBSCAN package is downloaded. For the selection of parameters (MinPts and Min Eps), different values are tested and minPts=125 for tourist, minPts=175 for local datasets are determined after several trial. Eps is calculated using kNN function in R and best Eps output is 70 both for local and tourist datasets. Codes and kNN plots are presented in appendix 1. In this step, several maps are produced by using different Eps values. The most representative one is chosen for further analysis (see appendix 4). Smaller minPts results in more cluster and it could lead to deceptive analysis, because clusters are spread within the core. As the goal of this research is to find the most popular/attractive areas, concentrated points are found to be useful for the analysis.

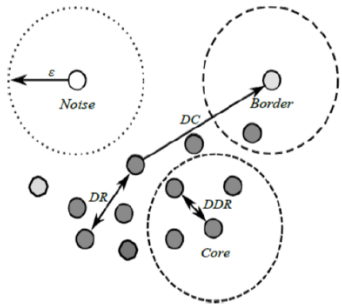


Figure 3. 4 Dbscan concept (Gotz et al. 2015)

Step 3 is a cluster mapping and it is generated using QGIS software. The results of DBSCAN (step 2) are saved as csv files from R and noise points are turned off in the query builder tab, otherwise all points appear on the map canvas and they could lead to error in analysis. After that, clustered points are used as input, and convex hulls are created using the geoprocessing tools in QGIS. Each convex hull represents bounding geometry around the points. These convex hulls are processed to make a comparison between the area of clusters (POIs). The larger convex hulls represent the larger areas. The output of step 3 will be used to understand which locations are most photographed by Flickr user groups (tourists and local residents). Also, it will be processed in step 5, in order to define the heritage sites and buildings that fall under the clusters (popular/attractive locations).

Step 4 consists of identification of spatio-temporal differences in clusters between local and tourist user groups. Clusters, which are generated with DBSCAN (step 2), are analyzed in Excel using the temporal data (hour, day, month and year of the photo records) from the Flickr dataset. Additionally, chi-square goodness of fit values are calculated both manually and in R to test the independence of a significant relation between variables. Using temporal distribution of each cluster, degrees of freedom (df), expected frequency of counts (e), test statistics (x^2) and p-value are calculated. Pivot tables and graphs of temporal data (hourly, daily, monthly and yearly) per user groups are created to observe the differences between clusters. Tables and graphs also presented the percentage format to make comparisons between the temporal distribution of local and tourist photographs (see appendix 6).

Step 5, points out that relation between clusters (step 2) and the national monuments (table 3). Within this step, existing clusters that represent most photographed locations in Amsterdam are processed to create buffers. Following that, 100-meter fixed buffers around the clusters are created in QGIS. These buffers represent a polygon within a specified proximity of each photographed points. Flickr users consist of both professional and amateur photographers; therefore, 100-meter is a proper distance for taking photographs by professional camera and mobile phones. Afterwards, intersected heritage points (national monuments) under the buffers are saved as intersection files. The intersection areas can be assumed as attractive heritages for tourists and locals, because they intersect with most photographed locations. Figure 3.5 represents tourist photographs, local photographs, and national monuments, to the right part of the figure details can be seen. The results of step 5 will be used to understand the most attractive urban heritage areas and the influence of urban facilities such as tram-metro stops and eating-drinking points on the attractiveness of urban heritage areas. Also, they will be used to make recommendations in order to distribute overcrowded heritage points in Amsterdam.

Figure 3. 5 Heritage and POI analysis

Step 6 consists of detailed heritage analysis by using the results of step 5. From QGIS, intersected points are downloaded as csv format and they are processed in Excel. National monuments data from Cultural Heritage Agency is divided into more aggregated groups as given in table 3. Step 6 explains identification of spatio-temporal differences regarding the most photographed heritages between local and tourist user groups. Intersected locations, which are generated in step 5, are analyzed in Excel using the temporal data (hour, day, month and year of the photo records) from the Flickr dataset. Pivot tables and graphs of temporal data (hourly, daily, monthly and yearly) by location cluster per user groups are created to observe the differences between heritage types. Tables and graphs also presented the percentage format to make comparisons between the temporal distribution of local and tourist photographs around the heritages (see appendix 5). Results are presented tables and graphs regarding spatio-temporal differences will be given in chapter 4, and it can provide answers to the most attractive urban heritage points and they could be used to make a recommendation to reduce overcrowding around the heritages. The results of step 6 also will be used to investigate the influence of urban facilities such as tram-metro stops and eating-drinking points on urban heritage areas in next step.

Step 7 is a comparison of heritage map (step 5) with existing tourist map (City Sightseeing, 2019) and investigation of urban facilities. It could explain whether each map supports another or not. The intersected points (step 5) regarding facilities such as tram-metro stops and eating-drinking points with the most popular heritage areas are analyzed by mapping techniques. Tram-metro stops and eating-drinking points, which are downloaded from Amsterdam city data (City data, 2019), are explored to define the impact of urban facilities. They are uploaded to QGIS as points, and convex hulls are created for the intersected points (step 5) using the geoprocessing tools in QGIS. Each convex hull represents bounding geometry around the intersected points. The output of step 7 will be used to understand relation between heritages which locations are most photographed by Flickr user groups (tourists and local residents) and urban facilities.

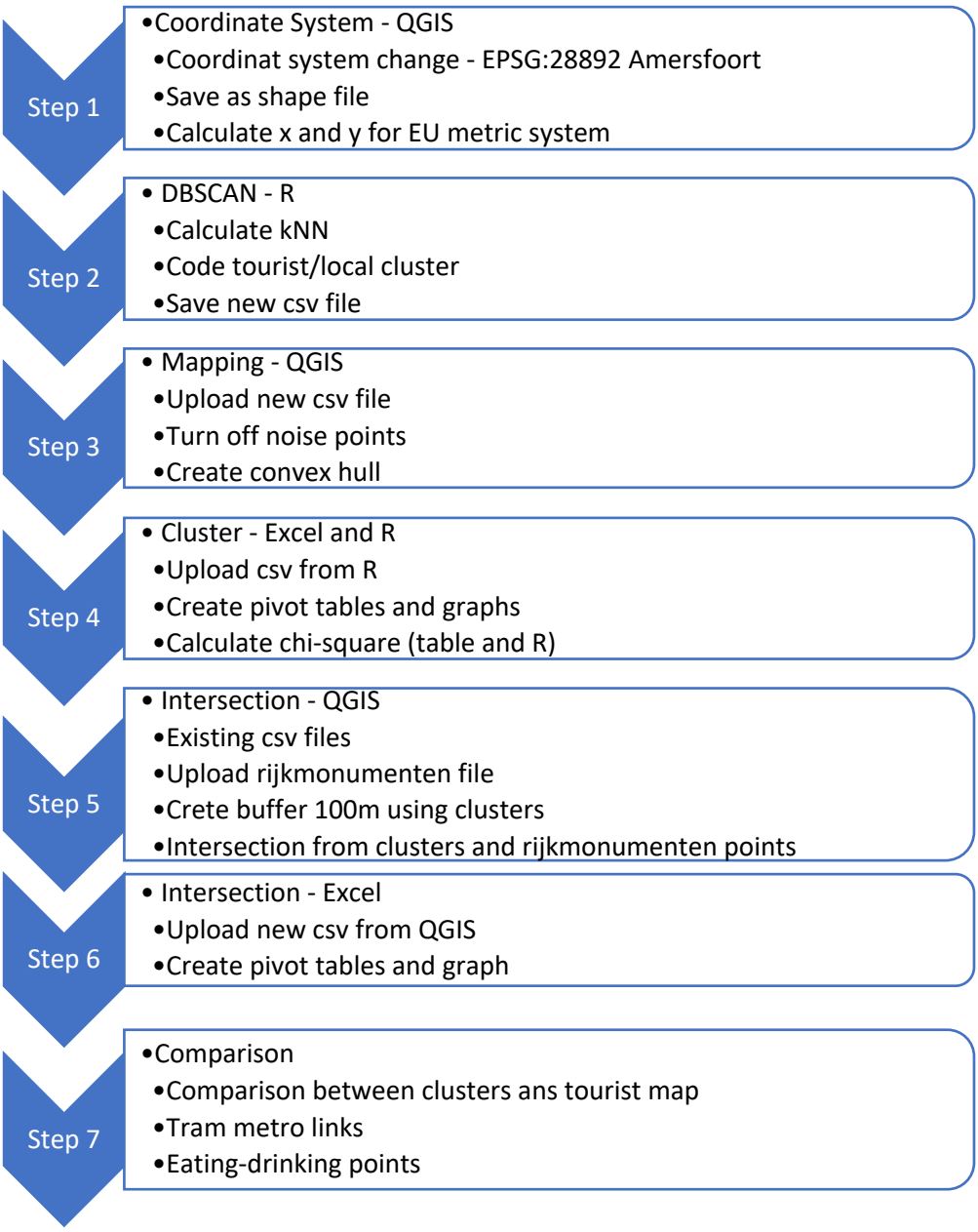


Figure 3. 6 Flowchart of data process

3.3. CONCLUSION

This chapter describes the several steps that involved in the investigating of the utilization of newly available big data and urban heritage tourism. In order to achieve the aim, flow chart of data analysis (figure 3.6) is developed. For each step, several substantial choices are explained. After the selection of methods, the process of case study is shaped and methodological framework is being outlined.

In this chapter, obtaining Flickr data and cleaning process are identified which are the built up the base of the study. Following that, division of local and tourist is explained to understand spatial and temporal distributions of these two groups. Two groups are segregated by using the 30-day threshold for uploading photos. Clustering analysis techniques are explained briefly and DBSCAN method is selected, because it is the most effective approach to generate

the concentration of most photographed locations. In the subsequent steps, the process of the relation between heritages and the spatio-temporal patterns of Flickr users for local and tourist are explained.

Figure 3.6 represents a flow chart of data analysis. Therefore, the designated case study investigates the location of most popular heritage buildings and sites, and explains their popularity in time stamps hourly, daily, weekly and yearly regarding the division of tourist and local using different datasets in Amsterdam. Also, the influence of urban facilities on attractive spots are explored, and recommendations are given by considering the preferences of residents and tourists. Next chapter will elaborate the results of the analysis.

4. RESULTS

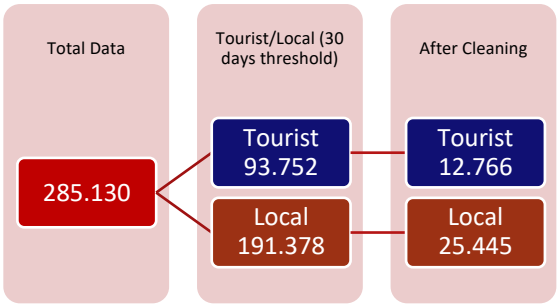
In this chapter, results of data analysis are presented respectively. The goal of this research is to determine attractive/popular areas in order to define overcrowding in time and space around urban heritage areas in relation to urban heritage tourism in Amsterdam, and to understand the relation between heritage areas, facilities in urbanscape and people. Data analysis start with the process of Flickr data and it continues with detailed POI analysis. After, the result of DBSCAN is explained and clusters are presented with maps. These clusters are used to find the answers of 1st subquestion, they demonstrate the most attractive/popular areas in historical urban core. The temporal spatial differences between local residents and tourists are found by processing clusters using time stamp of Flickr data. In addition, the results of relation with POI and heritages are explained and they will provide the answer of 2nd sub question. Detailed heritage analysis which consist of heritage types and spatio-temporal distribution of photographs are used to find the answers of 3rd subquestion, they demonstrate attractive/popular heritage types and spatio-temporal differences for both and local photographs around urban heritage areas. In the comparison part, tourist map that is promoted by the tourist information in Amsterdam and final map that is generated by this research are compared to understand whether they support each other or not regarding urban heritage tourism. Lastly, urban facilities and their impacts of the urban heritage tourism are described using maps from detailed heritage analysis and it provides the answer of 4th sub question.

4.1. PROCESSING FLICKR DATASET

Flickr dataset constitute the base of this study. It is processed to understand the most photographed locations which represents the most popular areas in Amsterdam. The metadata of 285.130 photographs are downloaded within delimited area the boundary of "minx": 4.867080, "miny": 52.357924, "maxx": 4.933176, "maxy": 52.390259 (figure 4.2). These coordinates represent the border of the study area as well as the urban core in Amsterdam. Code snippets are run in the environment of GO, and dataset is saved as csv file.

In the dataset, time stamps of photographs vary from 1927 and 2019. When the photographs are checked manually, it can be seen that old black and white photos are tagged with taken time and uploaded to Flickr (see appendix 3). These photos are kept in the dataset, because they still represent spatio-temporal information. In order to reduce the bias in the dataset, the data records of such old photos are checked manually considering their spatio-temporal data and irrelevant ones are deleted from the dataset. The photos which are taken by the same owner names and taken in the same locations are defined as duplicate data and they are removed. As a result, the data of tourist's photographs are merged from 1986 to 2007 and the data of locals' photographs are merged from 1927 to 2007.

Unprocessed dataset contains the data records of 285.130 photographs. When the dataset is divided to tourists and locals, data records of 93.752 photographs belong to tourists and 191.378 photographs belong to local residents. After the cleaning process, 12.766 photographs remain from 1808 tourists, and 25.445 photographs remain from 654 locals. 73% of photos are uploaded by tourist and 27% is uploaded by local. An overview of the distribution of tourist photos and local photos, and the distribution of user groups are given below in figure 4.1.



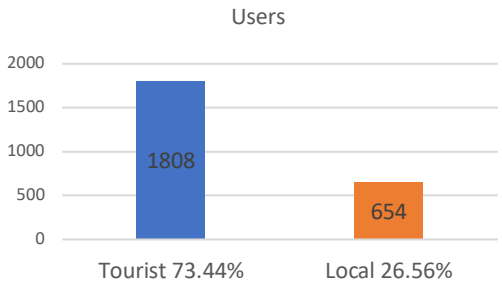


Figure 4. 1 Valid Photographs and User Distribution

It can be seen in figure 4.2, the photos of tourists are taken mainly in the urban core; while the photos of locals cover a wider range of the city. The cleaned Flickr data is used to cluster analysis to identify most attractive locations in Amsterdam.

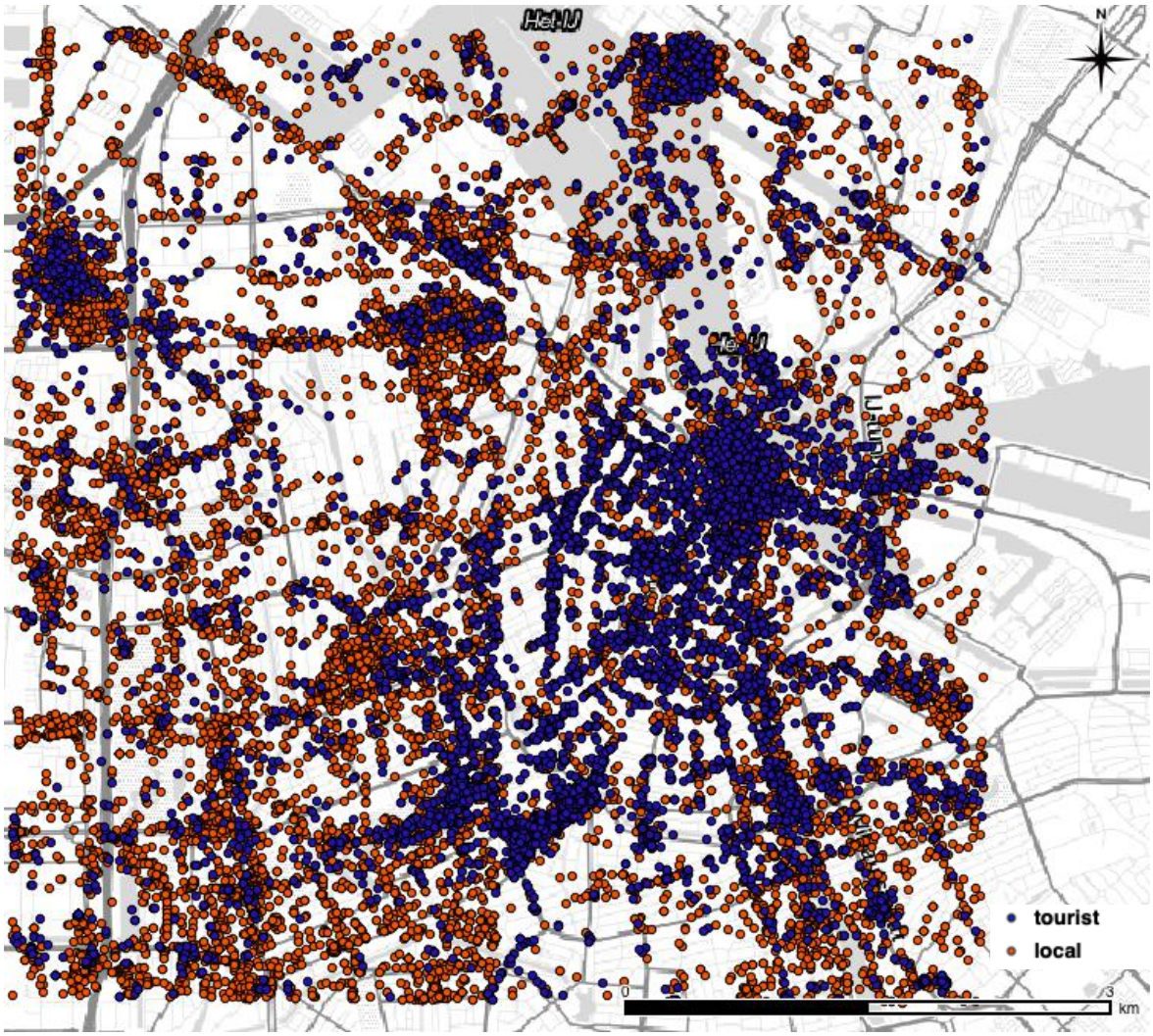
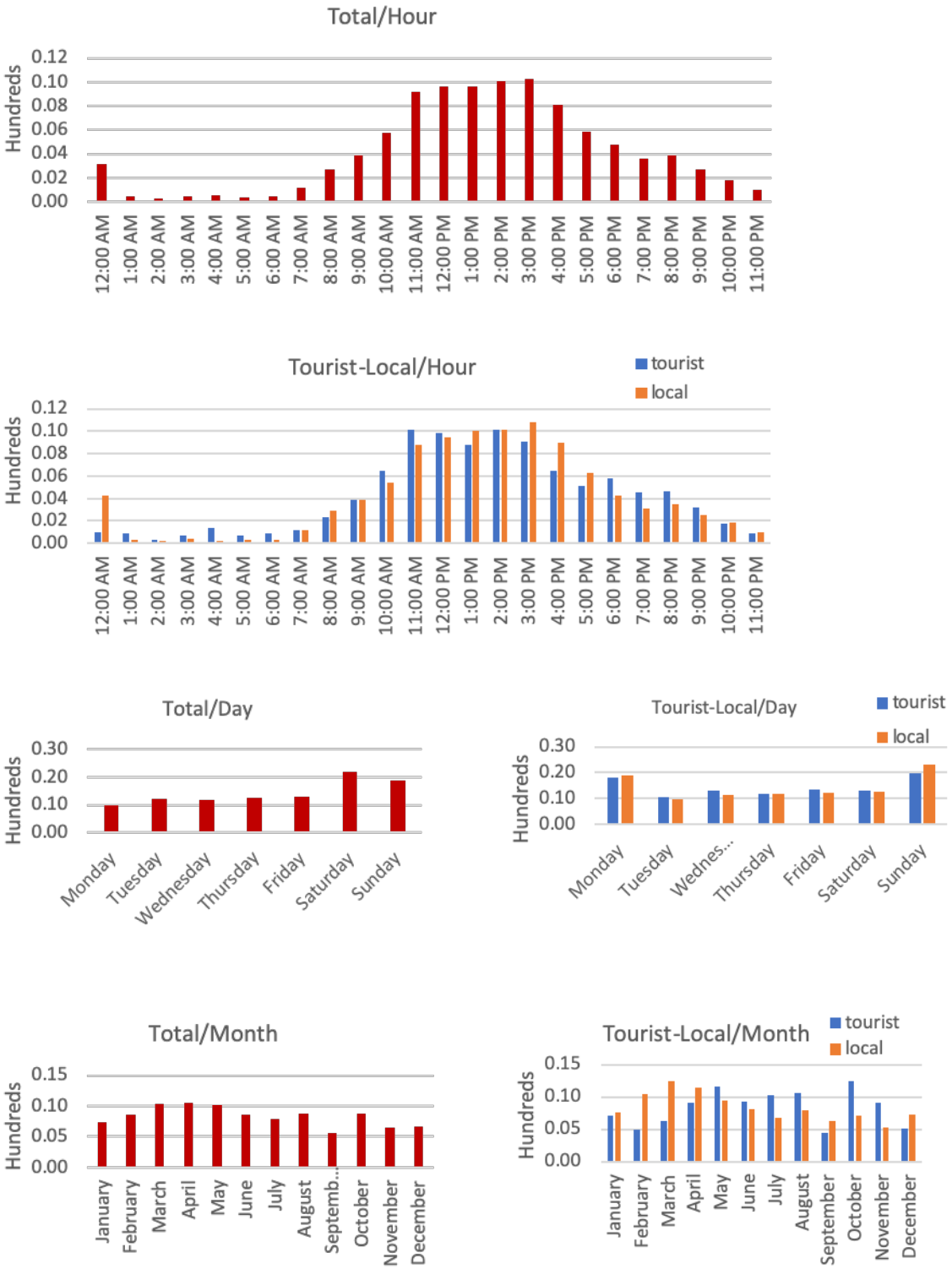


Figure 4. 2 Tourist and local photographs

4.2. TEMPORAL DISTRIBUTION OF ALL PHOTOGRAPHS

Before the cluster analysis, the differences in the temporal distribution of photographs in the whole dataset (including both local residents and tourists) and per user groups is analysed to understand the overall time pattern within Amsterdam historical urban core. After classifying

the users as tourists and locals Flickr dataset, temporal distribution of each groups' is also analysed and represented by graphs. Total graphs illustrate the total number of photographs with specified time such as hour, day, month, year; and tourist-local graphs depict their timely distribution. Percentages are calculated for each time stamps. Results are presented below in figure 4.3.



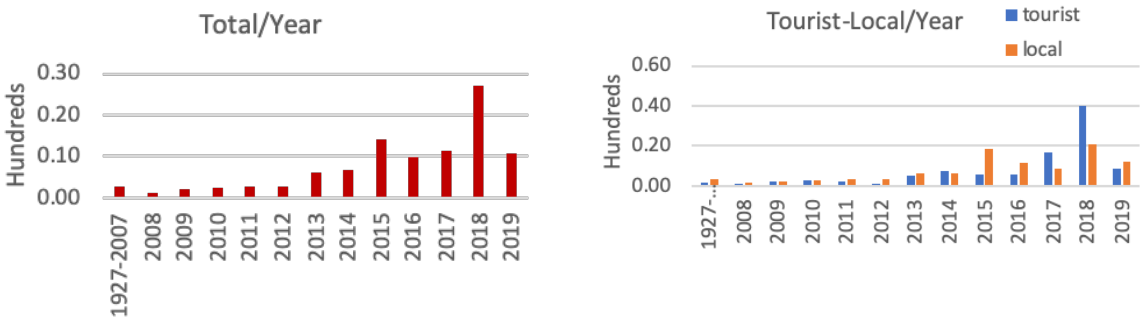


Figure 4. 3 Total distribution and division of local/tourist

Regarding the results, photos are taken mostly during the daytime between 11.00AM and 3.00PM. Tourist take more photos in the evening and at night; while, locals take more photos during the midday. In daily analysis, as it can be expected, more photographs are taken at weekends compare to weekdays. Local and tourist distributions are nearly the same, except for Sunday. On Sundays, local residents took and uploaded more photos than tourists. Spring is the busiest season, the number of photographs are roughly similar at the months of spring. On the other hand, less photos are uploaded in the fall season. Considering the yearly distribution, before the 2013 relatively less photographs are taken, after two years it increases by 5% and drops again 5%. The main reason for the drop is that mobile phones and internet access become more common in the last years and people prefer the instant services such as Instagram and Twitter instead of Flickr. The number of photos peaks in 2018, because Flickr user agreement has changed and they announced new membership types. Regular users can upload up to 1000 photographs on personal accounts in free subscription, and Flickr Pro users have unlimited storage on personal accounts which is more than allowed before. From 2015 to 2016, there are more photos that are uploaded by locals than tourist, and from 2017 to 2018 there are more photos that are uploaded by tourists than locals.

4.3. CLUSTER (POI) ANALYSIS FOR DETERMINING ATTRACTIVE AREAS PER USER GROUPS

Since the main topic of this study is utilizing big data to understand the overcrowding in Amsterdam in relation to urban heritage tourism, it is crucial to identify most attractive locations. For that purpose, cluster analysis is conducted. The most photographed locations are found by processing the Flickr dataset by using DBSCAN algorithm in R. after that, convex hull tool is used to generate areas out of points. The produced maps result in 9 clusters for tourist photographs dataset and 12 clusters for local photographs dataset. The differences between the spatio-temporal distribution of POI's per user groups are found by analysing clusters. Results are shown in figure 4.4 with graphs and figure 4.5 with map.

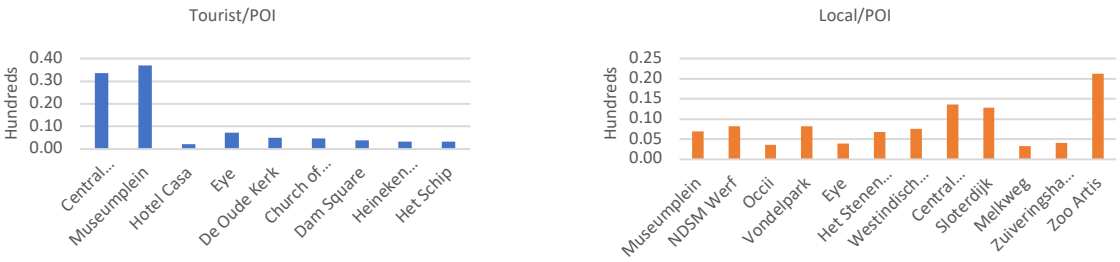
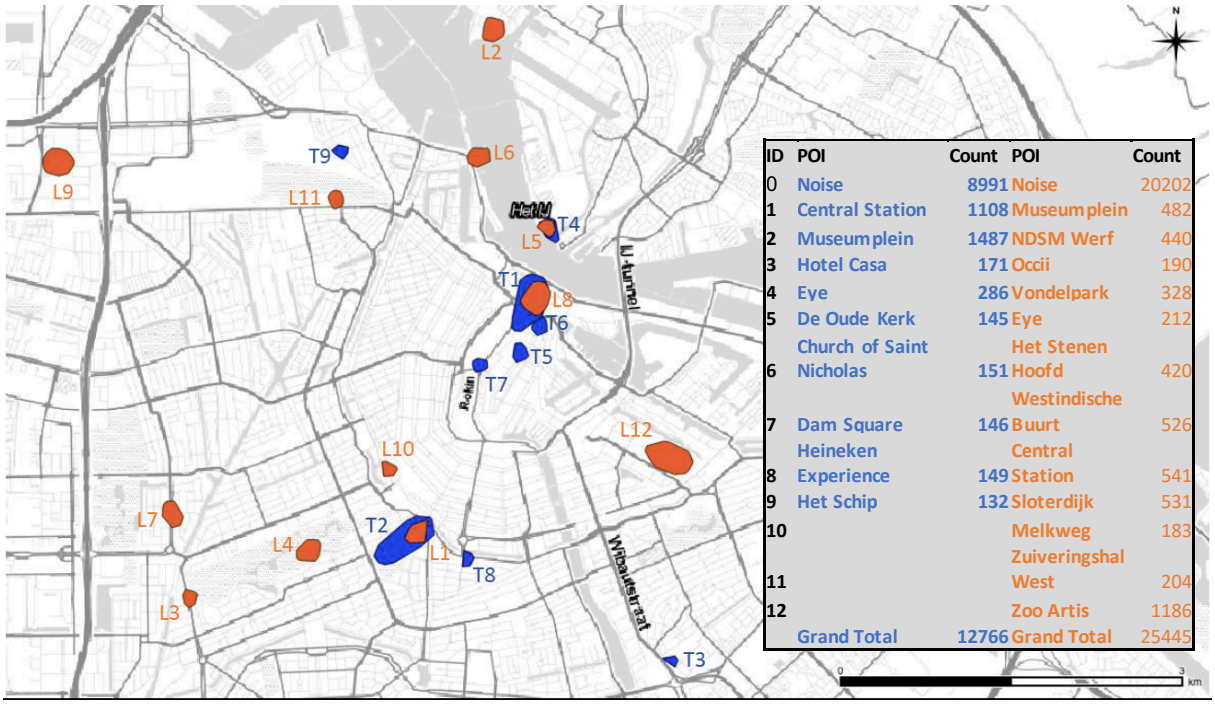


Figure 4. 4 Tourist and local POI by percentage of photos and locations



ID	POI	Count	POI	Count
0	Noise	8991	Noise	20202
1	Central Station	1108	Museumplein	482
2	Museumplein	1487	NDSM Werf	440
3	Hotel Casa	171	Occii	190
4	Eye	286	Vondelpark	328
5	De Oude Kerk	145	Eye	212
6	Church of Saint Nicholas	151	Het Stenen Hoofd	420
7	Dam Square	146	Westindische Buurt	526
8	Heineken Experience	149	Central Station	541
9	Het Schip	132	Sloterdijk	531
10			Melkweg	183
11			Zuiveringshal West	204
12			Zoo Artis	1186
	Grand Total	12766	Grand Total	25445

Figure 4. 5 Tourist and local POI map (blue: tourist, orange: local)

As seen in Figure 4.5, tourist photographs are clustered mostly around Centraal Station and Museumplein; locals prefer to take photos in Zoo Artis, Sloterdijk and Museumplein. Common POI(s) are appeared around Museumplein and Eye Film Museum. Tourist photographs are concentrated within urban core, except for Het Schip, whereas locals are distributed around the city. It appears that locals do not prefer to photograph the touristic destinations as much as the tourists (Kádár, 2014).

Table 4.2 shows a general overview of tourist and local distribution regarding the most attractive areas (table 4.2). The results are used for detailed heritage analysis to identify most popular urban heritage locations.

Table 4. 2 Overall distribution tourist and local regarding POI (blue: tourist, orange: local)

ID	POI	%	POI	area	ID	POI	%	POI	area
1	Central Station	33.56	Central Station	115068.7441	1	Museumplein	6.97	Museumplein	28034.33126
2	Museumplein	37.02	Museumplein	126946.6949	2	NDSM Werf	8.15	NDSM Werf	32766.20656
3	Hotel Casa	2.08	Hotel Casa	7166.0158	3	Occii	3.61	Occii	14509.31611
4	Eye	7.13	Eye	24480.04929	4	Vondelpark	8.13	Vondelpark	32691.19844
5	De Oude Kerk	5.11	De Oude Kerk	17542.32924	5	Eye	3.95	Eye	15896.43351
6	Church of Saint Nicholas	4.62	Church of Saint Nicholas	15864.79812	6	Het Stenen Hoofd	6.75	Het Stenen Hoofd	27119.15907
7	Dam Square	3.78	Dam Square	12971.03033	7	Westindische Buurt	7.54	Westindische Buurt	30314.71855

8	Heineken Experience	3.23	Heineken Experience	11086.83429	8	Central Station	13.53	Central Station	54394.34353
9	Het Schip	3.42	Het Schip	11747.35894	9	Sloterdijk	12.89	Sloterdijk	51809.85721
10					10	Melkweg	3.23	Melkweg	12989.22654
11					11	Zuiveringshal West	4.09	Zuiveringshal West	16454.74273
12					12	Zoo Artis	21.15	Zoo Artis	85008.86728
	Total	100	Total	342873.8551		Total	100.00	Total	401988.4008

As it can be seen in the map (figure 4.5) and the table (table 4.2), tourist photographs are dominated in the core, and locals follows a distributed pattern. Locals take photographs outside the core, and tourist photographs are along the diagonal axes from Centraal Station to Museumplein.

Besides the spatial distribution of local and tourist photographs, temporal distributions are also analysed to explore differences and relations among time stamp of clusters per user group. The analysis results can be seen in appendix 5. For the test, chi-square goodness of fit values are calculated both manually and in R to test the independence of a significant relation between variables. Using temporal distribution of each cluster, degrees of freedom (df), expected frequency of counts (e), test statistics (x^2) and p-values are calculated. According to the results, < 2.2e-16 as the p value indicate a significant result; therefore, the actual p value is even smaller than 2.2e-16 (a common threshold is 0.05 and smaller numbers count as statistically significant). In addition, x^2 values are compared both test result and observed values to analyse relation between clusters and temporal distribution. All variables are statistically significant and null hypothesis (clusters and temporal distributions are independent) is rejected (see appendix 6). Thus, there is a relation between clusters (POIs) and temporal distributions. In order to analyse the most contributing variables to the total chi-square score, chi-square statistics for each variable are calculated. Pearson residuals for each variable (standardized residual) is used for calculation. Results provide that the variables the highest score, contribute the most to total chi-square score. Pearson residuals are visualised by the package of "corrplot" in R (see appendix 6). In the graph, the size of the circle is proportional to the amount of the value contribution. Blue represents the most contributing value; it specifies an attraction (positive association) between corresponding row (time stamps) and column (POI). Red represents the least contributing value; it specifies a repulsion (negative association) between corresponding row (time stamps) and column (POI) (Chi-square, 2019). This indicates that, there are significant differences in the time of photos taken per POIs. In below sub-sections, detailed description of results are provided for each user group, namely tourist and locals.

4.3.1. Tourists and POI analysis

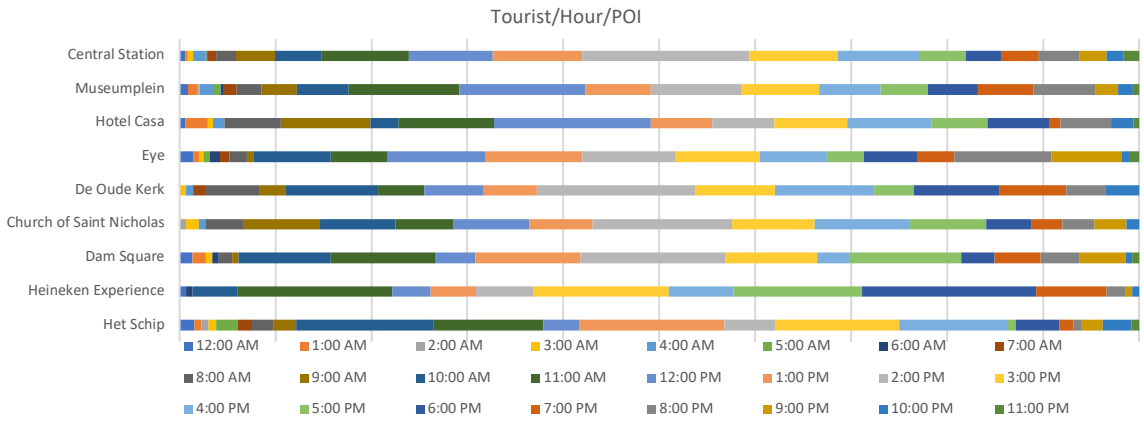
In order to understand the differences for spatio-temporal distribution of tourist photos within Amsterdam historical urban core, clusters are analysed. After that, heritage buildings and sites that fall under clusters and their characteristics are explained in chapter 4.4. Temporal distribution of tourist photographs shows that most photographed and therefore most attractive locations with their time stamp. Results are presented below by table of

overview of temporal distribution of tourist photographs per POI (table 4.3) and by graph detailed analysis of temporal distribution of tourist photographs per POI (figure 4.6)

Table 4. 3 Overview of Temporal Distribution of Tourist Photographs per POI

ID	POI	Description	Peak time			
			Hour	Day	Month	Year
T1	Centraal station	Transportation	2.00PM	Saturday	October	2017-2018
T2	Museumplein	Museum and cultural events	11.00AM and 3.00PM	Sunday	July-October	2018
T3	Hotel Casa	Accommodation	12.00PM	Friday	April	2014
T4	Eye	Museum and cultural events	12.00PM and 2.00PM	Friday	August	2017-2018
T5	De Oude Kerk	Church and exhibitions	2.00PM	Sunday-Tuesday	May	2018
T6	Church of Saint Nicholas	Church	2.00PM	Saturday	July	2018
T7	Dam Square	Public square	2.00PM	Thursday	October	2018-2019
T8	Heineken Experience	Museum	6.00PM	Saturday-Thursday	November	2018
T9	Het Schip	Museum	10.00AM to 2.00PM	Tuesday	November	2008

As it can be seen in table 4.3, the most attractive locations among the tourist consists of museums and churches. Majority of the tourist photographs are taken during middays and the weekends; however, no pattern is found for the month of the photos taken. Majority of the photographs are taken in 2018. The test results of chi-square show that relations between each time stamps of tourist photographs and POI are statistically significant different. For each variable, p-value < 2.2e-16 is calculated. Therefore, it is less than a significance level (0.05) and it is proven that there is a relationship between time stamp (hour, day, month, year) of the tourists' photographs and POIs.



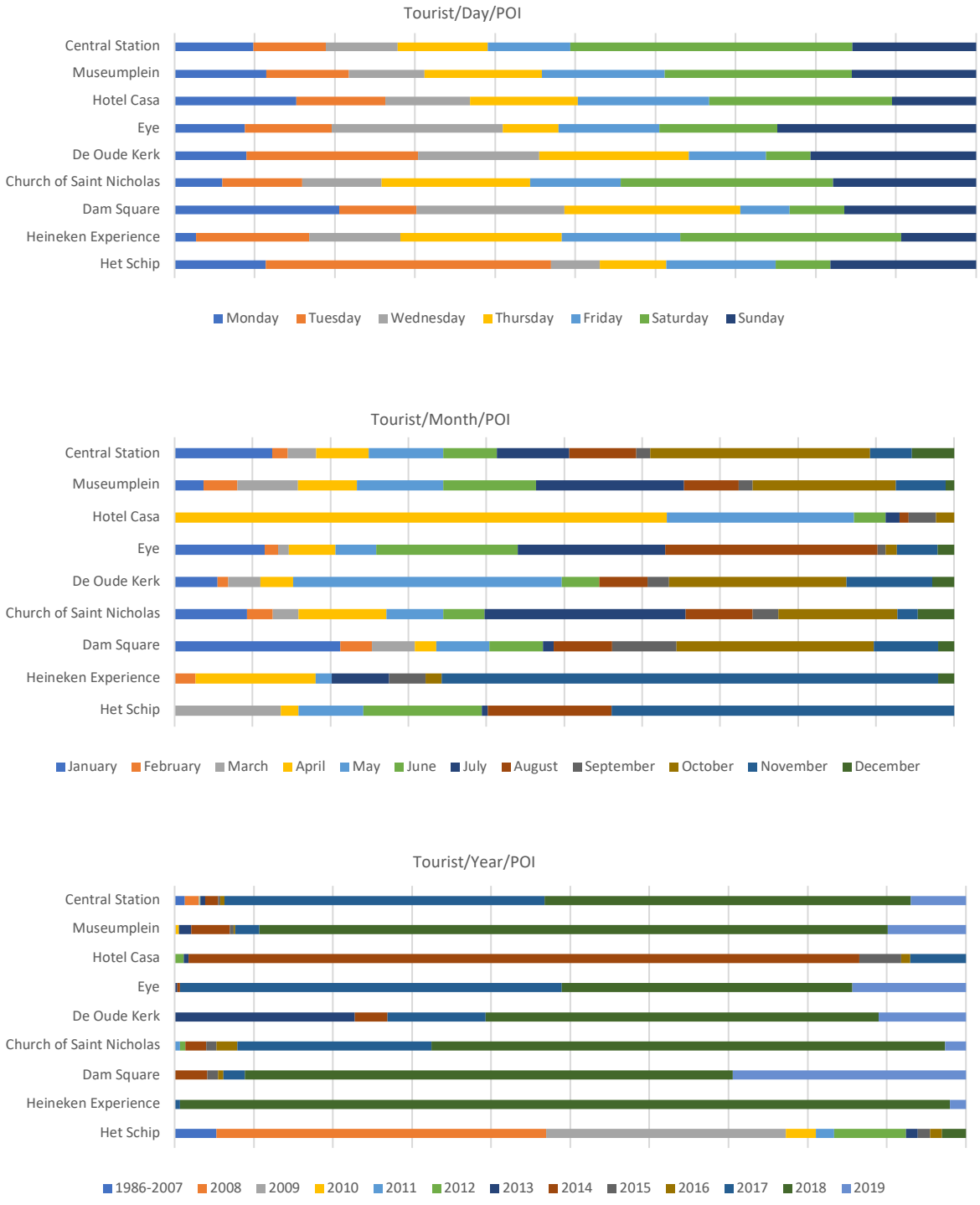


Figure 4. 6 Detailed analysis of Temporal distribution of tourist photographs per POI

As it shown in the figure 4.5, Centaal Station (T1) and Musemplein (T2) are the locations that represented large convex hulls; therefore, they are the most photographed locations. Hourly distribution of the taken photos shows that tourists have tendency to take photographs around transportation facility, churches and museums mostly at 2.00PM, the reason could be midday hours are the best time to visit touristic areas. Daily grouping is depicted that majority of the tourist photographs are taken at the weekend. Amsterdam is easily accessible by train throughout the Netherlands; therefore, it is an attractive location for daily visits as well.

Looking at the temporal distributions per POI, Only Het Schip is photographed mostly on Tuesday, the reason could be a special event or exhibition at that time, such as Sail Amsterdam. Monthly distribution of taken photos shows that POIs which have open spaces such as Eye and Museumplein are photographed mostly in summer season, and indoor places such as Heineken Experience and Centraal Station are photographed in fall season. It is expected that outdoor locations attract tourists when the weather is pleasant. Yearly distribution of taken photographs follows the same pattern 2018 is the most photographed years, except for Hotel Casa and Het Schip.

The graph of Pearson residuals illustrates relation between time stamps of tourists' photographs and POIs (see appendix 6). In hourly distribution, there are strong positive associations of taken photos between Heineken Experience and 6.00PM; Centraal Station and 2.00PM; Het Schip and 10.00AM. In daily grouping, the taken photographs of Centraal Station are highly correlated with Saturday, and photographs of Het Schip are highly correlated with Tuesday. In monthly distribution, there are positive associations of taken photos between Hotel Casa and April; Het Schip and November. In yearly grouping, the taken photographs of Hotel Casa are correlated with 2014, and photographs of Het Schip are highly correlated with 2008 and 2009. All Pearson residual values are also found the same in the table of overview of temporal distribution of tourist photographs per POI (table 4.3) and the detailed analysis of temporal distribution of tourist photographs per POI (figure 4.4); therefore, the findings in graphs of Pearson residuals (see appendix 6) and table 4.3-figure 4.4 supports each other.

4.3.2. LOCALS AND POI ANALYSIS

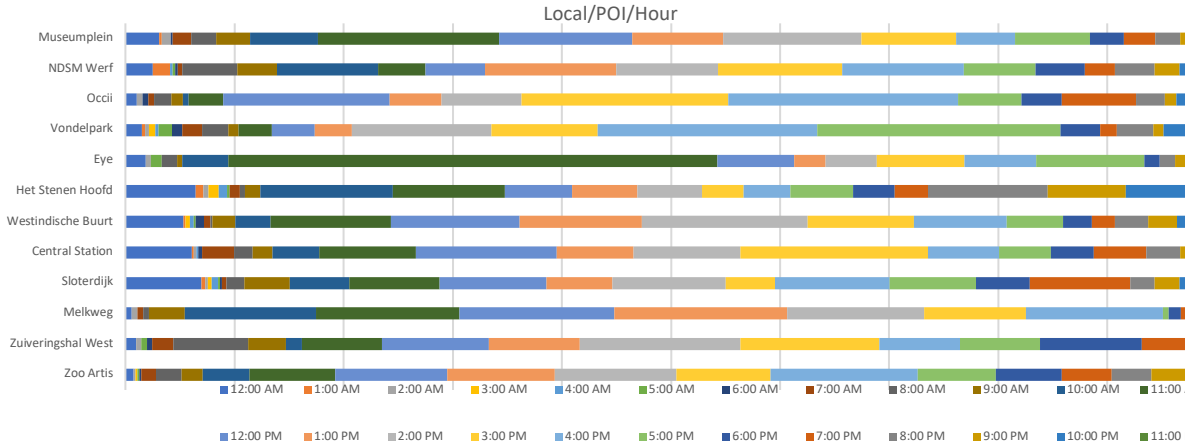
In order to understand the differences between the spatio-temporal distribution per POIs within Amsterdam historical urban core, clusters are analysed. After that, heritage buildings and sites that fall under clusters and their characteristics are explained in 4.4. Temporal distribution of locals' photographs shows that most photographed and therefore most attractive locations with their time stamp. Results are presented below by table of overview temporal distribution of local photographs per POI (table 4.4) and by graph of detailed analysis of temporal distribution of local photographs per POI (figure 4.7).

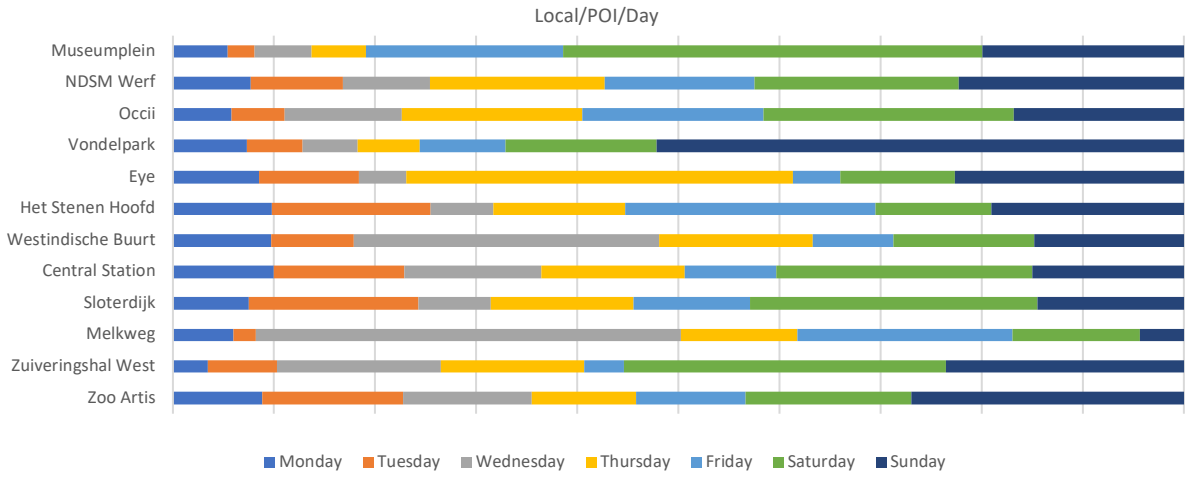
Table 4. 4 Overview of Temporal Distribution of Local Photographs per POI

ID	POI	Description	Peak time			
			Hour	Day	Month	Year
L1	Museumplein	Museum and cultural events	11.00AM and 2.00PM	Saturday	May	2018-2019
L2	NDSM Werf	Exhibitions	1.00PM to 4.00PM	Saturday-Sunday	June	2017-2018
L3	OCCII	Cultural center	3.00PM and 4.00PM	Saturday-Thursday	March	2016
L4	Vondelpark	Outdoor	4.00PM and 5.00PM	Sunday	August	2015
L5	Eye	Museum and cultural events	11.00AM	Thursday	March	2019
L6	Het Stenen Hoofd	Open space and cultural events	10.00AM to 11.00AM	Friday	October	2017-2018
L7	Westindische Buurt	Residential area	11.00AM to 2.00PM	Wednesday	October	2018

L8	Centraal Station	Transportation	3.00PM	Saturday	April	2018
L9	Sloterdijk	Residential area	2.00PM and 4.00PM	Sunday	April	2018
L10	Melkweg	Cultural events	10.00AM to 2.00PM	Wednesday	March	2019
L11	Zuiveringshal	Cultural events	2.00PM and 3.00PM	Saturday	March	2015
L12	Zoo Artis	Outdoor	12.00PM and 4.00PM	Sunday	March	2018

As it can be seen in table 4.4, cultural centers and outdoor areas are the most attractive locations among the locals. Hourly and daily distributions of photos taken do not follow any pattern. Monthly distribution also varies and it depends on the POI. The number of photographs peaks in 2018. The test results of chi-square show that relations between each time stamps of local photographs and POI are statistically significant different. In hourly, daily, monthly, yearly distribution, p-value < 2.2e-16 are calculated. Therefore, they are less than significance level (0.05) and it is proven that there is a relationship between time stamp (hour, day, month, year) of the locals' photographs and POIs.





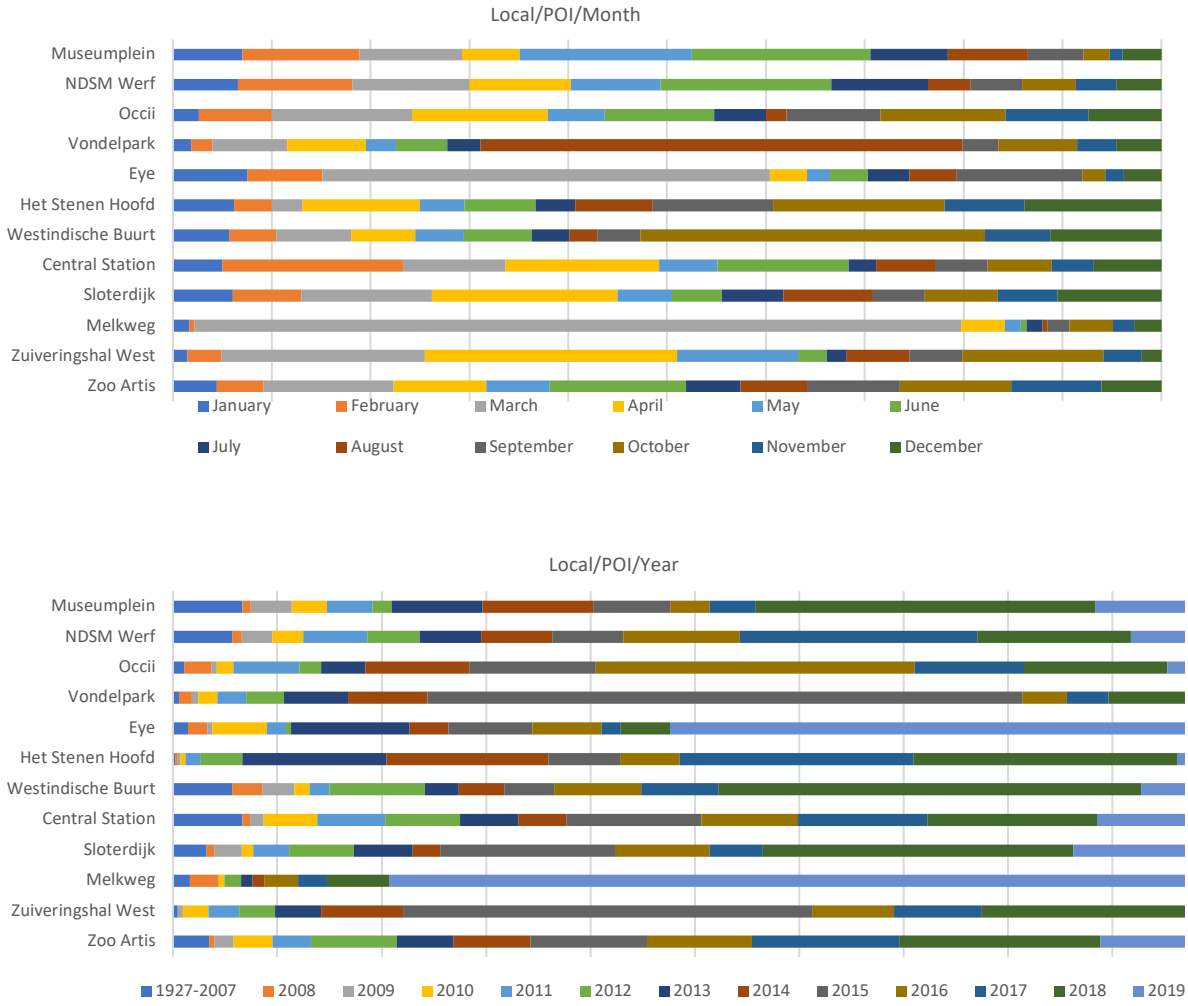


Figure 4. 7 Detailed analysis of Temporal distribution of local photographs per POI

Hourly distribution shows that locals have tendency to take photographs around exhibitions (L1) at 11.00AM and place of cultural events (L5, L6) mostly afternoon. One of the reasons could be the midday hours are preferred by the tourist, and locals could avoid the crowd times. Daily grouping of photos taken is depicted that local photographs are dominated at the weekend, similar to tourists' photographs. Only Melkweg is photographed mostly on Tuesdays. The reason for this could be special offer or concert on Tuesdays. Monthly distribution of taken photos shows that POIs which have open spaces such as Eye and Museumplein are photographed in spring season; and green spaces such as Vondelpark and Zoo are photographed in summer season. Yearly distribution of taken photos follows the same pattern like tourist photos, as 2018 is the year in which most photographs are taken.

The graph of Pearson residuals illustrates relation between time stamps of locals' photographs and POIs (see appendix 6). In hourly distribution, there are strong positive associations of taken photos between Eye and 11.00AM; Vondelpark and 5.00PM. In daily grouping, the taken photographs of Museumplein highly correlated to Saturday; Vondelpark correlated to Sunday; Eye correlated to Thursday; Westindische Buurt correlated to Wednesday, and Melkweg correlated to Wednesday. In monthly distribution, there are positive association of taken photos between Vondelpark and August; Melkweg and March. In yearly grouping, the taken

photographs of Vondelpark tie with 2015; photographs of Eye are correlated with 2019; photographs of Melkweg are connected to the year of 2019. All Pearson residual values are also found the same in the table of overview of temporal distribution of local photographs per POI (table 4.4) and the detailed analysis of temporal distribution of local photographs per POI (figure 4.5); therefore, the findings in graphs of Pearson residuals (see appendix 6) and table 4.4-figure 4.5 supports each other.

4.4. Analysis of Heritage Types within POI's

The result of cluster analysis is presented as POI analysis, and heritage analysis which consist of points that located under the POIs represent the most photographed national monuments. Existing clusters which are presented in section 4.3 represent most photographed points and they are used to create buffers, and 100-meter buffers around the national monuments are saved. Afterwards, intersections are processed using geoprocessing tools, therefore national monument points which are under the buffer of cluster points are saved as intersection files. The intersected areas can be assumed as popular/attractive heritage buildings and sites by tourists and locals. These heritage buildings and sites are analyzed based on their types. Application of intersection in QGIS, results in 12 heritage groups for tourist and local photographs. General results are shown in figure 4.8 with graphs and figure 4.9 with map.

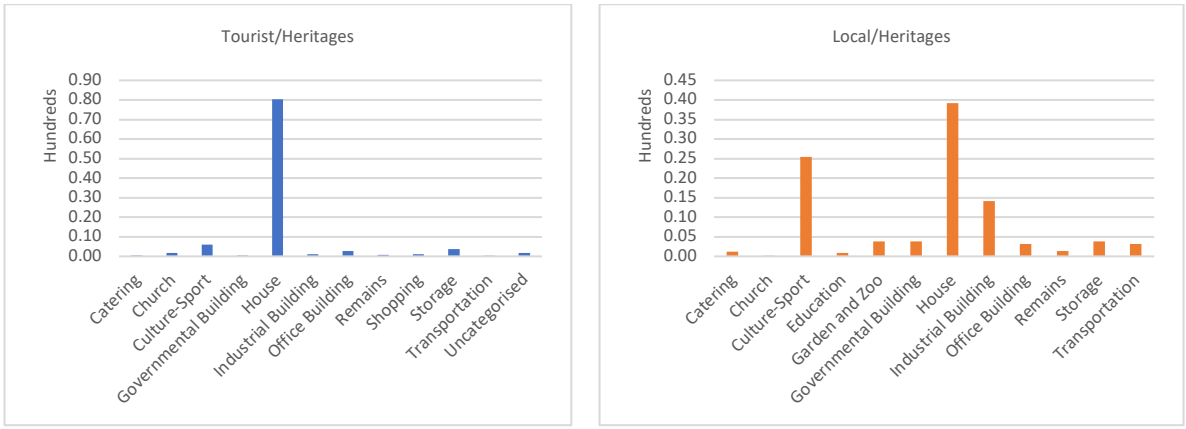


Figure 4. 8 Tourist and local heritage distribution by percentage of photos and locations

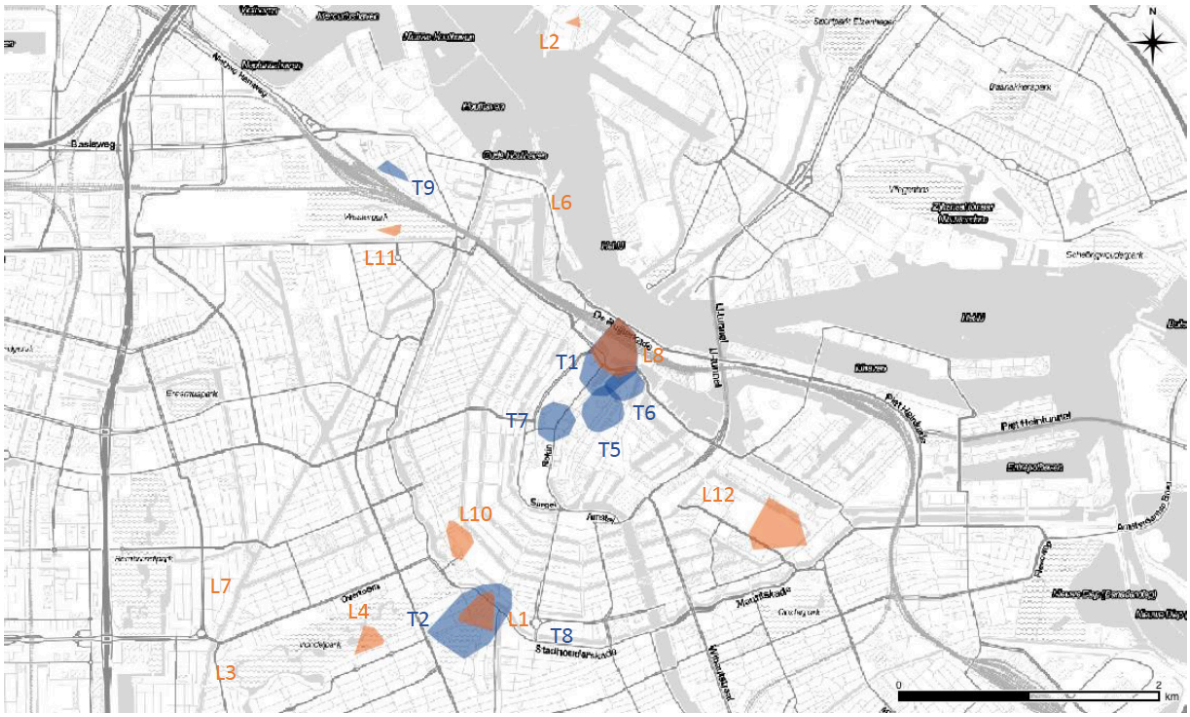


Figure 4. 9 POI and heritage intersections map (blue: tourist, orange: local)

Considering the heritage types, tourists' photographs are taken around house buildings, and it is followed by culture-sport areas; similarly, local residents prefer to take photos around house buildings, culture-sport areas and industrial sites (figure 4.8). Common heritage types are house buildings and culture-sport sites. The main reason is that, narrow canal houses are registered as national monument and they attract visitor's attention. Museums and concert halls are assigned in the group of culture-sport, and popular exhibitions are mostly photographed by locals. Heritage buildings and types which are photographed by tourists are coded as T (1,2,5,6,7,8,9) and locals are coded as L (1,2,3,4,6,7,8,10,11,12) (figure 4.9). T3, T4 and L5, L9 and T8, L3, L6 and L7 do not contain any heritage buildings or sites. Therefore, they are not presented as areas, because they contain only one heritage point.

Besides the spatial distribution of local and tourist photographs, temporal distributions are also analysed to explore differences and relations among heritage types per user group. The analysis results can be seen in appendix 5. For the analysis, chi-square goodness of fit values are calculated both manually and in R to test the independence of a significant relation between variables. Using temporal distribution of each cluster, degrees of freedom (df), expected frequency of counts (e), test statistics (x^2) and p-values are calculated. According to the results, < 2.2e-16 as the p value indicate a significant result; therefore, the actual p value is even smaller than 2.2e-16 (a common threshold is 0.05 and smaller numbers count as statistically significant). In addition, x^2 values are compared both test result and observed values to analyse relation between heritage types and temporal distribution. All variables are statistically significant and null hypothesis (heritage types and temporal distributions are independent) is rejected (see appendix 6). Thus, there is a relation between heritage types and temporal distributions. This indicates that, there are significant differences in the time of photos taken per heritage types. In below sub-sections, detailed description of results are provided for each user group, namely tourist and locals.

Details of temporal distribution of photos taken per heritage types regarding tourist and local are presented below.

4.4.1. ANALYSIS OF HERITAGE TYPES FOR TOURISTS

Detailed tourist and heritage analysis provide answer the tourist's temporal-spatial distribution within Amsterdam historical urban core. Temporal distribution of tourist and heritage table shows that most photographed as well as most attractive locations with their time stamp such as hour, day, month and year. Results are presented below by overview of temporal distribution of tourist photographs per heritage types (table 4.5) and by graph detailed analysis of temporal distribution of tourist photographs per heritage types (figure 4.10).

Table 4. 5 Overview of Temporal Distribution of Tourist Photographs per Heritage Types

ID	Heritage type	Peak time			
		Hour	Day	Month	Year
T1, T7	Catering	2.00PM and 3.00PM	Sunday	January	2018
T5, T6	Church	2.00PM	Thursday	May	2018
T2	Culture-sport	11.00AM and 2.00PM	Friday- Saturday	October	2018
T5, T6, T7	Governmental building	10.00AM and 2.00PM	Sunday	May	2018
T5, T6, T2	Houses	2.00PM	Thursday	May	2018
T8	Industrial building	11.00AM	Saturday	November	2018
T1	Office building	2.00PM and 4.00PM	Thursday	April	2018
T6, T8	Remains	2.00PM	Sunday	October	2018
T1, T7	Shop	2.00PM	Monday	January	2018
T6, T8	Storages	2.00PM	Saturday	July	2018
T1	Transportation	3.00PM and 5.00PM	Monday	July	2018
T9	Uncategorized	2.00PM	Thursday	May	2018

As it can be seen in table 4.5, 12 types of heritages are photographed by tourists. The most photographed heritage types are catering, church, culture- sport, governmental building, house, industrial building, office building, remains, shops, storages, transportation and uncategorized buildings. Houses and culture-sport are the most attractive heritage types among the tourists (figure 4.8). In hourly distribution of taken photos, 2.00PM is the most photographed time during the day. Thursday, Saturday and Sunday are the most photographs taken. Monthly distribution of photographs varies and it depends on the heritage type. 2018 is the year that attract tourists. The test results of chi-square show that relations between each time stamps of tourist photographs and heritage types are statistically significant different. For each variable, p-value < 2.2e-16 is calculated. Therefore, it is less than significance level (0.05) and it is proven that there is a relationship between time stamp (hour, day, month, year) of the tourists' photographs and heritage types. Also, the graph of Pearson

residuals illustrates relation between time stamps of heritage photographs taken by tourist and heritage types (see appendix 6). Detailed heritage descriptions are below, because the temporal distribution of tourist within historical urban core is one of the purposes of the study.

Catering building contains restaurants and cafes and they are located around the Central station (T1) and Dam Square (T7). The photos are taken mostly during the midday around 2.00PM and 3.00PM. Sunday is the busiest day and it is followed by Monday. In monthly scale, tourists take photographs in January, 18%. In the graph of Pearson residuals, there is positive associations of taken photos around catering building and 9.00PM. In daily analysis, the taken photographs around catering buildings tie with Monday. There is positive association of taken photos between catering buildings and January, and they are correlated to the year of 2019.

Church buildings namely, De Oude Kerk (T5) and Church of Saint Nicholas (T6) are two well-known churches in Amsterdam. Photographs around churches show rise in points at 2.00PM. On a daily basis, most photos are taken on Thursdays with 20%, and it is followed by Sunday around 18%. In monthly scale, tourists take photographs around churches in May, 21%. In the graph of Pearson residuals, there is not any significant association of taken photos around church buildings and hourly time stamps, all variables are distributed almost equally. In daily analysis, the taken photographs around churches correlated to Thursday. There are not significant association of taken photos around church buildings and months, and years.

Culture-sport buildings contain museum and recreational places which are situated around the Museumplein (T2). Well-known museums such as, Rijkmuseum, Van Gogh are located within Museumplein. 11.00AM and 12.00PM are the peak times for tourists to take photos around the culture-sport buildings. As it is expected, most photos are taken on Fridays and Saturdays with 23% and 26% respectively. On a monthly basis, most photographs are taken in October. In the graph of Pearson residuals, there is positive associations of taken photos around culture-sports building and 1.00AM-5.00AM. In daily analysis, the taken photographs around culture-sport buildings tie with Saturday. There is positive association of taken photos around culture-sport buildings and October, and they are correlated to the year of 2018.

Governmental buildings consist of court, military buildings, administration buildings and social care. They are located around churches (T5-T6) and Dam square (T7). Photographs around governmental buildings are mostly between 10.00AM and 2.00PM by tourists. Most tourists prefer to take photographs around governmental buildings on Sunday, with roughly 20%. On a monthly scale, May is the month that present a large number of photographs around governmental buildings. In the graph of Pearson residuals, there is not any significant association of taken photos around governmental buildings and hourly time stamps, all variables are distributed almost equally. In also daily and monthly analysis, the taken photographs around governmental buildings are not associated with any day and month. There is positive association of taken photos around governmental buildings and the year of 2013.

Houses are popular tourist attraction points, because they are located around the canals and historical core. Crowd-pulling houses are situated near the Oude Kerk (T5), Church of Saint Nicholas (T6) and Museumplein (T2). Photographs around houses are mostly at 2.00PM similar to churches. Most photos are taken on Thursday. In monthly scale, tourists take photographs in May, 21%. In the graph of Pearson residuals, there is not any significant association of taken

photos around houses and hourly time stamps, all variables are distributed almost equally. In daily analysis, the taken photographs of houses correlate with Wednesday and Thursday. There is positive association of taken photos around houses and May, and they are correlated to the year of 2013.

Industrial buildings are another heritage type in Amsterdam and they are close to the Heineken Experience (T8). Photographs around industrial buildings are taken mostly at 11.00AM by tourists. Most tourists prefer to take photographs on Saturday. On a monthly basis, most photographs are taken in October with 44%. In the graph of Pearson residuals, there is positive associations of taken photos around industrial buildings and 5.00PM-6.00PM. In daily analysis, the taken photographs around industrial buildings tie with Saturday. There is strong positive association of taken photos around industrial buildings and November, and they are correlated to the year of 2018.

Office buildings are clustered around Centraal station (T1). They include meeting points, trade offices and home-based offices. Offices are mostly photographed from 2.00PM to 4.00PM. On a daily basis, most photos are taken on Thursday. In monthly scale, tourists take photographs in April and May, 12%. In the graph of Pearson residuals, there is positive associations of taken photos around office buildings and 11.00PM. In daily analysis, the taken photographs around office buildings tie with Friday. There is positive association of taken photos around office buildings and January, and they are correlated to the year of 2019.

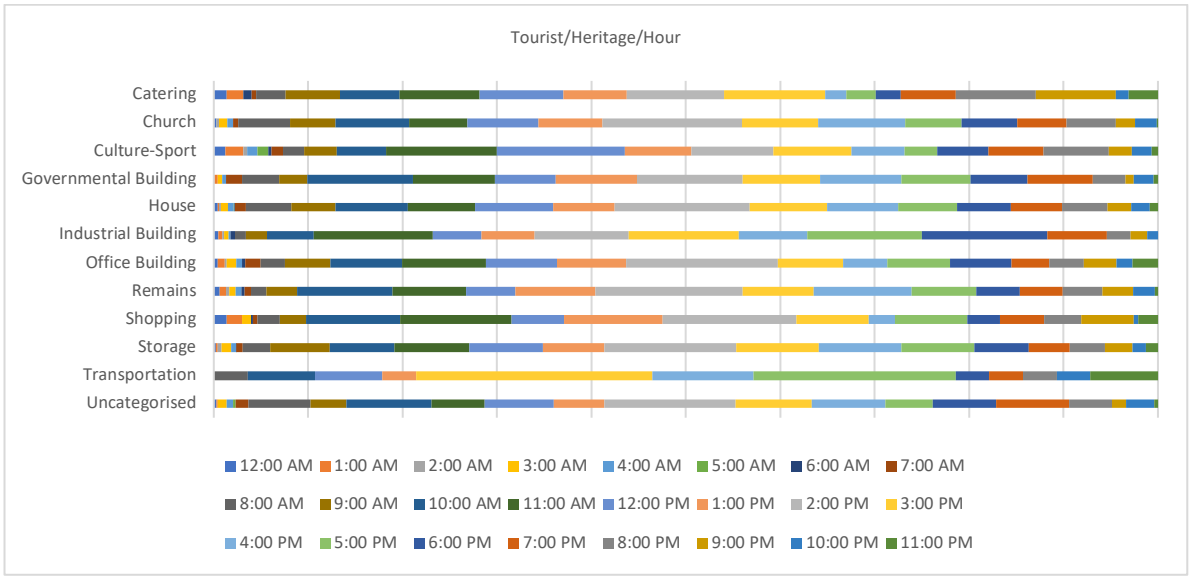
Remains are located around the Church of Saint Nicholas (T6) and the Heineken Experience (T8). Housing parts, street furniture and fort-fortress are assigned as remains. The most photos are taken at 2.00PM. Most tourists prefer to take photographs on Sunday. In monthly scale, the most tourists take photographs in October, 19%. In the graph of Pearson residuals, there is not any significant association of taken photos around remains and hourly time stamps, all variables are distributed almost equally. In daily analysis, the taken photographs of remains tie with Monday. In also monthly analysis, the taken photographs around remains are not associated with any month. There is positive association of taken photos around remains and the year of 2019.

Shopping is another photographed heritage location among the tourists. Centraal station (T1) and Dam square (T7) are two famous shopping point in Amsterdam. They are mostly photographed at 2.00PM. On a daily basis, most photographs are taken on Monday with 20%. In monthly scale, tourists take photographs in January, 20%. In the graph of Pearson residuals, there is positive associations of taken photos around shopping buildings and 1.00AM. In daily analysis, the taken photographs around shopping buildings strongly correlated to Monday. There is positive association of taken photos around shopping buildings and January, and they are correlated to the year of 2019.

Storages/Warehouses (Pakhuis) are situated around the Church of Saint Nicholas (T6) and the Heineken Experience (T8). Storage photographs show rise in points at 2.00PM. Most tourists prefer to take photographs on Saturday, with 21%. On a monthly basis, July is the month that present a large number of photographs around storages. In the graph of Pearson residuals, there is not any significant association of taken photos around storages and hourly time stamps, all variables are distributed almost equally. In daily analysis, the taken photographs around storages tie with Saturday. There is positive association of taken photos around storages and July, and they are correlated to the year of 2017.

Transportation building is only located in the Centraal station (T1). They are mostly photographed between 3.00PM and 5.00PM. Most tourists prefer to take photographs on Monday, 25%. On a monthly basis, tourists take photographs in July. In the graph of Pearson residuals, there is positive associations of taken photos around transportation buildings and 5.00PM. In daily analysis, the taken photographs around transportation buildings correlated to Monday. There is not any significant association of taken photos around transportation buildings and monthly time stamps, all variables are distributed almost equally. The photographs around transportation buildings are correlated to the year of 2009.

Uncategorised is only appeared around the Het Schip (T9) and they are located outside the urban core and serve as exhibition center and museum. They are mostly photographed at 2.00PM. Most tourists prefer to take photographs on Tuesday. In monthly scale, tourists take photographs in May, 33%. In the graph of Pearson residuals, there is not any significant association of taken photos around uncategorized buildings and hourly time stamps, all variables are distributed almost equally. In daily analysis, the taken photographs around uncategorized buildings tie with Tuesday. There is positive association of taken photos around uncategorized buildings and May, and they are strongly correlated to the year of 2008 and 2013.



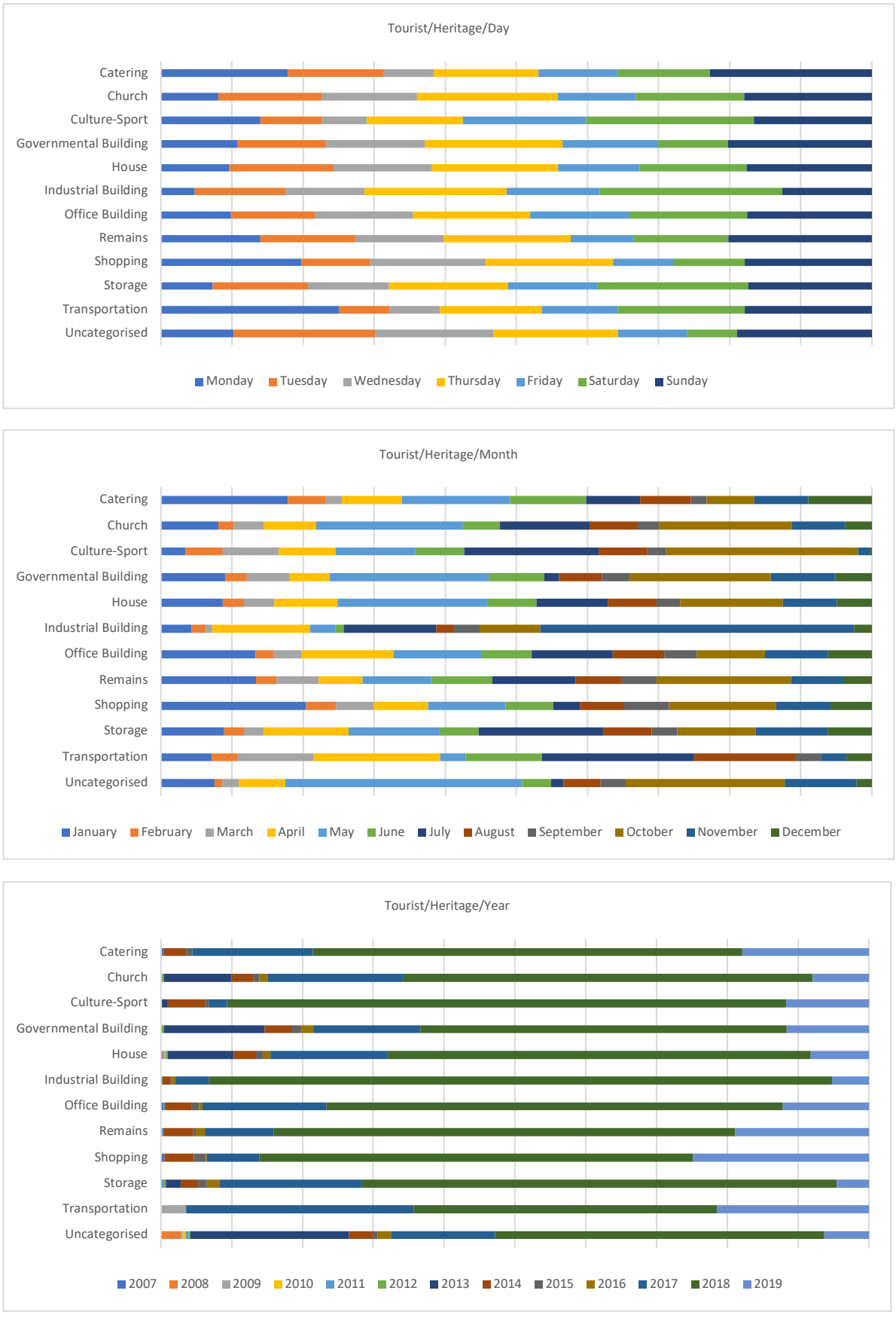


Figure 4. 10 Detailed analysis of Temporal Distribution of tourist photographs per heritage types

Hourly distribution shows that tourists have tendency to take heritage photographs around 2.00PM except for industrial building and transportation building. The reason could be that Heineken experience is classified under the industrial heritage types and it serve as a museum, and it opens at 10.30AM. For this reason, tourist mostly take photographs at 11.00AM. Daily grouping is depicted that tourist photographs are taken last four days of the week. Only heritage type that is photographed mostly on Mondays is shopping, the reason could be related to function. Other heritage types such as museum and exhibition serve scheduled activities. However, tourists do not need any schedule for shopping. Monthly distribution shows irregular pattern. For example, tourists take photographs around shopping facilities which are located in the Centraal Station and Dam Square in January. Churches and governmental buildings are photographed in May. The reason is not related to function, because Dam Square is open area and expectation is that Dam Square is photographed in summer months, and churches are indoor places and expectation is that they are photographed in fall or winter. In yearly distribution, 2018 is the most photographed years from tourists.

4.4.2. ANALYSIS OF HERITAGE TYPES OF LOCALS

Detailed local and heritage analysis provide answer for the local residents' temporal-spatial distribution within Amsterdam historical urban core. Temporal distribution of local and heritage table shows that most photographed as well as most attractive locations with their time stamp such as hour, day, month and year. Results are presented below by overview of temporal distribution of local photographs per heritage types (table 4.6) and by graph detailed analysis of temporal distribution of local photographs per heritage types (figure 4.11).

Table 4. 6 Overview of Temporal Distribution of Local Photographs per Heritage Types

ID	Heritage type	Peak time			
		Hour	Day	Month	Year
L4, L10	Catering	8.00AM	Saturday	April	2018
L8	Church	3.00PM	Sunday	September	2013
L6, L12	Culture-sport	5.00PM	Saturday	June	2016
L7	Education	1.00PM	Wednesday	October	2018
L12	Garden and Zoo	2.00PM	Sunday	October	2015
L11, L12	Governmental building	2.00PM	Saturday	April	2015
L1, L10	Houses	3.00PM	Wednesday	March	2019
L2, L11	Industrial building	2.00PM	Saturday	March	2015
L8, L11	Office building	2.00PM	Saturday	April	2018
L4	Remains	2.00PM	Sunday	April	2015
L10, L12	Storages	3.00PM	Tuesday	March	2019
L3, L8	Transportation	7.00PM	Saturday	April	2016

As it can be seen in table 4.6, 12 types of heritages are photographed by locals. The most photographed heritage types are catering, church, culture- sport, education, garden and zoo, governmental building, house, industrial building, office building, remains, storages and transportation. Houses, culture-sport and industrial buildings are the most attractive heritage types among the locals (figure 4.8). In hourly distribution, photographs are taken afternoon around the all heritages, except for catering. It is photographed at 8.00AM. Weekends are the most photographed days. Monthly distribution varies and it depends on the heritage type. For instance, education building and garden-zoo are photographed on October; church is photographed in September. Yearly distribution is not followed any pattern and photographs are taken from 2013 to 2019. The test results of chi-square show that relations between each time stamps of local photographs and heritage types are statistically significant different. For each variable, p-value < 2.2e-16 is calculated. Therefore, it is less than significance level (0.05) and it is proven that there is a relationship between time stamp (hour, day, month, year) of the locals' photographs and heritage types. Also, the graph of Pearson residuals illustrates relation between time stamps of heritage photographs taken by local and heritage types (see appendix 6). Detailed heritage descriptions are below, because the temporal distribution of local within historical urban core is one of the purposes of the study.

Catering building are one of the common heritage types among the locals and tourists and they contain restaurants and cafes. They are located around the Vondelpark (L4) and Melkweg (L10). The photos are taken mostly during the morning around 8.00AM with 52%. Saturday is the busiest day and it is followed by Friday. In monthly scale, locals take photographs in April, 15%. The most photographs are taken in 2018. In the graph of Pearson residuals, there is strong positive associations of taken photos around catering building and 8.00AM. In daily and monthly analysis, there is not any significant association of taken photos around catering buildings and daily-hourly time stamps, all variables are distributed almost equally. The photographs around catering buildings are slightly correlated to the year of 2008.

Church buildings are another photographed heritage between locals and tourists. It is located around the Centraal Station (L8). Church photographs show rise in points between 3.00PM and 4.00PM. On a daily basis, most photos are taken on Sunday with 41%, and it is followed by Saturday around 33%. In monthly scale, locals take photographs in September, 34%. The most photographs are taken in 2013. In the graph of Pearson residuals, there is not any significant association of taken photos around church buildings and hourly time stamps, all variables are distributed almost equally. In daily analysis, the taken photographs around churches slightly correlated to Sunday. There is positive association of taken photos around church buildings and September, and they are slightly correlated to the year of 2013.

Culture-sport buildings contain museum and recreational places which are situated around Het Stenen Hoofd (L6) and Zoo Artis (L12). 5.00PM is the peak times for local to take photos of culture-sport buildings. As it is expected, most photos are taken on Saturdays and Sundays. On a monthly basis, most photographs are taken in June with 14%. The most photographs are taken in 2016. In the graph of Pearson residuals, there is positive associations of taken photos around culture-sports building and 11.00AM-5.00PM. In daily analysis, the taken photographs around culture-sport buildings strongly tie with Sunday. There is positive association of taken photos around culture-sport buildings and June-August, and they are correlated to the year of 2018.

Education buildings are only photographed by locals and they are situated around the Westindische Buurt (L7). They are mostly photographed between 1.00PM and 11.00AM. On a daily basis, most photographs are taken on Wednesday with 32%. In monthly scale, locals take photographs in October, 42%. The most photographs are taken in 2018. In the graph of Pearson residuals, there is not any significant association of taken photos around education buildings and hourly time stamps, all variables are distributed almost equally. In daily analysis, the taken photographs around education buildings correlated to Tuesday. There is positive association of taken photos around education buildings and October, and they are slightly correlated to the year of 2016.

Garden and zoo are popular heritage points by the local and they are located in Zoo Artis (L12). Garden and zoo photographs show rise in points at 2.00PM. On a daily basis, most photos are taken on Sunday. In monthly scale, locals take photographs in October. The most photographs are taken in 2015. In the graph of Pearson residuals, there is positive associations of taken photos around garden and zoo and 2.00PM. In daily analysis, the taken photographs around garden and zoo correlated to Tuesday. There is positive association of taken photos around garden and zoo and October, and they are slightly correlated to the years of between 1927 and 2007.

Governmental buildings consist of court, military buildings, administration buildings and social care. They are located around Zuiveringshal (L11) and Zoo Artis (L12). Governmental buildings are mostly photographed at 2.00PM. Most locals prefer to take photographs on Saturday. On a monthly scale, April is the month that present a large number of photographs for governmental buildings. The most photographs are taken in 2015. In the graph of Pearson residuals, there is positive associations of taken photos around governmental buildings and 2.00PM. In daily analysis, the taken photographs around governmental buildings correlated to Saturday. There is positive association of taken photos around governmental buildings and April, and they are slightly correlated to the years of 2015.

Houses are attractive photograph points by locals as well as tourist. They are located around Museumplein (L1) and Melkweg (L10). They are mostly photographed at 3.00PM. Most photos are taken on Wednesday, roughly 28%. In monthly scale, locals take photographs in March. The most photographs are taken in 2019. In the graph of Pearson residuals, there is strong positive associations of taken photos around houses and 3.00PM. In daily analysis, the taken photographs around houses strongly tie with Wednesday. There is positive association of taken photos around houses and March, and they are highly correlated to the year of 2019.

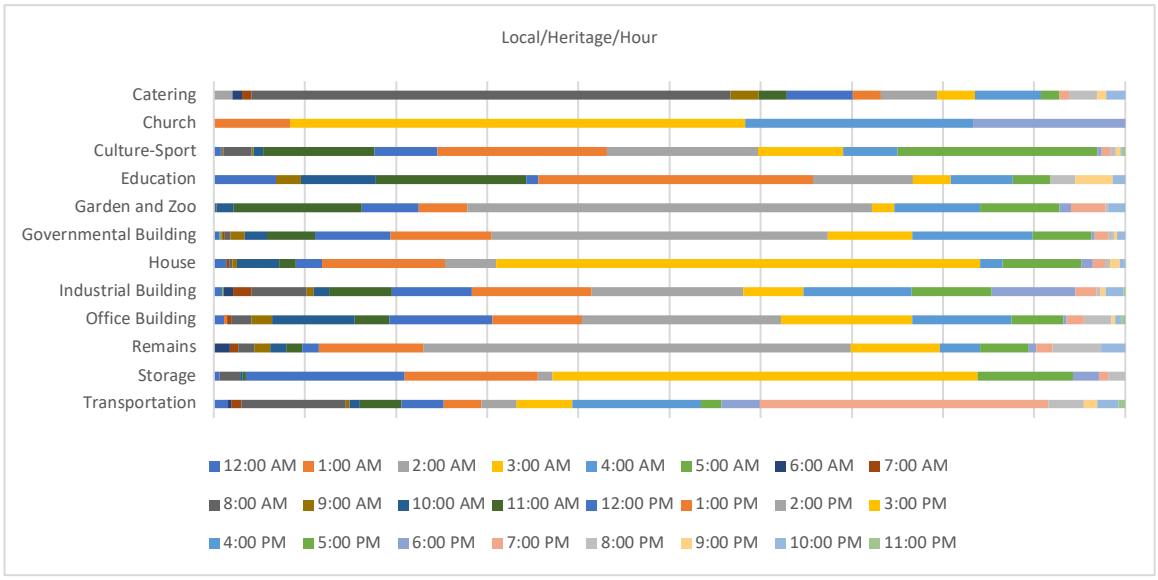
Industrial buildings are one of the common heritage points among the local and tourist. They are located around the NDSM Werf (L2) and Zuiveringshal (L11). They are mostly photographed between 2.00PM and 1.00PM by local. Most locals prefer to take photographs on Saturday. On a monthly basis, most photographs are taken in March with 22%. Locals took the photographs of industrial buildings in 2015. In the graph of Pearson residuals, there is positive associations of taken photos around industrial buildings and 6.00PM. In daily analysis, the taken photographs around industrial buildings tie with Thursday and Saturday. There is strong positive association of taken photos around industrial buildings and April, and they are correlated to the year of 2015.

Office buildings are situated around the Centaal Station (L8) and Zuiveringshal (L11). They include meeting points, trade offices and home-based offices. Offices are mostly photographed from 2.00PM to 3.00PM. On a daily basis, most photos are taken on Saturday. In monthly scale, locals take photographs in April. Locals took the photographs around office buildings in 2018. In the graph of Pearson residuals, there is a slight positive association of taken photos around office buildings and 10.00AM. In daily analysis, the taken photographs around office buildings tie with Monday and Saturday. There is positive association of taken photos around office buildings and October, and they are correlated to the years of between 1927 and 2007.

Remains are located around the Vondelpark (L4). Housing parts, street furniture and fort-fortress are assigned as remains. The most photos are taken at 1.00PM. Most locals prefer to take photographs on Sunday. In monthly scale, the most locals take photographs in August, nearly 37%. Locals took the photographs around remains in 2015. In the graph of Pearson residuals, there is a slight positive association of taken photos around remains and 2.00PM. In daily analysis, the taken photographs around remains tie with Sunday. There is positive association of taken photos around remains and August, and they are correlated to the year of 2015.

Storages/Warehouses (Pakhuis) are situated around Melkweg (L10) and Zoo Artis (L12). Storage photographs show rise in points at 3.00PM. Most locals prefer to take photographs on Tuesday, with 29%. On a monthly basis, March is the month that present a large number of photographs around storages. Locals took the photographs around storages mostly in 2019. In the graph of Pearson residuals, there is a slight positive association of taken photos around storages and 12.00PM. In daily analysis, the taken photographs around storages strongly tie with Tuesday. There is positive association of taken photos around storages and March, and they are correlated to the year of 2019.

Transportation building are appeared around OCCII (L3) and Centraal Station (L8). They are mostly photographed by local at 7.00PM. Most locals prefer to take photographs on Saturday, 25%. On a monthly basis, locals take photographs in April. Locals took the photographs around transportation buildings in 2016. In the graph of Pearson residuals, there is a strong positive association of taken photos around transportation buildings and 7.00PM. In daily analysis, the taken photographs around transportation buildings slightly correlated to Thursday. There is positive association of taken photos around transportation buildings and November, and they are correlated to the year of 2016.


Local/Heritage/Hour
Catering
Church
Culture-Sport
Education
Garden and Zoo
Governmental Building
House
Industrial Building
Office Building
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12:00 AM
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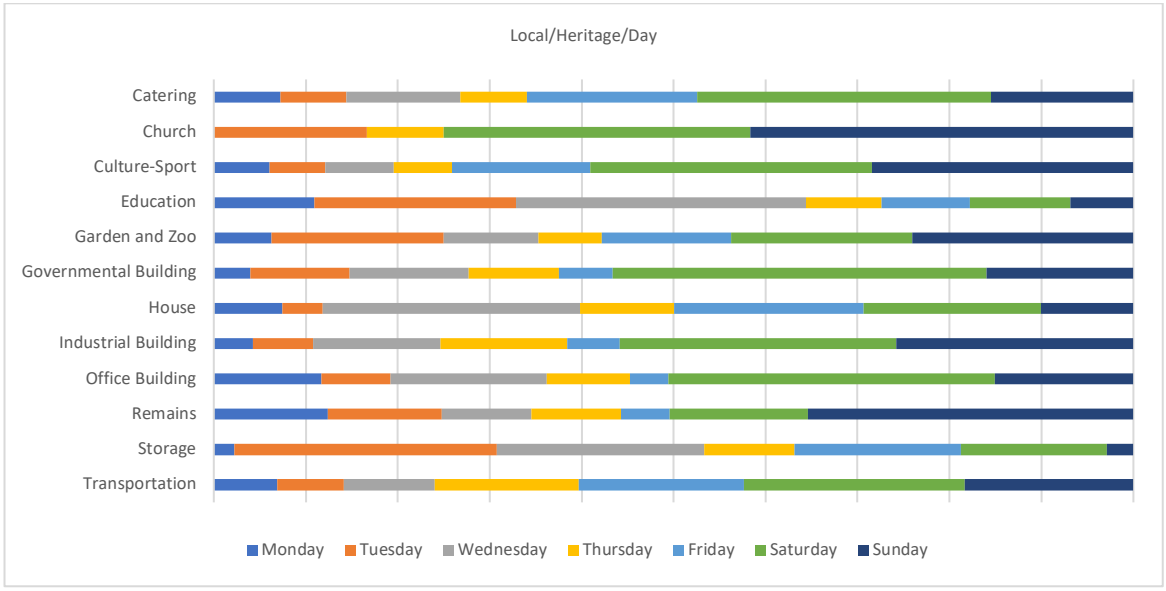
Local/Heritage/Day
Catering
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Culture-Sport
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Garden and Zoo
Governmental Building
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Industrial Building
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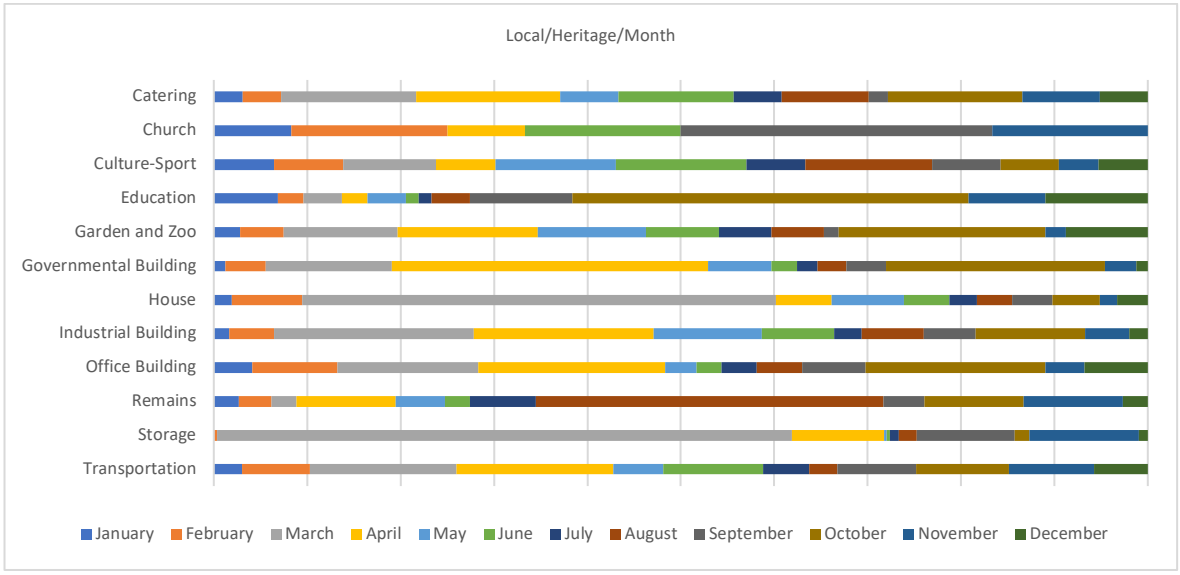
Local/Heritage/Month
Catering
Church
Culture-Sport
Education
Garden and Zoo
Governmental Building
House
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Office Building
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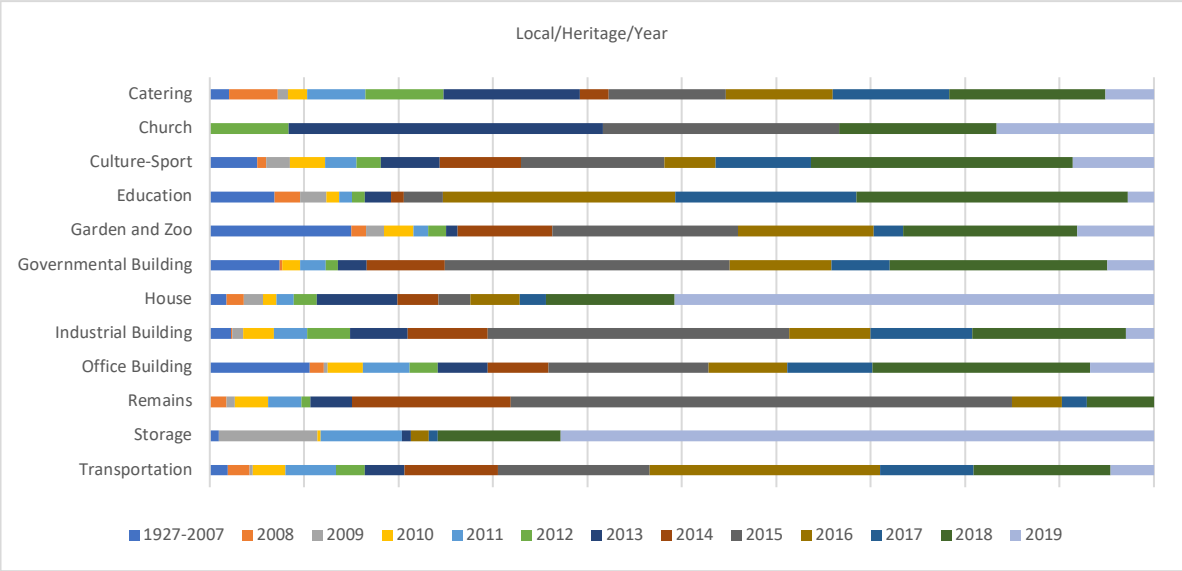

Figure 4. 11 Temporal distribution of heritages by local

Hourly distribution shows that locals have tendency to take heritage photographs afternoon until 7.00PM. Only catering locations including cafes are photographed at 8.00AM. The reason could be that locals prefer to have breakfast before the work. Daily grouping is depicted that local photographs are concentrated on weekends. However, the heritage types that are photographed mostly on Wednesdays are educational buildings and houses. The reason could be that educational buildings are open only weekdays. Monthly distribution shows that heritages are mostly photographed by local in spring and summer seasons. However, some heritage types such as church, education, garden-zoo are photographed in fall. It is expected that garden-zoo is open areas and it is preferred in spring and summer season. Yearly distribution is not followed any pattern locals take photographs continuously between 2013 and 2019.

4.5. COMPARISON OF PROMOTED TOURIST MAP AND CLUSTERS

This section provides an information about a comparison between generated the heritage map (figure 4.9) and promoted tourist map (figure 4.12) in order to understand whether the attractive/popular places are photographed due to the promotion of map provided by tourist information in Amsterdam. Also, the comparison could explain whether each map supports another or not. Since the main topic of this study is utilizing big data to understand the overcrowding in Amsterdam in relation to urban heritage tourism, it is important to understand relation between promoted tourist map and existing heritage map. Figure 4.10 consists of Amsterdam tourist map (City Sightseeing, 2019), heritage heat map from Cultural Heritage Agency and heritage intersection map (figure 4.9). In the map, blue points represent tourist, orange points are local and green points are the heritages. As it can be seen that, popular landmarks which are assigned in tourist map are also pointed out in heritage maps. However, tourists have tendency to take photographs within the urban core, since they start with their trip at Centraal Station and end with at Museumplein. They follow along the diagonal axis in the urban core. This can be explained as distance decay effect, because the farther away tourists are from Centraal Station, they less likely to move on edge of the urban core. Ioannides et al. (2018), investigate Airbnb as an instigator of tourism bubble expansion in Utrecht and they analyse where Airbnb activity clustered and influences of tourist

infrastructure. They state that, the highest concentration of AirBnb locations is found within city center and AirBnB activities are expose to distance decay outward the city center. A visual comparison of maps (figure 4.12), provides the nearly same result. Another researcher Kádár (2014) indicates that the most characteristics patterns in the urban core is the axial way and it related to urban facilities such as shopping places, squares and so on. It makes attractive places themselves; therefore, tourists use representative way instead of less attractive streets. It supports to the most photographed locations as well as heritages by tourists, because Centraal Station, Church of Saint Nicholas, De Oude Kerk and Dam Square are aligned throughout the axial way until the Museumplein.

Locals pattern are relatively balanced, they take photographs outside the mainstream area. Well-known destinations such as Museumplein, Heineken experience and Dam square are photographed by tourist; however, concert place (Melkweg) and exhibition areas (NDSM Werf and Het Stenen Hoofd) are photographed by locals. The reason could be that locals would like to be involved more in cultural activities and they tend to avoid touristic areas. As stated in chapter 1, overcrowding is one of the major issues in Amsterdam, locals might have tendency to escape from crowded places. In that sense, the places where far away from dominant touristic areas are more photographed by locals than tourists. As far as functions are concerned, tourists have limited time to discover the city; therefore, popular places such as Museumplein and Heineken Experience appeal to tourists more than exhibition and concert areas in which locals prefer to take photographs. Locals are used to live in Amsterdam and they could spend their time on temporary activities.

As seen it can be seen in the map (figure 4.12), there are more heritage buildings and sites than that are indicated in tourist map, for instance Westerkerk, however people do not prefer to take photographs at these locations. The reason could be that, the results of detailed heritage analysis (section 4.4) show the most photographed heritage sites and buildings have multipurpose usage. For example, NDSM Werf (L2) serves as a place of cultural events and it has also open spaces that are used for recreational purpose. Although it is located to the opposite side of the shore, it is photographed by locals.

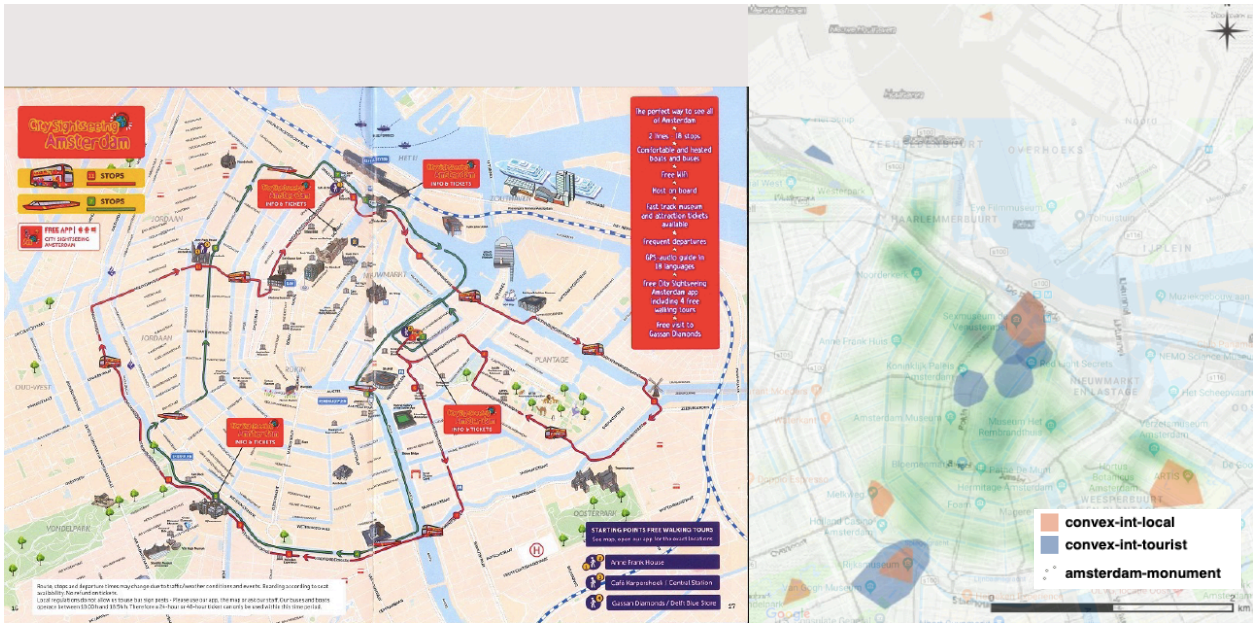

Figure 4. 12 Tourist map (City Sightseeing, 2019) and heritage heat map

In the heritage map dark green areas are the clustered heritage points. It can be observed that, some of the unphotographed heritages are located on the edge of historical core. Reasons are explored in section 4.6.

4.6. Relationship between Urban heritage areas and urban facilities

This section provides an answer about the how urban facilities and accessibility impact the popularity of urban heritage areas within Amsterdam historical urban core. Figure 4.13 consists of tram-metro stops and eating-drinking points from Amsterdam City Data, heritage heat map from Cultural Heritage Agency and heritage intersection map (figure 4.9). As it can be seen that, transportation is provided mostly outside the urban core. It could be resulted in less photographed heritage buildings and sites, since they are not supported by public transportation. For instance, to the northwest of urban core, well known heritages such as, Noordkerk, Westerkerk, and Anna Frank Huis are located; however, they are not reachable by tram. Another example is that, to the southeast, famous Amsterdam mills are situated; however, it was not photographed by people. As far as eating-drinking points are concerned, they are well distributed within the urban core. It can be observed that, local and tourist clusters are intersected with eating-drinking locations. It is stated that restaurants could have influence on destination choices of people (Sparks, Bowen, Wildman, & CRC for Sustainable Tourism, 2002). In that sense, connection between eating-drinking points and heritages can explain why certain heritages are photographed.

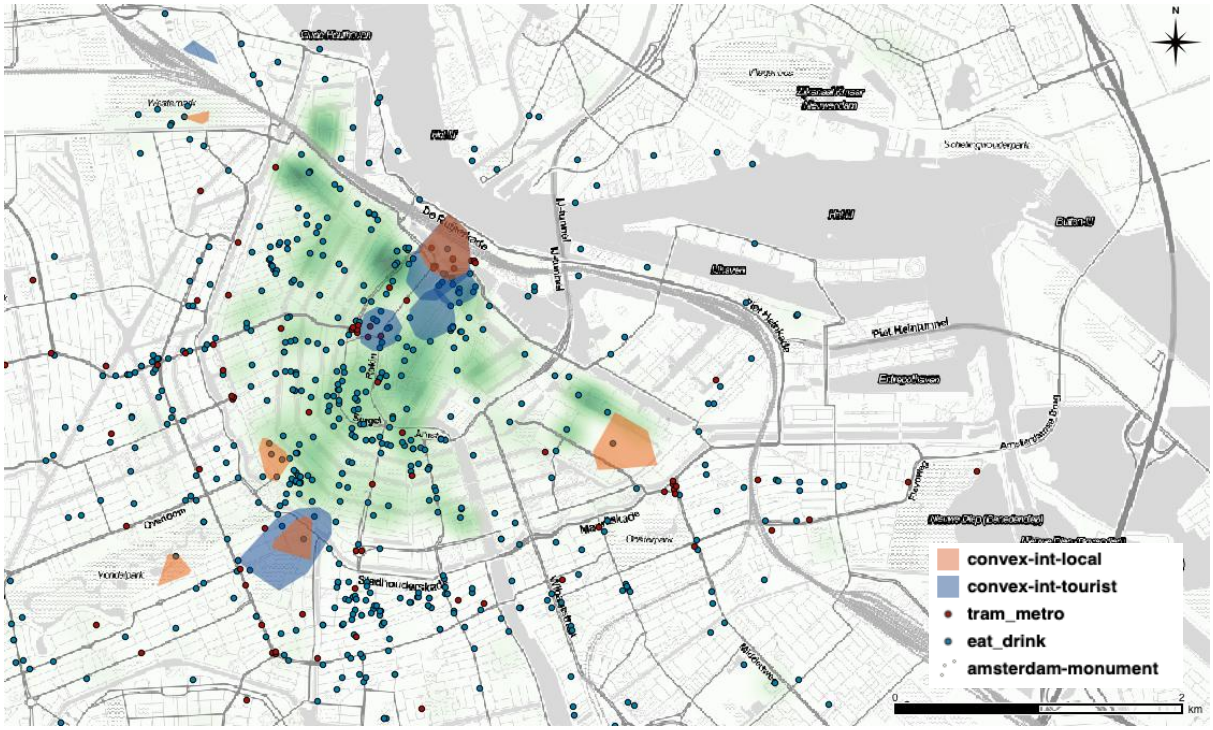

Figure 4. 13 Tram-metro stops and eating-drinking points

4.7. Conclusion

This chapter describes the results of analysis in the investigating of the relevance of newly available big data and urban heritage tourism. In order to find answers to the research questions, several datasets such as Flickr, National Monuments and Amsterdam City Data are processed. Selected method which is DBSCAN, provides clusters to understand most attractive

and popular locations in Amsterdam. In order to define most photographed heritages by local and tourist, several geoprocessing tools are used such as intersection and buffer. With the result of intersection map, most attractive heritages, their classifications and peoples' temporal distribution are found. After, by comparison promoted tourist map and heritage map unphotographed heritage locations are determined. Lastly, the impact of accessibility and urban facilities are explored by mapping. In discussion part, recommendations are proposed regarding time stamp of both tourist and local.

Big data-based study was conducted to understand overcrowding in Amsterdam in relation to urban heritage tourism. A quantitative approach was used to find answers to research questions. It can be stated that the characteristics of dataset and used methods influenced the results. By comparing tourist and local POIs regarding their temporal distribution, recommendations are explained. This section provides recommendations for tourist and local in order to distribute overcrowding through the city.

Table 4.7 tourist distribution in Amsterdam and figure 4.14 heritage types and POI are summarizing a tourist distribution in Amsterdam relation to urban heritage types. Recommendations are given hourly, daily and monthly, because the year of 2018 is dominated the data and results can lead to misinterpretation. Also, recommendations are given assuming that most photographed places are the most attractive and therefore the most visited areas by tourists and locals. As it can be seen that, middays and weekends are the most photographed times. Tourists should be distributed in a balanced way to avoid polarization in certain locations. T1 is the gate of Amsterdam and it is used by both user groups, also it has an influence on T5 and T6 regarding hourly distribution. T1 consists of transportation, office and catering (eating-drinking locations) regarding to heritage. People can be diverted to the tram and metro so that they can access facilities within the city. T2 is Museumplein that serve as popular tourist destination and distribution has followed the same pattern with Centraal station. Tourists who would like to join cultural events, can be directed to other museums during peak hours, and outdoor events can be organised in Vondelpark in order to decrease the crowd. T3 is accommodation points and it is not assigned as heritage; therefore, recommendation is not proposed. T4 is located opposite the T1 and it can be accessible by ferry. Also, it is not assigned as heritage; however, events and exhibitions can be proposed in Eye in order to minimize the pressure of crowded in historical core. T5, T6 and T7 are located in the central position in urban core and it attracts many tourists. They have the biggest number of photographs during 2.00PM. Exhibition in the T5 and T7 could be scheduled in the morning, so both T1 and these locations can be visited in different hours. T8 is photographed in the late afternoon and it can be proposed to tourist who would like to visit around T5, T6 and T7. T9 is located outside the urban core and is has been used as museum. Unlike other POIs, it is mostly photographed during weekdays on Tuesday, therefore visitations could be diverted from the T1 and polarization can be minimized.

Table 4. 7 Tourist distribution in Amsterdam

ID	POI	Heritage type	Peak time		
			Hour	Day	Month
T1	Centraal station	Transportation, office and catering	11.00AM and 3.00PM	Saturday	October
T2	Museumplein	Culture-sport	11.00AM and 3.00PM	Sunday	July and October
T3	Hotel Casa	Not assigned as heritage	8.00AM to 6.00PM	Friday	April
T4	Eye	Not assigned as heritage	12.00PM and 2.00PM	Friday	August
T5	De Oude Kerk	Church, house and remains	2.00PM	Sunday-Tuesday	May-October
T6	Church of Saint Nicholas	Church, storage and remains	2.00PM	Saturday	July
T7	Dam Square	Shopping and catering	2.00PM	Thursday	October
T8	Heineken Experience	Industrial	6.00PM	Saturday-Thursday	November
T9	Het Schip	Uncategorised	10.00AM to 2.00PM	Tuesday	November

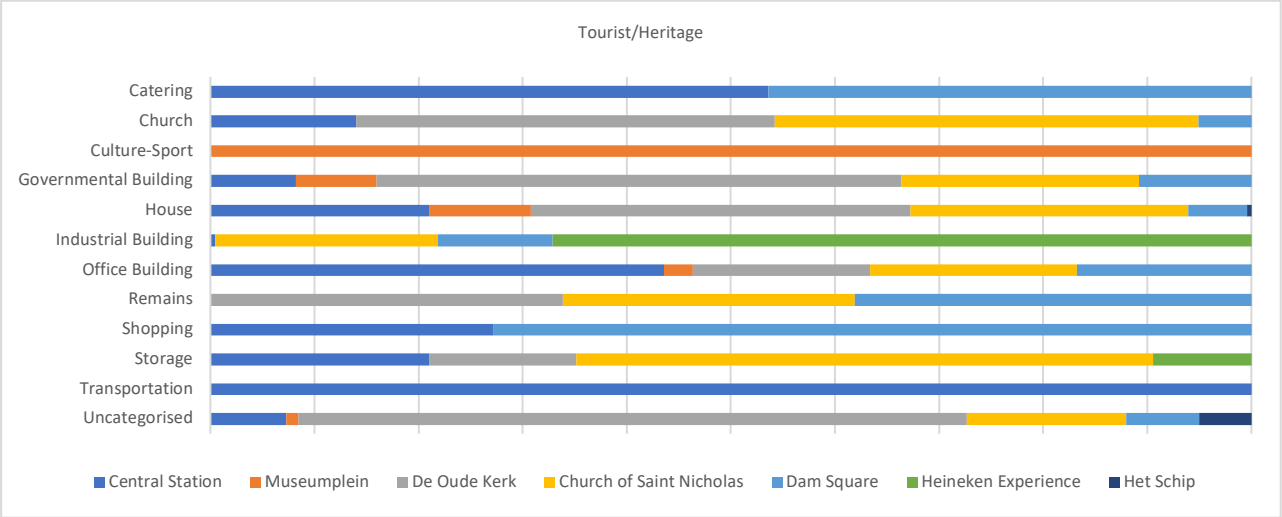

Figure 4. 14 Heritage types and POI of tourists

Table 4.8 local distribution in Amsterdam and figure 4.15 heritage types and POI of locals are summarizing local's distribution in the city of Amsterdam relation to urban heritage types. Recommendations are given assuming that most photographed places are the most attractive and therefore the most visited areas by tourists and locals. The photographs of local's are well distributed around the city compare to tourists. L1 is the common points between tourists and locals. In order to avoid crowded, events and exhibitions could be scheduled late afternoon, because 2.00PM is the peak hour regarding to local visitors and weekdays activities could be proposed within L1. L2 is located outside the urban core and it is used for exhibitions and performance arts. L2 is one of the industrial heritage locations and it is preserved very well. It is photographed mostly in summer months, since it is near the sea, so indoor and outdoor activities can be scheduled and they can attract local's attention. L3 is located at the edge of Vondelpark (L4). Activities and events can be shared between L3 and L4, because

locals are photographed both locations on weekends. L5 is a museum and event location and it is not assigned as heritage; therefore, recommendation is not proposed. L7 is a province in the North Holland and education building is assigned as heritage under the L7. Recommendation is not proposed because it has single usage. L8 is the gate of Amsterdam and consists of transportation, office and catering (eating-drinking locations) regarding the heritage types. Locals and tourists can be diverted to the tram and metro so that they can access facilities within the city. L9 is a province in the North Holland and it is not assigned as heritage; therefore, recommendation is not proposed. L10 is a former depot house and it is assigned as storage regarding to heritage. It is used as concert hall and locals are photographed mostly weekdays; therefore, weekend activities could be scheduled. L11 is also served as performance hall unlike L10, it is photographed mostly weekends. L12 is another outdoor event locations and new recommendation is not proposed, because it is the only one Zoo in urban core.

Table 4. 8 Local distribution in Amsterdam

ID	POI	Heritage type	Peak time		
			Hour	Day	Month
L1	Museumplein	Culture-sport and house	11.00AM and 2.00PM	Saturday	May and June
L2	NDSM Werf	Industrial	1.00PM to 4.00PM	Saturday-Sunday	June
L3	OCCII	Transportation	3.00PM and 4.00PM	Saturday-Thursday	March
L4	Vondelpark	Catering and culture-sport	4.00PM and 5.00PM	Sunday	August
L5	Eye	Not assigned as heritage	11.00AM	Thursday	March
L6	Het Stenen Hoofd	Storage	10.00AM to 11.00AM	Friday	October
L7	Westindische Buurt	Education	11.00AM to 2.00PM	Wednesday	October
L8	Centraal Station	Transportation and office	3.00PM	Saturday	April
L9	Sloterdijk	Not assigned as heritage	2.00PM and 4.00PM	Sunday	April
L10	Melkweg	Storage and house	10.00AM to 2.00PM	Wednesday	March
L11	Zuiveringshal	Industrial and governmental	2.00PM and 3.00PM	Saturday	March
L12	Zoo Artis	Garden and zoo, culture-sport	12.00PM and 4.00PM	Sunday	March

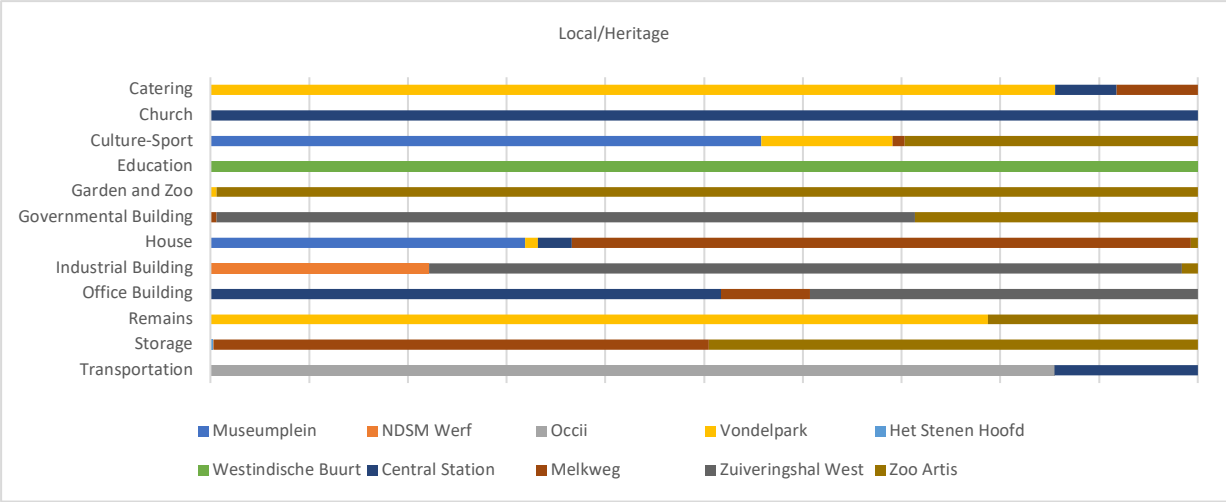

Figure 4. 15 Heritage types and POI of locals

As far as heritage types are concerned, some of them are photographed on the nature of most visited by both tourists and locals. Distribution recommendations are given to minimize overcrowd in certain areas. Although there are other factors such as weather conditions, special events (Kings Day, Sail Amsterdam, Canal Parade) and traffic conditions etc. have influence on reason of visitation, these recommendations could be the answer to solve overcrowding pressure in the urban core.

5. CONCLUSION

5.1. CONCLUSION

The main purpose of this research is to investigate how newly available big data can be utilized to understand the overcrowding in Amsterdam in relation to urban heritage tourism. First, problem definition and objectives are stated and research questions are determined regarding these problems (chapter 1). Second, the state of the art is examined to understand how big data can be used for urban studies. The first part of the literature review (chapter 2.1) focuses on the relation of newly available big data and urban studies. In the second part, the relation between newly available big data and urban heritage tourism is discussed (chapter 2.2) by explaining the different data types. Also, heritage and urban tourism problems regarding overcrowding are discussed. In the last part of literature review chapter, existing studies are explained in the last part (chapter 2.3). Within the literature review also different data types and their process are summarized with a general review of the current literature studies.

The methodology part describes the process of data in order to find the answers of research questions that are explained in the chapter 1. First, the method of data collection from different sources namely Flickr, Amsterdam City Data and National Monuments (Rijksmonumenten) are explained (chapter 3.1). Then, the approach for the division of local residents and tourist is explained. Second, the data process (chapter 3.2) is defined by explaining the variety of clustering methods and the reasoning for selecting DBSCAN method. For the analysis, R software packages are used for the processing of DBSCAN algorithm, and chi-square analysis is used to test the independence of a significant relation between variables, and QGIS is used to visualize the maps for attractive locations and comparisons with facilities such as transportation and eating/drinking datasets. Lastly, results chapter provides the results of data analysis which are structured in chapter 3. In results chapter (chapter 4), data analysis starts with the process of Flickr data (chapter 4.1) and it continues with detailed cluster (POI) analysis (chapter 4.3). The results of relation with POI and heritage types are explained in chapter 4.4. In the comparison part, tourist map that is promoted by the tourist information of Amsterdam and heritage intersection map that is generated by this research are compared to understand whether the attractive/popular places are photographed due to the promotion of map provided by tourist information in Amsterdam. (chapter 4.5). Lastly, urban facilities and their impacts of the urban heritage tourism are described in chapter 4.6.

The answers of research questions are presented below:

- Main research question: *"How can big data be utilized to understand the overcrowding in Amsterdam in relation to urban heritage tourism?"*

  It is well known that Information and Communication Technology (ICT) and the Internet of Things (IoT) face rapid growth in recent years. Big data provides a wide range of information regarding urban studies, and it allows to observe the changes in real-time at fine spatio-temporal scales. Datasets can be collected from different sources. In this research, user generated contents (UGC) from Flickr which consists of volunteered geographic information is used. Before processing, Flickr dataset is divided as local and tourist to understand temporal differences between them. Geotagged photographs are processed using density-based algorithm to find the overcrowded areas in Amsterdam.

This algorithm provides cluster in order to analyze dense points; therefore, the most concentrated areas (POIs) are assumed as the most crowded places. The results of POIs are used to find the most attractive urban heritages in Amsterdam. In order to find the relation between heritages and the spatio-temporal patterns of Flickr users for local and tourist, the results of POIs are processed with National Monuments data. Each heritage object has its own attributes including, coordinates, function, CBS category (building, church, monument, object), postcode, street name, municipality and so on. Heritage types are assigned as certain groups regarding their functions to perform meaningful analysis. The heritages which place fall under the buffer of POIs are assumed as the most attractive/popular ones, because they are photographed by both tourists and locals. The most photographed heritages are analyzed to understand spatio-temporal distribution of both locals and tourists. The results from POI analysis and heritage analysis are tested by chi-square distribution. Chi-square goodness of fit values are calculated both manually and in R to test the independence of a significant relation between variables. Moreover, Amsterdam city datasets including eating-drinking points and tram-metro stops are processed to investigate the influences of urban facilities and accessibility of heritages. The result from detailed heritage analysis is presented as a map; therefore, the influences of accessibility and urban facilities are analysed visually. Sub questions are analyzed to find detailed temporal differences of each POIs and heritages by both local and tourist photographs.

Sub questions:

- What are the newly available datasets and how are they used for urban and heritage studies?

  Based on the literature, newly available datasets can be collected by different sources such as social media, GPS and loyalty cards for urban studies. In this research, user generated content from social media is selected to understand the relevance of big data and urban heritage studies. Based on the literature, Flickr is found to be the most suitable data source for this study. Because, when people are in popular and attractive places, they tend to make photographs and upload on social media to show others. Flickr users can arrange their photos in album using title feature and photos can be kept in full resolution, for this reason Flickr dataset is mostly used in urban research. In the literature review, Flickr is found the most trustable photo sharing website regarding time and location. Therefore, it is possible to separate the Flickr dataset for different user groups such as local residents and tourists and look into details of spatial and temporal differences per groups. Finally, it is possible to combine this dataset with city and heritage data.

- “What are the most attractive/popular areas within Amsterdam historical urban core?”

  The analysis results in 9 locations for tourist photographs and 12 locations for local photographs. The majority of tourist photographs are taken around the Museumplein, Centraal Station, Eye, De Oude Kerk, Church of Saint Nicholas, Dam Square, Heineken Experience and Hotel Casa respectively. It can be seen that the most popular places that are Museumplein and Centraal station have influences on tourists’ destination choice. Also, churches and museums are other attractive areas for tourists. Locals’

photographs are clustered around the Zoo Artis, Centraal Station, Sloterdijk, NDSM Werf, Vondelpark, Westindische Buurt, Museumplein, Het Stenen Hoofd, Zuiveringshal West, Eye, OCCII and Melkweg respectively. The locals mostly photographed outdoor areas, parks and the place of cultural events. Common popular areas are Museumplein, Centraal Station and Eye. In addition, some local photographs are taken in the provinces of North Holland such as Sloterdijk and Westindische Buurt that do not contain any specific attractions.

- "What are the differences between local residents and tourists in terms of their spatio-temporal distribution within Amsterdam historical urban core?"

  Spatial distributions are analysed for each time stamps namely, hourly, daily, monthly and yearly for both local residents' and tourists' photographs. Daily analysis of photographs shows that the majority of tourist photographs are taken around the Centraal Station, Eye, De Oude Kerk, Church of Saint Nicholas and Dam Square at 2.00PM, whereas local photographs are not taken any specific place and period. These are followed by distributed patterns during the day. Looking at the daily distributions per POI, the most photographs are taken at weekends around the Centraal Station, Museumplein, De Oude Kerk and Heineken Experience by tourist, while locals took photographs at weekends too. During the weekends, local photographs are taken around the Museumplein, NDSM Werf, OCCII, Vondelpark, Centraal Station, Sloterdijk, Zuiveringshal and Zoo Artis. Both tourists and locals prefer to take photographs around Centraal Station and Museumplein at the weekends. Monthly analysis show that the outdoor places are photographed mostly in the months of summer. For instance, Museumplein and Eye are mostly photographed on July and August by tourists; NDSM Werf and Vondelpark are photographed on June and August by locals. Not surprisingly, indoor places such as Heineken Experience and Het Schip are photographed mostly in the fall season by tourists. Locals take photographs in their neighbourhood such as Westindische Buurt in October. In yearly scale, tourists' photographs are distributed the last two years in 2017 and 2018, whereas locals take photographs between 2015 and 2019.

- Which heritage types contribute to the attractiveness and popularity of certain areas within Amsterdam historical urban core? and What are the spatio-temporal differences between heritage types for local residents and tourists?

  Detailed heritage analysis is conducted processing POIs; therefore, heritage types under the POIs represent the most photographed/attractive national monuments. Application of intersection, results in 12 heritage groups for tourist and local photographs. Considering the heritage types, for tourists, the majority of photographs are taken around the houses, culture-sport buildings, storages/warehouses, office buildings, churches, uncategorized buildings/areas, shopping buildings, remains, industrial buildings, catering buildings, governmental buildings and transportation buildings respectively. For locals, the majority of photographs are taken around houses, culture-sport buildings, industrial buildings, garden-zoo, governmental buildings, storages/warehouses, transportation buildings, office buildings, remains, education buildings, catering buildings and churches respectively. The differences between locals and tourists are that shopping buildings and uncategorized buildings are photographed

by tourists, and education buildings and garden-zoo are photographed by locals. The most photographed heritage type is houses for both locals and tourists.

Hourly analysis of photographs show that for tourists the majority of photographs are taken around the churches, catering buildings, houses, office buildings, remains, shopping buildings, storage/warehouses and uncategorized buildings at 2.00PM, whereas for locals the majority of photographs are taken around the garden-zoo, governmental buildings, industrial buildings, office buildings and remains at 2.00PM. The rest of the heritage types such as industrial buildings, and governmental buildings are photographed in the morning hours by tourists; culture-sport buildings and transportation buildings are photographed in the late afternoon by locals.

Looking at the daily distributions per heritage type, the most photographs are taken at weekends around the catering buildings, culture-sport buildings, governmental buildings, industrial buildings, remains and storages/warehouses by tourist. The tourists' photographs of churches, houses and office buildings are taken in Thursday, shopping buildings and transportation buildings are taken on Mondays. Locals take heritage photographs mostly at weekends too. During the weekends, local photographs are taken around the culture-sport buildings, garden-zoo, governmental buildings, industrial buildings, office buildings, remains and transportation buildings. Both tourists and locals prefer to take heritage photographs mostly at weekend days.

Monthly distribution varies and it depends on the heritage type. For instance, churches, governmental buildings, uncategorized buildings and houses are mostly photographed in May; storages/warehouses and transportation buildings are photographed in July by tourists. Almost half of the heritage types such as education buildings, governmental buildings, office buildings, remains and transportation buildings are photographed in April by locals. In yearly scale, almost all heritage photographs are taken in 2018 by tourists, whereas locals took photographs between 2013 and 2019. 2018 was declared European Year of Cultural Heritage and it was celebrated all EU member states; therefore, this year of celebration may have influenced tourists' choice of destination.

- How do urban facilities and accessibility impact the popularity of urban heritage areas within Amsterdam historical urban core?

  It is analysed by processing heritage map that represents most photographed heritages and Amsterdam city data including eating-drinking points and tram-metro stops. Observation is done only visually; therefore, results consist of several assumptions. The most photographed locations have appeared as long as accessible by public transportation. Amsterdam, especially urban core home to invaluable and unique heritages. They should be evaluated and connected to the tram lines. The most photographed locations are found around the eating-drinking facilities. Tourists can be assumed as visitors and they would like to taste local food, therefore; positions of eating-drinking points may have influence on tourists' choice of destination.

5.2. Scientific Relevance

The main objective of this research is to investigate how newly available big data can be utilized to understand the overcrowding in Amsterdam in relation to urban heritage tourism. In order to achieve the aim spatio-temporal analyses on geotagged photographs and detailed heritage analyses for both local residents and tourists are presented to investigate their relations within the Amsterdam urban core. In the literature review different sources of datasets and their process are explained. Based on the literature review Flickr is the most used dataset among the researchers and it is widely used to analyse urban studies. The methodology applied in this thesis for the analysis of data downloaded from Flickr contribute to understanding relation between people and heritage in historical urban core. Spatio-temporal analysis show that the different heritage types are photographed in different time. The thesis shows that UGC data is useful to find the popular and attractive locations as the found clusters (POIs) match with the promoted touristic sites of Amsterdam municipality. It is found that the most popular locations such as Museumplein and Centraal Station are the most photographed places, therefore assumed to be the crowded areas in urban core. With this dataset, it could be understood when (hour, day, month, year) these locations are more popular. The results have important implication to understand heavily touristic areas, and they can be used to reduce overcrowd in certain locations. It is found that Flickr is powerful data sources to investigate relation between time and location, because it provides time stamp and coordinates (i.e. photo taken time and latitude-longitude) of each user. In addition, combination of geotagged photographs and different datasets such as National Monument Data and Amsterdam City Data reveals various information. In that sense, the answer of research questions (chapter 5.1) shows that user generated content contributes to urban heritage studies for better understanding.

5.3. Societal Relevance

This thesis provides better understanding about spatial and temporal characteristics of local residents and tourists in urban core, therefore urban heritage areas. Heritage areas is an important notion in cities and these areas generally suffers from popularity (being promoted by cities) in terms of their physical nature and social integrity or from unpopularity as they become neglected. In that sense, municipality could promote the heritage locations (i.e. garden/zoo, educational buildings that locals tend to take photos therefore find attractive) that might be attractive for tourists but not yet discovered by them, in order to distribute them evenly in the city. The recommendations can be proposed considering hourly, daily and monthly distribution. Also, most municipalities can access detailed information such as statistics of hotels, the number of visitors in museum or the number of train ticket in specific station and so on. However, when these information is merged with detailed information about spatio-temporal characteristics, that can provide better understanding about the usage of space in time.

5.4. Recommendation and limitation

This study has been proven that online photo datasets for the investigation of urban heritage tourism studies is possible. Flickr holds the perfect potential for better understanding related to urban heritage areas. On the other hand, the chosen method that is DBSCAN has some limitations. Data can be processed in various parameters and results could be changed regarding these values, these parameters might give arbitrary results. Therefore, more

advanced algorithms should be investigated and developed to limit the bias in results. Flickr is one of the oldest online photo sharing websites and people have been uploading photos continuously. In this research, geotagged photographs are analysed to find the most attractive/popular areas. Another limitation was to make an assumption of 30 days threshold which is used for division of locals' and tourists' photographs in other existing studies as well. However, different thresholds would result in different separation of user groups and therefore different results.

The advantage of Flickr dataset is that every day even every hour new data records are generated and can be downloaded. The automatically updated dataset can be used to answer the research questions dynamically. However, people do not use social media or web platform such as Flickr in order to answer the research questions. Flickr is a web-based platform and users upload their works to share with their community. Moreover, data tends to be demographically skewed (i.e. people who do not use Flickr are not represented). Therefore, this data might not provide completely accurate results about the human behaviour in time and space, thus it should be validated. Further research can involve comparing user generated content and traditional survey data in order to characterize attraction of POIs and heritage types. Moreover, validation should be done by having experts' opinions (tourism experts and urban planners from municipality of Amsterdam) on the results. Lastly, the correlation between attractive heritage types and urban facilities are done by only mapping technique; it could be developed using statistical methods such as regression analysis for further interpretation of these results.

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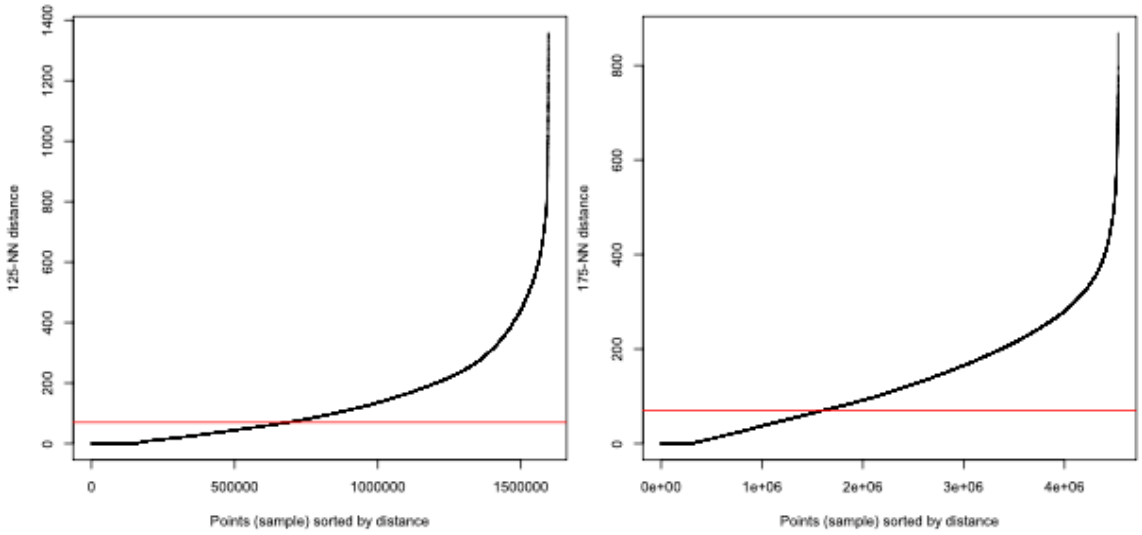
APPENDICES

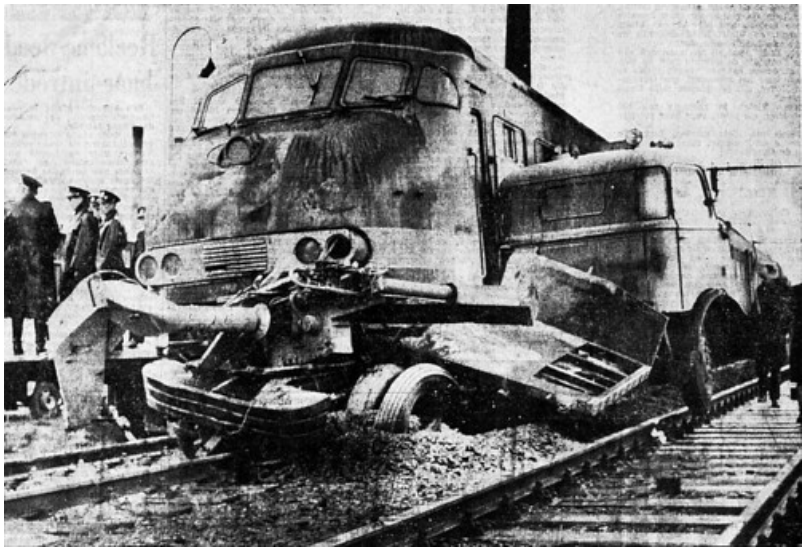
APPENDIX 1 – R CODES FOR DBSCAN

```
install.packages("dbscan")
library(dbscan)
setwd("/Users/sezikarayazi/Documents/TUe /2/Graduation/data/v2/tourist")
mydata<-read.csv("tourist.csv",header=TRUE,sep=",")
xy=as.matrix(mydata[,1:2])
kNNdist(xy, k=125, search="kd")
kNNdistplot(xy, k=125)
mydata<-data.frame(mydata)
clustering_dbscan<-dbscan(xy,eps=70,minPts=125,weights=NULL)
mydata$cluster<-clustering_dbscan$cluster
write.table(mydata,file="tourist.csv",sep=",")
```

APPENDIX 2 – KNN PLOTS FOR TOURIST AND LOCAL



APPENDIX 3 – EXAMPLE OF TOURIST PHOTO FROM 1967



APPENDIX 4 – DBSCAN TESTS

Figure a. 1 Tourist → clustering_dbscan<-dbscan(xy,eps=60,minPts=100,weights=NULL)

Local → clustering_dbscan<-dbscan(xy,eps=50,minPts=150,weights=NULL)

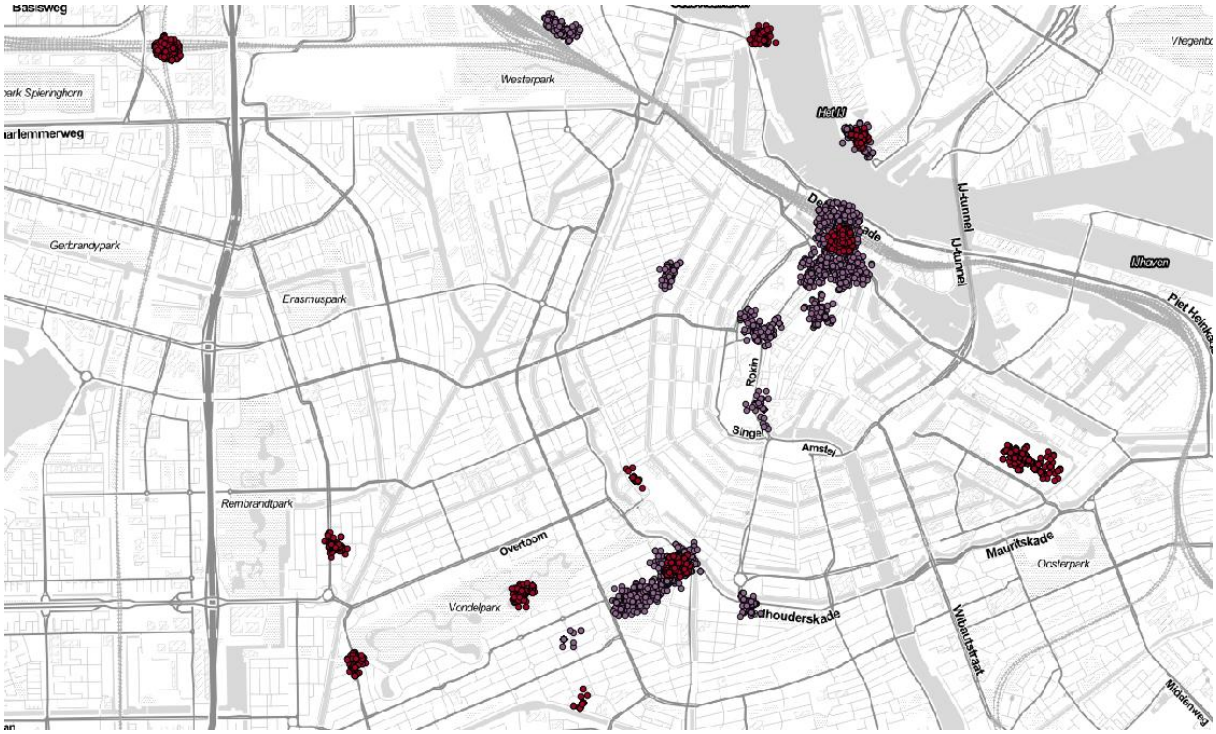


Figure a. 2 Tourist → clustering_dbscan<-dbscan(xy,eps=70,minPts=100,weights=NULL)

Local → clustering_dbscan<-dbscan(xy,eps=50,minPts=150,weights=NULL)

Figure a. 3 Tourist → clustering_dbscan<-dbscan(xy,eps=70,minPts=150,weights=NULL)

Local → clustering_dbscan<-dbscan(xy,eps=50,minPts=150,weights=NULL)

Figure a. 4 Tourist → clustering_dbscan<-dbscan(xy,eps=80,minPts=150,weights=NULL)

Local → clustering_dbscan<-dbscan(xy,eps=50,minPts=150,weights=NULL)

Figure a. 5 Tourist → clustering_dbscan<-dbscan(xy,eps=50,minPts=150,weights=NULL)

Local → clustering_dbscan<-dbscan(xy,eps=70,minPts=100,weights=NULL)

Figure a. 6 Tourist → clustering_dbscan<-dbscan(xy,eps=80,minPts=100,weights=NULL)

Local → clustering_dbscan<-dbscan(xy,eps=70,minPts=100,weights=NULL)

APPENDIX 5 –TEMPORAL DISTRIBUTION OF LOCAL AND TOURIST PHOTOGRAPHS PER POI AND PER HERITAGE

Table a. 1 Hourly temporal distribution of tourist photographs per POI

hours	Central Station	Museum plein	Hotel Casa	Eye	De Oude Kerk	Church of Saint Nicholas	Dam Square	Heineken Experience	Het Schip	Grand Total
12:00 AM	7	13	1	4			2	1	2	30
1:00 AM	2	14	4	2			2		1	25
2:00 AM	1	3				1			1	6
3:00 AM	6	1	1	1	1	2	1		1	14
4:00 AM	14	21	2		1	1				39
5:00 AM	1	12		2					3	18
6:00 AM	1	5		3			1	1		11
7:00 AM	10	19		3	2				2	36
8:00 AM	23	39	10	5	8	6	2		3	96
9:00 AM	45	55	16	2	4	12	1		3	138
10:00 AM	54	80	5	23	14	12	14	7	19	228
11:00 AM	101	172	17	17	7	9	16	24	15	378
12:00 PM	97	195	28	29	9	12	6	6	5	387
1:00 PM	103	101	11	29	8	10	16	7	20	305
2:00 PM	193	141	11	28	24	22	22	9	7	457
3:00 PM	102	120	13	25	12	13	14	21	17	337
4:00 PM	94	96	15	20	15	15	5	10	15	285
5:00 PM	54	73	10	11	6	12	17	20	1	204
6:00 PM	41	77	11	16	13	7	5	27	6	203
7:00 PM	43	87	2	11	10	5	7	11	2	178
8:00 PM	47	96	9	29	6	5	6	3	1	202
9:00 PM	32	35		21		5	7	1	3	104
10:00 PM	19	23	4	2	5	2	1	1	4	61
11:00 PM	18	9	1	3			1		1	33
Grand Total	1108	1487	171	286	145	151	146	149	132	3775

Table a. 2 Percentage table/ hourly temporal distribution of tourist photographs per POI

hours	Central Station	Museumplein	Hotel Casa	Eye	De Oude Kerk	Church of Saint Nicholas	Dam Square	Heineken Experience	Het Schip
12:00 AM	0.63	0.87	0.58	1.40	0.00	0.00	1.37	0.67	1.52
1:00 AM	0.18	0.94	2.34	0.70	0.00	0.00	1.37	0.00	0.76
2:00 AM	0.09	0.20	0.00	0.00	0.00	0.66	0.00	0.00	0.76
3:00 AM	0.54	0.07	0.58	0.35	0.69	1.32	0.68	0.00	0.76
4:00 AM	1.26	1.41	1.17	0.00	0.69	0.66	0.00	0.00	0.00
5:00 AM	0.09	0.81	0.00	0.70	0.00	0.00	0.00	0.00	2.27
6:00 AM	0.09	0.34	0.00	1.05	0.00	0.00	0.68	0.67	0.00
7:00 AM	0.90	1.28	0.00	1.05	1.38	0.00	0.00	0.00	1.52
8:00 AM	2.08	2.62	5.85	1.75	5.52	3.97	1.37	0.00	2.27
9:00 AM	4.06	3.70	9.36	0.70	2.76	7.95	0.68	0.00	2.27
10:00 AM	4.87	5.38	2.92	8.04	9.66	7.95	9.59	4.70	14.39
11:00 AM	9.12	11.57	9.94	5.94	4.83	5.96	10.96	16.11	11.36
12:00 PM	8.75	13.11	16.37	10.14	6.21	7.95	4.11	4.03	3.79
1:00 PM	9.30	6.79	6.43	10.14	5.52	6.62	10.96	4.70	15.15
2:00 PM	17.42	9.48	6.43	9.79	16.55	14.57	15.07	6.04	5.30
3:00 PM	9.21	8.07	7.60	8.74	8.28	8.61	9.59	14.09	12.88
4:00 PM	8.48	6.46	8.77	6.99	10.34	9.93	3.42	6.71	11.36
5:00 PM	4.87	4.91	5.85	3.85	4.14	7.95	11.64	13.42	0.76
6:00 PM	3.70	5.18	6.43	5.59	8.97	4.64	3.42	18.12	4.55
7:00 PM	3.88	5.85	1.17	3.85	6.90	3.31	4.79	7.38	1.52
8:00 PM	4.24	6.46	5.26	10.14	4.14	3.31	4.11	2.01	0.76
9:00 PM	2.89	2.35	0.00	7.34	0.00	3.31	4.79	0.67	2.27
10:00 PM	1.71	1.55	2.34	0.70	3.45	1.32	0.68	0.67	3.03
11:00 PM	1.62	0.61	0.58	1.05	0.00	0.00	0.68	0.00	0.76
Grand Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table a. 3 Daily temporal distribution of tourist photographs per POI

days	Central Station	Museum plein	Hotel Casa	Eye	De Oude Kerk	Church of Saint Nicholas	Dam Square	Heineken Experience	Het Schip	Grand Total
Monday	109	170	26	25	13	9	30	4	15	401
Tuesday	100	153	19	31	31	15	14	21	47	431
Wednesday	99	141	18	61	22	15	27	17	8	408
Thursday	125	217	23	20	27	28	32	30	11	513
Friday	114	228	28	36	14	17	9	22	18	486
Saturday	390	347	39	42	8	40	10	41	9	926
Sunday	171	231	18	71	30	27	24	14	24	610
Grand Total	1108	1487	171	286	145	151	146	149	132	3775

Table a. 4 Percentage table /daily temporal distribution of tourist photographs per POI

days	Central Station	Museum plein	Hotel Casa	Eye	De Oude Kerk	Church of Saint Nicholas	Dam Square	Heineken Experience	Het Schip
Monday	9.84	11.43	15.20	8.74	8.97	5.96	20.55	2.68	11.36
Tuesday	9.03	10.29	11.11	10.84	21.38	9.93	9.59	14.09	35.61
Wednesday	8.94	9.48	10.53	21.33	15.17	9.93	18.49	11.41	6.06
Thursday	11.28	14.59	13.45	6.99	18.62	18.54	21.92	20.13	8.33
Friday	10.29	15.33	16.37	12.59	9.66	11.26	6.16	14.77	13.64
Saturday	35.20	23.34	22.81	14.69	5.52	26.49	6.85	27.52	6.82
Sunday	15.43	15.53	10.53	24.83	20.69	17.88	16.44	9.40	18.18
Grand Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table a. 5 Monthly temporal distribution of tourist photographs per POI

months	Central Station	Museum plein	Hotel Casa	Eye	De Oude Kerk	Church of Saint Nicholas	Dam Square	Heineken Experience	Het Schip	Grand Total
January	139	55	0	33	8	14	31	0	0	280
February	22	65	0	5	2	5	6	4	0	109
March	40	115	0	4	6	5	8	0	18	196
April	75	113	108	17	6	17	4	23	3	366
May	106	165	41	15	50	11	10	3	11	412
June	76	177	7	52	7	8	10	0	20	357
July	103	282	3	54	0	39	2	11	1	495
August	95	104	2	78	9	13	11	0	21	333
September	20	27	6	3	4	5	12	7	0	84
October	313	273	4	4	33	23	37	3	0	690
November	59	95	0	15	16	4	12	95	58	354
December	60	16	0	6	4	7	3	3	0	99
Grand Total	1108	1487	171	286	145	151	146	149	132	3775

Table a. 6 Percentage table /monthly temporal distribution of tourist photographs per POI

months	Central Station	Museumplein	Hotel Casa	Eye	De Oude Kerk	Church of Saint Nicholas	Dam Square	Heineken Experience	Het Schip
January	12.55	3.70	0.00	11.54	5.52	9.27	21.23	0.00	0.00
February	1.99	4.37	0.00	1.75	1.38	3.31	4.11	2.68	0.00
March	3.61	7.73	0.00	1.40	4.14	3.31	5.48	0.00	13.64
April	6.77	7.60	63.16	5.94	4.14	11.26	2.74	15.44	2.27
May	9.57	11.10	23.98	5.24	34.48	7.28	6.85	2.01	8.33
June	6.86	11.90	4.09	18.18	4.83	5.30	6.85	0.00	15.15
July	9.30	18.96	1.75	18.88	0.00	25.83	1.37	7.38	0.76
August	8.57	6.99	1.17	27.27	6.21	8.61	7.53	0.00	15.91
September	1.81	1.82	3.51	1.05	2.76	3.31	8.22	4.70	0.00

October	313	273	4	4	33	23	37	3	0
November	59	95	0	15	16	4	12	95	58
December	60	16	0	6	4	7	3	3	0
Grand Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table a. 7 Yearly temporal distribution of tourist photographs per POI

years	Central Station	Museum plein	Hotel Casa	Eye	De Oude Kerk	Church of Saint Nicholas	Dam Square	Heineken Experience	Het Schip	Grand Total
1986-2007	14	0	0	0	0	0	0	0	7	21
2008	20	1							55	76
2009	1	1							40	42
2010		6							5	11
2011						1			3	4
2012	1		2			1			12	16
2013	7	23	1	1	33				2	67
2014	18	73	145	1	6	4	6			253
2015	3	7	9			2	2		2	25
2016	6	3	2			4	1		2	18
2017	448	45	12	138	18	37	4	1		703
2018	513	1181		105	72	98	90	145	4	2208
2019	77	147		41	16	4	43	3		331
Grand Total	1108	1487	171	286	145	151	146	149	132	3775

Table a. 8 Percentage table /yearly temporal distribution of tourist photographs per POI

years	Central Station	Museumplein	Hotel Casa	Eye	De Oude Kerk	Church of Saint Nicholas	Dam Square	Heineken Experience	Het Schip
1986-2007	1.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.30
2008	1.81	0.07	0.00	0.00	0.00	0.00	0.00	0.00	41.67
2009	0.09	0.07	0.00	0.00	0.00	0.00	0.00	0.00	30.30
2010	0.00	0.40	0.00	0.00	0.00	0.00	0.00	0.00	3.79
2011	0.00	0.00	0.00	0.00	0.00	0.66	0.00	0.00	2.27
2012	0.09	0.00	1.17	0.00	0.00	0.66	0.00	0.00	9.09
2013	0.63	1.55	0.58	0.35	22.76	0.00	0.00	0.00	1.52
2014	1.62	4.91	84.80	0.35	4.14	2.65	4.11	0.00	0.00
2015	0.27	0.47	5.26	0.00	0.00	1.32	1.37	0.00	1.52
2016	0.54	0.20	1.17	0.00	0.00	2.65	0.68	0.00	1.52
2017	40.43	3.03	7.02	48.25	12.41	24.50	2.74	0.67	0.00
2018	46.30	79.42	0.00	36.71	49.66	64.90	61.64	97.32	3.03
2019	6.95	9.89	0.00	14.34	11.03	2.65	29.45	2.01	0.00
Grand Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table a. 9 Hourly temporal distribution of local photographs per POI

hours	Museumplein	NDSM Werf	Occii	Vondelpark	Eye	Het Stenen Hoofd	Westindische Buurt	Central Station	Sloterdijk	Melkweg	Zuiveringshal West	Zoo Artis	Grand Total
12:00 AM	15	11	2	5	4	27	28	33	37	1	2	9	174
1:00 AM	1	7		1		3	1	1	2				16
2:00 AM	4		1	1	1	2		1	1	1	1	2	15
3:00 AM				2		4	2		2			2	12
4:00 AM		1		1		3	2	1	3				11

5:00 AM		1		4	2	1	1		1		1	2	13
6:00 AM	1	1	1	3			4	2	1		1	2	16
7:00 AM	8	2	1	6		4	3	16	2	1	4	16	63
8:00 AM	11	22	3	8	3	2	1	9	9	1	14	28	111
9:00 AM	15	16	2	3	1	6	11	10	22	6	7	23	122
10:00 AM	30	41	1		9	51	17	23	29	22	3	51	277
11:00 AM	80	19	6	10	95	43	58	48	44	24	15	93	535
12:00 PM	59	24	29	13	15	26	62	70	52	26	20	122	518
1:00 PM	40	53	9	11	6	25	59	38	32	29	17	117	436
2:00 PM	61	41	14	42	10	25	80	53	55	23	30	132	566
3:00 PM	42	50	36	32	17	16	51	93	24	17	26	102	506
4:00 PM	26	49	40	66	14	18	45	35	56	23	15	160	547
5:00 PM	33	29	11	73	21	24	27	26	42	1	15	85	387
6:00 PM	15	20	7	12	3	16	14	21	26	2	19	72	227
7:00 PM	14	12	13	5		13	11	26	49	2	10	54	209
8:00 PM	11	16	5	11	3	46	16	17	12	3	2	43	185
9:00 PM	9	10	2	3	4	30	14	7	12	1		48	140
10:00 PM	3	9	5	11	1	26	9	8	14		2	16	104
11:00 PM	4	6	2	5	3	9	10	3	4			7	53
Grand Total	482	440	190	328	212	420	526	541	531	183	204	1186	5243

Table a. 10 Percentage table /hourly temporal distribution of local photographs per POI

hours	Museumplein	NDSM Werf	Occii	Vondelpark	Eye	Het Stenen Hoofd	Westindische Buurt	Central Station	Sloterdijk	Melkweg	Zuiveringshal West	Zoo Artis
12:00 AM	3.11	2.50	1.05	1.52	1.89	6.43	5.32	6.10	6.97	0.55	0.98	0.76
1:00 AM	0.21	1.59	0.00	0.30	0.00	0.71	0.19	0.18	0.38	0.00	0.00	0.00
2:00 AM	0.83	0.00	0.53	0.30	0.47	0.48	0.00	0.18	0.19	0.55	0.49	0.17
3:00 AM	0.00	0.00	0.00	0.61	0.00	0.95	0.38	0.00	0.38	0.00	0.00	0.17
4:00 AM	0.00	0.23	0.00	0.30	0.00	0.71	0.38	0.18	0.56	0.00	0.00	0.00
5:00 AM	0.00	0.23	0.00	1.22	0.94	0.24	0.19	0.00	0.19	0.00	0.49	0.17
6:00 AM	0.21	0.23	0.53	0.91	0.00	0.00	0.76	0.37	0.19	0.00	0.49	0.17
7:00 AM	1.66	0.45	0.53	1.83	0.00	0.95	0.57	2.96	0.38	0.55	1.96	1.35
8:00 AM	2.28	5.00	1.58	2.44	1.42	0.48	0.19	1.66	1.69	0.55	6.86	2.36
9:00 AM	3.11	3.64	1.05	0.91	0.47	1.43	2.09	1.85	4.14	3.28	3.43	1.94
10:00 AM	6.22	9.32	0.53	0.00	4.25	12.14	3.23	4.25	5.46	12.02	1.47	4.30
11:00 AM	16.60	4.32	3.16	3.05	44.81	10.24	11.03	8.87	8.29	13.11	7.35	7.84
12:00 PM	12.24	5.45	15.26	3.96	7.08	6.19	11.79	12.94	9.79	14.21	9.80	10.29
1:00 PM	8.30	12.05	4.74	3.35	2.83	5.95	11.22	7.02	6.03	15.85	8.33	9.87
2:00 PM	12.66	9.32	7.37	12.80	4.72	5.95	15.21	9.80	10.36	12.57	14.71	11.13
3:00 PM	8.71	11.36	18.95	9.76	8.02	3.81	9.70	17.19	4.52	9.29	12.75	8.60
4:00 PM	5.39	11.14	21.05	20.12	6.60	4.29	8.56	6.47	10.55	12.57	7.35	13.49
5:00 PM	6.85	6.59	5.79	22.26	9.91	5.71	5.13	4.81	7.91	0.55	7.35	7.17
6:00 PM	3.11	4.55	3.68	3.66	1.42	3.81	2.66	3.88	4.90	1.09	9.31	6.07

7:00 PM	2.90	2.73	6.84	1.52	0.00	3.10	2.09	4.81	9.23	1.09	4.90	4.55
8:00 PM	2.28	3.64	2.63	3.35	1.42	10.95	3.04	3.14	2.26	1.64	0.98	3.63
9:00 PM	1.87	2.27	1.05	0.91	1.89	7.14	2.66	1.29	2.26	0.55	0.00	4.05
10:00 PM	0.62	2.05	2.63	3.35	0.47	6.19	1.71	1.48	2.64	0.00	0.98	1.35
11:00 PM	0.83	1.36	1.05	1.52	1.42	2.14	1.90	0.55	0.75	0.00	0.00	0.59
Grand Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table a. 11 Daily temporal distribution of local photographs per POI

days	Museumplein	NDSM Werf	Occii	Vondelpark	Eye	Het Stenen Hoofd	Westindische Buurt	Central Station	Sloterdijk	Melkweg	Zuiveringshal West	Zoo Artis	Grand Total
Monday	26	34	11	24	18	41	51	54	40	11	7	105	422
Tuesday	13	40	10	18	21	66	43	70	89	4	14	165	553
Wednesday	27	38	22	18	10	26	159	73	38	77	33	151	672
Thursday	26	76	34	20	81	55	80	77	75	21	29	122	696
Friday	94	65	34	28	10	104	42	49	61	39	8	129	663
Saturday	200	89	47	49	24	48	73	137	151	23	65	194	1100
Sunday	96	98	32	171	48	80	78	81	77	8	48	320	1137
Grand Total	482	440	190	328	212	420	526	541	531	183	204	1186	5243

Table a. 12 Percentage table /daily temporal distribution of local photographs per POI

days	Museumplein	NDSM Werf	Occii	Vondelpark	Eye	Het Stenen Hoofd	Westindische Buurt	Central Station	Sloterdijk	Melkweg	Zuiveringshal West	Zoo Artis
Monday	5.39	7.73	5.79	7.32	8.49	9.76	9.70	9.98	7.53	6.01	3.43	8.85
Tuesday	2.70	9.09	5.26	5.49	9.91	15.71	8.17	12.94	16.76	2.19	6.86	13.91
Wednesday	5.60	8.64	11.58	5.49	4.72	6.19	30.23	13.49	7.16	42.08	16.18	12.73

Thursday	5.39	17.27	17.89	6.10	38.21	13.10	15.21	14.23	14.12	11.48	14.22	10.29
Friday	19.50	14.77	17.89	8.54	4.72	24.76	7.98	9.06	11.49	21.31	3.92	10.88
Saturday	41.49	20.23	24.74	14.94	11.32	11.43	13.88	25.32	28.44	12.57	31.86	16.36
Sunday	19.92	22.27	16.84	52.13	22.64	19.05	14.83	14.97	14.50	4.37	23.53	26.98
Grand Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table a. 13 Monthly temporal distribution of local photographs per POI

months	Museumplein	NDSM Werf	Occii	Vondelpark	Eye	Het Stenen Hoofd	Westindische Buurt	Central Station	Sloterdijk	Melkweg	Zuiveringshal West	Zoo Artis	Grand Total
January	34	29	5	6	16	26	30	27	32	3	3	53	264
February	57	51	14	7	16	16	25	99	37	1	7	56	386
March	50	52	27	25	96	13	40	56	70	142	42	156	769
April	28	45	26	26	8	50	34	84	100	8	52	111	572
May	84	40	11	10	5	19	26	32	29	3	25	76	360
June	87	76	21	17	8	30	36	72	27	1	6	164	545
July	38	43	10	11	9	17	20	15	33	3	4	65	268
August	39	19	4	160	10	33	15	32	48	1	13	80	454
September	27	23	18	12	27	51	23	29	28	4	11	111	364
October	13	24	24	26	5	73	183	35	39	8	29	134	593
November	6	18	16	13	4	34	35	23	32	4	8	108	301
December	19	20	14	15	8	58	59	37	56	5	4	72	367
Grand Total	482	440	190	328	212	420	526	541	531	183	204	1186	5243

Table a. 14 Percentage table /monthly temporal distribution of local photographs per POI

months	Museumplein	NDSM Werf	Occii	Vondelpark	Eye	Het Stenen Hoofd	Westindische Buurt	Central Station	Sloterdijk	Melkweg	Zuiverings hal West	Zoo Artis
January	7.05	6.59	2.63	1.83	7.55	6.19	5.70	4.99	6.03	1.64	1.47	4.47
February	11.83	11.59	7.37	2.13	7.55	3.81	4.75	18.30	6.97	0.55	3.43	4.72
March	10.37	11.82	14.21	7.62	45.28	3.10	7.60	10.35	13.18	77.60	20.59	13.15
April	5.81	10.23	13.68	7.93	3.77	11.90	6.46	15.53	18.83	4.37	25.49	9.36
May	17.43	9.09	5.79	3.05	2.36	4.52	4.94	5.91	5.46	1.64	12.25	6.41
June	18.05	17.27	11.05	5.18	3.77	7.14	6.84	13.31	5.08	0.55	2.94	13.83
July	7.88	9.77	5.26	3.35	4.25	4.05	3.80	2.77	6.21	1.64	1.96	5.48
August	8.09	4.32	2.11	48.78	4.72	7.86	2.85	5.91	9.04	0.55	6.37	6.75
September	5.60	5.23	9.47	3.66	12.74	12.14	4.37	5.36	5.27	2.19	5.39	9.36
October	2.70	5.45	12.63	7.93	2.36	17.38	34.79	6.47	7.34	4.37	14.22	11.30
November	1.24	4.09	8.42	3.96	1.89	8.10	6.65	4.25	6.03	2.19	3.92	9.11
December	3.94	4.55	7.37	4.57	3.77	13.81	11.22	6.84	10.55	2.73	1.96	6.07
Grand Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table a. 15 Yearly temporal distribution of local photographs per POI

years	Museumplein	NDSM Werf	Occii	Vondelpark	Eye	Het Stenen Hoofd	Westindische Buurt	Central Station	Sloterdijk	Melkweg	Zuiverings hal West	Zoo Artis	Grand Total
1927-2007	32	25	2	2	3	1	30	36	17	3	1	41	193
2008	4	4	5	4	4	1	15	4	4	5		6	56
2009	19	13	1	2	1	1	16	7	14		1	22	97
2010	16	13	3	6	11	2	8	28	6	1	5	44	143
2011	21	27	12	9	4	6	10	35	18		6	44	192
2012	9	22	4	12	1	17	48	39	33	3	7	97	292

2013	42	26	8	20	24	58	17	30	30	2	9	65	331
2014	51	30	19	25	8	65	23	25	14	2	16	87	365
2015	36	30	23	187	17	29	25	70	89		80	133	719
2016	18	49	58	14	14	24	44	50	48	6	16	119	460
2017	21	100	20	13	4	94	39	67	27	5	17	167	574
2018	157	65	26	28	10	106	213	88	158	11	40	229	1131
2019	56	36	9	6	111	16	38	62	73	145	6	132	690
Grand Total	482	440	190	328	212	420	526	541	531	183	204	1186	5243

Table a. 16 Percentage table /yearly temporal distribution of local photographs per POI

years	Museumplein	NDSM Werf	Vondelpark Occii		Eye	Het Stenen Hoofd	Westindische Buurt	Central Station	Sloterdijk	Zuiverings Melkweg	hal West	Zoo Artis
1927-2007	6.64	5.68	1.05	0.61	1.42	0.24	5.70	6.65	3.20	1.64	0.49	3.46
2008	0.83	0.91	2.63	1.22	1.89	0.24	2.85	0.74	0.75	2.73	0.00	0.51
2009	3.94	2.95	0.53	0.61	0.47	0.24	3.04	1.29	2.64	0.00	0.49	1.85
2010	3.32	2.95	1.58	1.83	5.19	0.48	1.52	5.18	1.13	0.55	2.45	3.71
2011	4.36	6.14	6.32	2.74	1.89	1.43	1.90	6.47	3.39	0.00	2.94	3.71
2012	1.87	5.00	2.11	3.66	0.47	4.05	9.13	7.21	6.21	1.64	3.43	8.18
2013	8.71	5.91	4.21	6.10	11.32	13.81	3.23	5.55	5.65	1.09	4.41	5.48
2014	10.58	6.82	10.00	7.62	3.77	15.48	4.37	4.62	2.64	1.09	7.84	7.34
2015	7.47	6.82	12.11	57.01	8.02	6.90	4.75	12.94	16.76	0.00	39.22	11.21
2016	3.73	11.14	30.53	4.27	6.60	5.71	8.37	9.24	9.04	3.28	7.84	10.03
2017	4.36	22.73	10.53	3.96	1.89	22.38	7.41	12.38	5.08	2.73	8.33	14.08
2018	32.57	14.77	13.68	8.54	4.72	25.24	40.49	16.27	29.76	6.01	19.61	19.31
2019	11.62	8.18	4.74	1.83	52.36	3.81	7.22	11.46	13.75	79.23	2.94	11.13

Grand Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table a. 17 Hourly temporal distribution of tourist photographs per heritage type

hours	Catering	Church	Culture-Sport	Governmental Building	House	Industrial Building	Office Building	Remains	Shopping	Storage	Transportation	Uncategorised	Grand Total
12:00 AM	3	2	32		138	2	5	2	6	3		2	195
1:00 AM	4		52	1	61	2	9	2	7	4		1	143
2:00 AM		2	10		58	1	2	1		6			80
3:00 AM		6		1	271	2	12	2	4	16		7	321
4:00 AM		4	30	1	215	1	7	2		8		5	273
5:00 AM			30		21							2	53
6:00 AM	2		9		26	2	4	1	1	1			46
7:00 AM	1	4	33	4	390		20	2	2	10		10	476
8:00 AM	7	38	60	9	1698	5	30	5	10	46	1	49	1958
9:00 AM	13	33	93	7	1645	10	57	10	12	99		28	2007
10:00 AM	14	54	139	26	2676	22	90	31	43	108	2	67	3272
11:00 AM	19	43	313	20	2491	56	105	24	51	125		42	3289
12:00 PM	20	52	362	15	2882	23	89	16	24	123	2	54	3662
1:00 PM	15	47	189	20	2295	25	86	26	45	103	1	40	2892
2:00 PM	23	102	232	26	4991	44	190	48	61	220		103	6040
3:00 PM	24	56	221	19	2879	52	82	23	33	137	7	60	3593
4:00 PM	5	64	150	20	2645	32	55	32	12	138	3	58	3214

5:00 PM	7	41	93	17	2168	54	79	21	33	122	6	37	2678
6:00 PM	6	41	146	14	1992	59	77	14	15	91	1	50	2506
7:00 PM	13	36	155	16	1920	28	47	14	20	68	1	57	2375
8:00 PM	19	36	185	8	1666	11	43	13	17	59	1	34	2092
9:00 PM	19	14	65	2	879	8	41	10	24	46		11	1119
10:00 PM	3	16	57	5	696	5	20	7	2	22	1	22	856
11:00 PM	7	1	17	1	305		32	1	9	20	2	3	398
Grand Total	224	692	2673	232	35008	444	1182	307	431	1575	28	742	43538

Table a. 18 Percentage table /hourly temporal distribution of tourist photographs per heritage type

hours	Catering	Church	Culture-Sport	Governmental Building	House	Industrial Building	Office Building	Remains	Shopping	Storage	Transportation	Uncategorised
12:00 AM	1.34	0.29	1.20	0.00	0.39	0.45	0.42	0.65	1.39	0.19	0.00	0.27
1:00 AM	1.79	0.00	1.95	0.43	0.17	0.45	0.76	0.65	1.62	0.25	0.00	0.13
2:00 AM	0.00	0.29	0.37	0.00	0.17	0.23	0.17	0.33	0.00	0.38	0.00	0.00
3:00 AM	0.00	0.87	0.00	0.43	0.77	0.45	1.02	0.65	0.93	1.02	0.00	0.94
4:00 AM	0.00	0.58	1.12	0.43	0.61	0.23	0.59	0.65	0.00	0.51	0.00	0.67
5:00 AM	0.00	0.00	1.12	0.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.27
6:00 AM	0.89	0.00	0.34	0.00	0.07	0.45	0.34	0.33	0.23	0.06	0.00	0.00
7:00 AM	0.45	0.58	1.23	1.72	1.11	0.00	1.69	0.65	0.46	0.63	0.00	1.35
8:00 AM	3.13	5.49	2.24	3.88	4.85	1.13	2.54	1.63	2.32	2.92	3.57	6.60
9:00 AM	5.80	4.77	3.48	3.02	4.70	2.25	4.82	3.26	2.78	6.29	0.00	3.77

10:00 AM	6.25	7.80	5.20	11.21	7.64	4.95	7.61	10.10	9.98	6.86	7.14	9.03
11:00 AM	8.48	6.21	11.71	8.62	7.12	12.61	8.88	7.82	11.83	7.94	0.00	5.66
12:00 PM	8.93	7.51	13.54	6.47	8.23	5.18	7.53	5.21	5.57	7.81	7.14	7.28
1:00 PM	6.70	6.79	7.07	8.62	6.56	5.63	7.28	8.47	10.44	6.54	3.57	5.39
2:00 PM	10.27	14.74	8.68	11.21	14.26	9.91	16.07	15.64	14.15	13.97	0.00	13.88
3:00 PM	10.71	8.09	8.27	8.19	8.22	11.71	6.94	7.49	7.66	8.70	25.00	8.09
4:00 PM	2.23	9.25	5.61	8.62	7.56	7.21	4.65	10.42	2.78	8.76	10.71	7.82
5:00 PM	3.13	5.92	3.48	7.33	6.19	12.16	6.68	6.84	7.66	7.75	21.43	4.99
6:00 PM	2.68	5.92	5.46	6.03	5.69	13.29	6.51	4.56	3.48	5.78	3.57	6.74
7:00 PM	5.80	5.20	5.80	6.90	5.48	6.31	3.98	4.56	4.64	4.32	3.57	7.68
8:00 PM	8.48	5.20	6.92	3.45	4.76	2.48	3.64	4.23	3.94	3.75	3.57	4.58
9:00 PM	8.48	2.02	2.43	0.86	2.51	1.80	3.47	3.26	5.57	2.92	0.00	1.48
10:00 PM	1.34	2.31	2.13	2.16	1.99	1.13	1.69	2.28	0.46	1.40	3.57	2.96
11:00 PM	3.13	0.14	0.64	0.43	0.87	0.00	2.71	0.33	2.09	1.27	7.14	0.40
Grand Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table a. 19 Daily temporal distribution of tourist photographs per heritage type

days	Catering	Church	Culture-Sport	Governmental Building	House	Industrial Building	Office Building	Remains	Shopping	Storage	Transportation	Uncategorised	Grand Total
Monday	40	56	373	25	3355	21	116	43	85	114	7	76	4311
Tuesday	30	101	233	29	5149	57	140	41	42	212	2	148	6184
Wednesday	16	92	168	32	4809	49	163	38	70	179	2	123	5741
Thursday	33	137	361	45	6238	89	195	55	77	264	4	130	7628
Friday	25	76	464	31	4011	58	165	27	37	199	3	72	5168

Saturday	29	106	630	23	5283	114	196	41	43	333	5	52	6855
Sunday	51	124	444	47	6163	56	207	62	77	274	5	141	7651
Grand Total	224	692	2673	232	35008	444	1182	307	431	1575	28	742	43538

Table a. 20 Percentage table /daily temporal distribution of tourist photographs per heritage type

days	Catering	Church	Culture-Sport	Governmental Building	House	Industrial Building	Office Building	Remains	Shopping	Storage	Transportation	Uncategorised
Monday	17.86	8.09	13.95	10.78	9.58	4.73	9.81	14.01	19.72	7.24	25.00	10.24
Tuesday	13.39	14.60	8.72	12.50	14.71	12.84	11.84	13.36	9.74	13.46	7.14	19.95
Wednesday	7.14	13.29	6.29	13.79	13.74	11.04	13.79	12.38	16.24	11.37	7.14	16.58
Thursday	14.73	19.80	13.51	19.40	17.82	20.05	16.50	17.92	17.87	16.76	14.29	17.52
Friday	11.16	10.98	17.36	13.36	11.46	13.06	13.96	8.79	8.58	12.63	10.71	9.70
Saturday	12.95	15.32	23.57	9.91	15.09	25.68	16.58	13.36	9.98	21.14	17.86	7.01
Sunday	22.77	17.92	16.61	20.26	17.60	12.61	17.51	20.20	17.87	17.40	17.86	19.00
Grand Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table a. 21 Monthly temporal distribution of tourist photographs per heritage type

months	Catering	Church	Culture-Sport	Governmental Building	House	Industrial Building	Office Building	Remains	Shopping	Storage	Transportation	Uncategorised	Grand Total
January	40	56	92	21	3035	19	157	41	88	140	2	56	3747
February	12	15	140	7	1051	9	31	9	18	44	1	8	1345
March	5	29	210	14	1491	4	46	18	23	44	3	17	1904
April	19	51	215	13	3107	61	152	19	33	187	5	49	3911
May	34	143	298	52	7412	16	146	30	47	202	1	247	8628
June	24	36	186	18	2395	5	84	26	29	87	3	30	2923
July	17	87	504	5	3524	58	135	36	16	275	6	13	4676

August	16	47	183	14	2382	11	86	20	27	108	4	39	2937
September	5	21	71	9	1174	16	54	15	27	57	1	26	1476
October	15	129	721	46	5059	38	113	58	65	174		166	6584
November	17	52	45	21	2655	196	105	23	33	159	1	75	3382
December	20	26	8	12	1723	11	73	12	25	98	1	16	2025
Grand Total	224	692	2673	232	35008	444	1182	307	431	1575	28	742	43538

Table a. 22 Percentage table /monthly temporal distribution of tourist photographs per heritage type

months	Catering	Church	Culture-Sport	Governmental Building	House	Industrial Building	Office Building	Remains	Shopping	Storage	Transportation	Uncategorised
January	17.86	8.09	3.44	9.05	8.67	4.28	13.28	13.36	20.42	8.89	7.14	7.55
February	5.36	2.17	5.24	3.02	3.00	2.03	2.62	2.93	4.18	2.79	3.57	1.08
March	2.23	4.19	7.86	6.03	4.26	0.90	3.89	5.86	5.34	2.79	10.71	2.29
April	8.48	7.37	8.04	5.60	8.88	13.74	12.86	6.19	7.66	11.87	17.86	6.60
May	15.18	20.66	11.15	22.41	21.17	3.60	12.35	9.77	10.90	12.83	3.57	33.29
June	10.71	5.20	6.96	7.76	6.84	1.13	7.11	8.47	6.73	5.52	10.71	4.04
July	7.59	12.57	18.86	2.16	10.07	13.06	11.42	11.73	3.71	17.46	21.43	1.75
August	7.14	6.79	6.85	6.03	6.80	2.48	7.28	6.51	6.26	6.86	14.29	5.26
September	2.23	3.03	2.66	3.88	3.35	3.60	4.57	4.89	6.26	3.62	3.57	3.50
October	6.70	18.64	26.97	19.83	14.45	8.56	9.56	18.89	15.08	11.05	0.00	22.37
November	7.59	7.51	1.68	9.05	7.58	44.14	8.88	7.49	7.66	10.10	3.57	10.11
December	8.93	3.76	0.30	5.17	4.92	2.48	6.18	3.91	5.80	6.22	3.57	2.16
Grand Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table a. 23 Yearly temporal distribution of tourist photographs per heritage type

years	Catering	Church	Culture-Sport	Governmental Building	House	Industrial Building	Office Building	Remains	Shopping	Storage	Transportation	Uncategorised	Grand Total
2007	1				81		4		2	3			91
2008			3		64							21	88
2009					50						1	2	53
2010					34							3	37
2011		1			17	1	1	1		2		3	26
2012		2		1	102		1			6		2	114
2013		66	23	33	3250		1			33		166	3572
2014	7	21	139	9	1109	5	45	13	18	39		25	1430
2015	2	6	16	3	316	1	12	1	7	19		5	388
2016		8		4	383	2	5	4	1	28		14	449
2017	38	133	68	35	5787	21	207	30	32	317	9	109	6786
2018	136	400	2112	120	20945	391	762	200	264	1057	12	345	26744
2019	40	55	312	27	2870	23	144	58	107	71	6	47	3760
Grand Total	224	692	2673	232	35008	444	1182	307	431	1575	28	742	43538

Table a. 24 Percentage table /yearly temporal distribution of tourist photographs per heritage type

years	Catering	Church	Culture-Sport	Governmental Building	House	Industrial Building	Office Building	Remains	Shopping	Storage	Transportation	Uncategorised
2007	0.45	0.00	0.00	0.00	0.23	0.00	0.34	0.00	0.46	0.19	0.00	0.00
2008	0.00	0.00	0.11	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00	2.83
2009	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00	0.00	3.57	0.27
2010	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.40
2011	0.00	0.14	0.00	0.00	0.05	0.23	0.08	0.33	0.00	0.13	0.00	0.40

2012	0.00	0.29	0.00	0.43	0.29	0.00	0.08	0.00	0.00	0.38	0.00	0.27
2013	0.00	9.54	0.86	14.22	9.28	0.00	0.08	0.00	0.00	2.10	0.00	22.37
2014	3.13	3.03	5.20	3.88	3.17	1.13	3.81	4.23	4.18	2.48	0.00	3.37
2015	0.89	0.87	0.60	1.29	0.90	0.23	1.02	0.33	1.62	1.21	0.00	0.67
2016	0.00	1.16	0.00	1.72	1.09	0.45	0.42	1.30	0.23	1.78	0.00	1.89
2017	16.96	19.22	2.54	15.09	16.53	4.73	17.51	9.77	7.42	20.13	32.14	14.69
2018	60.71	57.80	79.01	51.72	59.83	88.06	64.47	65.15	61.25	67.11	42.86	46.50
2019	17.86	7.95	11.67	11.64	8.20	5.18	12.18	18.89	24.83	4.51	21.43	6.33
Grand Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table a. 25 Hourly temporal distribution of local photographs per heritage type

hours	Catering	Church	Culture-Sport	Education	Garden and Zoo	Governmental Building	House	Industrial Building	Office Building	Remains	Storage	Transportation	Grand Total
12:00 AM			16	5		2	41	11	3		2	4	84
1:00 AM									1				1
2:00 AM	2		1										3
3:00 AM													0
4:00 AM													0
5:00 AM			1			1		2					4
6:00 AM	1		2				5	12		2		1	23
7:00 AM	1		2			1	9	24	1	1		3	42
8:00 AM	51		66		1	2	12	72	6	2	7	30	249
9:00 AM	3		5	2		5	16	9	6	2		1	49

10:00 AM			23	6	6	8	153	20	24	2	1	3	246
11:00 AM	3		261	12	45	17	60	82	10	2	1	12	505
12:00 PM	7		146	1	20	27	95	105	30	2	55	12	500
1:00 PM	3	1	398	22	17	36	446	156	26	13	46	11	1175
2:00 PM	6		353	8	142	120	185	198	58	53	5	10	1138
3:00 PM	4	6	199	3	8	30	1752	78	38	11	147	16	2292
4:00 PM	7	3	128	5	30	43	82	141	29	5		37	510
5:00 PM	2		467	3	28	21	284	105	15	6	33	6	970
6:00 PM		2	11		4	1	43	109	1	1	9	11	192
7:00 PM	1		21		12	5	43	28	5	2	3	83	203
8:00 PM	3		12	2	1	2	20	5	8	6	6	10	75
9:00 PM	1		10	3		1	33	6	1			4	59
10:00 PM	2		3	1	6	3	20	24	2	3		6	70
11:00 PM			9				1	2	1			2	15
Grand Total	97	12	2134	73	320	325	3300	1189	265	113	315	262	8405

Table a. 26 Percentage table /hourly temporal distribution of local photographs per heritage type

hours	Catering	Church	Culture-Sport	Education	Garden and Zoo	Governmental Building	House	Industrial Building	Office Building	Remains	Storage	Transportation
12:00 AM	0.00	0.00	0.75	6.85	0.00	0.62	1.24	0.93	1.13	0.00	0.63	1.53
1:00 AM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.38	0.00	0.00	0.00
2:00 AM	2.06	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:00 AM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

4:00 AM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:00 AM	0.00	0.00	0.05	0.00	0.00	0.31	0.00	0.17	0.00	0.00	0.00	0.00
6:00 AM	1.03	0.00	0.09	0.00	0.00	0.00	0.15	1.01	0.00	1.77	0.00	0.38
7:00 AM	1.03	0.00	0.09	0.00	0.00	0.31	0.27	2.02	0.38	0.88	0.00	1.15
8:00 AM	52.58	0.00	3.09	0.00	0.31	0.62	0.36	6.06	2.26	1.77	2.22	11.45
9:00 AM	3.09	0.00	0.23	2.74	0.00	1.54	0.48	0.76	2.26	1.77	0.00	0.38
10:00 AM	0.00	0.00	1.08	8.22	1.88	2.46	4.64	1.68	9.06	1.77	0.32	1.15
11:00 AM	3.09	0.00	12.23	16.44	14.06	5.23	1.82	6.90	3.77	1.77	0.32	4.58
12:00 PM	7.22	0.00	6.84	1.37	6.25	8.31	2.88	8.83	11.32	1.77	17.46	4.58
1:00 PM	3.09	8.33	18.65	30.14	5.31	11.08	13.52	13.12	9.81	11.50	14.60	4.20
2:00 PM	6.19	0.00	16.54	10.96	44.38	36.92	5.61	16.65	21.89	46.90	1.59	3.82
3:00 PM	4.12	50.00	9.33	4.11	2.50	9.23	53.09	6.56	14.34	9.73	46.67	6.11
4:00 PM	7.22	25.00	6.00	6.85	9.38	13.23	2.48	11.86	10.94	4.42	0.00	14.12
5:00 PM	2.06	0.00	21.88	4.11	8.75	6.46	8.61	8.83	5.66	5.31	10.48	2.29
6:00 PM	0.00	16.67	0.52	0.00	1.25	0.31	1.30	9.17	0.38	0.88	2.86	4.20
7:00 PM	1.03	0.00	0.98	0.00	3.75	1.54	1.30	2.35	1.89	1.77	0.95	31.68
8:00 PM	3.09	0.00	0.56	2.74	0.31	0.62	0.61	0.42	3.02	5.31	1.90	3.82
9:00 PM	1.03	0.00	0.47	4.11	0.00	0.31	1.00	0.50	0.38	0.00	0.00	1.53
10:00 PM	2.06	0.00	0.14	1.37	1.88	0.92	0.61	2.02	0.75	2.65	0.00	2.29
11:00 PM	0.00	0.00	0.42	0.00	0.00	0.00	0.03	0.17	0.38	0.00	0.00	0.76
Grand Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table a. 27 Daily temporal distribution of local photographs per heritage type

days	Catering	Church	Culture-Sport	Education	Garden and Zoo	Governmental Building	House	Industrial Building	Office Building	Remains	Storage	Transportation	Grand Total
Monday	7		129	8	20	13	246	51	31	14	7	18	544
Tuesday	7	2	130	16	60	35	144	77	20	14	90	19	614
Wednesday	12		158	23	33	42	924	165	45	11	71	26	1510
Thursday	7	1	136	6	22	32	338	164	24	11	31	41	813
Friday	18		320	7	45	19	679	68	11	6	57	47	1277
Saturday	31	4	654	8	63	132	637	357	94	17	50	63	2110
Sunday	15	5	607	5	77	52	332	307	40	40	9	48	1537
Grand Total	97	12	2134	73	320	325	3300	1189	265	113	315	262	8405

Table a. 28 Percentage table /daily temporal distribution of local photographs per heritage type

days	Catering	Church	Culture-Sport	Education	Garden and Zoo	Governmental Building	House	Industrial Building	Office Building	Remains	Storage	Transportation
Monday	7.22	0.00	6.04	10.96	6.25	4.00	7.45	4.29	11.70	12.39	2.22	6.87
Tuesday	7.22	16.67	6.09	21.92	18.75	10.77	4.36	6.48	7.55	12.39	28.57	7.25
Wednesday	12.37	0.00	7.40	31.51	10.31	12.92	28.00	13.88	16.98	9.73	22.54	9.92
Thursday	7.22	8.33	6.37	8.22	6.88	9.85	10.24	13.79	9.06	9.73	9.84	15.65
Friday	18.56	0.00	15.00	9.59	14.06	5.85	20.58	5.72	4.15	5.31	18.10	17.94
Saturday	31.96	33.33	30.65	10.96	19.69	40.62	19.30	30.03	35.47	15.04	15.87	24.05
Sunday	15.46	41.67	28.44	6.85	24.06	16.00	10.06	25.82	15.09	35.40	2.86	18.32
Grand Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table a. 29 Monthly temporal distribution of local photographs per heritage type

months	Catering	Church	Culture-Sport	Education	Garden and Zoo	Governmental Building	House	Industrial Building	Office Building	Remains	Storage	Transportation	Grand Total
January	3	1	137	5	9	4	63	20	11	3		8	264
February	4	2	158	2	15	14	250	57	24	4	1	19	550
March	14		213	3	39	44	1672	254	40	3	194	41	2517
April	15	1	136	2	48	110	197	229	53	12	31	44	878
May	6		275	3	37	22	257	138	9	6	1	14	768
June	12	2	298	1	25	9	159	92	7	3	1	28	637
July	5		135	1	18	7	98	35	10	8	3	13	333
August	9		289	3	18	10	125	79	13	42	6	8	602
September	2	4	157	8	5	14	143	66	18	5	33	22	477
October	14		133	31	71	76	166	139	51	12	5	26	724
November	8	2	91	6	7	11	62	56	11	12	37	24	327
December	5		112	8	28	4	108	24	18	3	3	15	328
Grand Total	97	12	2134	73	320	325	3300	1189	265	113	315	262	8405

Table a. 30 Percentage table /monthly temporal distribution of local photographs per heritage type

months	Catering	Church	Culture-Sport	Education	Garden and Zoo	Governmental Building	House	Industrial Building	Office Building	Remains	Storage	Transportation
January	3.09	8.33	6.42	6.85	2.81	1.23	1.91	1.68	4.15	2.65	0.00	3.05
February	4.12	16.67	7.40	2.74	4.69	4.31	7.58	4.79	9.06	3.54	0.32	7.25
March	14.43	0.00	9.98	4.11	12.19	13.54	50.67	21.36	15.09	2.65	61.59	15.65
April	15.46	8.33	6.37	2.74	15.00	33.85	5.97	19.26	20.00	10.62	9.84	16.79
May	6.19	0.00	12.89	4.11	11.56	6.77	7.79	11.61	3.40	5.31	0.32	5.34
June	12.37	16.67	13.96	1.37	7.81	2.77	4.82	7.74	2.64	2.65	0.32	10.69

July	5.15	0.00	6.33	1.37	5.63	2.15	2.97	2.94	3.77	7.08	0.95	4.96
August	9.28	0.00	13.54	4.11	5.63	3.08	3.79	6.64	4.91	37.17	1.90	3.05
September	2.06	33.33	7.36	10.96	1.56	4.31	4.33	5.55	6.79	4.42	10.48	8.40
October	14.43	0.00	6.23	42.47	22.19	23.38	5.03	11.69	19.25	10.62	1.59	9.92
November	8.25	16.67	4.26	8.22	2.19	3.38	1.88	4.71	4.15	10.62	11.75	9.16
December	5.15	0.00	5.25	10.96	8.75	1.23	3.27	2.02	6.79	2.65	0.95	5.73
Grand Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table a. 31 Yearly temporal distribution of local photographs per heritage type

years	Catering	Church	Culture-Sport	Education	Garden and Zoo	Governmental Building	House	Industrial Building	Office Building	Remains	Storage	Transportation	Grand Total
1927-2007	2	0	107	5	48	24	59	27	28	0	3	5	308
2008	5		20	2	5	1	59	1	4	2		6	105
2009	1		54	2	6		67	14	1	1	33	1	180
2010	2		80	1	10	6	48	39	10	4	1	9	210
2011	6		71	1	5	9	61	42	13	4	27	14	253
2012	8	1	55	1	6	4	79	54	8	1		8	225
2013	14	4	132	2	4	10	282	72	14	5	3	11	553
2014	3		185	1	32	27	144	101	17	19		26	555
2015	12	3	323	3	63	98	112	380	45	60		42	1141
2016	11		116	18	46	35	173	102	22	6	6	64	599
2017	12		216	14	10	20	92	128	24	3	3	26	548
2018	16	2	592	21	59	75	448	194	61	8	41	38	1555
2019	5	2	183	2	26	16	1676	35	18		198	12	2173
Grand Total	97	12	2134	73	320	325	3300	1189	265	113	315	262	8405

Table a. 32 Percentage table /Yearly temporal distribution of local photographs per heritage type

years	Catering	Church	Culture-Sport	Education	Garden and Zoo	Governmental Building	House	Industrial Building	Office Building	Remains	Storage	Transportation
1927-2007	2.06	0.00	5.01	6.85	15.00	7.38	1.79	2.27	10.57	0.00	0.95	1.91
2008	5.15	0.00	0.94	2.74	1.56	0.31	1.79	0.08	1.51	1.77	0.00	2.29
2009	1.03	0.00	2.53	2.74	1.88	0.00	2.03	1.18	0.38	0.88	10.48	0.38
2010	2.06	0.00	3.75	1.37	3.13	1.85	1.45	3.28	3.77	3.54	0.32	3.44
2011	6.19	0.00	3.33	1.37	1.56	2.77	1.85	3.53	4.91	3.54	8.57	5.34
2012	8.25	8.33	2.58	1.37	1.88	1.23	2.39	4.54	3.02	0.88	0.00	3.05
2013	14.43	33.33	6.19	2.74	1.25	3.08	8.55	6.06	5.28	4.42	0.95	4.20
2014	3.09	0.00	8.67	1.37	10.00	8.31	4.36	8.49	6.42	16.81	0.00	9.92
2015	12.37	25.00	15.14	4.11	19.69	30.15	3.39	31.96	16.98	53.10	0.00	16.03
2016	11.34	0.00	5.44	24.66	14.38	10.77	5.24	8.58	8.30	5.31	1.90	24.43
2017	12.37	0.00	10.12	19.18	3.13	6.15	2.79	10.77	9.06	2.65	0.95	9.92
2018	16.49	16.67	27.74	28.77	18.44	23.08	13.58	16.32	23.02	7.08	13.02	14.50
2019	5.15	16.67	8.58	2.74	8.13	4.92	50.79	2.94	6.79	0.00	62.86	4.58
Grand Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

APPENDIX 6 – CHI-SQUARE DISTRIBUTIONS OF LOCAL AND TOURIST PHOTOGRAPHS PER POI AND PER HERITAGE

Table b. 1 Hourly temporal distribution of tourist photographs per POI – observed count

hours	Central Station	Museumplein	Hotel Casa	Eye	De Oude Kerk	Church of Saint Nicholas	Dam Square	Heineken Experience	Het Schip	Grand Total
12:00 AM	7	13	1	4			2	1	2	30
1:00 AM	2	14	4	2			2		1	25
2:00 AM	1	3				1			1	6
3:00 AM	6	1	1	1	1	2	1		1	14
4:00 AM	14	21	2		1	1				39
5:00 AM	1	12		2					3	18
6:00 AM	1	5		3			1	1		11
7:00 AM	10	19		3	2				2	36
8:00 AM	23	39	10	5	8	6	2		3	96
9:00 AM	45	55	16	2	4	12	1		3	138
10:00 AM	54	80	5	23	14	12	14	7	19	228
11:00 AM	101	172	17	17	7	9	16	24	15	378
12:00 PM	97	195	28	29	9	12	6	6	5	387
1:00 PM	103	101	11	29	8	10	16	7	20	305
2:00 PM	193	141	11	28	24	22	22	9	7	457
3:00 PM	102	120	13	25	12	13	14	21	17	337
4:00 PM	94	96	15	20	15	15	5	10	15	285
5:00 PM	54	73	10	11	6	12	17	20	1	204
6:00 PM	41	77	11	16	13	7	5	27	6	203
7:00 PM	43	87	2	11	10	5	7	11	2	178
8:00 PM	47	96	9	29	6	5	6	3	1	202
9:00 PM	32	35		21		5	7	1	3	104
10:00 PM	19	23	4	2	5	2	1	1	4	61
11:00 PM	18	9	1	3			1		1	33
Grand Total	1108	1487	171	286	145	151	146	149	132	3775

Table b. 2 Hourly temporal distribution of tourist photographs per POI – expected count

hours	Central Station	Museum plein	Hotel Casa	Eye	De Oude Kerk	Church of Saint Nicholas	Dam Square	Heineken Experience	Het Schip	Grand Total
12:00 AM	8.81	11.82	1.36	2.27	1.15	1.20	1.16	1.18	1.05	30
1:00 AM	7.34	9.85	1.13	1.89	0.96	1.00	0.97	0.99	0.87	25
2:00 AM	1.76	2.36	0.27	0.45	0.23	0.24	0.23	0.24	0.21	6
3:00 AM	4.11	5.51	0.63	1.06	0.54	0.56	0.54	0.55	0.49	14
4:00 AM	11.45	15.36	1.77	2.95	1.50	1.56	1.51	1.54	1.36	39
5:00 AM	5.28	7.09	0.82	1.36	0.69	0.72	0.70	0.71	0.63	18
6:00 AM	3.23	4.33	0.50	0.83	0.42	0.44	0.43	0.43	0.38	11
7:00 AM	10.57	14.18	1.63	2.73	1.38	1.44	1.39	1.42	1.26	36
8:00 AM	28.18	37.82	4.35	7.27	3.69	3.84	3.71	3.79	3.36	96
9:00 AM	40.50	54.36	6.25	10.46	5.30	5.52	5.34	5.45	4.83	138
10:00 AM	66.92	89.81	10.33	17.27	8.76	9.12	8.82	9.00	7.97	228
11:00 AM	110.95	148.90	17.12	28.64	14.52	15.12	14.62	14.92	13.22	378
12:00 PM	113.59	152.44	17.53	29.32	14.86	15.48	14.97	15.27	13.53	387
1:00 PM	89.52	120.14	13.82	23.11	11.72	12.20	11.80	12.04	10.66	305
2:00 PM	134.13	180.02	20.70	34.62	17.55	18.28	17.67	18.04	15.98	457
3:00 PM	98.91	132.75	15.27	25.53	12.94	13.48	13.03	13.30	11.78	337
4:00 PM	83.65	112.26	12.91	21.59	10.95	11.40	11.02	11.25	9.97	285
5:00 PM	59.88	80.36	9.24	15.46	7.84	8.16	7.89	8.05	7.13	204
6:00 PM	59.58	79.96	9.20	15.38	7.80	8.12	7.85	8.01	7.10	203
7:00 PM	52.24	70.12	8.06	13.49	6.84	7.12	6.88	7.03	6.22	178
8:00 PM	59.29	79.57	9.15	15.30	7.76	8.08	7.81	7.97	7.06	202
9:00 PM	30.53	40.97	4.71	7.88	3.99	4.16	4.02	4.10	3.64	104
10:00 PM	17.90	24.03	2.76	4.62	2.34	2.44	2.36	2.41	2.13	61
11:00 PM	9.69	13.00	1.49	2.50	1.27	1.32	1.28	1.30	1.15	33
Grand Total	1108	1487	171	286	145	151	146	149	132	3775

Table b. 3 Hourly temporal distribution of tourist photographs per POI – Pearson residuals

hours	Central Station	Museumplein	Hotel Casa	Eye	De Oude Kerk	Church of Saint Nicholas	Dam Square	Heineken Experience	Het Schip
12:00 AM	-0.608	0.344	-0.308	1.146	-1.073	-1.095	0.78	-0.169	0.929
1:00 AM	-1.971	1.323	2.695	0.077	-0.98	-1	1.051	-0.993	0.135
2:00 AM	-0.573	0.414	-0.521	-0.674	-0.48	1.551	-0.482	-0.487	1.725
3:00 AM	0.933	-1.923	0.459	-0.059	0.63	1.924	0.623	-0.743	0.73
4:00 AM	0.755	1.438	0.176	-1.719	-0.407	-0.448	-1.228	-1.241	-1.168
5:00 AM	-1.863	1.844	-0.903	0.545	-0.831	-0.849	-0.834	-0.843	2.988
6:00 AM	-1.24	0.32	-0.706	2.373	-0.65	-0.663	0.881	0.859	-0.62
7:00 AM	-0.174	1.28	-1.277	0.165	0.525	-1.2	-1.18	-1.192	0.661
8:00 AM	-0.975	0.193	2.71	-0.843	2.246	1.102	-0.889	-1.947	-0.195
9:00 AM	0.706	0.087	3.899	-2.615	-0.565	2.758	-1.877	-2.334	-0.831
10:00 AM	-1.579	-1.035	-1.658	1.378	1.771	0.954	1.745	-0.666	3.906
11:00 AM	-0.944	1.893	-0.03	-2.175	-1.973	-1.574	0.361	2.351	0.49
12:00 PM	-1.556	3.447	2.501	-0.059	-1.521	-0.884	-2.318	-2.373	-2.319
1:00 PM	1.425	-1.746	-0.758	1.226	-1.085	-0.63	1.224	-1.452	2.859
2:00 PM	5.083	-2.908	-2.132	-1.126	1.539	0.87	1.029	-2.128	-2.246
3:00 PM	0.31	-1.106	-0.58	-0.105	-0.262	-0.131	0.268	2.111	1.52
4:00 PM	1.132	-1.535	0.582	-0.343	1.225	1.066	-1.814	-0.372	1.595
5:00 PM	-0.759	-0.821	0.25	-1.133	-0.656	1.344	3.243	4.211	-2.296
6:00 PM	-2.407	-0.331	0.595	0.158	1.863	-0.393	-1.018	6.708	-0.412
7:00 PM	-1.279	2.016	-2.135	-0.677	1.21	-0.795	0.044	1.499	-1.693
8:00 PM	-1.596	1.842	-0.05	3.501	-0.631	-1.084	-0.648	-1.761	-2.281
9:00 PM	0.267	-0.932	-2.17	4.674	-1.999	0.412	1.485	-1.532	-0.334
10:00 PM	0.259	-0.21	0.744	-1.219	1.736	-0.282	-0.885	-0.907	1.278
11:00 PM	2.671	-1.109	-0.405	0.316	-1.126	-1.149	-0.245	-1.141	-0.14

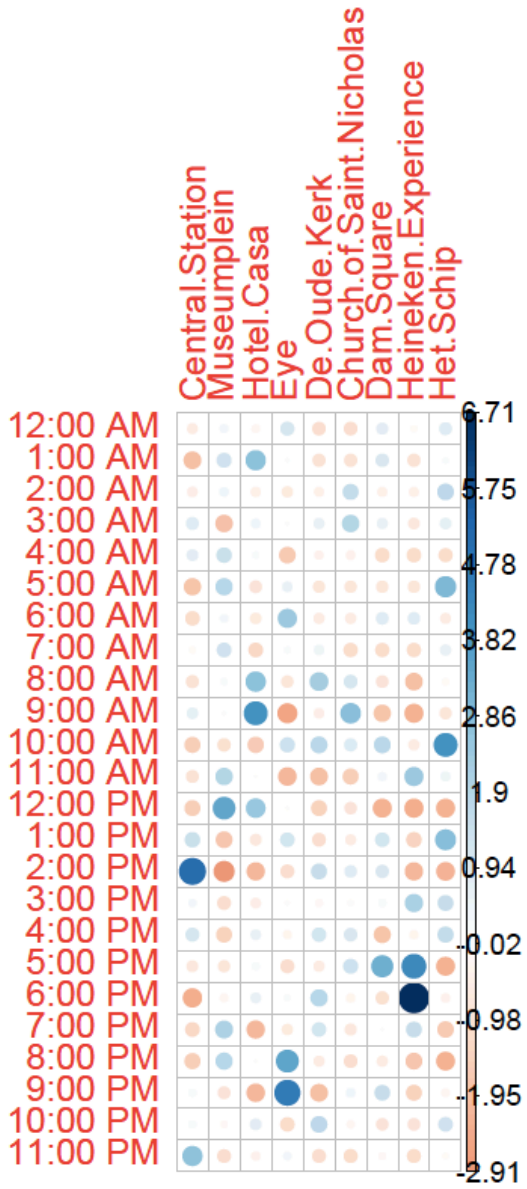


Figure b. 1 Hourly temporal distribution of tourist photographs per POI – Pearson residuals (blue: positive, red: negative)

Table b. 4 Hourly temporal distribution of tourist photographs per POI – chi-square value

hours	Central Station	Museum plein	Hotel Casa	Eye	De Oude Kerk	Church of Saint Nicholas	Dam Square	Heineken Experience	Het Schip	Grand Total
12:00 AM	0.37	0.12	0.09	1.31	1.15	1.20	0.61	0.03	0.86	5.75
1:00 AM	3.88	1.75	7.26	0.01	0.96	1.00	1.10	0.99	0.02	16.97
2:00 AM	0.33	0.17	0.27	0.45	0.23	2.41	0.23	0.24	2.98	7.31
3:00 AM	0.87	3.70	0.21	0.00	0.40	3.70	0.39	0.55	0.53	10.35

4:00 AM	0.57	2.07	0.03	2.95	0.17	0.20	1.51	1.54	1.36	10.40
5:00 AM	3.47	3.40	0.82	0.30	0.69	0.72	0.70	0.71	8.93	19.73
6:00 AM	1.54	0.10	0.50	5.63	0.42	0.44	0.78	0.74	0.38	10.53
7:00 AM	0.03	1.64	1.63	0.03	0.28	1.44	1.39	1.42	0.44	8.29
8:00 AM	0.95	0.04	7.34	0.71	5.04	1.22	0.79	3.79	0.04	19.92
9:00 AM	0.50	0.01	15.20	6.84	0.32	7.61	3.52	5.45	0.69	40.14
10:00 AM	2.49	1.07	2.75	1.90	3.14	0.91	3.05	0.44	15.25	31.00
11:00 AM	0.89	3.58	0.00	4.73	3.89	2.48	0.13	5.53	0.24	21.48
12:00 PM	2.42	11.88	6.25	0.00	2.31	0.78	5.37	5.63	5.38	40.04
1:00 PM	2.03	3.05	0.57	1.50	1.18	0.40	1.50	2.11	8.17	20.51
2:00 PM	25.83	8.46	4.55	1.27	2.37	0.76	1.06	4.53	5.05	53.86
3:00 PM	0.10	1.22	0.34	0.01	0.07	0.02	0.07	4.46	2.31	8.59
4:00 PM	1.28	2.36	0.34	0.12	1.50	1.14	3.29	0.14	2.54	12.70
5:00 PM	0.58	0.67	0.06	1.28	0.43	1.81	10.52	17.73	5.27	38.36
6:00 PM	5.80	0.11	0.35	0.03	3.47	0.15	1.04	45.00	0.17	56.11
7:00 PM	1.64	4.07	4.56	0.46	1.46	0.63	0.00	2.25	2.87	17.93
8:00 PM	2.55	3.39	0.00	12.26	0.40	1.17	0.42	3.10	5.20	28.50
9:00 PM	0.07	0.87	4.71	21.85	3.99	0.17	2.20	2.35	0.11	36.33
10:00 PM	0.07	0.04	0.55	1.49	3.01	0.08	0.78	0.82	1.63	8.48
11:00 PM	7.14	1.23	0.16	0.10	1.27	1.32	0.06	1.30	0.02	12.60
Grand Total	65.39	55.00	58.57	65.23	38.16	31.74	40.51	110.83	70.45	535.89

Pearson's Chi-squared test

data: mydata

X-squared = 535.89, df = 184, p-value < 2.2e-16

Table b. 5 Daily temporal distribution of tourist photographs per POI – observed count

days	Central Station	Museumplein	Hotel Casa	Eye	De Oude Kerk	Church of Saint Nicholas	Dam Square	Heineken Experience	Het Schip	Grand Total
Monday	109	170	26	25	13	9	30	4	15	401
Tuesday	100	153	19	31	31	15	14	21	47	431
Wednesday	99	141	18	61	22	15	27	17	8	408
Thursday	125	217	23	20	27	28	32	30	11	513
Friday	114	228	28	36	14	17	9	22	18	486
Saturday	390	347	39	42	8	40	10	41	9	926
Sunday	171	231	18	71	30	27	24	14	24	610
Grand Total	1108	1487	171	286	145	151	146	149	132	3775

Table b. 6 Daily temporal distribution of tourist photographs per POI – Expected count

days	Central Station	Museumplein	Hotel Casa	Eye	De Oude Kerk	Church of Saint Nicholas	Dam Square	Heineken Experience	Het Schip	Grand Total
Monday	117.70	157.96	18.16	30.38	15.40	16.04	15.51	15.83	14.02	401
Tuesday	126.50	169.77	19.52	32.65	16.55	17.24	16.67	17.01	15.07	431
Wednesday	119.75	160.71	18.48	30.91	15.67	16.32	15.78	16.10	14.27	408
Thursday	150.57	202.07	23.24	38.87	19.70	20.52	19.84	20.25	17.94	513
Friday	142.65	191.44	22.01	36.82	18.67	19.44	18.80	19.18	16.99	486
Saturday	271.79	364.76	41.95	70.16	35.57	37.04	35.81	36.55	32.38	926
Sunday	179.04	240.28	27.63	46.21	23.43	24.40	23.59	24.08	21.33	610
Grand Total	1108	1487	171	286	145	151	146	149	132	3775

Table b. 7 Daily temporal distribution of tourist photographs per POI – Pearson residuals

days	Central Station	Museumplein	Hotel Casa	Eye	De Oude Kerk	Church of Saint Nicholas	Dam Square	Heineken Experience	Het Schip
Monday	-0.802	0.958	1.838	-0.976	-0.612	-1.758	3.68	-2.973	0.261
Tuesday	-2.356	-1.287	-0.118	-0.289	3.55	-0.539	-0.654	0.967	8.225
Wednesday	-1.896	-1.555	-0.112	5.412	1.599	-0.327	2.825	0.223	-1.659
Thursday	-2.084	1.05	-0.049	-3.026	1.643	1.651	2.73	2.167	-1.638
Friday	-2.395	2.642	1.276	-0.135	-1.08	-0.553	-2.26	0.643	0.244
Saturday	7.17	-0.39	-0.455	-3.361	-4.623	0.486	-4.313	0.736	-4.109
Sunday	-0.601	-0.059	-1.832	3.646	1.357	0.526	0.084	-2.054	0.578

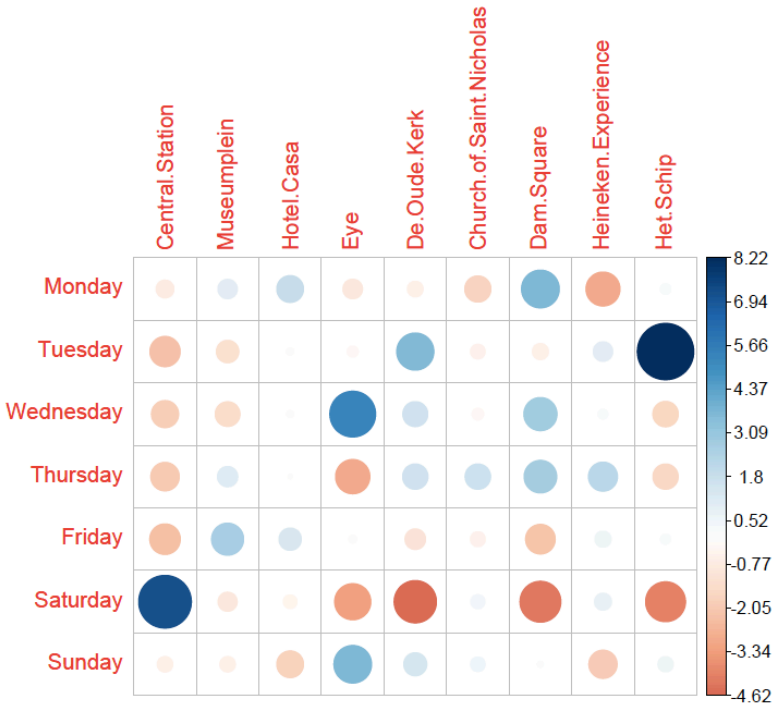


Figure b. 2 Daily temporal distribution of tourist photographs per POI – Pearson residuals (blue: positive, red: negative)

Table b. 8 Daily temporal distribution of tourist photographs per POI – chi-square value

days	Central Station	Museum plein	Hotel Casa	Eye	De Oude Kerk	Church of Saint Nicholas	Dam Square	Heineken Experience	Het Schip	Grand Total
Monday	0.64	0.92	3.38	0.95	0.37	3.09	13.54	8.84	0.07	31.81
Tuesday	5.55	1.66	0.01	0.08	12.60	0.29	0.43	0.94	67.65	89.21
Wednesday	3.60	2.42	0.01	29.29	2.56	0.11	7.98	0.05	2.75	48.76
Thursday	4.34	1.10	0.00	9.16	2.70	2.73	7.45	4.70	2.68	34.86
Friday	5.75	6.98	1.63	0.02	1.17	0.31	5.11	0.41	0.06	21.43
Saturday	51.41	0.86	0.21	11.30	21.37	0.24	18.61	0.54	16.88	121.42
Sunday	0.36	0.36	3.36	13.29	1.84	0.28	0.01	4.22	0.33	24.05
Grand Total	71.66	14.30	8.60	64.09	42.61	7.03	53.12	19.69	90.43	371.54

Pearson's Chi-squared test

X-squared = 371.54, df = 48, p-value < 2.2e-16

Table b. 9 Monthly temporal distribution of tourist photographs per POI – observed count

months	Central Station	Museumplein	Hotel Casa	Eye	De Oude Kerk	Church of Saint Nicholas	Dam Square	Heineken Experience	Het Schip	Grand Total
January	139	55	0	33	8	14	31	0	0	280
February	22	65	0	5	2	5	6	4	0	109
March	40	115	0	4	6	5	8	0	18	196
April	75	113	108	17	6	17	4	23	3	366
May	106	165	41	15	50	11	10	3	11	412
June	76	177	7	52	7	8	10	0	20	357
July	103	282	3	54	0	39	2	11	1	495
August	95	104	2	78	9	13	11	0	21	333
September	20	27	6	3	4	5	12	7	0	84
October	313	273	4	4	33	23	37	3	0	690
November	59	95	0	15	16	4	12	95	58	354
December	60	16	0	6	4	7	3	3	0	99
Grand Total	1108	1487	171	286	145	151	146	149	132	3775

Table b. 10 Monthly temporal distribution of tourist photographs per POI – expected count

months	Central Station	Museum plein	Hotel Casa	Eye	De Oude Kerk	Church of Saint Nicholas	Dam Square	Heineken Experience	Het Schip	Grand Total
January	82.18	110.29	12.68	21.21	10.75	11.20	10.83	11.05	9.79	280
February	31.99	42.94	4.94	8.26	4.19	4.36	4.22	4.30	3.81	109
March	57.53	77.21	8.88	14.85	7.53	7.84	7.58	7.74	6.85	196
April	107.42	144.17	16.58	27.73	14.06	14.64	14.16	14.45	12.80	366
May	120.93	162.29	18.66	31.21	15.83	16.48	15.93	16.26	14.41	412
June	104.78	140.62	16.17	27.05	13.71	14.28	13.81	14.09	12.48	357
July	145.29	194.98	22.42	37.50	19.01	19.80	19.14	19.54	17.31	495
August	97.74	131.17	15.08	25.23	12.79	13.32	12.88	13.14	11.64	333
September	24.65	33.09	3.81	6.36	3.23	3.36	3.25	3.32	2.94	84
October	202.52	271.80	31.26	52.28	26.50	27.60	26.69	27.23	24.13	690
November	103.90	139.44	16.04	26.82	13.60	14.16	13.69	13.97	12.38	354
December	29.06	39.00	4.48	7.50	3.80	3.96	3.83	3.91	3.46	99
Grand Total	1108	1487	171	286	145	151	146	149	132	3775

Table b. 11 Monthly temporal distribution of tourist photographs per POI – Pearson residuals

months	Central Station	Museumplein	Hotel Casa	Eye	De Oude Kerk	Church of Saint Nicholas	Dam Square	Heineken Experience	Het Schip
January	6.267	-5.265	-3.561	2.559	-0.84	0.837	6.13	-3.324	-3.129
February	-1.767	3.367	-2.222	-1.134	-1.069	0.307	0.869	-0.146	-1.952
March	-2.311	4.301	-2.98	-2.815	-0.557	-1.014	0.152	-2.781	4.258
April	-3.128	-2.596	22.453	-2.037	-2.149	0.617	-2.699	2.251	-2.739
May	-1.357	0.213	5.171	-2.902	8.591	-1.35	-1.487	-3.289	-0.897
June	-2.812	3.067	-2.281	4.798	-1.813	-1.662	-1.025	-3.754	2.128
July	-3.508	6.232	-4.102	2.694	-4.36	4.315	-3.918	-1.932	-3.92
August	-0.277	-2.372	-3.369	10.506	-1.06	-0.088	-0.524	-3.625	2.742
September	-0.937	-1.058	1.125	-1.333	0.431	0.895	4.855	2.024	-1.714

October	7.763	0.073	-4.875	-6.677	1.262	-0.876	1.997	-4.644	-4.912
November	-4.405	-3.764	-4.004	-2.282	0.652	-2.7	-0.457	21.677	12.967
December	5.74	-3.683	-2.118	-0.548	0.101	1.528	-0.424	-0.459	-1.861

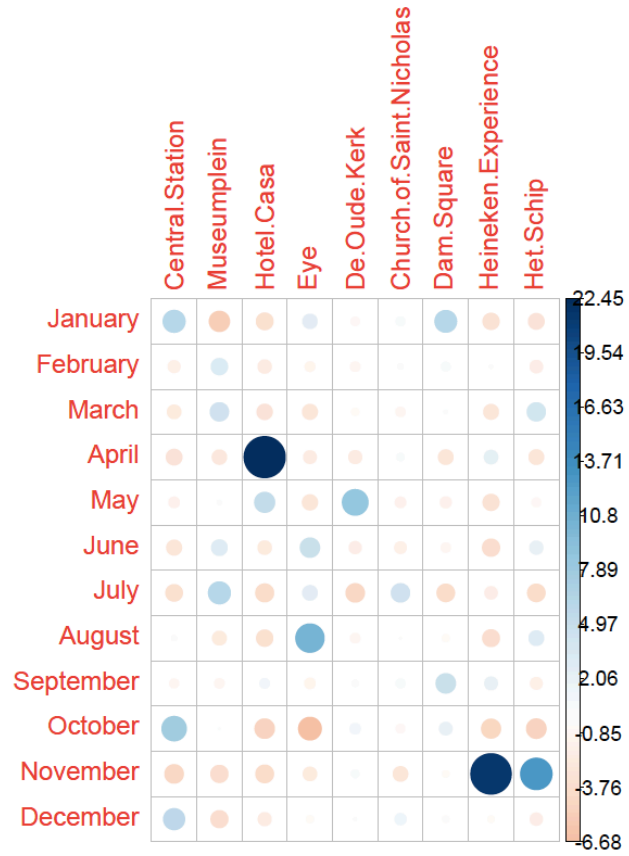


Figure b. 3 Monthly temporal distribution of tourist photographs per POI – Pearson residuals (blue: positive, red: negative)

Table b. 12 Monthly temporal distribution of tourist photographs per POI – chi-square value

months	Central Station	Museum plein	Hotel Casa	Eye	De Oude Kerk	Church of Saint Nicholas	Dam Square	Heineken Experience	Het Schip	Grand Total
January	39.28	27.72	12.68	6.55	0.71	0.70	37.57	11.05	9.79	146.05
February	3.12	11.34	4.94	1.29	1.14	0.09	0.76	0.02	3.81	26.51
March	5.34	18.50	8.88	7.93	0.31	1.03	0.02	7.74	18.13	67.87
April	9.79	6.74	504.12	4.15	4.62	0.38	7.29	5.06	7.50	549.64

May	1.84	0.05	26.74	8.42	73.80	1.82	2.21	10.82	0.81	126.50
June	7.91	9.41	5.20	23.02	3.29	2.76	1.05	14.09	4.53	71.25
July	12.31	38.83	16.82	7.26	19.01	18.62	15.35	3.73	15.37	147.30
August	0.08	5.63	11.35	110.38	1.12	0.01	0.27	13.14	7.52	149.50
September	0.88	1.12	1.27	1.78	0.19	0.80	23.57	4.09	2.94	36.63
October	60.27	0.01	23.77	44.58	1.59	0.77	3.99	21.56	24.13	180.66
November	19.41	14.16	16.04	5.21	0.42	7.29	0.21	469.89	168.14	700.77
December	32.95	13.56	4.48	0.30	0.01	2.33	0.18	0.21	3.46	57.49
Grand Total	193.16	147.07	636.28	220.87	106.21	36.60	92.47	561.41	266.12	2260.19

Pearson's Chi-squared test

X-squared = 2260.2, df = 88, p-value < 2.2e-16

Table b. 13 Yearly temporal distribution of tourist photographs per POI – observed count

years	Central Station	Museum plein	Hotel Casa	Eye	De Oude Kerk	Church of Saint Nicholas	Dam Square	Heineken Experience	Het Schip	Grand Total
1986-2007	14	0	0	0	0	0	0	0	7	21
2008	20	1							55	76
2009	1	1							40	42
2010		6							5	11
2011						1			3	4
2012	1		2			1			12	16
2013	7	23	1	1	33				2	67
2014	18	73	145	1	6	4	6			253
2015	3	7	9			2	2		2	25
2016	6	3	2			4	1		2	18
2017	448	45	12	138	18	37	4	1		703

2018	513	1181		105	72	98	90	145	4	2208
2019	77	147		41	16	4	43	3		331
Grand Total	1108	1487	171	286	145	151	146	149	132	3775

Table b. 14 Yearly temporal distribution of tourist photographs per POI – expected count

years	Central Station	Museum plein	Hotel Casa	Eye	De Oude Kerk	Church of Saint Nicholas	Dam Square	Heineken Experience	Het Schip	Grand Total
1986-2007	6.16	8.27	0.95	1.59	0.81	0.84	0.81	0.83	0.73	21
2008	22.31	29.94	3.44	5.76	2.92	3.04	2.94	3.00	2.66	76
2009	12.33	16.54	1.90	3.18	1.61	1.68	1.62	1.66	1.47	42
2010	3.23	4.33	0.50	0.83	0.42	0.44	0.43	0.43	0.38	11
2011	1.17	1.58	0.18	0.30	0.15	0.16	0.15	0.16	0.14	4
2012	4.70	6.30	0.72	1.21	0.61	0.64	0.62	0.63	0.56	16
2013	19.67	26.39	3.03	5.08	2.57	2.68	2.59	2.64	2.34	67
2014	74.26	99.66	11.46	19.17	9.72	10.12	9.78	9.99	8.85	253
2015	7.34	9.85	1.13	1.89	0.96	1.00	0.97	0.99	0.87	25
2016	5.28	7.09	0.82	1.36	0.69	0.72	0.70	0.71	0.63	18
2017	206.34	276.92	31.84	53.26	27.00	28.12	27.19	27.75	24.58	703
2018	648.07	869.75	100.02	167.28	84.81	88.32	85.40	87.15	77.21	2208
2019	97.15	130.38	14.99	25.08	12.71	13.24	12.80	13.06	11.57	331
Grand Total	1108	1487	171	286	145	151	146	149	132	3775

Table b. 15 Yearly temporal distribution of tourist photographs per POI – Pearson residuals

years	Central Station	Museumplein	Hotel Casa	Eye	De Oude Kerk	Church of Saint Nicholas	Dam Square	Heineken Experience	Het Schip
1986-2007	3.156	-2.876	-0.975	-1.261	-0.898	-0.917	-0.901	-0.91	7.312
2008	-0.488	-5.289	-1.855	-2.4	-1.709	-1.744	-1.714	-1.732	32.108
2009	-3.226	-3.822	-1.379	-1.784	-1.27	-1.296	-1.275	-1.288	31.795
2010	-1.797	0.801	-0.706	-0.913	-0.65	-0.663	-0.652	-0.659	7.442
2011	-1.084	-1.255	-0.426	-0.55	-0.392	2.1	-0.393	-0.397	7.648
2012	-1.706	-2.51	1.498	-1.101	-0.784	0.45	-0.787	-0.795	15.295
2013	-2.856	-0.66	-1.168	-1.809	18.967	-1.637	-1.61	-1.626	-0.224
2014	-6.528	-2.67	39.447	-4.15	-1.193	-1.924	-1.21	-3.16	-2.974
2015	-1.601	-0.907	7.393	-1.376	-0.98	1	1.051	-0.993	1.204
2016	0.312	-1.536	1.312	-1.168	-0.831	3.866	0.364	-0.843	1.728
2017	16.824	-13.937	-3.517	11.611	-1.732	1.675	-4.447	-5.078	-4.958
2018	-5.306	10.554	-10.001	-4.815	-1.391	1.03	0.498	6.197	-8.332
2019	-2.045	1.455	-3.872	3.18	0.922	-2.539	8.44	-2.785	-3.402

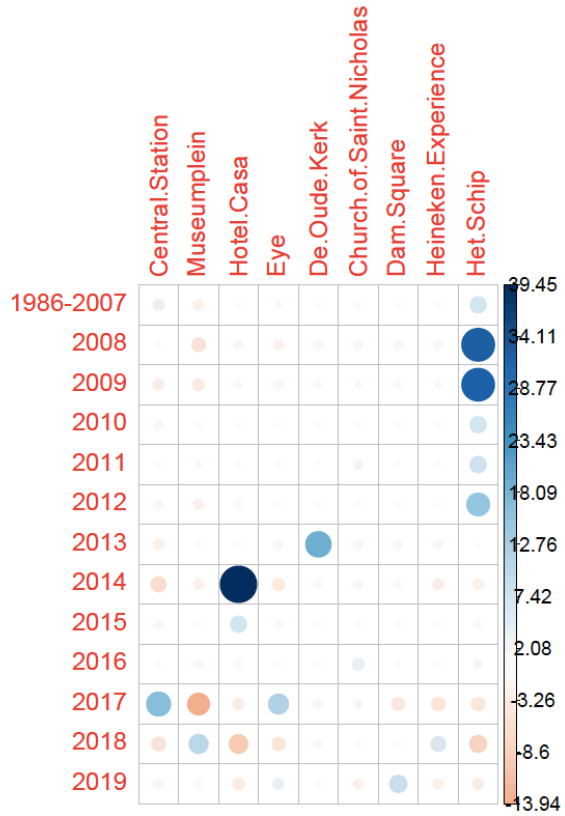


Figure b. 4 Yearly temporal distribution of tourist photographs per POI – Pearson residuals (blue: positive, red: negative)

Table b. 16 Yearly temporal distribution of tourist photographs per POI – chi-square value

years	Central Station	Museumplein	Hotel Casa	Eye	De Oude Kerk	Church of Saint Nicholas	Dam Square	Heineken Experience	Het Schip	Grand Total
1986-2007	9.96	8.27	0.95	1.59	0.81	0.84	0.81	0.83	53.46	77.53
2008	0.24	27.97	3.44	5.76	2.92	3.04	2.94	3.00	1030.95	1080.26
2009	10.41	14.60	1.90	3.18	1.61	1.68	1.62	1.66	1010.93	1047.61
2010	3.23	0.64	0.50	0.83	0.42	0.44	0.43	0.43	55.38	62.30
2011	1.17	1.58	0.18	0.30	0.15	4.41	0.15	0.16	58.49	66.60
2012	2.91	6.30	2.24	1.21	0.61	0.20	0.62	0.63	233.95	248.68
2013	8.16	0.44	1.36	3.27	359.73	2.68	2.59	2.64	0.05	380.93
2014	42.62	7.13	1556.04	17.22	1.42	3.70	1.46	9.99	8.85	1648.43
2015	2.56	0.82	54.66	1.89	0.96	1.00	1.10	0.99	1.45	65.44

2016	0.10	2.36	1.72	1.36	0.69	14.94	0.13	0.71	2.98	25.00
2017	283.04	194.23	12.37	134.82	3.00	2.80	19.78	25.78	24.58	700.40
2018	28.15	111.39	100.02	23.19	1.94	1.06	0.25	38.40	69.41	373.80
2019	4.18	2.12	14.99	10.11	0.85	6.45	71.24	7.75	11.57	129.26
Grand Total	396.73	377.85	1750.38	204.75	375.12	43.25	103.13	92.98	2562.07	5906.25

Pearson's Chi-squared test

X-squared = 5906.3, df = 96, p-value < 2.2e-16

Table b. 17 Hourly temporal distribution of local photographs per POI – observed count

hours	Museumplein	NDSM Werf	Occii	Vondelpark	Eye	Het Stenen Hoofd	Westindische Buurt	Central Station	Sloterdijk	Melkweg	Zuiveringshal West	Zoo Artis	Grand Total
12:00 AM	15	11	2	5	4	27	28	33	37	1	2	9	174
1:00 AM	1	7		1		3	1	1	2				16
2:00 AM	4		1	1	1	2		1	1	1	1	2	15
3:00 AM				2		4	2		2			2	12
4:00 AM		1		1		3	2	1	3				11
5:00 AM		1		4	2	1	1		1		1	2	13
6:00 AM	1	1	1	3			4	2	1		1	2	16
7:00 AM	8	2	1	6		4	3	16	2	1	4	16	63
8:00 AM	11	22	3	8	3	2	1	9	9	1	14	28	111
9:00 AM	15	16	2	3	1	6	11	10	22	6	7	23	122
10:00 AM	30	41	1		9	51	17	23	29	22	3	51	277

11:00 AM	80	19	6	10	95	43	58	48	44	24	15	93	535
12:00 PM	59	24	29	13	15	26	62	70	52	26	20	122	518
1:00 PM	40	53	9	11	6	25	59	38	32	29	17	117	436
2:00 PM	61	41	14	42	10	25	80	53	55	23	30	132	566
3:00 PM	42	50	36	32	17	16	51	93	24	17	26	102	506
4:00 PM	26	49	40	66	14	18	45	35	56	23	15	160	547
5:00 PM	33	29	11	73	21	24	27	26	42	1	15	85	387
6:00 PM	15	20	7	12	3	16	14	21	26	2	19	72	227
7:00 PM	14	12	13	5		13	11	26	49	2	10	54	209
8:00 PM	11	16	5	11	3	46	16	17	12	3	2	43	185
9:00 PM	9	10	2	3	4	30	14	7	12	1		48	140
10:00 PM	3	9	5	11	1	26	9	8	14		2	16	104
11:00 PM	4	6	2	5	3	9	10	3	4			7	53
Grand Total	482	440	190	328	212	420	526	541	531	183	204	1186	5243

Table b. 18 Hourly temporal distribution of local photographs per POI – expected count

hours	Museumplein	NDSM Werf	Occii	Vondelpark	Eye	Het Stenen Hoofd	Westindische Buurt	Central Station	Sloterdijk	Melkweg	Zuiverings hal West	Zoo Artis	Grand Total
12:00 AM	16.00	14.60	6.31	10.89	7.04	13.94	17.46	17.95	17.62	6.07	6.77	39.36	174
1:00 AM	1.47	1.34	0.58	1.00	0.65	1.28	1.61	1.65	1.62	0.56	0.62	3.62	16
2:00 AM	1.38	1.26	0.54	0.94	0.61	1.20	1.50	1.55	1.52	0.52	0.58	3.39	15
3:00 AM	1.10	1.01	0.43	0.75	0.49	0.96	1.20	1.24	1.22	0.42	0.47	2.71	12
4:00 AM	1.01	0.92	0.40	0.69	0.44	0.88	1.10	1.14	1.11	0.38	0.43	2.49	11

5:00 AM	1.20	1.09	0.47	0.81	0.53	1.04	1.30	1.34	1.32	0.45	0.51	2.94	13
6:00 AM	1.47	1.34	0.58	1.00	0.65	1.28	1.61	1.65	1.62	0.56	0.62	3.62	16
7:00 AM	5.79	5.29	2.28	3.94	2.55	5.05	6.32	6.50	6.38	2.20	2.45	14.25	63
8:00 AM	10.20	9.32	4.02	6.94	4.49	8.89	11.14	11.45	11.24	3.87	4.32	25.11	111
9:00 AM	11.22	10.24	4.42	7.63	4.93	9.77	12.24	12.59	12.36	4.26	4.75	27.60	122
10:00 AM	25.47	23.25	10.04	17.33	11.20	22.19	27.79	28.58	28.05	9.67	10.78	62.66	277
11:00 AM	49.18	44.90	19.39	33.47	21.63	42.86	53.67	55.20	54.18	18.67	20.82	121.02	535
12:00 PM	47.62	43.47	18.77	32.41	20.95	41.50	51.97	53.45	52.46	18.08	20.15	117.17	518
1:00 PM	40.08	36.59	15.80	27.28	17.63	34.93	43.74	44.99	44.16	15.22	16.96	98.63	436
2:00 PM	52.03	47.50	20.51	35.41	22.89	45.34	56.78	58.40	57.32	19.76	22.02	128.03	566
3:00 PM	46.52	42.46	18.34	31.66	20.46	40.53	50.76	52.21	51.25	17.66	19.69	114.46	506
4:00 PM	50.29	45.91	19.82	34.22	22.12	43.82	54.88	56.44	55.40	19.09	21.28	123.73	547
5:00 PM	35.58	32.48	14.02	24.21	15.65	31.00	38.83	39.93	39.19	13.51	15.06	87.54	387
6:00 PM	20.87	19.05	8.23	14.20	9.18	18.18	22.77	23.42	22.99	7.92	8.83	51.35	227
7:00 PM	19.21	17.54	7.57	13.07	8.45	16.74	20.97	21.57	21.17	7.29	8.13	47.28	209
8:00 PM	17.01	15.53	6.70	11.57	7.48	14.82	18.56	19.09	18.74	6.46	7.20	41.85	185
9:00 PM	12.87	11.75	5.07	8.76	5.66	11.21	14.05	14.45	14.18	4.89	5.45	31.67	140
10:00 PM	9.56	8.73	3.77	6.51	4.21	8.33	10.43	10.73	10.53	3.63	4.05	23.53	104
11:00 PM	4.87	4.45	1.92	3.32	2.14	4.25	5.32	5.47	5.37	1.85	2.06	11.99	53
Grand Total	482	440	190	328	212	420	526	541	531	183	204	1186	5243

Table b. 19 Yearly temporal distribution of local photographs per POI – Pearson residuals

hours	Museumplein	NDSM Werf	Occii	Vondelpark	Eye	Het Stenen Hoofd	Westindische Buurt	Central Station	Sloterdijk	Melkweg	Zuiveringshal West	Zoo Artis
12:00 AM	-0.249	-0.943	-1.715	-1.784	-1.144	3.498	2.524	3.551	4.616	-2.059	-1.833	-4.839
1:00 AM	-0.388	4.882	-0.761	-0.001	-0.804	1.518	-0.478	-0.507	0.298	-0.747	-0.789	-1.902
2:00 AM	2.232	-1.122	0.619	0.064	0.505	0.728	-1.227	-0.44	-0.421	0.658	0.545	-0.756
3:00 AM	-1.05	-1.004	-0.659	1.442	-0.697	3.099	0.726	-1.113	0.712	-0.647	-0.683	-0.434
4:00 AM	-1.006	0.08	-0.631	0.376	-0.667	2.257	0.853	-0.127	1.787	-0.62	-0.654	-1.577
5:00 AM	-1.093	-0.087	-0.686	3.534	2.034	-0.041	-0.266	-1.158	-0.276	-0.674	0.695	-0.549
6:00 AM	-0.388	-0.296	0.552	1.998	-0.804	-1.132	1.89	0.272	-0.487	-0.747	0.478	-0.851
7:00 AM	0.918	-1.43	-0.849	1.037	-1.596	-0.466	-1.321	3.726	-1.734	-0.809	0.989	0.463
8:00 AM	0.249	4.156	-0.51	0.401	-0.702	-2.311	-3.037	-0.725	-0.669	-1.46	4.658	0.577
9:00 AM	1.13	1.801	-1.151	-1.677	-1.771	-1.207	-0.354	-0.73	2.744	0.844	1.034	-0.875
10:00 AM	0.899	3.682	-2.853	-4.163	-0.657	6.116	-2.047	-1.044	0.179	3.966	-2.369	-1.473
11:00 AM	4.394	-3.865	-3.04	-4.057	15.774	0.022	0.591	-0.97	-1.383	1.233	-1.275	-2.547
12:00 PM	1.649	-2.953	2.361	-3.409	-1.299	-2.405	1.392	2.264	-0.064	1.863	-0.034	0.446
1:00 PM	-0.013	2.713	-1.711	-3.116	-2.77	-1.68	2.307	-1.042	-1.829	3.533	0.009	1.85
2:00 PM	1.243	-0.943	-1.438	1.108	-2.694	-3.021	3.081	-0.707	-0.307	0.73	1.7	0.351
3:00 PM	-0.662	1.156	4.125	0.061	-0.765	-3.854	0.033	5.645	-3.806	-0.157	1.423	-1.165
4:00 PM	-3.425	0.457	4.532	5.433	-1.726	-3.9	-1.333	-2.854	0.081	0.894	-1.362	3.26
5:00 PM	-0.432	-0.61	-0.808	9.916	1.353	-1.257	-1.898	-2.205	0.448	-3.403	-0.015	-0.272
6:00 PM	-1.285	0.218	-0.428	-0.584	-2.039	-0.512	-1.838	-0.501	0.628	-2.104	3.421	2.882

7:00 PM	-1.189	-1.323	1.972	-2.233	-2.907	-0.915	-2.177	0.955	6.05	-1.96	0.655	0.978
8:00 PM	-1.457	0.12	-0.658	-0.169	-1.638	8.1	-0.594	-0.478	-1.556	-1.361	-1.937	0.178
9:00 PM	-1.079	-0.51	-1.364	-1.946	-0.698	5.609	-0.012	-1.959	-0.579	-1.758	-2.334	2.902
10:00 PM	-2.122	0.092	0.634	1.762	-1.563	6.122	-0.444	-0.834	1.068	-1.905	-1.017	-1.552
11:00 PM	-0.395	0.736	0.057	0.925	0.585	2.307	2.031	-1.056	-0.59	-1.36	-1.436	-1.441

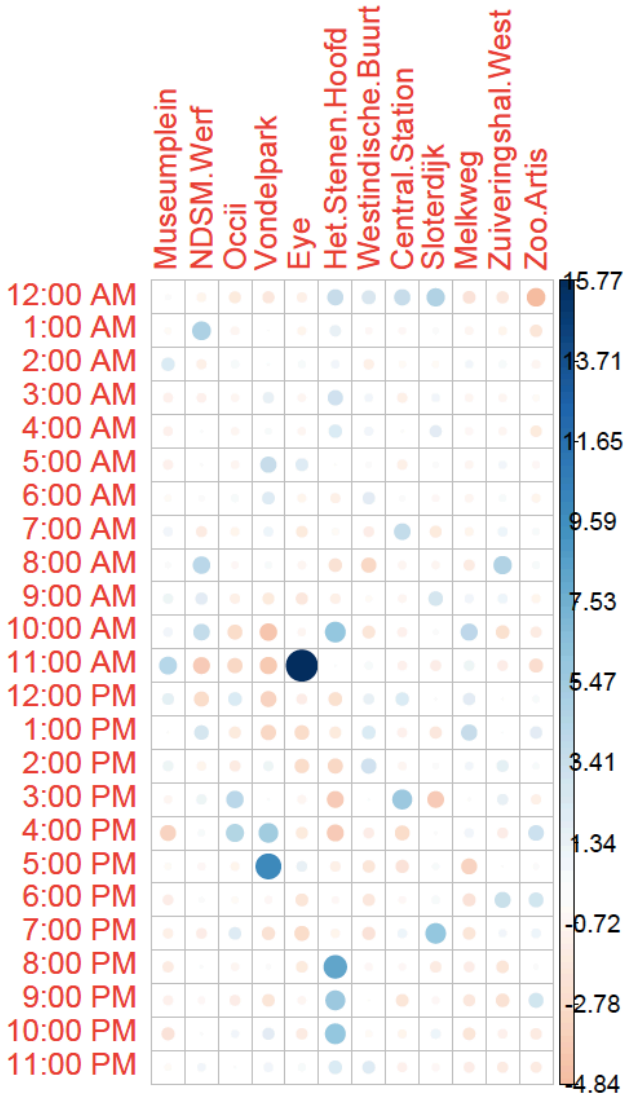


Figure b. 5 Hourly temporal distribution of local photographs per POI – Pearson residuals (blue: positive, red: negative

Table b. 20 Hourly temporal distribution of local photographs per POI – chi-square value

hours	Museumplein	NDSM Werf	Occii	Vondelpark	Eye	Het Stenen Hoofd	Westindische Buurt	Central Station	Sloterdijk	Melkweg	Zuiverings hal West	Zoo Artis	Grand Total
12:00 AM	0.06	0.89	2.94	3.18	1.31	12.24	6.37	12.61	21.31	4.24	3.36	23.42	91.92
1:00 AM	0.15	23.84	0.58	0.00	0.65	2.30	0.23	0.26	0.09	0.56	0.62	3.62	32.89
2:00 AM	4.98	1.26	0.38	0.00	0.26	0.53	1.50	0.19	0.18	0.43	0.30	0.57	10.59
3:00 AM	1.10	1.01	0.43	2.08	0.49	9.61	0.53	1.24	0.51	0.42	0.47	0.19	18.06
4:00 AM	1.01	0.01	0.40	0.14	0.44	5.09	0.73	0.02	3.19	0.38	0.43	2.49	14.33
5:00 AM	1.20	0.01	0.47	12.49	4.14	0.00	0.07	1.34	0.08	0.45	0.48	0.30	21.02
6:00 AM	0.15	0.09	0.30	3.99	0.65	1.28	3.57	0.07	0.24	0.56	0.23	0.72	11.86
7:00 AM	0.84	2.04	0.72	1.08	2.55	0.22	1.74	13.88	3.01	0.65	0.98	0.21	27.93
8:00 AM	0.06	17.27	0.26	0.16	0.49	5.34	9.23	0.53	0.45	2.13	21.70	0.33	57.96
9:00 AM	1.28	3.24	1.33	2.81	3.14	1.46	0.13	0.53	7.53	0.71	1.07	0.77	23.98
10:00 AM	0.81	13.56	8.14	17.33	0.43	37.41	4.19	1.09	0.03	15.73	5.61	2.17	106.49
11:00 AM	19.31	14.94	9.24	16.46	248.83	0.00	0.35	0.94	1.91	1.52	1.63	6.49	321.61
12:00 PM	2.72	8.72	5.57	11.62	1.69	5.79	1.94	5.12	0.00	3.47	0.00	0.20	46.84
1:00 PM	0.00	7.36	2.93	9.71	7.67	2.82	5.32	1.09	3.35	12.48	0.00	3.42	56.15
2:00 PM	1.55	0.89	2.07	1.23	7.26	9.13	9.49	0.50	0.09	0.53	2.89	0.12	35.74
3:00 PM	0.44	1.34	17.01	0.00	0.59	14.85	0.00	31.86	14.49	0.02	2.02	1.36	83.99
4:00 PM	11.73	0.21	20.54	29.51	2.98	15.21	1.78	8.15	0.01	0.80	1.85	10.63	103.40
5:00 PM	0.19	0.37	0.65	98.32	1.83	1.58	3.60	4.86	0.20	11.58	0.00	0.07	123.26
6:00 PM	1.65	0.05	0.18	0.34	4.16	0.26	3.38	0.25	0.39	4.43	11.70	8.31	35.11

7:00 PM	1.41	1.75	3.89	4.99	8.45	0.84	4.74	0.91	36.60	3.84	0.43	0.96	68.80
8:00 PM	2.12	0.01	0.43	0.03	2.68	65.60	0.35	0.23	2.42	1.85	3.75	0.03	79.52
9:00 PM	1.16	0.26	1.86	3.79	0.49	31.46	0.00	3.84	0.33	3.09	5.45	8.42	60.16
10:00 PM	4.50	0.01	0.40	3.10	2.44	37.47	0.20	0.70	1.14	3.63	1.04	2.41	57.04
11:00 PM	0.16	0.54	0.00	0.86	0.34	5.32	4.12	1.11	0.35	1.85	2.06	2.08	18.80
Grand Total	58.58	99.66	80.74	223.22	303.94	265.82	63.56	91.32	97.89	75.37	68.08	79.28	1507.46

Pearson's Chi-squared test

X-squared = 1507.5, df = 253 p-value < 2.2e-16

Table b. 21 Daily temporal distribution of local photographs per POI – observed value

days	Museumplein	NDSM Werf	Occii	Vondelpark	Eye	Het Stenen Hoofd	Westindische Buurt	Central Station	Sloterdijk	Melkweg	Zuiverings hal West	Zoo Artis	Grand Total
Monday	26	34	11	24	18	41	51	54	40	11	7	105	422
Tuesday	13	40	10	18	21	66	43	70	89	4	14	165	553
Wednesday	27	38	22	18	10	26	159	73	38	77	33	151	672
Thursday	26	76	34	20	81	55	80	77	75	21	29	122	696
Friday	94	65	34	28	10	104	42	49	61	39	8	129	663
Saturday	200	89	47	49	24	48	73	137	151	23	65	194	1100
Sunday	96	98	32	171	48	80	78	81	77	8	48	320	1137
Grand Total	482	440	190	328	212	420	526	541	531	183	204	1186	5243

Table b. 22 Daily temporal distribution of local photographs per POI – expected value

days	Museumplein	NDSM Werf	Occii	Vondelpark	Eye	Het Stenen Hoofd	Westindische Buurt	Central Station	Sloterdijk	Melkweg	Zuiveringshal West	Zoo Artis	Grand Total
Monday	38.80	35.41	15.29	26.40	17.06	33.81	42.34	43.54	42.74	14.73	16.42	95.46	422
Tuesday	50.84	46.41	20.04	34.60	22.36	44.30	55.48	57.06	56.01	19.30	21.52	125.09	553
Wednesday	61.78	56.40	24.35	42.04	27.17	53.83	67.42	69.34	68.06	23.46	26.15	152.01	672
Thursday	63.98	58.41	25.22	43.54	28.14	55.75	69.83	71.82	70.49	24.29	27.08	157.44	696
Friday	60.95	55.64	24.03	41.48	26.81	53.11	66.51	68.41	67.15	23.14	25.80	149.97	663
Saturday	101.13	92.31	39.86	68.82	44.48	88.12	110.36	113.50	111.41	38.39	42.80	248.83	1100
Sunday	104.53	95.42	41.20	71.13	45.97	91.08	114.07	117.32	115.15	39.69	44.24	257.20	1137
Grand Total	482	440	190	328	212	420	526	541	531	183	204	1186	5243

Table b. 23 Daily temporal distribution of local photographs per POI – Pearson residuals

days	Museumplein	NDSM Werf	Occii	Vondelpark	Eye	Het Stenen Hoofd	Westindische Buurt	Central Station	Sloterdijk	Melkweg	Zuiveringshal West	Zoo Artis
Monday	-2.054	-0.238	-1.098	-0.467	0.227	1.237	1.331	1.585	-0.419	-0.972	-2.325	0.977
Tuesday	-5.307	-0.941	-2.243	-2.821	-0.288	3.26	-1.675	1.713	4.409	-3.483	-1.62	3.568
Wednesday	-4.425	-2.45	-0.477	-3.708	-3.294	-3.793	11.154	0.439	-3.644	11.056	1.34	-0.082
Thursday	-4.749	2.302	1.748	-3.568	9.964	-0.101	1.218	0.612	0.537	-0.668	0.369	-2.824
Friday	4.233	1.255	2.035	-2.093	-3.246	6.983	-3.006	-2.347	-0.75	3.297	-3.504	-1.713
Saturday	9.832	-0.345	1.13	-2.389	-3.071	-4.274	-3.556	2.205	3.751	-2.484	3.393	-3.476
Sunday	-0.834	0.264	-1.434	11.841	0.299	-1.161	-3.377	-3.353	-3.555	-5.03	0.565	3.916

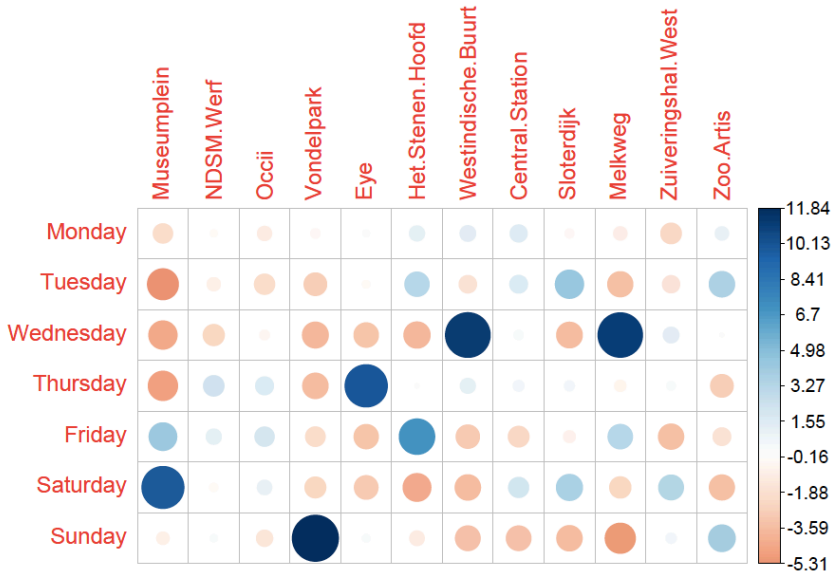


Figure b. 6 Daily temporal distribution of local photographs per POI – Pearson residuals (blue: positive, red: negative)

Table b. 24 Daily temporal distribution of local photographs per POI – chi-square value

days	Museumplein	NDSM Werf	Occii	Vondelpark	Eye	Het Stenen Hoofd	Westindische Buurt	Central Station	Sloterdijk	Melkweg	Zuiveringshal West	Zoo Artis	Grand Total
Monday	4.22	0.06	1.21	0.22	0.05	1.53	1.77	2.51	0.18	0.94	5.40	0.95	19.04
Tuesday	28.16	0.88	5.03	7.96	0.08	10.63	2.81	2.93	19.44	12.13	2.63	12.73	105.42
Wednesday	19.58	6.00	0.23	13.75	10.85	14.39	124.41	0.19	13.28	122.23	1.80	0.01	326.71
Thursday	22.55	5.30	3.05	12.73	99.28	0.01	1.48	0.37	0.29	0.45	0.14	7.98	153.62
Friday	17.92	1.57	4.14	4.38	10.54	48.76	9.04	5.51	0.56	10.87	12.28	2.93	128.50
Saturday	96.67	0.12	1.28	5.71	9.43	18.26	12.65	4.86	14.07	6.17	11.52	12.08	192.82
Sunday	0.70	0.07	2.06	140.22	0.09	1.35	11.40	11.24	12.64	25.30	0.32	15.34	220.72
Grand Total	189.80	14.00	16.99	184.96	130.32	94.93	163.56	27.63	60.45	178.09	34.07	52.02	1146.83

Pearson's Chi-squared test

X-squared = 1146.8, df = 66, p-value < 2.2e-16

Table b. 25 Monthly temporal distribution of local photographs per POI – observed value

months	Museumplein	NDSM Werf	Occii	Vondelpark	Eye	Het Stenen Hoofd	Westindische Buurt	Central Station	Sloterdijk	Melkweg	Zuiverings hal West	Zoo Artis	Grand Total
January	34	29	5	6	16	26	30	27	32	3	3	53	264
February	57	51	14	7	16	16	25	99	37	1	7	56	386
March	50	52	27	25	96	13	40	56	70	142	42	156	769
April	28	45	26	26	8	50	34	84	100	8	52	111	572
May	84	40	11	10	5	19	26	32	29	3	25	76	360
June	87	76	21	17	8	30	36	72	27	1	6	164	545
July	38	43	10	11	9	17	20	15	33	3	4	65	268
August	39	19	4	160	10	33	15	32	48	1	13	80	454
September	27	23	18	12	27	51	23	29	28	4	11	111	364
October	13	24	24	26	5	73	183	35	39	8	29	134	593
November	6	18	16	13	4	34	35	23	32	4	8	108	301
December	19	20	14	15	8	58	59	37	56	5	4	72	367
Grand Total	482	440	190	328	212	420	526	541	531	183	204	1186	5243

Table b. 26 Monthly temporal distribution of local photographs per POI – expected value

months	Museumplein	NDSM Werf	Occii	Vondelpark	Eye	Het Stenen Hoofd	Westindische Buurt	Central Station	Sloterdijk	Melkweg	Zuiverings hal West	Zoo Artis	Grand Total
January	24.27	22.16	9.57	16.52	10.67	21.15	26.49	27.24	26.74	9.21	10.27	59.72	264
February	35.49	32.39	13.99	24.15	15.61	30.92	38.73	39.83	39.09	13.47	15.02	87.32	386
March	70.70	64.54	27.87	48.11	31.09	61.60	77.15	79.35	77.88	26.84	29.92	173.95	769
April	52.59	48.00	20.73	35.78	23.13	45.82	57.39	59.02	57.93	19.96	22.26	129.39	572
May	33.10	30.21	13.05	22.52	14.56	28.84	36.12	37.15	36.46	12.57	14.01	81.43	360
June	50.10	45.74	19.75	34.09	22.04	43.66	54.68	56.24	55.20	19.02	21.21	123.28	545

July	24.64	22.49	9.71	16.77	10.84	21.47	26.89	27.65	27.14	9.35	10.43	60.62	268
August	41.74	38.10	16.45	28.40	18.36	36.37	45.55	46.85	45.98	15.85	17.66	102.70	454
September	33.46	30.55	13.19	22.77	14.72	29.16	36.52	37.56	36.87	12.70	14.16	82.34	364
October	54.52	49.77	21.49	37.10	23.98	47.50	59.49	61.19	60.06	20.70	23.07	134.14	593
November	27.67	25.26	10.91	18.83	12.17	24.11	30.20	31.06	30.48	10.51	11.71	68.09	301
December	33.74	30.80	13.30	22.96	14.84	29.40	36.82	37.87	37.17	12.81	14.28	83.02	367
Grand Total	482	440	190	328	212	420	526	541	531	183	204	1186	5243

Table b. 27 Monthly temporal distribution of local photographs per POI – Pearson residuals

months	Museumplein	NDSM Werf	Occii	Vondelpark	Eye	Het Stenen Hoofd	Westindische Buurt	Central Station	Sloterdijk	Melkweg	Zuiveringshal West	Zoo Artis
January	1.975	1.454	-1.477	-2.588	1.63	1.055	0.683	-0.046	1.018	-2.047	-2.269	-0.869
February	3.612	3.269	0.003	-3.49	0.099	-2.683	-2.206	9.376	-0.335	-3.398	-2.069	-3.351
March	-2.461	-1.56	-0.164	-3.332	11.64	-6.192	-4.229	-2.621	-0.893	22.228	2.208	-1.361
April	-3.39	-0.433	1.158	-1.636	-3.146	0.617	-3.087	3.251	5.527	-2.678	6.305	-1.617
May	8.849	1.781	-0.566	-2.638	-2.505	-1.832	-1.683	-0.844	-1.235	-2.698	2.937	-0.602
June	5.213	4.475	0.281	-2.928	-2.99	-2.067	-2.526	2.102	-3.795	-4.132	-3.302	3.667
July	2.692	4.325	0.092	-1.408	-0.558	-0.964	-1.328	-2.406	1.124	-2.078	-1.99	0.562
August	-0.424	-3.094	-3.07	24.693	-1.951	-0.559	-4.526	-2.169	0.298	-3.73	-1.11	-2.24
September	-1.117	-1.366	1.324	-2.257	3.201	4.045	-2.237	-1.397	-1.46	-2.442	-0.84	3.159
October	-5.623	-3.652	0.542	-1.822	-3.876	3.699	16.013	-3.348	-2.717	-2.791	1.234	-0.012
November	-4.12	-1.445	1.542	-1.344	-2.342	2.014	0.874	-1.446	0.274	-2.007	-1.085	4.837
December	-2.537	-1.946	0.192	-1.661	-1.775	5.275	3.655	-0.141	3.089	-2.182	-2.72	-1.209
Grand Total	482	440	190	328	212	420	526	541	531	183	204	1186

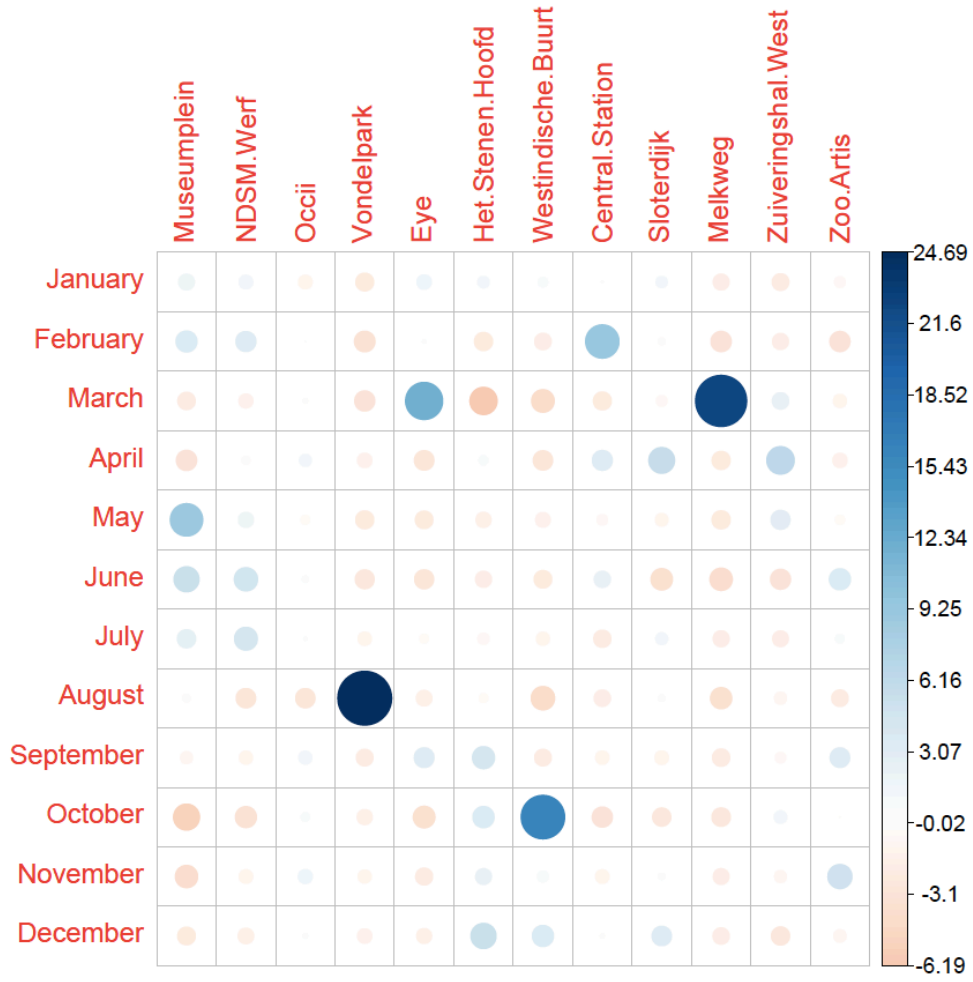


Figure b. 7 Monthly temporal distribution of local photographs per POI – Pearson residuals (blue: positive, red: negative)

Table b. 28 Monthly temporal distribution of local photographs per POI – chi-square value

months	Museumplein	NDSM Werf	Occii	Vondelpark	Eye	Het Stenen Hoofd	Westindische Buurt	Central Station	Sloterdijk	Melkweg	Zuiveringshal West	Zoo Artis	Grand Total
January	3.90	2.11	2.18	6.70	2.66	1.11	0.47	0.00	1.04	4.19	5.15	0.76	30.26
February	13.04	10.69	0.00	12.18	0.01	7.20	4.86	87.90	0.11	11.55	4.28	11.23	163.06
March	6.06	2.43	0.03	11.10	135.48	38.35	17.89	6.87	0.80	494.08	4.88	1.85	719.82
April	11.49	0.19	1.34	2.68	9.90	0.38	9.53	10.57	30.55	7.17	39.75	2.61	126.16
May	78.30	3.17	0.32	6.96	6.27	3.36	2.83	0.71	1.53	7.28	8.63	0.36	119.73
June	27.17	20.02	0.08	8.57	8.94	4.27	6.38	4.42	14.40	17.08	10.90	13.45	135.69
July	7.25	18.70	0.01	1.98	0.31	0.93	1.76	5.79	1.26	4.32	3.96	0.32	46.59

August	0.18	9.58	9.42	609.75	3.80	0.31	20.49	4.70	0.09	13.91	1.23	5.02	678.48
September	1.25	1.86	1.75	5.10	10.25	16.36	5.00	1.95	2.13	5.96	0.71	9.98	62.30
October	31.62	13.34	0.29	3.32	15.02	13.68	256.41	11.21	7.38	7.79	1.52	0.00	361.58
November	16.97	2.09	2.38	1.81	5.49	4.05	0.76	2.09	0.08	4.03	1.18	23.40	64.31
December	6.44	3.79	0.04	2.76	3.15	27.82	13.36	0.02	9.54	4.76	7.40	1.46	80.54
Grand Total	203.67	87.97	17.84	672.89	201.28	117.84	339.75	136.24	68.91	582.12	89.59	70.43	2588.53

Pearson's Chi-squared test

X-squared = 590.3, df = 121,p-value < 2.2e-16

Table b. 29 Yearly temporal distribution of local photographs per POI – observed value

years	Museumplein	NDSM Werf	Occii	Vondelpark	Eye	Het Stenen Hoofd	Westindische Buurt	Central Station	Sloterdijk	Melkweg	Zuiveringshal West	Zoo Artis	Grand Total
1927-2007	32	25	2	2	3	1	30	36	17	3	1	41	193
2008	4	4	5	4	4	1	15	4	4	5		6	56
2009	19	13	1	2	1	1	16	7	14		1	22	97
2010	16	13	3	6	11	2	8	28	6	1	5	44	143
2011	21	27	12	9	4	6	10	35	18		6	44	192
2012	9	22	4	12	1	17	48	39	33	3	7	97	292
2013	42	26	8	20	24	58	17	30	30	2	9	65	331
2014	51	30	19	25	8	65	23	25	14	2	16	87	365
2015	36	30	23	187	17	29	25	70	89		80	133	719
2016	18	49	58	14	14	24	44	50	48	6	16	119	460
2017	21	100	20	13	4	94	39	67	27	5	17	167	574
2018	157	65	26	28	10	106	213	88	158	11	40	229	1131

2019	56	36	9	6	111	16	38	62	73	145	6	132	690
Grand Total	482	440	190	328	212	420	526	541	531	183	204	1186	5243

Table b. 30 Yearly temporal distribution of local photographs per POI – expected value

years	Museumplein	NDSM Werf	Occii	Vondelpark	Eye	Het Stenen Hoofd	Westindische Buurt	Central Station	Sloterdijk	Melkweg	Zuiveringshal West	Zoo Artis	Grand Total
1927-2007	17.74	16.20	6.99	12.07	7.80	15.46	19.36	19.91	19.55	6.74	7.51	43.66	193
2008	5.15	4.70	2.03	3.50	2.26	4.49	5.62	5.78	5.67	1.95	2.18	12.67	56
2009	8.92	8.14	3.52	6.07	3.92	7.77	9.73	10.01	9.82	3.39	3.77	21.94	97
2010	13.15	12.00	5.18	8.95	5.78	11.46	14.35	14.76	14.48	4.99	5.56	32.35	143
2011	17.65	16.11	6.96	12.01	7.76	15.38	19.26	19.81	19.45	6.70	7.47	43.43	192
2012	26.84	24.51	10.58	18.27	11.81	23.39	29.29	30.13	29.57	10.19	11.36	66.05	292
2013	30.43	27.78	12.00	20.71	13.38	26.52	33.21	34.15	33.52	11.55	12.88	74.87	331
2014	33.56	30.63	13.23	22.83	14.76	29.24	36.62	37.66	36.97	12.74	14.20	82.57	365
2015	66.10	60.34	26.06	44.98	29.07	57.60	72.13	74.19	72.82	25.10	27.98	162.64	719
2016	42.29	38.60	16.67	28.78	18.60	36.85	46.15	47.47	46.59	16.06	17.90	104.05	460
2017	52.77	48.17	20.80	35.91	23.21	45.98	57.59	59.23	58.13	20.03	22.33	129.84	574
2018	103.98	94.92	40.99	70.75	45.73	90.60	113.47	116.70	114.55	39.48	44.01	255.84	1131
2019	63.43	57.91	25.00	43.17	27.90	55.27	69.22	71.20	69.88	24.08	26.85	156.08	690
Grand Total	482	440	190	328	212	420	526	541	531	183	204	1186	5243

Table b. 31 Yearly temporal distribution of local photographs per POI – Pearson residuals

years	Museumplein	NDSM Werf	Occii	Vondelpark	Eye	Het Stenen Hoofd	Westindische Buurt	Central Station	Sloterdijk	Melkweg	Zuiveringshal West	Zoo Artis
1927-2007	3.385	2.187	-1.888	-2.899	-1.72	-3.678	2.417	3.604	-0.576	-1.44	-2.375	-0.402
2008	-0.506	-0.323	2.085	0.265	1.153	-1.646	3.958	-0.74	-0.702	2.178	-1.476	-1.873
2009	3.376	1.703	-1.342	-1.651	-1.476	-2.429	2.009	-0.951	1.332	-1.84	-1.428	0.012
2010	0.787	0.288	-0.959	-0.985	2.17	-2.794	-1.676	3.448	-2.229	-1.786	-0.239	2.049
2011	0.797	2.712	1.912	-0.869	-1.351	-2.392	-2.11	3.412	-0.328	-2.589	-0.538	0.086
2012	-3.444	-0.506	-2.023	-1.466	-3.145	-1.321	3.456	1.616	0.63	-2.253	-1.294	3.808
2013	2.098	-0.337	-1.154	-0.155	2.902	6.114	-2.813	-0.711	-0.608	-2.811	-1.081	-1.141
2014	3.012	-0.114	1.587	0.453	-1.759	6.613	-2.25	-2.063	-3.777	-3.009	0.477	0.488
2015	-3.702	-3.906	-0.599	21.176	-2.239	-3.768	-5.55	-0.486	1.896	-5.01	9.836	-2.324
2016	-3.735	1.673	10.123	-2.755	-1.067	-2.117	-0.316	0.368	0.207	-2.51	-0.449	1.465
2017	-4.373	7.468	-0.176	-3.823	-3.987	7.081	-2.449	1.01	-4.083	-3.359	-1.129	3.261
2018	5.2	-3.071	-2.341	-5.083	-5.284	1.618	9.344	-2.657	4.06	-4.532	-0.604	-1.678
2019	-0.933	-2.879	-3.201	-5.657	15.733	-5.283	-3.753	-1.09	0.373	24.639	-4.023	-1.928
Grand Total	3.385	2.187	-1.888	-2.899	-1.72	-3.678	2.417	3.604	-0.576	-1.44	-2.375	-0.402

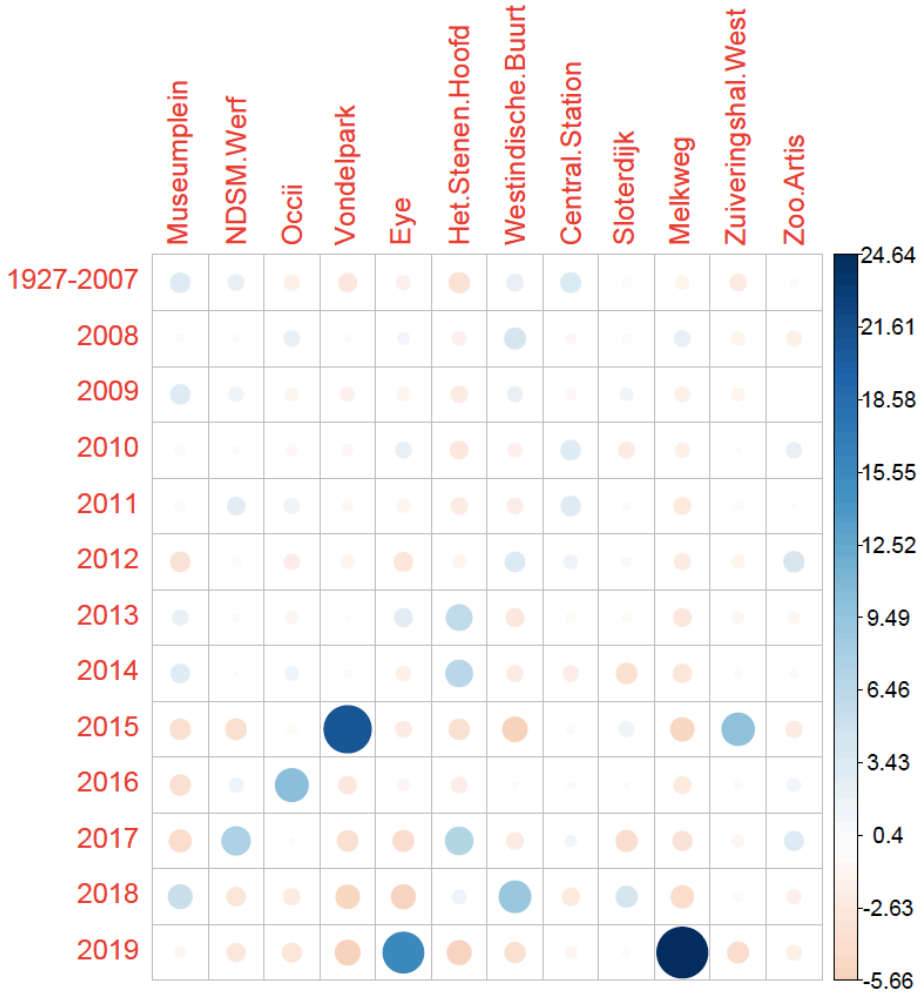


Figure b. 8 Yearly temporal distribution of local photographs per POI – Pearson residuals (blue: positive, red: negative)

Table b. 32 Yearly temporal distribution of local photographs per POI – chi-square value

years	Museumplein	NDSM Werf	Occii	Vondelpark	Eye	Het Stenen Hoofd	Westindische Buurt	Central Station	Sloterdijk	Melkweg	Zuiverings hal West	Zoo Artis	Grand Total
1927-2007	11.46	4.78	3.57	8.41	2.96	13.53	5.84	12.99	0.33	2.07	5.64	0.16	71.74
2008	0.26	0.10	4.35	0.07	1.33	2.71	15.67	0.55	0.49	4.74	2.18	3.51	35.96
2009	11.40	2.90	1.80	2.73	2.18	5.90	4.04	0.90	1.78	3.39	2.04	0.00	39.05
2010	0.62	0.08	0.92	0.97	4.71	7.80	2.81	11.89	4.97	3.19	0.06	4.20	42.22
2011	0.64	7.36	3.65	0.76	1.82	5.72	4.45	11.64	0.11	6.70	0.29	0.01	43.15
2012	11.86	0.26	4.09	2.15	9.89	1.75	11.94	2.61	0.40	5.07	1.67	14.50	66.20
2013	4.40	0.11	1.33	0.02	8.42	37.39	7.91	0.51	0.37	7.90	1.17	1.30	70.83

2014	9.07	0.01	2.52	0.21	3.10	43.74	5.06	4.26	14.27	9.05	0.23	0.24	91.75
2015	13.71	15.26	0.36	448.41	5.01	14.20	30.80	0.24	3.60	25.10	96.75	5.40	658.81
2016	13.95	2.80	102.47	7.59	1.14	4.48	0.10	0.14	0.04	6.30	0.20	2.15	141.35
2017	19.13	55.77	0.03	14.62	15.90	50.15	6.00	1.02	16.67	11.28	1.27	10.63	202.47
2018	27.04	9.43	5.48	25.84	27.92	2.62	87.31	7.06	16.49	20.54	0.36	2.82	232.90
2019	0.87	8.29	10.24	32.00	247.51	27.91	14.08	1.19	0.14	607.09	16.19	3.72	969.22
Grand Total	124.39	107.15	140.81	543.76	331.89	217.88	196.02	54.99	59.65	712.43	128.05	48.63	2665.64

Pearson's Chi-squared test

X-squared = 2665.6, df = 132,= 121,p-value < 2.2e-16

Table b. 33 Hourly temporal distribution of tourist photographs per heritage type- observed value

hours	Catering	Church	Culture-Sport	Governmental Building	House	Industrial Building	Office Building	Remains	Shopping	Storage	Transportation	Uncategorised	Grand Total
12:00 AM	3	2	32		138	2	5	2	6	3		2	195
1:00 AM	4		52	1	61	2	9	2	7	4		1	143
2:00 AM		2	10		58	1	2	1		6			80
3:00 AM		6		1	271	2	12	2	4	16		7	321
4:00 AM		4	30	1	215	1	7	2		8		5	273
5:00 AM			30		21							2	53
6:00 AM	2		9		26	2	4	1	1	1			46
7:00 AM	1	4	33	4	390		20	2	2	10		10	476
8:00 AM	7	38	60	9	1698	5	30	5	10	46	1	49	1958
9:00 AM	13	33	93	7	1645	10	57	10	12	99		28	2007

10:00 AM	14	54	139	26	2676	22	90	31	43	108	2	67	3272
11:00 AM	19	43	313	20	2491	56	105	24	51	125		42	3289
12:00 PM	20	52	362	15	2882	23	89	16	24	123	2	54	3662
1:00 PM	15	47	189	20	2295	25	86	26	45	103	1	40	2892
2:00 PM	23	102	232	26	4991	44	190	48	61	220		103	6040
3:00 PM	24	56	221	19	2879	52	82	23	33	137	7	60	3593
4:00 PM	5	64	150	20	2645	32	55	32	12	138	3	58	3214
5:00 PM	7	41	93	17	2168	54	79	21	33	122	6	37	2678
6:00 PM	6	41	146	14	1992	59	77	14	15	91	1	50	2506
7:00 PM	13	36	155	16	1920	28	47	14	20	68	1	57	2375
8:00 PM	19	36	185	8	1666	11	43	13	17	59	1	34	2092
9:00 PM	19	14	65	2	879	8	41	10	24	46		11	1119
10:00 PM	3	16	57	5	696	5	20	7	2	22	1	22	856
11:00 PM	7	1	17	1	305		32	1	9	20	2	3	398
Grand Total	224	692	2673	232	35008	444	1182	307	431	1575	28	742	43538

Table b. 34 Hourly temporal distribution of tourist photographs per heritage type- expected value

hours	Catering	Church	Culture-Sport	Governmental Building	House	Industrial Building	Office Building	Remains	Shopping	Storage	Transportation	Uncategorised	Grand Total
12:00 AM	1.00	3.10	11.97	1.04	156.80	1.99	5.29	1.38	1.93	7.05	0.13	3.32	195
1:00 AM	0.74	2.27	8.78	0.76	114.98	1.46	3.88	1.01	1.42	5.17	0.09	2.44	143
2:00 AM	0.41	1.27	4.91	0.43	64.33	0.82	2.17	0.56	0.79	2.89	0.05	1.36	80
3:00 AM	1.65	5.10	19.71	1.71	258.11	3.27	8.71	2.26	3.18	11.61	0.21	5.47	321

4:00 AM	1.40	4.34	16.76	1.45	219.51	2.78	7.41	1.93	2.70	9.88	0.18	4.65	273
5:00 AM	0.27	0.84	3.25	0.28	42.62	0.54	1.44	0.37	0.52	1.92	0.03	0.90	53
6:00 AM	0.24	0.73	2.82	0.25	36.99	0.47	1.25	0.32	0.46	1.66	0.03	0.78	46
7:00 AM	2.45	7.57	29.22	2.54	382.74	4.85	12.92	3.36	4.71	17.22	0.31	8.11	476
8:00 AM	10.07	31.12	120.21	10.43	1574.39	19.97	53.16	13.81	19.38	70.83	1.26	33.37	1958
9:00 AM	10.33	31.90	123.22	10.69	1613.79	20.47	54.49	14.15	19.87	72.60	1.29	34.20	2007
10:00 AM	16.83	52.01	200.88	17.44	2630.95	33.37	88.83	23.07	32.39	118.37	2.10	55.76	3272
11:00 AM	16.92	52.28	201.93	17.53	2644.62	33.54	89.29	23.19	32.56	118.98	2.12	56.05	3289
12:00 PM	18.84	58.20	224.83	19.51	2944.54	37.35	99.42	25.82	36.25	132.47	2.36	62.41	3662
1:00 PM	14.88	45.97	177.55	15.41	2325.40	29.49	78.51	20.39	28.63	104.62	1.86	49.29	2892
2:00 PM	31.08	96.00	370.82	32.19	4856.64	61.60	163.98	42.59	59.79	218.50	3.88	102.94	6040
3:00 PM	18.49	57.11	220.59	19.15	2889.06	36.64	97.55	25.34	35.57	129.98	2.31	61.23	3593
4:00 PM	16.54	51.08	197.32	17.13	2584.31	32.78	87.26	22.66	31.82	116.27	2.07	54.77	3214
5:00 PM	13.78	42.56	164.41	14.27	2153.32	27.31	72.70	18.88	26.51	96.88	1.72	45.64	2678
6:00 PM	12.89	39.83	153.85	13.35	2015.02	25.56	68.03	17.67	24.81	90.66	1.61	42.71	2506
7:00 PM	12.22	37.75	145.81	12.66	1909.69	24.22	64.48	16.75	23.51	85.92	1.53	40.48	2375
8:00 PM	10.76	33.25	128.44	11.15	1682.13	21.33	56.80	14.75	20.71	75.68	1.35	35.65	2092
9:00 PM	5.76	17.79	68.70	5.96	899.76	11.41	30.38	7.89	11.08	40.48	0.72	19.07	1119
10:00 PM	4.40	13.61	52.55	4.56	688.29	8.73	23.24	6.04	8.47	30.97	0.55	14.59	856
11:00 PM	2.05	6.33	24.44	2.12	320.02	4.06	10.81	2.81	3.94	14.40	0.26	6.78	398
Grand Total	224	692	2673	232	35008	444	1182	307	431	1575	28	742	43538

Table b. 35 Hourly temporal distribution of tourist photographs per heritage type – Pearson residuals

hours	Catering	Church	Culture-Sport	Governmental Building	House	Industrial Building	Office Building	Remains	Shopping	Storage	Transportation	Uncategorised
12:00 AM	1.993	-0.624	5.788	-1.019	-1.501	0.008	-0.128	0.533	2.929	-1.526	-0.354	-0.726
1:00 AM	3.806	-1.508	14.587	0.273	-5.034	0.449	2.597	0.988	4.694	-0.516	-0.303	-0.921
2:00 AM	-0.642	0.646	2.296	-0.653	-0.789	0.204	-0.117	0.58	-0.89	1.826	-0.227	-1.168
3:00 AM	-1.285	0.398	-4.439	-0.543	0.802	-0.704	1.113	-0.175	0.461	1.288	-0.454	0.654
4:00 AM	-1.185	-0.163	3.234	-0.377	-0.305	-1.069	-0.151	0.054	-1.644	-0.597	-0.419	0.161
5:00 AM	-0.522	-0.918	14.827	-0.531	-3.311	-0.735	-1.2	-0.611	-0.724	-1.385	-0.185	1.154
6:00 AM	3.625	-0.855	3.675	-0.495	-1.807	2.235	2.462	1.186	0.807	-0.515	-0.172	-0.885
7:00 AM	-0.926	-1.296	0.699	0.919	0.371	-2.203	1.969	-0.74	-1.249	-1.74	-0.553	0.663
8:00 AM	-0.968	1.233	-5.492	-0.444	3.115	-3.35	-3.176	-2.37	-2.131	-2.95	-0.231	2.706
9:00 AM	0.832	0.195	-2.722	-1.13	0.777	-2.314	0.34	-1.104	-1.765	3.098	-1.136	-1.061
10:00 AM	-0.691	0.277	-4.366	2.051	0.878	-1.968	0.124	1.651	1.864	-0.953	-0.072	1.505
11:00 AM	0.505	-1.283	7.816	0.591	-2.987	3.878	1.662	0.168	3.232	0.552	-1.454	-1.877
12:00 PM	0.267	-0.813	9.148	-1.022	-1.152	-2.347	-1.045	-1.933	-2.035	-0.823	-0.231	-1.065
1:00 PM	0.031	0.153	0.859	1.169	-0.63	-0.827	0.845	1.242	3.06	-0.158	-0.631	-1.323
2:00 PM	-1.449	0.612	-7.209	-1.09	1.928	-2.242	2.032	0.829	0.156	0.102	-1.971	0.006
3:00 PM	1.283	-0.147	0.028	-0.033	-0.187	2.537	-1.574	-0.464	-0.431	0.616	3.085	-0.158
4:00 PM	-2.837	1.807	-3.369	0.694	1.194	-0.136	-3.453	1.961	-3.513	2.015	0.649	0.436
5:00 PM	-1.826	-0.24	-5.57	0.723	0.316	5.107	0.738	0.487	1.26	2.552	3.26	-1.279
6:00 PM	-1.92	0.185	-0.633	0.177	-0.513	6.616	1.087	-0.873	-1.969	0.036	-0.482	1.116

7:00 PM	0.223	-0.285	0.761	0.94	0.236	0.768	-2.177	-0.671	-0.724	-1.933	-0.427	2.597
8:00 PM	2.511	0.477	4.991	-0.943	-0.393	-2.237	-1.83	-0.456	-0.815	-1.917	-0.298	-0.277
9:00 PM	5.519	-0.898	-0.446	-1.623	-0.692	-1.01	1.927	0.751	3.883	0.868	-0.848	-1.848
10:00 PM	-0.669	0.649	0.613	0.205	0.294	-1.262	-0.672	0.392	-2.224	-1.611	0.606	1.94
11:00 PM	3.461	-2.118	-1.504	-0.77	-0.84	-2.015	6.448	-1.078	2.549	1.476	3.447	-1.453
Grand Total	1.993	-0.624	5.788	-1.019	-1.501	0.008	-0.128	0.533	2.929	-1.526	-0.354	-0.726

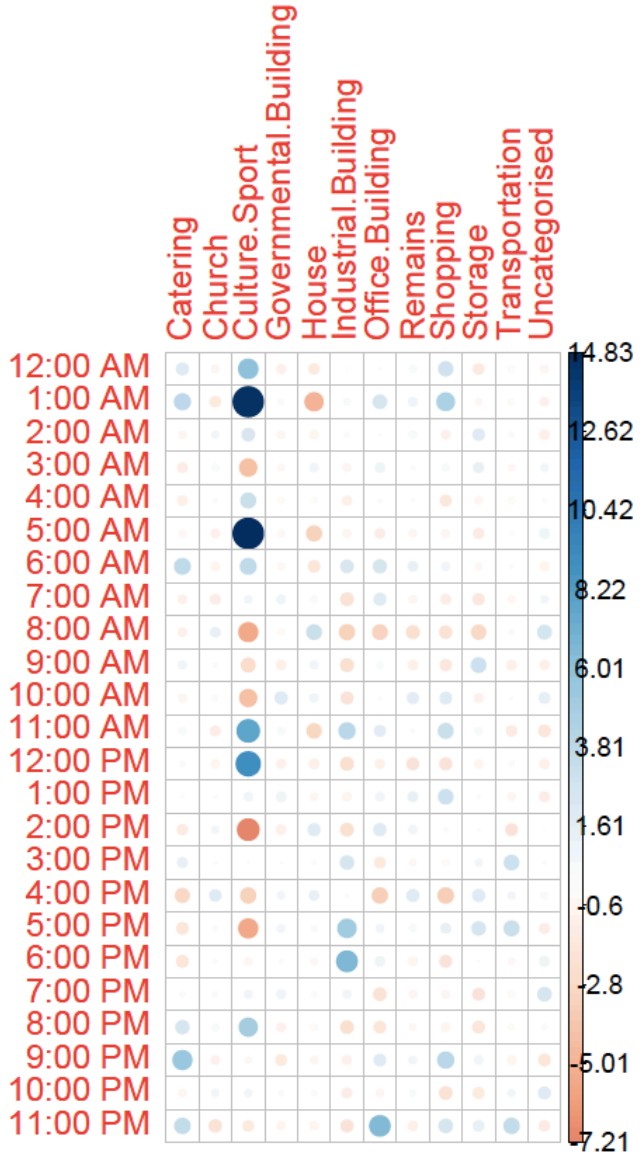


Figure b. 9 Hourly temporal distribution of tourist photographs per heritage type – Pearson residuals (blue: positive, red: negative)

Table b. 36 Hourly temporal distribution of tourist photographs per heritage type – chi-square value

hours	Catering	Church	Culture-Sport	Governmental Building	House	Industrial Building	Office Building	Remains	Shopping	Storage	Transportation	Uncategorised	Grand Total
12:00 AM	3.97	0.39	33.51	1.04	2.25	0.00	0.02	0.28	8.58	2.33	0.13	0.53	53.02
1:00 AM	14.48	2.27	212.77	0.07	25.34	0.20	6.75	0.98	22.03	0.27	0.09	0.85	286.10
2:00 AM	0.41	0.42	5.27	0.43	0.62	0.04	0.01	0.34	0.79	3.33	0.05	1.36	13.08
3:00 AM	1.65	0.16	19.71	0.30	0.64	0.50	1.24	0.03	0.21	1.66	0.21	0.43	26.73
4:00 AM	1.40	0.03	10.46	0.14	0.09	1.14	0.02	0.00	2.70	0.36	0.18	0.03	16.55
5:00 AM	0.27	0.84	219.84	0.28	10.96	0.54	1.44	0.37	0.52	1.92	0.03	1.33	238.37
6:00 AM	13.14	0.73	13.51	0.25	3.26	5.00	6.06	1.41	0.65	0.27	0.03	0.78	45.08
7:00 AM	0.86	1.68	0.49	0.84	0.14	4.85	3.88	0.55	1.56	3.03	0.31	0.44	18.62
8:00 AM	0.94	1.52	30.16	0.20	9.71	11.22	10.09	5.62	4.54	8.71	0.05	7.32	90.07
9:00 AM	0.69	0.04	7.41	1.28	0.60	5.35	0.12	1.22	3.12	9.60	1.29	1.13	31.84
10:00 AM	0.48	0.08	19.06	4.21	0.77	3.87	0.02	2.72	3.47	0.91	0.01	2.26	37.86
11:00 AM	0.26	1.65	61.10	0.35	8.92	15.04	2.76	0.03	10.44	0.30	2.12	3.52	106.49
12:00 PM	0.07	0.66	83.69	1.04	1.33	5.51	1.09	3.74	4.14	0.68	0.05	1.13	103.14
1:00 PM	0.00	0.02	0.74	1.37	0.40	0.68	0.71	1.54	9.36	0.03	0.40	1.75	17.00
2:00 PM	2.10	0.37	51.97	1.19	3.72	5.03	4.13	0.69	0.02	0.01	3.88	0.00	73.11
3:00 PM	1.64	0.02	0.00	0.00	0.04	6.44	2.48	0.22	0.19	0.38	9.52	0.02	20.94
4:00 PM	8.05	3.27	11.35	0.48	1.43	0.02	11.92	3.85	12.34	4.06	0.42	0.19	57.37
5:00 PM	3.33	0.06	31.02	0.52	0.10	26.08	0.55	0.24	1.59	6.51	10.62	1.64	82.26
6:00 PM	3.69	0.03	0.40	0.03	0.26	43.77	1.18	0.76	3.88	0.00	0.23	1.24	55.48

7:00 PM	0.05	0.08	0.58	0.88	0.06	0.59	4.74	0.45	0.52	3.74	0.18	6.75	18.62
8:00 PM	6.30	0.23	24.91	0.89	0.15	5.01	3.35	0.21	0.66	3.68	0.09	0.08	45.55
9:00 PM	30.46	0.81	0.20	2.63	0.48	1.02	3.71	0.56	15.08	0.75	0.72	3.42	59.84
10:00 PM	0.45	0.42	0.38	0.04	0.09	1.59	0.45	0.15	4.95	2.60	0.37	3.77	15.25
11:00 PM	11.98	4.48	2.26	0.59	0.71	4.06	41.57	1.16	6.50	2.18	11.88	2.11	89.49
Grand Total	106.68	20.26	840.78	19.06	72.07	147.55	108.29	27.11	117.86	57.28	42.86	42.07	1601.86

Pearson's Chi-squared test

X-squared = 1604, df = 253= 121,p-value < 2.2e-16

Table b. 37 Daily temporal distribution of tourist photographs per heritage type- observed value

days	Catering	Church	Culture-Sport	Governmental Building	House	Industrial Building	Office Building	Remains	Shopping	Storage	Transportation	Uncategorised	Grand Total
Monday	40	56	373	25	3355	21	116	43	85	114	7	76	4311
Tuesday	30	101	233	29	5149	57	140	41	42	212	2	148	6184
Wednesday	16	92	168	32	4809	49	163	38	70	179	2	123	5741
Thursday	33	137	361	45	6238	89	195	55	77	264	4	130	7628
Friday	25	76	464	31	4011	58	165	27	37	199	3	72	5168
Saturday	29	106	630	23	5283	114	196	41	43	333	5	52	6855
Sunday	51	124	444	47	6163	56	207	62	77	274	5	141	7651
Grand Total	224	692	2673	232	35008	444	1182	307	431	1575	28	742	43538

Table b. 38 Daily temporal distribution of tourist photographs per heritage type- expected value

days	Catering	Church	Culture-Sport	Governmental Building	House	Industrial Building	Office Building	Remains	Shopping	Storage	Transportation	Uncategorised	Grand Total
Monday	22.18	68.52	264.67	22.97	3466.39	43.96	117.04	30.40	42.68	155.95	2.77	73.47	4311
Tuesday	31.82	98.29	379.66	32.95	4972.43	63.06	167.89	43.61	61.22	223.71	3.98	105.39	6184
Wednesday	29.54	91.25	352.47	30.59	4616.22	58.55	155.86	40.48	56.83	207.68	3.69	97.84	5741
Thursday	39.25	121.24	468.32	40.65	6133.52	77.79	207.09	53.79	75.51	275.95	4.91	130.00	7628
Friday	26.59	82.14	317.29	27.54	4155.48	52.70	140.30	36.44	51.16	186.95	3.32	88.08	5168
Saturday	35.27	108.95	420.86	36.53	5511.96	69.91	186.10	48.34	67.86	247.98	4.41	116.83	6855
Sunday	39.36	121.61	469.73	40.77	6152.01	78.02	207.71	53.95	75.74	276.78	4.92	130.39	7651
Grand Total	22.18	68.52	264.67	22.97	3466.39	43.96	117.04	30.40	42.68	155.95	2.77	73.47	43538

Table b. 39 Daily temporal distribution of tourist photographs per heritage type- Pearson residuals

days	Catering	Church	Culture-Sport	Governmental Building	House	Industrial Building	Office Building	Remains	Shopping	Storage	Transportation	Uncategorised
Monday	3.784	-1.512	6.659	0.423	-1.892	-3.463	-0.096	2.286	6.479	-3.359	2.539	0.295
Tuesday	-0.322	0.273	-7.527	-0.689	2.504	-0.764	-2.152	-0.395	-2.456	-0.783	-0.991	4.15
Wednesday	-2.491	0.079	-9.826	0.255	2.837	-1.248	0.572	-0.39	1.747	-1.99	-0.881	2.543
Thursday	-0.997	1.431	-4.959	0.683	1.334	1.271	-0.84	0.165	0.171	-0.719	-0.409	0
Friday	-0.308	-0.678	8.236	0.66	-2.241	0.73	2.085	-1.564	-1.98	0.881	-0.178	-1.713
Saturday	-1.056	-0.283	10.195	-2.238	-3.084	5.274	0.725	-1.055	-3.018	5.399	0.282	-5.998
Sunday	1.855	0.217	-1.187	0.976	0.14	-2.493	-0.05	1.096	0.145	-0.167	0.036	0.929

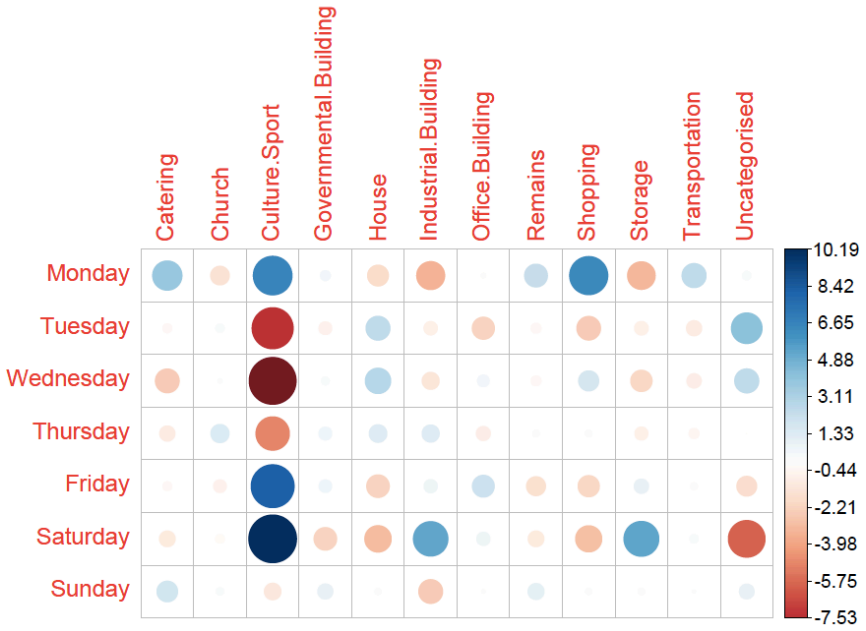


Figure b. 10 Daily temporal distribution of tourist photographs per heritage type – Pearson residuals (blue: positive, red: negative)

Table b. 40 Daily temporal distribution of tourist photographs per heritage type- chi-square value

days	Catering	Church	Culture-Sport	Governmental Building	House	Industrial Building	Office Building	Remains	Shopping	Storage	Transportation	Uncategorised	Grand Total
Monday	14.32	2.29	44.34	0.18	3.58	11.99	0.01	5.22	41.97	11.29	6.45	0.09	141.72
Tuesday	0.10	0.07	56.66	0.47	6.27	0.58	4.63	0.16	6.03	0.61	0.98	17.23	93.81
Wednesday	6.20	0.01	96.54	0.06	8.05	1.56	0.33	0.15	3.05	3.96	0.78	6.47	127.16
Thursday	0.99	2.05	24.59	0.47	1.78	1.62	0.71	0.03	0.03	0.52	0.17	0.00	32.94
Friday	0.09	0.46	67.84	0.44	5.02	0.53	4.35	2.45	3.92	0.78	0.03	2.93	88.84
Saturday	1.11	0.08	103.93	5.01	9.51	27.81	0.53	1.11	9.11	29.15	0.08	35.97	223.40
Sunday	3.44	0.05	1.41	0.95	0.02	6.22	0.00	1.20	0.02	0.03	0.00	0.86	14.20
Grand Total	26.27	5.00	395.31	7.58	34.23	50.31	10.55	10.32	64.13	46.33	8.48	63.55	722.07

Pearson's Chi-squared test

X-squared = 722.07, df = 66= 121,p-value < 2.2e-16

Table b. 41 Monthly temporal distribution of tourist photographs per heritage type- observed value

months	Catering	Church	Culture-Sport	Governmental Building	House	Industrial Building	Office Building	Remains	Shopping	Storage	Transportation	Uncategorised	Grand Total
January	40	56	92	21	3035	19	157	41	88	140	2	56	3747
February	12	15	140	7	1051	9	31	9	18	44	1	8	1345
March	5	29	210	14	1491	4	46	18	23	44	3	17	1904
April	19	51	215	13	3107	61	152	19	33	187	5	49	3911
May	34	143	298	52	7412	16	146	30	47	202	1	247	8628
June	24	36	186	18	2395	5	84	26	29	87	3	30	2923
July	17	87	504	5	3524	58	135	36	16	275	6	13	4676
August	16	47	183	14	2382	11	86	20	27	108	4	39	2937
September	5	21	71	9	1174	16	54	15	27	57	1	26	1476
October	15	129	721	46	5059	38	113	58	65	174		166	6584
November	17	52	45	21	2655	196	105	23	33	159	1	75	3382
December	20	26	8	12	1723	11	73	12	25	98	1	16	2025
Grand Total	224	692	2673	232	35008	444	1182	307	431	1575	28	742	43538

Table b. 42 Monthly temporal distribution of tourist photographs per heritage type- expected value

months	Catering	Church	Culture-Sport	Governmental Building	House	Industrial Building	Office Building	Remains	Shopping	Storage	Transportation	Uncategorised	Grand Total
January	19.28	59.56	230.05	19.97	3012.88	38.21	101.73	26.42	37.09	135.55	2.41	63.86	3747
February	6.92	21.38	82.58	7.17	1081.49	13.72	36.51	9.48	13.31	48.66	0.86	22.92	1345
March	9.80	30.26	116.90	10.15	1530.97	19.42	51.69	13.43	18.85	68.88	1.22	32.45	1904
April	20.12	62.16	240.11	20.84	3144.75	39.88	106.18	27.58	38.72	141.48	2.52	66.65	3911
May	44.39	137.13	529.71	45.98	6937.60	87.99	234.24	60.84	85.41	312.12	5.55	147.04	8628
June	15.04	46.46	179.46	15.58	2350.32	29.81	79.36	20.61	28.94	105.74	1.88	49.82	2923

July	24.06	74.32	287.08	24.92	3759.87	47.69	126.95	32.97	46.29	169.16	3.01	79.69	4676
August	15.11	46.68	180.32	15.65	2361.58	29.95	79.74	20.71	29.07	106.25	1.89	50.05	2937
September	7.59	23.46	90.62	7.87	1186.82	15.05	40.07	10.41	14.61	53.39	0.95	25.15	1476
October	33.87	104.65	404.22	35.08	5294.06	67.14	178.75	46.43	65.18	238.18	4.23	112.21	6584
November	17.40	53.75	207.64	18.02	2719.40	34.49	91.82	23.85	33.48	122.34	2.18	57.64	3382
December	10.42	32.19	124.32	10.79	1628.26	20.65	54.98	14.28	20.05	73.25	1.30	34.51	2025
Grand Total	19.28	59.56	230.05	19.97	3012.88	38.21	101.73	26.42	37.09	135.55	2.41	63.86	43538

Table b. 43 Monthly temporal distribution of tourist photographs per heritage type- Pearson residuals

months	Catering	Church	Culture-Sport	Governmental Building	House	Industrial Building	Office Building	Remains	Shopping	Storage	Transportation	Uncategorised
January	4.72	-0.461	-9.102	0.231	0.403	-3.108	5.48	2.836	8.359	0.382	-0.264	-0.983
February	1.931	-1.379	6.319	-0.062	-0.927	-1.273	-0.913	-0.157	1.284	-0.667	0.145	-3.117
March	-1.532	-0.229	8.611	1.21	-1.021	-3.499	-0.792	1.248	0.956	-2.998	1.605	-2.712
April	-0.25	-1.416	-1.621	-1.717	-0.673	3.344	4.447	-1.633	-0.919	3.827	1.567	-2.162
May	-1.56	0.501	-10.068	0.888	5.696	-7.674	-5.765	-3.954	-4.156	-6.233	-1.931	8.243
June	2.311	-1.534	0.488	0.614	0.922	-4.544	0.521	1.187	0.012	-1.822	0.817	-2.808
July	-1.439	1.471	12.802	-3.99	-3.847	1.494	0.715	0.527	-4.452	8.138	1.726	-7.471
August	0.229	0.047	0.2	-0.417	0.42	-3.463	0.702	-0.156	-0.385	0.17	1.536	-1.562
September	-0.941	-0.508	-2.061	0.405	-0.372	0.244	2.2	1.423	3.241	0.493	0.052	0.169
October	-3.243	2.381	15.756	1.843	-3.231	-3.557	-4.918	1.699	-0.022	-4.158	-2.058	5.078
November	-0.096	-0.239	-11.287	0.702	-1.235	27.502	1.376	-0.174	-0.083	3.314	-0.797	2.287
December	10.42	32.19	124.32	10.79	1628.26	20.65	54.98	14.28	20.05	73.25	1.30	34.51
Grand Total	19.28	59.56	230.05	19.97	3012.88	38.21	101.73	26.42	37.09	135.55	2.41	63.86

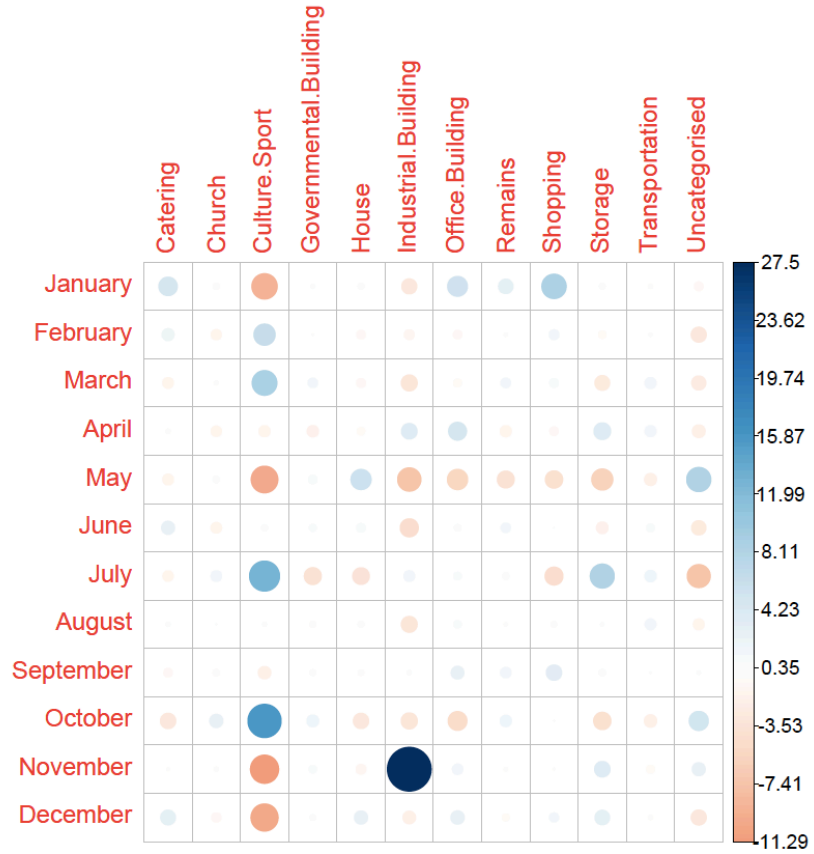


Figure b. 11 Monthly temporal distribution of tourist photographs per heritage type – Pearson residuals (blue: positive, red: negative)

Table b. 44 Monthly temporal distribution of tourist photographs per heritage type- chi-square value

months	Catering	Church	Culture-Sport	Governmental Building	House	Industrial Building	Office Building	Remains	Shopping	Storage	Transportation	Uncategorised	Grand Total
January	22.27	0.21	82.84	0.05	0.16	9.66	30.03	8.04	69.87	0.15	0.07	0.97	224.33
February	3.73	1.90	39.93	0.00	0.86	1.62	0.83	0.02	1.65	0.45	0.02	9.71	60.74
March	2.35	0.05	74.16	1.46	1.04	12.24	0.63	1.56	0.91	8.99	2.57	7.36	113.32
April	0.06	2.00	2.63	2.95	0.45	11.18	19.77	2.67	0.84	14.64	2.45	4.68	64.34
May	2.43	0.25	101.36	0.79	32.44	58.90	33.24	15.63	17.27	38.85	3.73	67.95	372.85
June	5.34	2.35	0.24	0.38	0.85	20.65	0.27	1.41	0.00	3.32	0.67	7.88	43.36
July	2.07	2.16	163.90	15.92	14.80	2.23	0.51	0.28	19.82	66.23	2.98	55.81	346.71
August	0.05	0.00	0.04	0.17	0.18	11.99	0.49	0.02	0.15	0.03	2.36	2.44	17.93
September	0.89	0.26	4.25	0.16	0.14	0.06	4.84	2.03	10.50	0.24	0.00	0.03	23.40

October	10.52	5.67	248.25	3.40	10.44	12.65	24.18	2.89	0.00	17.29	4.23	25.79	365.30
November	0.01	0.06	127.39	0.49	1.52	756.33	1.89	0.03	0.01	10.98	0.63	5.23	904.58
December	8.81	1.19	108.84	0.14	5.51	4.51	5.91	0.36	1.22	8.36	0.07	9.93	154.85
Grand Total	58.53	16.11	953.82	25.92	68.39	902.02	122.61	34.94	122.25	169.53	19.80	197.77	2691.70

Pearson's Chi-squared test

X-squared = 2691.7, df = 121= 121,p-value < 2.2e-16

Table b. 45 Yearly temporal distribution of tourist photographs per heritage type - observed value

years	Catering	Church	Culture-Sport	Governmental Building	House	Industrial Building	Office Building	Remains	Shopping	Storage	Transportation	Uncategorised	Grand Total
2007	1				81		4		2	3			91
2008			3		64							21	88
2009					50						1	2	53
2010					34							3	37
2011		1			17	1	1	1		2		3	26
2012		2		1	102		1			6		2	114
2013		66	23	33	3250		1			33		166	3572
2014	7	21	139	9	1109	5	45	13	18	39		25	1430
2015	2	6	16	3	316	1	12	1	7	19		5	388
2016		8		4	383	2	5	4	1	28		14	449
2017	38	133	68	35	5787	21	207	30	32	317	9	109	6786
2018	136	400	2112	120	20945	391	762	200	264	1057	12	345	26744
2019	40	55	312	27	2870	23	144	58	107	71	6	47	3760
Grand Total	224	692	2673	232	35008	444	1182	307	431	1575	28	742	43538

Table b. 46 Yearly temporal distribution of tourist photographs per heritage type - expected value

years	Catering	Church	Culture-Sport	Governmental Building	House	Industrial Building	Office Building	Remains	Shopping	Storage	Transportation	Uncategorised	Grand Total
2007	0.47	1.45	5.59	0.48	73.17	0.93	2.47	0.64	0.90	3.29	0.06	1.55	91
2008	0.45	1.40	5.40	0.47	70.76	0.90	2.39	0.62	0.87	3.18	0.06	1.50	88
2009	0.27	0.84	3.25	0.28	42.62	0.54	1.44	0.37	0.52	1.92	0.03	0.90	53
2010	0.19	0.59	2.27	0.20	29.75	0.38	1.00	0.26	0.37	1.34	0.02	0.63	37
2011	0.13	0.41	1.60	0.14	20.91	0.27	0.71	0.18	0.26	0.94	0.02	0.44	26
2012	0.59	1.81	7.00	0.61	91.67	1.16	3.09	0.80	1.13	4.12	0.07	1.94	114
2013	18.38	56.77	219.30	19.03	2872.17	36.43	96.98	25.19	35.36	129.22	2.30	60.88	3572
2014	7.36	22.73	87.79	7.62	1149.83	14.58	38.82	10.08	14.16	51.73	0.92	24.37	1430
2015	2.00	6.17	23.82	2.07	311.98	3.96	10.53	2.74	3.84	14.04	0.25	6.61	388
2016	2.31	7.14	27.57	2.39	361.03	4.58	12.19	3.17	4.44	16.24	0.29	7.65	449
2017	34.91	107.86	416.62	36.16	5456.48	69.20	184.23	47.85	67.18	245.49	4.36	115.65	6786
2018	137.60	425.07	1641.94	142.51	21504.29	272.73	726.06	188.58	264.75	967.47	17.20	455.79	26744
2019	19.34	59.76	230.84	20.04	3023.34	38.34	102.08	26.51	37.22	136.02	2.42	64.08	3760
Grand Total	224	692	2673	232	35008	444	1182	307	431	1575	28	742	43538

Table b. 47 Yearly temporal distribution of tourist photographs per heritage type - Pearson residuals

years	Catering	Church	Culture-Sport	Governmental Building	House	Industrial Building	Office Building	Remains	Shopping	Storage	Transportation	Uncategorised
2007	0.777	-1.203	-2.364	-0.696	0.915	-0.963	0.973	-0.801	1.158	-0.161	-0.242	-1.245
2008	-0.673	-1.183	-1.034	-0.685	-0.804	-0.947	-1.546	-0.788	-0.933	-1.784	-0.238	15.923
2009	-0.522	-0.918	-1.804	-0.531	1.131	-0.735	-1.2	-0.611	-0.724	-1.385	5.232	1.154
2010	-0.436	-0.767	-1.507	-0.444	0.779	-0.614	-1.002	-0.511	-0.605	-1.157	-0.154	2.984
2011	-0.366	0.913	-1.263	-0.372	-0.854	1.427	0.35	1.907	-0.507	1.092	-0.129	3.841

2012	-0.766	0.14	-2.646	0.504	1.079	-1.078	-1.191	-0.897	-1.062	0.924	-0.271	0.041
2013	-4.287	1.224	-13.256	3.201	7.05	-6.035	-9.746	-5.019	-5.946	-8.464	-1.516	13.473
2014	-0.132	-0.363	5.465	0.5	-1.204	-2.509	0.991	0.918	1.022	-1.77	-0.959	0.127
2015	0.003	-0.067	-1.602	0.649	0.227	-1.486	0.452	-1.049	1.612	1.325	-0.5	-0.627
2016	-1.52	0.323	-5.25	1.039	1.156	-1.205	-2.059	0.469	-1.634	2.917	-0.537	2.295
2017	0.522	2.421	-17.08	-0.193	4.474	-5.794	1.677	-2.58	-4.292	4.564	2.219	-0.618
2018	-0.136	-1.216	11.6	-1.886	-3.814	7.161	1.334	0.832	-0.046	2.878	-1.254	-5.189
2019	4.696	-0.616	5.341	1.556	-2.789	-2.478	4.149	6.115	11.437	-5.575	2.303	-2.134

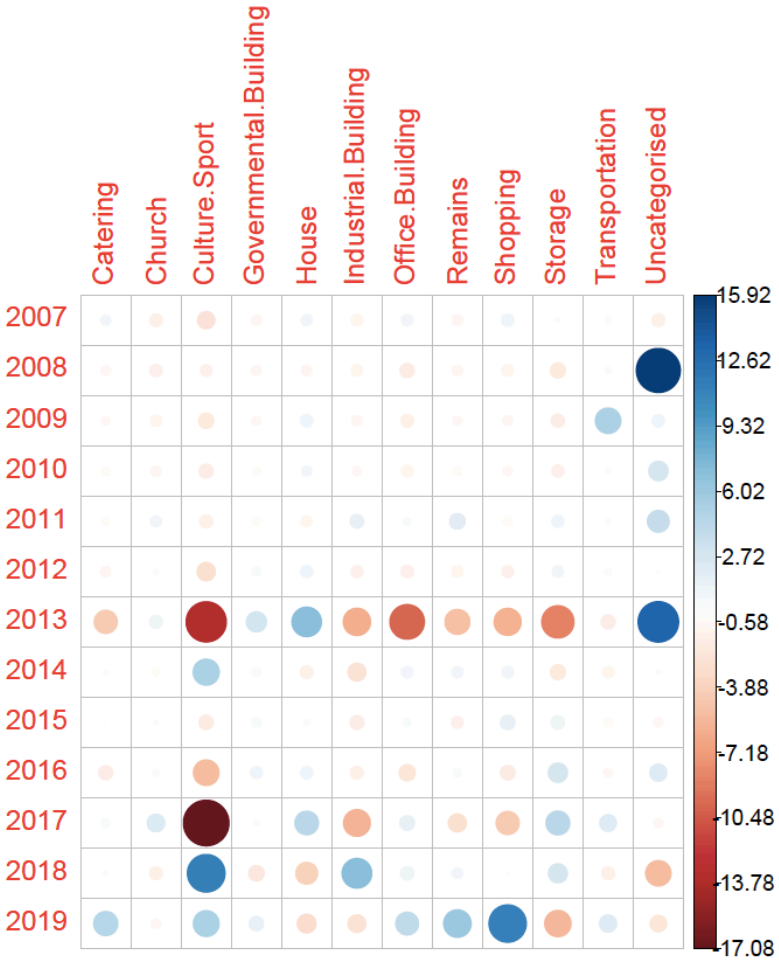


Figure b. 12 Yearly temporal distribution of tourist photographs per heritage type - Pearson residuals (blue: positive, red: negative)

Table b. 48 Yearly temporal distribution of tourist photographs per heritage type - chi-square value

years	Catering	Church	Culture-Sport	Governmental Building	House	Industrial Building	Office Building	Remains	Shopping	Storage	Transportation	Uncategorised	Grand Total
2007	0.60	1.45	5.59	0.48	0.84	0.93	0.95	0.64	1.34	0.03	0.06	1.55	14.45
2008	0.45	1.40	1.07	0.47	0.65	0.90	2.39	0.62	0.87	3.18	0.06	253.55	265.60
2009	0.27	0.84	3.25	0.28	1.28	0.54	1.44	0.37	0.52	1.92	27.37	1.33	39.43
2010	0.19	0.59	2.27	0.20	0.61	0.38	1.00	0.26	0.37	1.34	0.02	8.90	16.13
2011	0.13	0.83	1.60	0.14	0.73	2.04	0.12	3.64	0.26	1.19	0.02	14.75	25.45
2012	0.59	0.02	7.00	0.25	1.17	1.16	1.42	0.80	1.13	0.85	0.07	0.00	14.47
2013	18.38	1.50	175.71	10.25	49.70	36.43	94.99	25.19	35.36	71.65	2.30	181.53	702.98
2014	0.02	0.13	29.87	0.25	1.45	6.30	0.98	0.84	1.04	3.13	0.92	0.02	44.95
2015	0.00	0.00	2.57	0.42	0.05	2.21	0.20	1.10	2.60	1.76	0.25	0.39	11.56
2016	2.31	0.10	27.57	1.08	1.34	1.45	4.24	0.22	2.67	8.51	0.29	5.27	55.05
2017	0.27	5.86	291.72	0.04	20.02	33.58	2.81	6.66	18.42	20.83	4.92	0.38	405.52
2018	0.02	1.48	134.57	3.56	14.55	51.28	1.78	0.69	0.00	8.28	1.57	26.93	244.71
2019	22.05	0.38	28.53	2.42	7.78	6.14	17.22	37.39	130.81	31.08	5.31	4.55	293.66
Grand Total	45.29	14.59	711.32	19.84	100.15	143.33	129.54	78.44	195.39	153.75	43.16	499.16	2133.96

Pearson's Chi-squared test

X-squared = 2134, df = 132,= 121,p-value < 2.2e-16

Table b. 49 Hourly temporal distribution of local photographs per heritage type - observed value

hours	Catering	Church	Culture-Sport	Education	Garden and Zoo	Governmental Building	House	Industrial Building	Office Building	Remains	Storage	Transportation	Grand Total
12:00 AM			16	5		2	41	11	3		2	4	84
1:00 AM									1				1
2:00 AM	2		1										3
3:00 AM													0
4:00 AM													0
5:00 AM			1			1		2					4
6:00 AM	1		2				5	12		2		1	23
7:00 AM	1		2			1	9	24	1	1		3	42
8:00 AM	51		66		1	2	12	72	6	2	7	30	249
9:00 AM	3		5	2		5	16	9	6	2		1	49
10:00 AM			23	6	6	8	153	20	24	2	1	3	246
11:00 AM	3		261	12	45	17	60	82	10	2	1	12	505
12:00 PM	7		146	1	20	27	95	105	30	2	55	12	500
1:00 PM	3	1	398	22	17	36	446	156	26	13	46	11	1175
2:00 PM	6		353	8	142	120	185	198	58	53	5	10	1138
3:00 PM	4	6	199	3	8	30	1752	78	38	11	147	16	2292
4:00 PM	7	3	128	5	30	43	82	141	29	5		37	510
5:00 PM	2		467	3	28	21	284	105	15	6	33	6	970
6:00 PM		2	11		4	1	43	109	1	1	9	11	192

7:00 PM	1		21		12	5	43	28	5	2	3	83	203
8:00 PM	3		12	2	1	2	20	5	8	6	6	10	75
9:00 PM	1		10	3		1	33	6	1			4	59
10:00 PM	2		3	1	6	3	20	24	2	3		6	70
11:00 PM			9				1	2	1			2	15
Grand Total	97	12	2134	73	320	325	3300	1189	265	113	315	262	8405

Table b. 50 Hourly temporal distribution of local photographs per heritage type - expected value

hours	Catering	Church	Culture-Sport	Education	Garden and Zoo	Governmental Building	House	Industrial Building	Office Building	Remains	Storage	Transportation	Grand Total
12:00 AM	0.97	0.12	21.33	0.73	3.20	3.25	32.98	11.88	2.65	1.13	3.15	2.62	84
1:00 AM	0.01	0.00	0.25	0.01	0.04	0.04	0.39	0.14	0.03	0.01	0.04	0.03	1
2:00 AM	0.03	0.00	0.76	0.03	0.11	0.12	1.18	0.42	0.09	0.04	0.11	0.09	3
3:00 AM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
4:00 AM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
5:00 AM	0.05	0.01	1.02	0.03	0.15	0.15	1.57	0.57	0.13	0.05	0.15	0.12	4
6:00 AM	0.27	0.03	5.84	0.20	0.88	0.89	9.03	3.25	0.73	0.31	0.86	0.72	23
7:00 AM	0.48	0.06	10.66	0.36	1.60	1.62	16.49	5.94	1.32	0.56	1.57	1.31	42
8:00 AM	2.87	0.36	63.22	2.16	9.48	9.63	97.76	35.22	7.85	3.35	9.33	7.76	249
9:00 AM	0.57	0.07	12.44	0.43	1.87	1.89	19.24	6.93	1.54	0.66	1.84	1.53	49
10:00 AM	2.84	0.35	62.46	2.14	9.37	9.51	96.59	34.80	7.76	3.31	9.22	7.67	246
11:00 AM	5.83	0.72	128.22	4.39	19.23	19.53	198.27	71.44	15.92	6.79	18.93	15.74	505

12:00 PM	5.77	0.71	126.95	4.34	19.04	19.33	196.31	70.73	15.76	6.72	18.74	15.59	500
1:00 PM	13.56	1.68	298.33	10.21	44.74	45.43	461.33	166.22	37.05	15.80	44.04	36.63	1175
2:00 PM	13.13	1.62	288.93	9.88	43.33	44.00	446.81	160.99	35.88	15.30	42.65	35.47	1138
3:00 PM	26.45	3.27	581.93	19.91	87.26	88.63	899.89	324.23	72.26	30.81	85.90	71.45	2292
4:00 PM	5.89	0.73	129.49	4.43	19.42	19.72	200.24	72.15	16.08	6.86	19.11	15.90	510
5:00 PM	11.19	1.38	246.28	8.42	36.93	37.51	380.84	137.22	30.58	13.04	36.35	30.24	970
6:00 PM	2.22	0.27	48.75	1.67	7.31	7.42	75.38	27.16	6.05	2.58	7.20	5.99	192
7:00 PM	2.34	0.29	51.54	1.76	7.73	7.85	79.70	28.72	6.40	2.73	7.61	6.33	203
8:00 PM	0.87	0.11	19.04	0.65	2.86	2.90	29.45	10.61	2.36	1.01	2.81	2.34	75
9:00 PM	0.68	0.08	14.98	0.51	2.25	2.28	23.16	8.35	1.86	0.79	2.21	1.84	59
10:00 PM	0.81	0.10	17.77	0.61	2.67	2.71	27.48	9.90	2.21	0.94	2.62	2.18	70
11:00 PM	0.17	0.02	3.81	0.13	0.57	0.58	5.89	2.12	0.47	0.20	0.56	0.47	15
Grand Total	0.97	0.12	21.33	0.73	3.20	3.25	32.98	11.88	2.65	1.13	3.15	2.62	8405

Table b. 51 Hourly temporal distribution of local photographs per heritage type - Pearson residuals

hours	Catering	Church	Culture-Sport	Education	Garden and Zoo	Governmental Building	House	Industrial Building	Office Building	Remains	Storage	Transportation
12:00 AM	-0.985	-0.346	-1.154	5	-1.788	-0.693	1.396	-0.256	0.216	-1.063	-0.647	0.854
1:00 AM	-0.107	-0.038	-0.504	-0.093	-0.195	-0.197	-0.627	-0.376	5.454	-0.116	-0.194	-0.177
2:00 AM	10.563	-0.065	0.273	-0.161	-0.338	-0.341	-1.085	-0.651	-0.308	-0.201	-0.335	-0.306
3:00 AM												
4:00 AM												
5:00 AM	-0.215	-0.076	-0.015	-0.186	-0.39	2.149	-1.253	1.907	-0.355	-0.232	-0.387	-0.353

6:00 AM	1.426	-0.181	-1.589	-0.447	-0.936	-0.943	-1.341	4.849	-0.852	3.041	-0.928	0.334
7:00 AM	0.74	-0.245	-2.653	-0.604	-1.265	-0.49	-1.845	7.409	-0.282	0.579	-1.255	1.478
8:00 AM	28.39	-0.596	0.35	-1.471	-2.754	-2.458	-8.674	6.196	-0.661	-0.737	-0.763	7.982
9:00 AM	3.237	-0.264	-2.11	2.413	-1.366	2.256	-0.738	0.786	3.584	1.652	-1.355	-0.427
10:00 AM	-1.685	-0.593	-4.993	2.643	-1.1	-0.49	5.74	-2.509	5.833	-0.719	-2.707	-1.686
11:00 AM	-1.171	-0.849	11.726	3.636	5.878	-0.572	-9.82	1.25	-1.484	-1.838	-4.121	-0.943
12:00 PM	0.512	-0.845	1.691	-1.604	0.221	1.744	-7.231	4.075	3.585	-1.821	8.377	-0.908
1:00 PM	-2.868	-0.523	5.771	3.692	-4.147	-1.4	-0.714	-0.793	-1.815	-0.704	0.296	-4.234
2:00 PM	-1.968	-1.275	3.769	-0.599	14.991	11.456	-12.386	2.917	3.693	9.638	-5.765	-4.277
3:00 PM	-4.365	1.508	-15.874	-3.789	-8.485	-6.227	28.405	-13.675	-4.031	-3.569	6.593	-6.56
4:00 PM	0.459	2.662	-0.131	0.271	2.402	5.242	-8.356	8.106	3.222	-0.709	-4.372	5.293
5:00 PM	-2.748	-1.177	14.065	-1.869	-1.47	-2.695	-4.963	-2.75	-2.818	-1.95	-0.556	-4.408
6:00 PM	-1.489	3.296	-5.407	-1.291	-1.224	-2.358	-3.73	15.703	-2.054	-0.984	0.673	2.05
7:00 PM	-0.877	-0.538	-4.254	-1.328	1.536	-1.017	-4.111	-0.134	-0.554	-0.441	-1.671	30.479
8:00 PM	2.294	-0.327	-1.614	1.671	-1.098	-0.529	-1.741	-1.722	3.665	4.971	1.902	5.011
9:00 PM	0.387	-0.29	-1.287	3.475	-1.499	-0.848	2.043	-0.812	-0.631	-0.891	-1.487	1.593
10:00 PM	1.326	-0.316	-3.504	0.503	2.043	0.178	-1.427	4.48	-0.139	2.122	-1.62	2.585
11:00 PM	-0.416	-0.146	2.66	-0.361	-0.756	-0.762	-2.015	-0.084	0.766	-0.449	-0.75	2.241

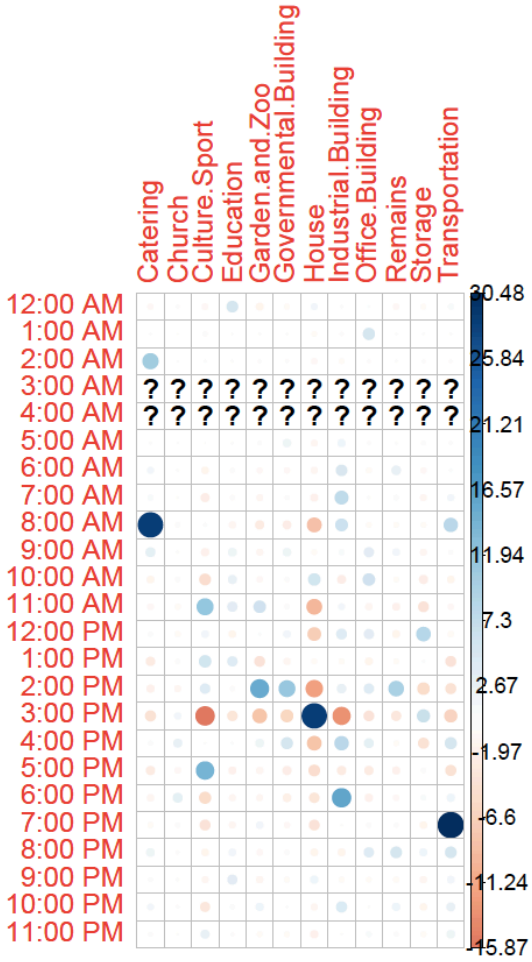


Figure b. 13 Hourly temporal distribution of local photographs per heritage type - Pearson residuals (blue: positive, red: negative)

Table b. 52 Hourly temporal distribution of local photographs per heritage type - chi-square value

hours	Catering	Church	Culture-Sport	Education	Garden and Zoo	Governmental Building	House	Industrial Building	Office Building	Remains	Storage	Transportation	Grand Total
12:00 AM	0.97	0.12	1.33	25.00	3.20	0.48	1.95	0.07	0.05	1.13	0.42	0.73	35.43
1:00 AM	0.01	0.00	0.25	0.01	0.04	0.04	0.39	0.14	29.75	0.01	0.04	0.03	30.72
2:00 AM	111.57	0.00	0.07	0.03	0.11	0.12	1.18	0.42	0.09	0.04	0.11	0.09	113.85
3:00 AM													
4:00 AM													
5:00 AM	0.05	0.01	0.00	0.03	0.15	4.62	1.57	3.63	0.13	0.05	0.15	0.12	10.52

6:00 AM	2.03	0.03	2.52	0.20	0.88	0.89	1.80	23.51	0.73	9.24	0.86	0.11	42.81
7:00 AM	0.55	0.06	7.04	0.36	1.60	0.24	3.40	54.89	0.08	0.34	1.57	2.18	72.31
8:00 AM	806.00	0.36	0.12	2.16	7.59	6.04	75.24	38.40	0.44	0.54	0.58	63.71	1001.17
9:00 AM	10.48	0.07	4.45	5.82	1.87	5.09	0.55	0.62	12.85	2.73	1.84	0.18	46.54
10:00 AM	2.84	0.35	24.93	6.99	1.21	0.24	32.95	6.29	34.02	0.52	7.33	2.84	120.51
11:00 AM	1.37	0.72	137.51	13.22	34.55	0.33	96.43	1.56	2.20	3.38	16.98	0.89	309.14
12:00 PM	0.26	0.71	2.86	2.57	0.05	3.04	52.28	16.60	12.85	3.32	70.17	0.83	165.55
1:00 PM	8.22	0.27	33.30	13.63	17.20	1.96	0.51	0.63	3.29	0.50	0.09	17.93	97.53
2:00 PM	3.87	1.62	14.21	0.36	224.72	131.25	153.40	8.51	13.64	92.90	33.24	18.29	696.01
3:00 PM	19.06	2.27	251.98	14.36	72.00	38.78	806.86	187.00	16.25	12.74	43.46	43.03	1507.78
4:00 PM	0.21	7.09	0.02	0.07	5.77	27.48	69.82	65.71	10.38	0.50	19.11	28.01	234.18
5:00 PM	7.55	1.38	197.81	3.49	2.16	7.27	24.63	7.57	7.94	3.80	0.31	19.43	283.34
6:00 PM	2.22	10.87	29.23	1.67	1.50	5.56	13.91	246.59	4.22	0.97	0.45	4.20	321.38
7:00 PM	0.77	0.29	18.10	1.76	2.36	1.03	16.90	0.02	0.31	0.19	2.79	929.00	973.52
8:00 PM	5.26	0.11	2.60	2.79	1.21	0.28	3.03	2.97	13.43	24.71	3.62	25.11	85.12
9:00 PM	0.15	0.08	1.66	12.08	2.25	0.72	4.18	0.66	0.40	0.79	2.21	2.54	27.71
10:00 PM	1.76	0.10	12.28	0.25	4.17	0.03	2.04	20.07	0.02	4.50	2.62	6.68	54.53
11:00 PM	0.17	0.02	7.08	0.13	0.57	0.58	4.06	0.01	0.59	0.20	0.56	5.02	18.99
Grand Total	985.37	26.55	749.35	106.99	385.13	236.06	1367.07	685.86	163.64	163.12	208.52	1170.97	6248.64

Pearson's Chi-squared test

X-squared = 6248.6, df = 231,= 121,p-value < 2.2e-16

Table b. 53 Daily temporal distribution of local photographs per heritage type - observed value

days	Catering	Church	Culture-Sport	Education	Garden and Zoo	Governmental Building	House	Industrial Building	Office Building	Remains	Storage	Transportation	Grand Total
Monday	7		129	8	20	13	246	51	31	14	7	18	544
Tuesday	7	2	130	16	60	35	144	77	20	14	90	19	614
Wednesday	12		158	23	33	42	924	165	45	11	71	26	1510
Thursday	7	1	136	6	22	32	338	164	24	11	31	41	813
Friday	18		320	7	45	19	679	68	11	6	57	47	1277
Saturday	31	4	654	8	63	132	637	357	94	17	50	63	2110
Sunday	15	5	607	5	77	52	332	307	40	40	9	48	1537
Grand Total	97	12	2134	73	320	325	3300	1189	265	113	315	262	8405

Table b. 54 Daily temporal distribution of local photographs per heritage type – expected value

days	Catering	Church	Culture-Sport	Education	Garden and Zoo	Governmental Building	House	Industrial Building	Office Building	Remains	Storage	Transportation	Grand Total
Monday	6.28	0.78	138.12	4.72	20.71	21.04	213.59	76.96	17.15	7.31	20.39	16.96	544
Tuesday	7.09	0.88	155.89	5.33	23.38	23.74	241.07	86.86	19.36	8.25	23.01	19.14	614
Wednesday	17.43	2.16	383.38	13.11	57.49	58.39	592.86	213.61	47.61	20.30	56.59	47.07	1510
Thursday	9.38	1.16	206.42	7.06	30.95	31.44	319.20	115.01	25.63	10.93	30.47	25.34	813
Friday	14.74	1.82	324.23	11.09	48.62	49.38	501.38	180.65	40.26	17.17	47.86	39.81	1277
Saturday	24.35	3.01	535.72	18.33	80.33	81.59	828.44	298.49	66.53	28.37	79.08	65.77	2110
Sunday	17.74	2.19	390.24	13.35	58.52	59.43	603.46	217.43	48.46	20.66	57.60	47.91	1537
Grand Total	97	12	2134	73	320	325	3300	1189	265	113	315	262	8405

Table b. 55 Daily temporal distribution of local photographs per heritage type – Pearson residuals

days	Catering	Church	Culture-Sport	Education	Garden and Zoo	Governmental Building	House	Industrial Building	Office Building	Remains	Storage	Transportation
Monday	0.288	-0.881	-0.776	1.507	-0.156	-1.752	2.218	-2.959	3.344	2.472	-2.965	0.253
Tuesday	-0.032	1.2	-2.074	4.619	7.575	2.311	-6.252	-1.058	0.146	2	13.965	-0.032
Wednesday	-1.3	-1.468	-11.511	2.73	-3.23	-2.145	13.6	-3.326	-0.378	-2.064	1.915	-3.071
Thursday	-0.778	-0.149	-4.901	-0.399	-1.609	0.1	1.052	4.568	-0.323	0.021	0.096	3.11
Friday	0.85	-1.35	-0.235	-1.228	-0.519	-4.323	7.932	-8.381	-4.612	-2.695	1.321	1.14
Saturday	1.347	0.569	5.11	-2.412	-1.934	5.581	-6.651	3.387	3.368	-2.134	-3.27	-0.342
Sunday	-0.65	1.894	10.973	-2.285	2.416	-0.964	-11.051	6.074	-1.215	4.254	-6.404	0.013

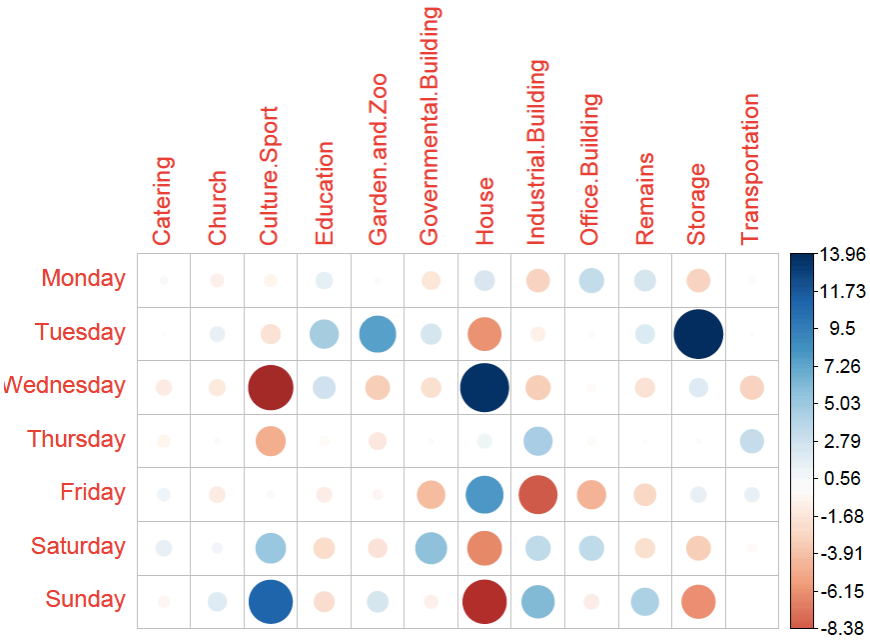


Figure b. 14 Daily temporal distribution of local photographs per heritage type – Pearson residuals (blue: positive, red: negative)

Table b. 56 Daily temporal distribution of local photographs per heritage type – chi-square value

days	Catering	Church	Culture-Sport	Education	Garden and Zoo	Governmental Building	House	Industrial Building	Office Building	Remains	Storage	Transportation	Grand Total
Monday	0.08	0.78	0.60	2.27	0.02	3.07	4.92	8.75	11.18	6.11	8.79	0.06	46.65
Tuesday	0.00	1.44	4.30	21.34	57.38	5.34	39.09	1.12	0.02	4.00	195.01	0.00	329.03
Wednesday	1.69	2.16	132.50	7.45	10.43	4.60	184.96	11.06	0.14	4.26	3.67	9.43	372.35
Thursday	0.61	0.02	24.02	0.16	2.59	0.01	1.11	20.87	0.10	0.00	0.01	9.67	59.17
Friday	0.72	1.82	0.06	1.51	0.27	18.69	62.92	70.25	21.27	7.27	1.75	1.30	187.82
Saturday	1.82	0.32	26.11	5.82	3.74	31.15	44.24	11.47	11.35	4.56	10.69	0.12	151.38
Sunday	0.42	3.59	120.40	5.22	5.84	0.93	122.11	36.90	1.48	18.09	41.01	0.00	355.99
Grand Total	5.34	10.13	307.99	43.77	80.27	63.78	459.34	160.42	45.54	44.29	260.93	20.59	1502.39

Pearson's Chi-squared test

X-squared = 1502.4, df = 66,= 121,p-value < 2.2e-16

Table b. 57 Monthly temporal distribution of local photographs per heritage type - observed value

months	Catering	Church	Culture-Sport	Education	Garden and Zoo	Governmental Building	House	Industrial Building	Office Building	Remains	Storage	Transportation	Grand Total
January	3	1	137	5	9	4	63	20	11	3		8	264
February	4	2	158	2	15	14	250	57	24	4	1	19	550
March	14		213	3	39	44	1672	254	40	3	194	41	2517
April	15	1	136	2	48	110	197	229	53	12	31	44	878
May	6		275	3	37	22	257	138	9	6	1	14	768
June	12	2	298	1	25	9	159	92	7	3	1	28	637
July	5		135	1	18	7	98	35	10	8	3	13	333
August	9		289	3	18	10	125	79	13	42	6	8	602
September	2	4	157	8	5	14	143	66	18	5	33	22	477

October	14		133	31	71	76	166	139	51	12	5	26	724
November	8	2	91	6	7	11	62	56	11	12	37	24	327
December	5		112	8	28	4	108	24	18	3	3	15	328
Grand Total	97	12	2134	73	320	325	3300	1189	265	113	315	262	8405

Table b. 58 Monthly temporal distribution of local photographs per heritage type - expected value

months	Catering	Church	Culture-Sport	Education	Garden and Zoo	Governmental Building	House	Industrial Building	Office Building	Remains	Storage	Transportation	Grand Total
January	3.05	0.38	67.03	2.29	10.05	10.21	103.65	37.35	8.32	3.55	9.89	8.23	264
February	6.35	0.79	139.64	4.78	20.94	21.27	215.94	77.80	17.34	7.39	20.61	17.14	550
March	29.05	3.59	639.06	21.86	95.83	97.33	988.23	356.06	79.36	33.84	94.33	78.46	2517
April	10.13	1.25	222.92	7.63	33.43	33.95	344.72	124.20	27.68	11.80	32.91	27.37	878
May	8.86	1.10	194.99	6.67	29.24	29.70	301.53	108.64	24.21	10.33	28.78	23.94	768
June	7.35	0.91	161.73	5.53	24.25	24.63	250.10	90.11	20.08	8.56	23.87	19.86	637
July	3.84	0.48	84.55	2.89	12.68	12.88	130.74	47.11	10.50	4.48	12.48	10.38	333
August	6.95	0.86	152.85	5.23	22.92	23.28	236.36	85.16	18.98	8.09	22.56	18.77	602
September	5.50	0.68	121.11	4.14	18.16	18.44	187.28	67.48	15.04	6.41	17.88	14.87	477
October	8.36	1.03	183.82	6.29	27.56	28.00	284.26	102.42	22.83	9.73	27.13	22.57	724
November	3.77	0.47	83.02	2.84	12.45	12.64	128.39	46.26	10.31	4.40	12.26	10.19	327
December	3.79	0.47	83.28	2.85	12.49	12.68	128.78	46.40	10.34	4.41	12.29	10.22	328
Grand Total	97	12	2134	73	320	325	3300	1189	265	113	315	262	8405

Table b. 59 Monthly temporal distribution of local photographs per heritage type - Pearson residuals

months	Catering	Church	Culture-Sport	Education	Garden and Zoo	Governmental Building	House	Industrial Building	Office Building	Remains	Storage	Transportation
January	-0.027	1.015	8.547	1.788	-0.332	-1.943	-3.993	-2.838	0.928	-0.292	-3.145	-0.08
February	-0.932	1.371	1.553	-1.271	-1.298	-1.576	2.318	-2.359	1.599	-1.248	-4.32	0.448
March	-2.792	-1.896	-16.854	-4.034	-5.805	-5.405	21.751	-5.409	-4.418	-5.301	10.262	-4.229
April	1.529	-0.226	-5.822	-2.037	2.52	13.052	-7.956	9.403	4.812	0.057	-0.332	3.179
May	-0.962	-1.047	5.73	-1.421	1.435	-1.412	-2.565	2.816	-3.092	-1.346	-5.179	-2.032
June	1.714	1.144	10.715	-1.927	0.152	-3.15	-5.761	0.199	-2.92	-1.901	-4.681	1.828
July	0.59	-0.69	5.487	-1.113	1.495	-1.638	-2.864	-1.764	-0.154	1.665	-2.684	0.813
August	0.779	-0.927	11.013	-0.975	-1.028	-2.752	-7.243	-0.668	-1.373	11.918	-3.487	-2.485
September	-1.494	4.022	3.261	1.895	-3.088	-1.035	-3.236	-0.18	0.763	-0.558	3.577	1.849
October	1.953	-1.017	-3.748	9.855	8.273	9.073	-7.014	3.615	5.897	0.726	-4.249	0.722
November	2.175	2.244	0.875	1.875	-1.545	-0.462	-5.859	1.432	0.215	3.626	7.068	4.325
December	0.624	-0.684	3.147	3.052	4.39	-2.438	-1.831	-3.288	2.382	-0.671	-2.65	1.494

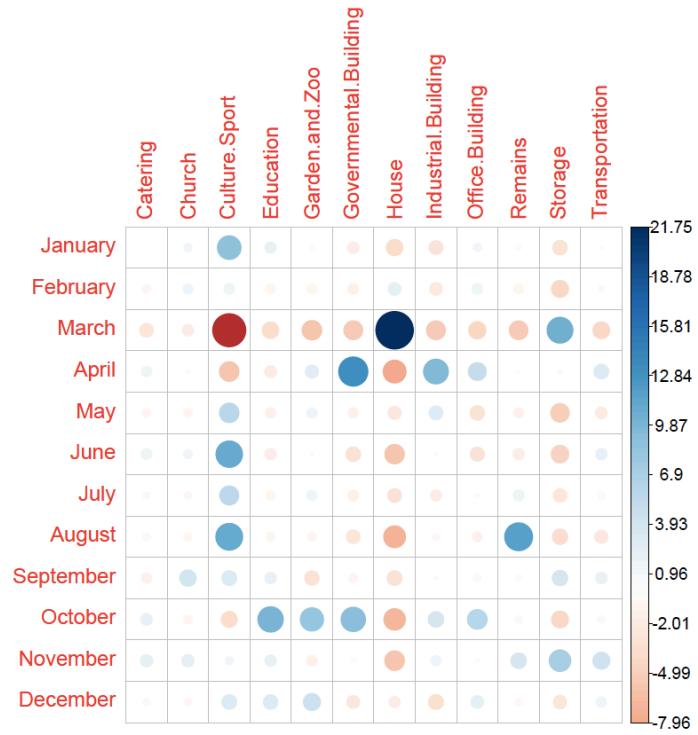


Figure b. 15 Monthly temporal distribution of local photographs per heritage type - Pearson residuals (blue: positive, red: negative)

Table b. 60 Monthly temporal distribution of local photographs per heritage type - chi-square value

months	Catering	Church	Culture-Sport	Education	Garden and Zoo	Governmental Building	House	Industrial Building	Office Building	Remains	Storage	Transportation	Grand Total
January	0.00	1.03	73.04	3.20	0.11	3.78	15.94	8.06	0.86	0.09	9.89	0.01	116.00
February	0.87	1.88	2.41	1.61	1.68	2.48	5.37	5.56	2.56	1.56	18.66	0.20	44.85
March	7.80	3.59	284.05	16.27	33.70	29.22	473.10	29.26	19.52	28.11	105.31	17.88	1047.81
April	2.34	0.05	33.89	4.15	6.35	170.36	63.30	88.42	23.15	0.00	0.11	10.11	402.24
May	0.92	1.10	32.83	2.02	2.06	1.99	6.58	7.93	9.56	1.81	26.82	4.13	97.75
June	2.94	1.31	114.81	3.71	0.02	9.92	33.18	0.04	8.52	3.61	21.92	3.34	203.33
July	0.35	0.48	30.11	1.24	2.23	2.68	8.20	3.11	0.02	2.77	7.20	0.66	59.05
August	0.61	0.86	121.29	0.95	1.06	7.57	52.47	0.45	1.88	142.05	12.16	6.18	347.51
September	2.23	16.18	10.64	3.59	9.54	1.07	10.47	0.03	0.58	0.31	12.79	3.42	70.85
October	3.81	1.03	14.05	97.12	68.44	82.32	49.20	13.07	34.77	0.53	18.06	0.52	382.91

November	4.73	5.03	0.77	3.52	2.39	0.21	34.33	2.05	0.05	13.15	49.96	18.70	134.89
December	0.39	0.47	9.91	9.31	19.27	5.94	3.35	10.81	5.67	0.45	7.02	2.23	74.84
Grand Total	26.99	33.00	727.79	146.69	146.86	317.55	755.50	168.79	107.16	194.44	289.90	67.38	2982.04

Pearson's Chi-squared test

X-squared = 2982, df = 121,,= 121,p-value < 2.2e-16

Table b. 61 Yearly temporal distribution of local photographs per heritage type - observed value

years	Catering	Church	Culture-Sport	Education	Garden and Zoo	Governmental Building	House	Industrial Building	Office Building	Remains	Storage	Transportation	Grand Total
1927-2007	2	0	107	5	48	24	59	27	28	0	3	5	308
2008	5		20	2	5	1	59	1	4	2		6	105
2009	1		54	2	6		67	14	1	1	33	1	180
2010	2		80	1	10	6	48	39	10	4	1	9	210
2011	6		71	1	5	9	61	42	13	4	27	14	253
2012	8	1	55	1	6	4	79	54	8	1		8	225
2013	14	4	132	2	4	10	282	72	14	5	3	11	553
2014	3		185	1	32	27	144	101	17	19		26	555
2015	12	3	323	3	63	98	112	380	45	60		42	1141
2016	11		116	18	46	35	173	102	22	6	6	64	599
2017	12		216	14	10	20	92	128	24	3	3	26	548
2018	16	2	592	21	59	75	448	194	61	8	41	38	1555
2019	5	2	183	2	26	16	1676	35	18		198	12	2173
Grand Total	97	12	2134	73	320	325	3300	1189	265	113	315	262	8405

Table b. 62 Yearly temporal distribution of local photographs per heritage type - expected value

years	Catering	Church	Culture-Sport	Education	Garden and Zoo	Governmental Building	House	Industrial Building	Office Building	Remains	Storage	Transportation	Grand Total
1927-2007	3.55	0.44	78.20	2.68	11.73	11.91	120.93	43.57	9.71	4.14	11.54	9.60	308
2008	1.21	0.15	26.66	0.91	4.00	4.06	41.23	14.85	3.31	1.41	3.94	3.27	105
2009	2.08	0.26	45.70	1.56	6.85	6.96	70.67	25.46	5.68	2.42	6.75	5.61	180
2010	2.42	0.30	53.32	1.82	8.00	8.12	82.45	29.71	6.62	2.82	7.87	6.55	210
2011	2.92	0.36	64.24	2.20	9.63	9.78	99.33	35.79	7.98	3.40	9.48	7.89	253
2012	2.60	0.32	57.13	1.95	8.57	8.70	88.34	31.83	7.09	3.02	8.43	7.01	225
2013	6.38	0.79	140.40	4.80	21.05	21.38	217.12	78.23	17.44	7.43	20.73	17.24	553
2014	6.41	0.79	140.91	4.82	21.13	21.46	217.91	78.51	17.50	7.46	20.80	17.30	555
2015	13.17	1.63	289.70	9.91	43.44	44.12	447.98	161.41	35.97	15.34	42.76	35.57	1141
2016	6.91	0.86	152.08	5.20	22.81	23.16	235.18	84.74	18.89	8.05	22.45	18.67	599
2017	6.32	0.78	139.14	4.76	20.86	21.19	215.16	77.52	17.28	7.37	20.54	17.08	548
2018	17.95	2.22	394.81	13.51	59.20	60.13	610.53	219.98	49.03	20.91	58.28	48.47	1555
2019	25.08	3.10	551.72	18.87	82.73	84.02	853.17	307.40	68.51	29.21	81.44	67.74	2173
Grand Total	97	12	2134	73	320	325	3300	1189	265	113	315	262	8405

Table b. 63 Yearly temporal distribution of local photographs per heritage type - Pearson residuals

years	Catering	Church	Culture-Sport	Education	Garden and Zoo	Governmental Building	House	Industrial Building	Office Building	Remains	Storage	Transportation
1927-2007	-0.825	-0.663	3.257	1.421	10.593	3.503	-5.631	-2.51	5.869	-2.035	-2.515	-1.485
2008	3.441	-0.387	-1.29	1.139	0.501	-1.519	2.768	-3.595	0.379	0.495	-1.984	1.507
2009	-0.747	-0.507	1.228	0.349	-0.326	-2.638	-0.437	-2.272	-1.962	-0.913	10.108	-1.947
2010	-0.272	-0.548	3.654	-0.61	0.709	-0.744	-3.794	1.705	1.313	0.7	-2.449	0.959

2011	1.803	-0.601	0.844	-0.808	-1.493	-0.25	-3.846	1.038	1.779	0.325	5.689	2.177
2012	3.353	1.198	-0.281	-0.683	-0.877	-1.593	-0.994	3.93	0.34	-1.164	-2.904	0.372
2013	3.016	3.613	-0.709	-1.279	-3.717	-2.462	4.403	-0.704	-0.823	-0.893	-3.894	-1.502
2014	-1.345	-0.89	3.714	-1.74	2.365	1.196	-5.007	2.538	-0.119	4.224	-4.561	2.092
2015	-0.322	1.074	1.957	-2.195	2.968	8.112	-15.874	17.205	1.505	11.403	-6.539	1.079
2016	1.554	-0.925	-2.926	5.611	4.857	2.46	-4.055	1.875	0.717	-0.724	-3.472	10.49
2017	2.257	-0.885	6.516	4.236	-2.378	-0.258	-8.396	5.733	1.617	-1.609	-3.87	2.158
2018	-0.459	-0.148	9.924	2.039	-0.026	1.918	-6.578	-1.751	1.71	-2.823	-2.263	-1.504
2019	-4.009	-0.626	-15.698	-3.884	-6.237	-7.421	28.17	-15.537	-6.103	-5.405	12.916	-6.772

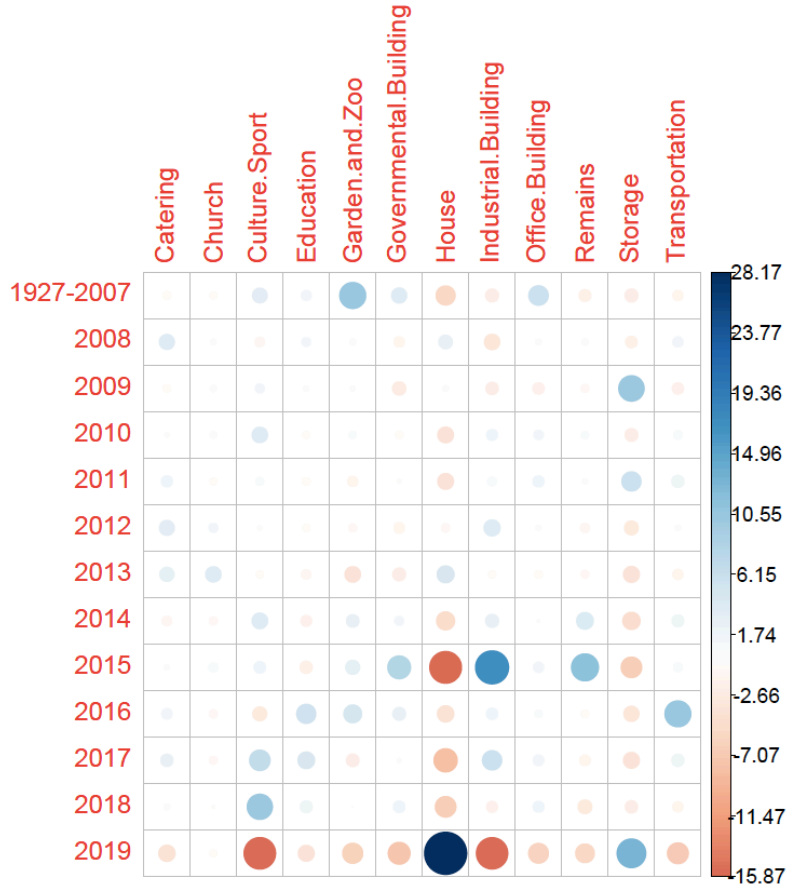


Figure b. 16 Yearly temporal distribution of local photographs per heritage type - Pearson residuals (blue: positive, red: negative)

Table b. 64 Yearly temporal distribution of local photographs per heritage type - chi-square value

years	Catering	Church	Culture-Sport	Education	Garden and Zoo	Governmental Building	House	Industrial Building	Office Building	Remains	Storage	Transportation	Grand Total
1927-2007	0.68	0.44	10.61	2.02	112.21	12.27	31.71	6.30	34.45	4.14	6.32	2.20	223.36
2008	11.84	0.15	1.66	1.30	0.25	2.31	7.66	12.92	0.14	0.25	3.94	2.27	44.69
2009	0.56	0.26	1.51	0.12	0.11	6.96	0.19	5.16	3.85	0.83	102.18	3.79	125.51
2010	0.07	0.30	13.35	0.37	0.50	0.55	14.39	2.91	1.72	0.49	6.00	0.92	41.59
2011	3.25	0.36	0.71	0.65	2.23	0.06	14.79	1.08	3.16	0.11	32.37	4.74	63.51
2012	11.24	1.43	0.08	0.47	0.77	2.54	0.99	15.44	0.12	1.36	8.43	0.14	43.00
2013	9.09	13.05	0.50	1.64	13.81	6.06	19.39	0.50	0.68	0.80	15.16	2.26	82.93
2014	1.81	0.79	13.79	3.03	5.59	1.43	25.07	6.44	0.01	17.84	20.80	4.37	100.98
2015	0.10	1.15	3.83	4.82	8.81	65.80	251.98	296.03	2.26	130.02	42.76	1.16	808.73
2016	2.42	0.86	8.56	31.48	23.59	6.05	16.44	3.52	0.51	0.52	12.05	110.04	216.04
2017	5.09	0.78	42.46	17.94	5.66	0.07	70.50	32.87	2.62	2.59	14.98	4.66	200.20
2018	0.21	0.02	98.49	4.16	0.00	3.68	43.27	3.07	2.92	7.97	5.12	2.26	171.17
2019	16.07	0.39	246.42	15.09	38.90	55.07	793.57	241.39	37.24	29.21	166.83	45.86	1686.04
Grand Total	62.45	19.99	441.98	83.08	212.43	162.85	1289.95	627.61	89.69	196.12	436.93	184.68	3807.77

Pearson's Chi-squared test

X-squared = 3807.8, df = 132,,= 121,p-value < 2.2e-16