Analysis of Public Space Dynamics Based on Instagram and Flickr Data

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Abstract. The general increase in the use of social media platforms since 2010 is related to the growing amount of data collected on the Internet, which may represent an opportunity for urban research. By analysing publicly available geolocated data from social media platforms, it is possible to track changes in the attractiveness and spatiotemporal dynamics of public spaces through their different stages of development. In this paper, we analyse data obtained from the Instagram and Flickr - for both platforms, user-sharing photographs is their main feature. Photos taken during daily interactions in public space have a symbolic value. In addition, social media posts contain valuable metadata that can be used for analysis and information discovery. In research, social media posts are used to measure and identify the attractiveness and dynamics of a selected public space. Data was collected by using the REST API technology. Two case studies are presented that retrospectively analyse the attractiveness and dynamics of selected public spaces from Graz (Austria) and Maribor (Slovenia). The research results show that the data from the Flickr platform, which provides access to the exact geolocation of the posted photos, can show the attractiveness of the locations, as the popular sights in both cities were clearly identified on the generated heatmaps. The maps showed locations that were perceived as important and attractive by residents or visitors in order to document the, which indicates certain motivation or even quality that confirms the expected correlation. With the methodology presented, the data collected on the Instagram social media platform can, to a certain extent, reflect the activities carried out in the physical public space, even if it cannot provide a complete picture. The research results are considered a valuable proxy for determining the general level of social interaction in public space. The methodology presented demonstrates the innovative approach to retrospective analysis of dynamics and changing attractiveness from social media perspective in public space. In the future, however, more social media data will be available, which will allow a more specific analysis and - in combination with other data sources - a more effective detection of deficiencies in public space, but also better urban planning and management. Finally, there is an enormous potential for retrospective research using the comparative method, but also for linking new ICT driven approaches with traditional methods.
1. Introduction
The general increase in the use of social media (SocM) platforms since 2010 [1] is related to the growing amount of data collected on the Internet, which may represent an opportunity for urban research [2, 3]. The focus of our attention is put on platforms that share user-generated photos, such as Facebook, Twitter, LinkedIn, Instagram, Snapchat, Pinterest, etc., and which are used by the specific group of people who like to post photos when they attend events, visit places of interest, enjoy a good meal. By posting and sharing photos on the Internet they also contribute valuable metadata that can represent a digital footprint of existing social interactions. In general, meta data can reveal the time and the location of the posted photos, consequently from a larger amount of such data it is possible to track different aspects of the use and dynamics of public spaces [4], among others. Nevertheless, there are different policies between the platforms regarding the accessibility of metadata.

In the paper, meta data from two photo-sharing SocM platforms is used, namely Instagram and Flickr. Instagram was founded in 2010 and has a growing number of users taking lifestyle photos with mobile phones. In fact, Instagram only offers applications for smartphones and is not available on PCs, laptops or tablets. This selective approach enables more effective location tracking, that can be used for geotagged spatial analysis. Flickr, on the other hand, was founded in 2004 and was designated for amateur photographers who use cameras to capture artistic subjects and architectural highlights. By using two different SocM platforms, each of which is aimed at different user groups, by using different tools and by selecting different motives, the different possibilities of spatiotemporal analysis of public space can be presented, which is the main objective of the paper.

2. Methodology
In this research, social media posts from Instagram and Flickr are used as indicators to measure and identify specific characteristics of selected public spaces, which are retrieved from the stored metadata of the two SocM platforms. Using REST API (Representational State Transfer / Application Program Interface) technology [5], two case studies are presented that retrospectively analyse the spatiotemporal dynamics of selected public spaces from Graz (Austria) and Maribor (Slovenia). For each SocM platform a different methodological framework was created, and different aspects were observed (table 1). Since the SocM data does not directly correspond to the data collected e.g. by manual counting of visitors in public space, the approach presented is to be understood as an approximation or proxy [3].

| aspect               | scope                                      | identified by                           | focus                              |
|----------------------|--------------------------------------------|----------------------------------------|------------------------------------|
| site attractiveness  | attractive public spaces and landmarks     | the number of posts in Flickr           | geotagged information              |
| daily use            | general daily activities of residents or visitors | daily posts in Instagram              | georeferenced information (minimum posts per day or even none) |
| events frequency     | highlights of an increased activity, which last only for few days (e.g. Christmas market, music event, fair, sports event, etc.), | weekly or monthly posts in Instagram | georeferenced information (looking at the peaks and repeating patterns in the curve) |

It should be noted that when reviewing the literature, not as many studies on the use of Instagram and Flickr data for urban research were found as expected. Those using metadata from photos posted on
Instagram focus mainly on tourism research, especially destination management, as Instagram is considered the most popular social medium in tourism [6]. Studies were also found that relate to research on urban dynamics and daytime activities, i.e. how people gather and communicate in public spaces and how these activities correlate with social media posts on Instagram [7]. Studies related to Flickr deal with temporal patterns through geotagged photographs [5] and identification of events based on time and location [8].

2.1. Flickr and Instagram data
In the case of Flickr, the metadata of geolocated posts was collected within a radius of 500 metres around each city centre (table 2). Given the nature and ambition of the Flickr posts, it is assumed that the data collected can identify sites that are attractive for photography and from which a general attractiveness of public space can be discerned. As the Flickr posts can reveal the exact geopositioning of the photo taken, the broader spatial framework could be included in the research – the city centre of Graz and the city centre of Maribor. The broader time span was also used, from 2004 to the end of 2019.

| Table 2. Number of collected posts from Flickr (author) |
| --- |
| Flickr | Graz | Maribor |
| city center | | |
| research period | 2004-2019 | 2004-2019 |
| posts collected | 3496 | 3242 |
| radius | 500 m | 500 m |

In the case of Instagram, however, since May 2018 the platform no longer announces the exact geolocation of the photos taken, while respecting the users’ privacy policy. The locations of posts can be identified in other way by using Instagram’s location ID’s and relevant hashtags or a combination of hashtags. Location ID replaces the information on exact location with, for example, the name of the nearest street, square, restaurant, etc. If hashtags are used, the same principle can be applied. In the example of Mariahilferplatz in Graz, the hashtags used for data collection were #mariahilferplatzgraz and #mariahilferplatz + #graz. Since the information about the location of the photo taken is not as accurate as in the case of Flickr, research focused on tracking the temporal dynamics of posted photos that could correspond to specific events in public space. This could not be implemented in a larger area as in the case of Flickr, therefore two public spaces were selected in each city, Mariahilferplatz in Graz and Leon Stukelj Square in Maribor. As both are located in the city centre, they were found interesting as they are not traditional public spaces.

The spatiotemporal dynamics of the collected posts is presented as a time series showing the weekly number of posts within the defined time span – from 2017, 2018 and until the end of 2019. The number of collected post per day is presented only for one year – 2019. The number of collected posts for both locations is presented in the table 3.

| Table 3. Number of collected posts from Instagram (author) |
| --- |
| Instagram | Mariahilferplatz | Leon Stukelj Square |
| focus location | | |
| research period | 2017-2019 | 2017-2019 |
| posts collected | 1165 | 649 |
2.2. Research area and context
As briefly described above, the research area has two frameworks, the larger one covering the city centre of both cities and the smaller one only a selected public space in each city. Just for information, it should be mentioned that both cities, Graz and Maribor, are the second largest in their respective countries, both were European Capitals of Culture (ECoC). Like the neighboring cities, they have the same historical and cultural background. The city of Graz has about 260,000 inhabitants, Maribor 110,000.

In Graz the Mariahilferplatz was chosen because it is located in the heart of the formerly disadvantaged district of Lend on the right side of the Mur. The square was renovated in 1994. In 2003, when Graz was holding the ECoC title, a new urban scene, the Kunsthau Graz and the Murinsel, developed around it. Mariahilferplatz is a very interesting place to investigate whether this public space has changed and whether it has become more attractive or more activities and events are taking place.

In Maribor, Leon Stukelj Square (Trg Leona Štuklja) was selected because it is a rather newly developed urban public space. It did not exist in this form and size before 2012, it was built shortly before the beginning of the ECoC year in Maribor. Although many public spaces were planned for reconstruction at that time, only this one took place (grand opening of the ECoC took place there).

3. Results and discussions
The research results are divided into two parts, the first part relates to the site attractiveness seen from the SocM perspective and the second part to the other two aspects, daily use and frequency of events.

3.1. Evaluating the site attractiveness

3.1.1. Graz city centre. The location data retrieved by the Flickr SocM platform for the defined radius of 500 metres around the city centre of Graz (figure 1) shows some of the most important locations. The highest concentrations of posts were identified in following locations (marked by dark red colour on the heatmap): i) the Schlossberg, the Castle Hill - it is no surprise that this is a very attractive public space and at the same time a very attractive place to photograph as it enjoys the wide view of the city, especially the roofscape of the old city UNESCO heritage site, as well as the new landmarks; ii) Main Square (Hauptplatz), a historical public space with its rich architecture, the Town Hall, the sculptural fountain and many functional nodes for gastronomy and public transfer; iii) Am Eiserner Tor, at the end of the main shopping street, on Herrengasse, another focal point can be seen; iv) on the right bank of the Mur, in the area that has changed its appearance considerably through the ECoC, two new landmarks, Kunsthau Graz and the Murinsel, stand out as strong visual attractions. The area of the research focus, Mariahilferplatz, shows smaller number of posts compared to the other architectural landmarks. The public square, the Mariahilferplatz, is rather functional and restrained in design, but has a prominent church, the Mariahilferkirche, and a view of the castle hill, so that more posts were expected. Nevertheless, according to the heatmap generated from the posts published on the Flickr SocM platform, it is visible that a new pole of attraction and attention has been created on the right bank of the river, including Mariahilferplatz and the public space along the river, which represent a new addition to the traditional and already established inner city public space.

3.1.2. Maribor city centre. The research results show that in the case of Maribor the historical sights correspond to the areas of interest and attractions (figure 2). The most accentuated one is Glavni trg, the Main Square, which has occupied a central position in the city since the 13th Century, with the Town Hall and the plague monument. It is interesting that apart from the Main Square, no other stronger accentuation is visible in the city centre and that other public spaces show an even distribution of attractiveness, measured by the number of posts collected from Flickr. The chosen location of Trg Leona Štuklja is surprisingly ‘pale’, which indicates the rather low number of posts. As a public space, which was newly established at the time of the ECoC, it could have received more attention, but the data
collected indicates the opposite. A closer look at the field reveals a rather empty public space, surrounded by two banks, commercial buildings and even a huge underused building. There are also not many facilities like bars or restaurants on the ground floor. There is also no fountain or sculpture, only a few benches are placed, as this public space was planned as an open space for various events. On the bases of on the data obtained, one could assume that the urban renewal of this public space has not been successful, as it cannot compete with other traditional and established public spaces in the city.

**Figure 1.** Heatmap compiled according to the frequency of data-points for Graz city centre

**Figure 2.** Heatmap compiled according to the frequency of data-points for Maribor city centre
3.2. Evaluating the daily use and events frequency

3.2.1 Mariahilferplatz (Graz). The research results show the spatiotemporal dynamics of social media interactions in connection with activities in public space. These are represented by the peaks of increased activity, which can last up to several days. The frequency of events is shown in figure 3, representing three consecutive years in which the number of activities in public space has generally increased. Since 2018, a higher density of peaks is visible, with about 13 activity peaks identified in 2018 and the same in 2019. The number of peaks representing organized events is considered substantial, which shows the important use of the observed public space. When looking at the few posted photos, they show various activities related to the local church leading a children's choir, or activities at the Christmas market.

![Weekly number of posts (Instagram)](image)

**Figure 3.** Weekly number of posts in years 2017, 2018 and 2019 for Mariahilferplatz

The aspect of daily use is represented in figure 4 by the daily number of Flickr posts collected. According to the available data, in 2019 approximately 30 days of 5 or more posts per day were noticed, representing social interactions related to specific activities. September and December are the months with the highest number of social interactions that took place at Mariahilferplatz, which is not surprising. The daily display of posted images shows that about 30% of all days in 2019 were days without posted photos in the Instagram SocM platform. Regarding the daily use, it can be assumed that this public space has a transitory character.

3.1.2 Leon Stukelj Square (Maribor). The dynamics of special events in three consecutive years shows that the number of activities in the public square increased in 2019 compared to 2018, as more peaks are visible (figure 5). For the year 2019, about 5 activity peaks and a maximum of 18 posts per day were observed. Among the events that have attracted attention are Carnival, Lent Festival (end of June), St. Martin’s Day (11th of November), etc. During the events, the square is redesigned with additional functionalities such as a stage, food and drink stands are placed around. Christmas activities in December are seen repeatedly occurring every year, seen in figure 5, with more posts added to the Instagram platform each year.
The data collected for the Leon Stukelj Square shows rather weak social dynamic, represented by daily posts on Instagram in 2019 (figure 6). With regard to the special events represented in peaks (spikes), there were about 30 days in 2019 with 5 or more posts per day. The accentuated peaks show activities that are the same as those mentioned in the previous paragraph. Surprisingly, the quantity is similar to the number of peaks counted at *Mariahilferplatz*, although there is a visible difference in the number of days with no posted photos. In 2019 there were almost 70% of all days without any social media interaction, the annual average was 2 post per day. Looking at the visualised data, it can be
assumed that this public space does not have any major attractions that would motivate people to post photos on a daily basis, but rather becomes interesting when special events take place several times a year.

Figure 6. Daily number of posts for Leon Stukelj Square

3.3. Discussion

The research results show that by collecting and visualising the location data from the photographs posted on Flickr, it is possible to determine, which public spaces are attractive not only for photography, but consequently also as interesting public spaces. On the generated heatmaps, well-known and popular sights in both cities were clearly identified. It is questionable whether these results are representative, since the photographs were taken by the specific user group, but they can still show a perspective. In the case of the Instagram data and the research area of Mariahilferplatz in Graz and Leon Stukelj Square in Maribor, the presented data shows that identified activities were in general a product of organized events. The daily activity was minimal indicating the lack of visitors such as tourists, but also indirectly indicating low numbers of citizens visiting these places (i.e. night-life related activities, etc.). The proposed methodology can thus be used to analyse the typology, the general activity in observed public space long after the actual events have been finished. The data collected on the Instagram social media platform, namely daily use and frequency of events/activities, showed that they reflect a certain extent of activities carried out in the public space, even though they do not provide a complete picture by far. Rather, the results can be considered a valuable proxy for determining the general level of social interaction in public space. Finally, since the data from both platforms can be collected remotely from a physical space, but also retrospectively, the methodology can also provide important insights into spatiotemporal dynamics of public spaces that may not have been recognised before or in any other way.

4. Conclusions

The methodology presented shows the innovative approach to retrospective analyses of the spatiotemporal dynamics in public space. In the future, however, more metadata will be available, which will allow for a more specific analysis and, in combination with other data sources, will also allow for a more effective detection of deficiencies in public space. Finally, there is enormous potential for
retrospective research using the comparative method, but also for linking new ICT driven approaches with traditional methods.

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