Original Scientific Article

Data Mining of Visitors' Spatial Movement Patterns Using Flickr Geotagged Photos: The Case of Dispersed Plečnik's Architectural Heritage in Ljubljana

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The aim of this study is to analyse the patterns and structure of spatial visitor behaviour in Ljubljana, focusing on the spatially dispersed attractions of Jože Plečnik's architectural heritage recently inscribed in the UNESCO World Heritage List. Meaningful incorporation of architectural heritage into the overall tourist experience of the city poses several challenges for DMOS – how to properly communicate the role and the value of remarkable architectural units, how to regulate uneven visiting times and place over-concentration, how to provide visitors the opportunity for a rich and comprehensive tourist experience, and finally, to form 'cumulative attractions.' In the case of Ljubljana, these challenges are compounded by the spatial dispersion of the elements of the chosen attraction. The objectives of our study were: to illustrate the spatial interactions between the World Heritage attractions in Ljubljana and their interaction with other tourist 'hot spots,' and to investigate the movement patterns of visitors to the Plečnik attractions. To this end, Big Data analysis was performed on geotagged photos uploaded by visitors to the photo-sharing platform Flickr. Spatial clustering and movement patterns were used to achieve the objectives. The results show that Ljubljana's landmarks designed by Plečnik in the old city centre are integrated into a broader attraction network, while the more remote landmarks appear to be less visited and isolated. It is reasonable to assume that one-day visitors who have visited one or more attractions in the historic centre rarely venture further away and therefore they do not experience the World Heritage Site entirely. The main contribution of this research is a better understanding of the behavioural patterns of dispersed UNESCO site visitors, their structure, and the role of these attractions within the destination.

Keywords: visitors' spatial movements, Plečnik's architectural heritage, big data analysis, geotagged photos, spatial behavioural patterns

 https://doi.org/10.26493/2335-4194.16.49-62

Introduction

Understanding inter-destination and especially intra-destination tourists' movement patterns is important for strategic policy-making decisions, organisation of public transport, planning of road networks and public spaces, safety issues, and management and marketing of the tourist destination, which includes product development and visitor use policies (Caldeira & Kastenholz, 2020; Lew & McKercher, 2006, 2006; Li et al., 2019; Park et al., 2020; Vu et al., 2015). While inter-destination movements have received considerable attention within tourism studies (Flognfeldt, 1999; Oppermann, 1995; Tideswell & Faulkner, 1999), there have been a relatively limited number of empirical studies on intra-destination tourist's movement patterns. One of the main reasons for this is the complexity of tourist movements within the destination, with a virtually unlimited number of combinations of places tourists might visit and stochastic individual movement patterns, which make the study of movements within a destination more challenging compared to movements between destinations (Mckercher & Lau, 2008). Another challenge is the difficulty in obtaining relevant and reliable data (Lau & McKercher, 2006). In the past, data for movement analysis was usually collected through resource-limited surveys. However, with the bloom of social media, evolution of mobile technology and data mining procedures these patterns have become easier to monitor (Park et al., 2020). In the last few years, user generated content (UGC) has become an important source of information for intra-destination movement patterns analysis. In particular, if we wish to monitor tourists' movement patterns in connection to freely accessible tourist attractions or points of interest, which can be accessed from many different directions, this approach has strong potential.

Tourist intra-destination movement is influenced by a set of destination's and a set of tourist's characteristics. The latter include time and money restrictions, motivations, transport mode preferences, interests, knowledge, familiarity with the destination, emotional attachment to the destination or attraction, etc. (Lew & McKercher, 2006; Zoltan & McKercher, 2015). On the other hand, destination configuration, type and locations of attractions and accommodation facilities location, and transportation accessibility – including costs, congestion and quality of signage and other destination features – affect tourists movements as well (Lau & McKercher, 2006).

Architecture as objectified cultural capital is a vital element of city tourism. It characterises a particular sense of the place. Especially, 'the iconic architecture (buildings, landmarks, monuments) is particularly alluring as it identifies a place' (Scerri et al., 2016, p. 1). As such, it has a major role within destination marketing. The touristic role of urban architecture is twofold. It can, on the one hand, be seen as a townscape, offering pleasant scenery for various touristic activities or, on the other hand, can represent an attraction per se. For architecture in urban spaces, Ebejer (2021, p. 65) suggests the following definition: architectural attraction is 'a site that is of sufficient aesthetic, narrative and cultural interest to provide for the enjoyment, amusement, entertainment and education of visitors.' Understanding the function and relative importance of specific architectural attractions is vital for their sensible inclusion into the overall tourism product and city marketing activities. This is especially true in the case of highlight attractions such as UNESCO protected buildings.

The aim of this study was to analyse the spatial movement patterns of visitors in the newly declared World Heritage city of Ljubljana, focusing on the spatially dispersed attractions of Jože Plečnik's architectural heritage.

Theoretical Framework

Tourism implies movement, and tourism attractions spatial distribution undoubtedly plays a crucial role in shaping tourist spatial movement patterns. As tourists usually cannot consume all the destination attractions in a few days' visit, they have to decide which attractions they will visit and which not (Shoval & Raveh, 2004). There are several tourist personal traits and destination specifics influencing these decisions, which to a great extent overlap with general factors defining intra-destination movement. Many scholars have investigated the role of tourists' socio-demographic, psychographic and behavioural characteris-

tics in connection to visited attractions. They found that tourists with limited time budgets, those with low incomes, or those travelling in organised groups, first-time visitors, and foreign tourists tend to visit only the main attractions of the destination, while those who are less constrained in terms of time and finances, individual tourists, repeat visitors, and domestic tourists are more active and explore more and also more remote areas (Zoltan & McKercher, 2015; Shoval & Raveh, 2004; Cooper, 1981). Regarding tourist personality traits, previous studies show that tourists from the allocentric pole tend to visit and explore a wider set of attractions compared to more psychocentric tourists (Debbage, 1991). Another obvious factor affecting the decision on the attractions visit is the length of stay in the destination (Kang et al., 2018).

On the other side, tourist movement patterns also depend on the destination's characteristics, including number, spatial distribution and density of attractions. Lue et al. (1996) introduced the concept of cumulative attraction, where the compatibility of attractions plays an important role. If there are many compatible attractions within an area, they have a greater chance to be visited than in the case where there is only a single attraction in the area (Lue et al., 1996). In addition, popularity and ratings of attractions cause co-occurrence of visits between specific attractions (Hernández et al., 2021). A destination can thus be perceived as a (more obvious) geographical space or as a relational space (of attractions), which can be different from each other (Van der Zee & Bertocchi, 2018). The authors (Van der Zee & Bertocchi, 2018) stress that the two spaces tend to be more interrelated for international tourists and less for domestic ones. Another theory that can explain the effects of the spatial distribution of attractions on movement patterns is gravitational theory (Park et al., 2020). According to this theory, primary attractions have greater gravitational pull than secondary attractions, while clustered attractions can create a greater gravitational effect than a single attraction. Another approach, the so-called anchor-point theory, was introduced by Couclelis et al. (1987). The so-called anchor points refer to primary nodes or reference points of distinct regions and define the spatial cognition of individuals. That means that tourists tend to create their specific cognitive maps of the destination according the relative importance and hierarchical arrangement of attractions (Couclelis et al., 1987).

Movement patterns within the destination are undoubtedly also affected by tourists' specific motives and affinity for different types of attractions. Spatial distribution of architectural attractions, for example, has a greater impact on movement patterns for cultural tourists than for recreational ones (Stebbins, 1996). Therefore, understanding the structure of tourists and the movement patterns of different segments in relation to the architectural attractions is also important for destination marketing decision-making.

Urban Spatial Structure, Architectural Attractions and Tourists' Spatial Behaviour

In the context of tourism, spatial behaviour refers to the sequence of attractions visited by tourists within a geographic space and the sequence of movements between one attraction and another (Caldeira & Kastenholz, 2017). Studies from the field of urban tourism have confirmed that spatial behaviour and spatial structure are interdependent (Ashworth, 1988; Karski, 1990; Law, 1996). Urban spatial characteristics that have a major impact on tourist spatial behaviour are 'the physical configuration of space, the location of attractions, and the relative distance between accommodation and attractions' (Caldeira & Kastenholz, 2020, p. 25).

Architecture has a specific role in urban spatial structure as it aestheticises spaces with recognisable markers that create a particular sense of place and draw tourists into an area by providing a focal point for tourist attention and experience (Hayllar et al., 2008). Iconic architecture provides, in the words of Marcus Vitruvius, the great Roman architect and historian, 'firmness, utility and delight' (Scerri et al., 2016). While firmness refers to structural durability and utility refers to its spatial functionality, delight refers to architectural aesthetics. As stated by Maitland and Smith (2009), architectural aesthetic value is particularly important to tourists because it involves intense sensory presence, resonates meanings, and expands awareness.

According to Maitland and Smith (2009), the aes-

thetics of the built environment influences tourists' spatial behaviour in three ways. First, the tourist experience is affected by the built environment design and the way in which it is consumed. Second, the tourism experience affects people's aesthetic judgments and influences their demands. Third, the form, appearance and aesthetic qualities of built environments are to some degree shaped by the desire of cities to impress visitors (Maitland & Smith, 2009, p. 171).

Urban cultural tourists tend to behave in a specific way – in order to visit as many historical sites as possible, they move predominantly in the central areas and frequently at a fast pace (Caldeira & Kastenholz, 2020, p. 8). Edwards and Griffin (2013) propose the use of spatial syntax in the analysis of tourists' spatial behaviour in cities. Space syntax theory, introduced by Hillier and Hanson (1984) and further elaborated by Edwards and Griffin (2013), explains spatial relations that consider how different groups organise and arrange space in which they find themselves. In their study, Edwards and Griffin (2013) used GPS tracking to find out how various segments of tourists moved around the cities. Using this method, the authors diagnosed, for example, the lack of spatial dispersion of tourists in Sydney and proposed more efficient wayfinding systems and tourism information policies. Paulino et al. (2019) noted that, despite the tendency of tourists to explore areas close or immediate to their accommodation, tourist movements can be more concentrated or dispersed due to the influence of various factors. These include the spatial relationship between attractions, attraction characteristics, agglomeration of attractions, and spatial characteristics of the destination. Generally, tourists are more willing to visit remote places if they are unique or more attractive (e.g. iconic sights, landmark cultural institutions, places of historical significance) (Paulino et al., 2019).

Urban intra-destination spatial behaviour can be examined through movement patterns and multi-attraction visitation patterns. The former are determined by territoriality (attractions visited and distance from accommodation), linearity (patterns of movement that depend mainly on spatial configuration), locomotion (means of transportation used), and wayfinding (orientation in physical space), while the latter refer to intensity (number of nodal points) and specificity (particular features of attractions) (Caldeira & Kastenholz, 2020, p. 11).

Over the past two decades, among the multiple sources of information used to monitor human mobility, location loggers, cell phone satellite position records, and geotagged content from social media have been used to track the spatial behaviour of tourists in urban destinations (Domènech et al., 2020). User-generated content (UGC) has become a central subject of examination in tourism studies, as users now produce, share, or tag large amounts of their own information, including images and videos. Költringer and Dickinger's (2015) research shows that UGC is the richest and most diverse source of online information used to analyse tourists' destination image and tourists' spatial behaviour at destinations.

Visualising the geographical positions of photos taken by tourists is a commonly used method for measuring tourist activity in cities, including World Heritage cities (cities with UNESCO World Heritage assets) (e. g. Domènech et al., 2020). Using Big Data, researchers have tracked tourists and identified areas of congestion and underutilisation (case of Akka, Israel; Shoval, 2008); compared spatial behaviour patterns of first-time and repeat visitors (case of Hong Kong; McKercher et al., 2012); measured public use of iconic buildings (Bilbao case; Plaza et al., 2015) and identified spatial shift of attention to exceptional architecture (Hamburg case; Alaily-Mattar et al., 2022).

Numerous studies have demonstrated the usefulness of network analysis in studying tourism system related networks. In the context of tourist destinations analysis, more recently, Kádár and Gede (2021) used network analysis to determine the spatial and temporal complexity of tourist flows in the cross-border Danube region, Xu et al. (2022) and Jin et al. (2018) analysed the characteristics of the tourist flow network in Nanjing City¸ Paulino et al. (2019) analysed the boundaries of destinations, Mou et al. (2020) used network analysis to study the spatiotemporal changes of tourist flows in Shanghai, Lozano and Gutierrez (2018) studied global tourism flows, and Zheng et al. (2021) analysed the spatiotemporal behaviour of Chinese tourists in the Nordic countries of Europe. These

authors used various network and node centrality indicators (e.g. degree centrality, weighted degree centrality, betweenness centrality) to assess the network as a whole and the importance of individual destinations/attractions.

The Case of Plečnik's Dispersed Architectural Heritage in Ljubljana

In 2021, the UNESCO World Heritage Committee inscribed the selected works of architect Jože Plečnik (1872–1957) in Ljubljana in the UNESCO List of World Heritage Sites. The UNESCO World Heritage property consists of a series of dispersed public spaces (squares, parks, streets, promenades, bridges) and public institutions (national library, churches, markets, funerary complex) created in the period between the two World Wars and sensitively integrated into the pre-existing urban, natural and cultural context, thus contributing to the city's new identity.

As a result of Jože Plečnik's intervention between the two world wars, the urban design in Ljubljana has the easily recognisable characteristics of a symbolic capital city (UNESCO, 2021). This is apparent through the urban landscape design of the two axes: the land axis and the water axis. The design of both promenades is based on the continuous use of space, which determines the structure and use of bridges, parks, squares, markets and other public spaces, as well as buildings. These public spaces serve as spiritual places (the churches of St. Michael and St. Francis of Assisi, Plečnik's Žale – The Garden of All Saints) and spaces for relaxation (archaeological park along the Roman walls and promenades along the embankments of the Ljubljanica River, Trnovo Quay), as well as enabling market activities (Plečnik's Market), socialising (Congress Square, the Three Bridges, the Cobblers' Bridge), and intellectual and cultural activities (Vegova Street, National and University Library). The selection of Plečnik's works in Ljubljana comprises 14 components:

I The Green Promenade
1. the Congress Square with Zvezda Park
2. Vegova Street
3. the National and University Library
4. the Square of the French Revolution with the Križanke open-air theatre

II The Promenade along the Embankments and Bridges of the Ljubljanica River
5. Plečnik's Arcades/Market
6. the Three Bridges
7. the Cobblers' Bridge
8. the Trnovo bridge
9. Trnovo Quay
10. the Sluice Gate

III Other Plečnik works
11. the Church of St. Michael
12. the Church of St. Francis of Assisi
13. Plečnik's Žale/the Garden of All Saints
14. The archaeological park/the Roman wall in Mirje.

The locations of the designated Plečnik's heritage in Ljubljana are shown in Figure 1.

Previous studies show that the designation of architectural heritage as a World Heritage Site increases its value in the eyes of tourists, arouses their interest and influences their spatial behaviour (Khairi et al., 2022). Plečnik's architecture was a highlight of the city even before the inscription on the UNESCO list. The city DMO 'Tourism Ljubljana' was awarded 'the best emerging Europe tourism campaign of the year' in London in 2018. The campaign was based on the Plečnik heritage. According to DMO staff, the Plečnik House is one of the most visited tourist spots (Bandur, 2018).

To better understand the role of Plečnik's heritage in the tourism system of Ljubljana, questions arise about the nature of the tourists' urban experience. As suggested by Gravari-Barbas (2020), analyses of heritage tourism should 'move away from the heritage attractions *per se* to the tourists and their motivations as *constitutive* of the visited heritage' (Gravari-Barbas, 2020, p. 5).

Study Area, Data and Methods

Data Collection and Database Construction

The data for this study has been retrieved from the photo-sharing platform Flickr (www.flickr.com). Flickr

is one of the first and largest social photo sharing platforms to offer a geotagging service, and unlike Instagram, Panoramio, Facebook and others, is available almost worldwide. There are numerous tourism studies that use Flickr data, as it is the only major platform that offers free access to photos and metadata.

Moreover, previous research has demonstrated the feasibility and reliability of using such data. Su et al. (2016) analysed the geographical preferences of foreign and domestic visitors to China using photos from the Flickr platform. The authors found an extremely strong correlation (r = 0.9) between the number of photos posted and the number of foreign tourists in official statistics. The same strong statistical correlation (r = 0.9) was also found by Kim et al. (2019) in a study of tourism in protected areas in developing countries when they compared the average daily number of photos posted over a year ('photo-used-day;' Wood et al., 2013) with tourism receipts.

An even stronger correlation (r = 0.98) between the number of photos on the Flickr platform and the official number of overnight stays in cities along the Danube was calculated in a study on tourism flows by Kádár and Gede (2021). Flickr data mining has been proved effective in previous studies of tourist movement behaviour (for details see e.g. Jankowski et al., 2010; Vu et al., 2015; Mou et al., 2020; Park et al., 2020; Kádár & Gede, 2021; Han et al., 2021).

To crawl the data, we used a Python code for recursive Flickr Application Programme Interfaces (API) calls. The API – flickr.photo.search returns the publicly available photos' meta-information including the photo ID, photo title, geocode (longitude and latitude), textual tags, photo timestamp, upload date, owner name and owner ID. A boundary box containing the administrative area of the city was used to limit a query response.

In the next step, the acquired owner IDS were used to retrieve the information about the user (API – flickr.people.getInfo), including the user's name and location. Then this information was merged with photos metadata using the owner ID. In this process, we also downloaded all available photos. However, the content of the photos was not relevant in this study and was therefore not included in this analysis. The collected dataset consisted of the meta-information of photos taken between January 2007 and December 2018. We were able to crawl 68,520 photo meta-information records that were taken by 4,735 individual users. Occasionally, the Flickr APIS returned duplicate photos, errors, spatial outliers and incomplete records. These records were deleted from the dataset during the data cleansing process. The final dataset contains 65,210 records.

In accordance with the purpose of the study, we developed a set of rules to distinguish locals (residents) from tourists. In previous studies (e.g. Kádár and Gede, 2013; Önder et al., 2016; Su et al., 2016; Li et al., 2018; Kádár and Gede, 2021) researchers have used various heuristic methods to identify tourists; however, none of these methods are completely reliable or statistically tested. Although our procedure follows the methods used in previous studies, we applied a more rigorous classification criterion. Specifically, all Flickr users who indicated a foreign home country or a hometown outside Slovenia and for whom the time span of a sequence of their uploaded photos (within one year) was less than one month were classified as tourists. All other users were classified as non-tourists and thus removed from the dataset.

In the next step, we followed the suggestions of Hu et al. (2015) and eliminated active user behaviour bias (caused by users uploading multiple photos of the same micro-location in a very short period of time) from the data. First, the photo collections of each user were sorted chronologically. Then, using a spatial and temporal filter, we merged multiple consecutive photos of the same attraction/location into a single record. After cleaning and filtering the dataset, we ended up with a dataset of 42,572 photos from 3,556 users classified as tourists. Their spatial distribution is shown in Figure 1.

The numbers of uploaded photos and users per year are shown in Table 1.

AOIs Identification and Network Construction

Since in this study we focus on intra-destination tourist movement, which in our case corresponds to tourists' trajectories from one spatial location to another (where locations represent tourist attractions or Areas

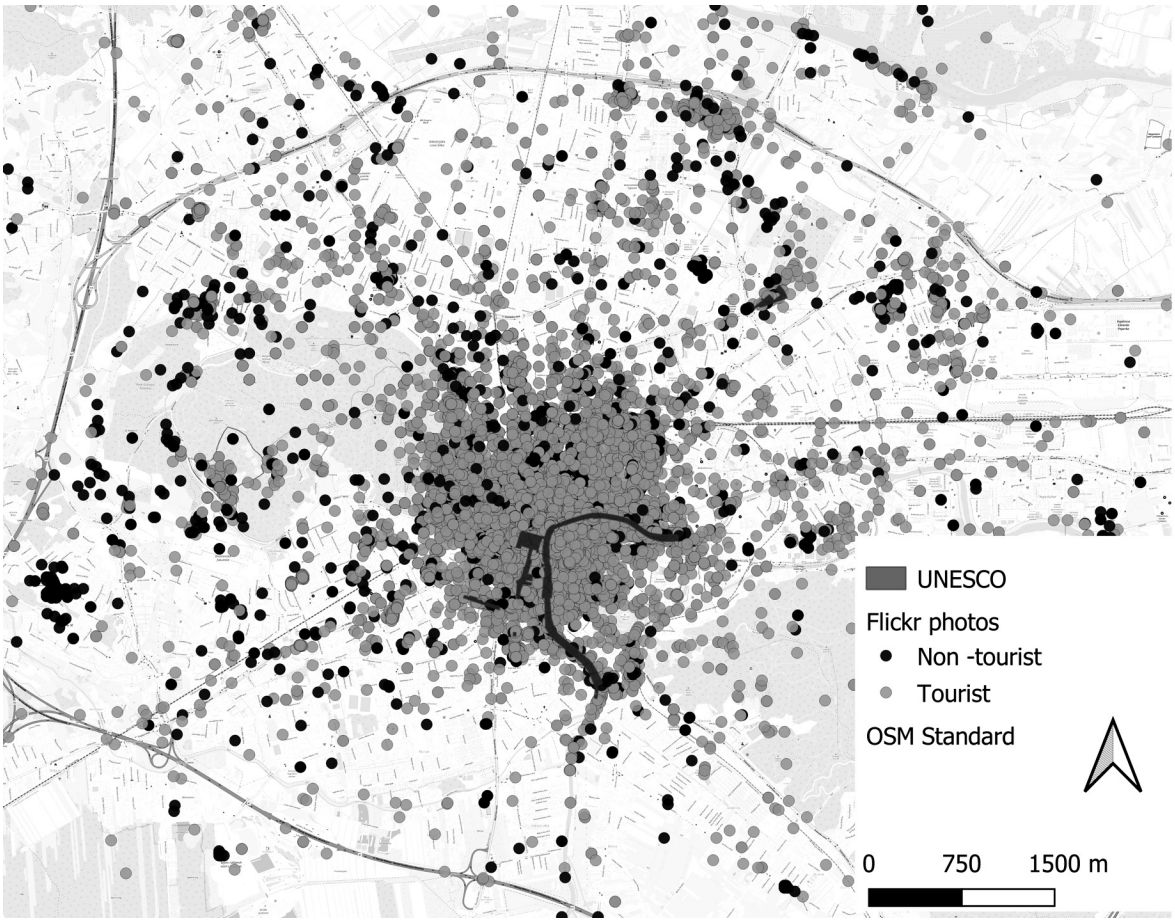

Figure 1 Spatial Distribution of Uploaded Photos in Ljubljana

Table 1 Number of Uploaded Photos and Users per Year

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Number of users	737	754	732	865	1085	1144	926	845	760	647	464	270
Number of photos	4248	4775	3933	4672	4816	5826	5294	4957	3502	2639	3440	2518

Of Interest (AOIs)), the temporal sequence of daily photos of different users was used to create daily trajectories. In this process, the density-based spatial clustering algorithm with noise DBSCAN (Ester et al., 1996) was applied to identify the most popular AOIs. Details of this widely used data mining algorithm for identifying AOIs can be found, for example, in Park et al. (2020), Hu et al. (2015), Vu et al. (2015), or Paliska et al. (2022). We then aggregated the users' individual daily trajectories into daily cluster level (AOIs) trajectories (see conceptual scheme in Figure 2). In this way, we constructed a weighted directed network where the AOIs (clusters) represent nodes, the edges between each pair of *i* and *j* nodes represent the movements, and the weight *wij* of the edges equals the count of user trajectories (tourist flow) between *i* and *j* nodes. A total of 2,612 trajectories between 559 nodes and 8,537 tourist movements were extracted.

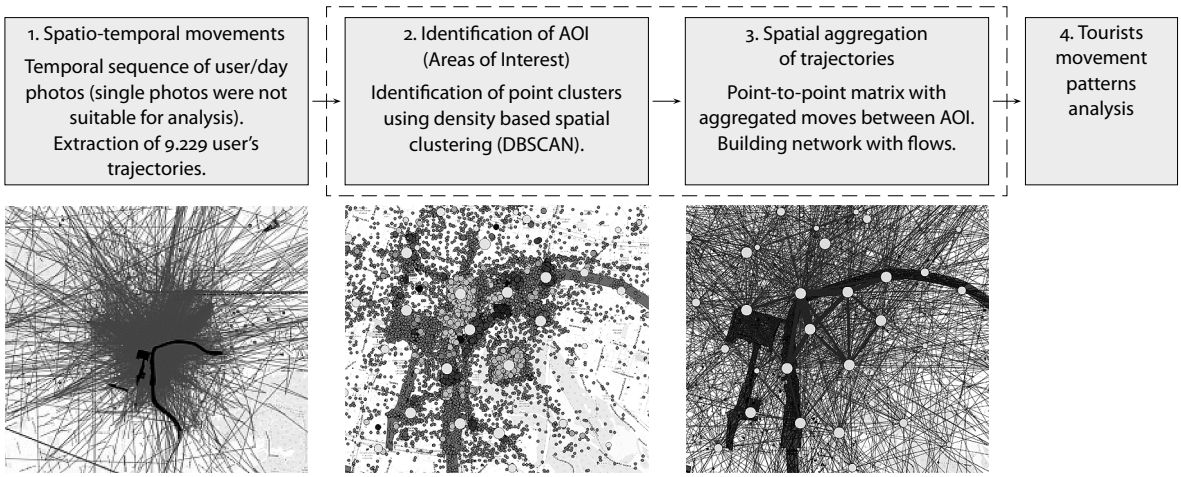

Figure 2 Conceptual Scheme of Tourist Trajectories Building Process

Network Analysis

The constructed weighted directed network of tourist movements provides an opportunity to quantitatively analyse structural properties of the tourist attractions and the relations between them. Following the previously cited studies (e.g. Kádár and Gede, 2021; Liu et al., 2017), we selected node degree centrality (Freeman, 1978), node weighted degree centrality (Barrat et al., 2004; Newman et al, 2004), and betweenness centrality (Freeman, 1978; Wasserman & Faust, 1994) to estimate the role and importance of individual attractions. In the context of tourism flows analysis, node degree (in-degree and out-degree for directed networks) measures the importance of attractions in terms of how well (number of edges between nodes) they are connected to other attractions.

A comparison of node in-degree and out-degree of each attraction can be used to determine the attraction's role in the tourists' route: as a beginning, core, or terminal (Shih, 2006). When analysing weighted networks, it is common to extend the node degree indicator to the weighted degree. The weighted degree reflects the connection frequency (sum of edge weights or tourist flows) between the target attraction and adjacent attractions. Opsahl et al. (2010) argue that it is important to consider both indicators when examining the centrality of a node because node weighted degree only takes into consideration a node's total level of involvement in the network and not the number of adjacent nodes to which it is connected.

The final indicator, betweenness centrality, measures the number of shortest paths (or weighted shortest paths) between pairs of non-adjacent nodes that pass through a given node and reflects the ability of a given attraction to control interactions between pairs of other attractions in the attraction network (Shih, 2010). A high betweenness centrality of a particular attraction means that tourists would most likely make a stop at that attraction while travelling between other attractions (Shih, 2010).

Results and Findings

By visualising the constructed network, valuable insights into the movement can be gained. As can be seen in Figure 3, movement patterns are spatially concentrated within the city centre. Additional analysis of the non-clustered movement trajectories shows that nearly two-thirds of the movements (63%) occurred in the city centre between the 10 main attractions and that the maximum number of moves (213) were recorded between the Three Bridges area (1D1) and the Robba Fountain area (1D3). In addition, the analysis revealed that more than half (51%) of the movements were related to only two attractions, 15% were related to three attractions, and 23% of trajectories connected six or more attractions. These results suggest

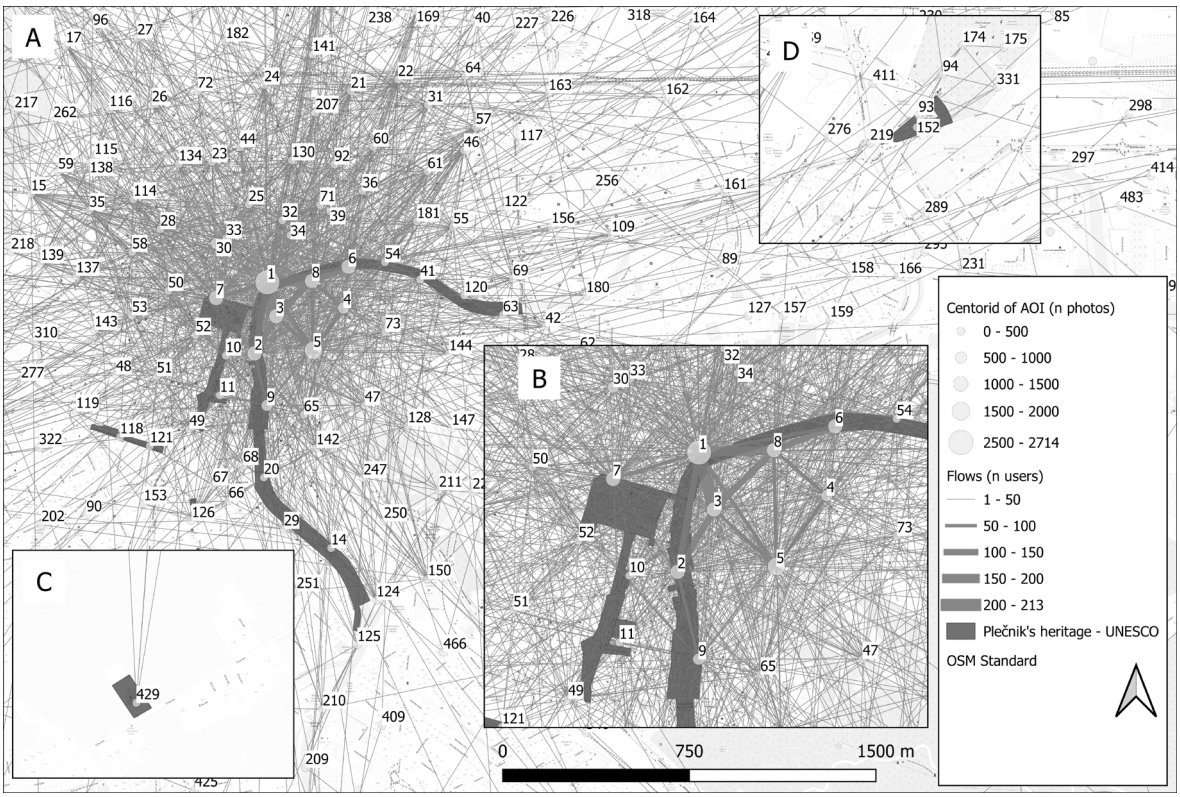

Figure 3 Network of Movement between Attractions in Ljubljana

that the destination attracts different tourist profiles – roughly, those who exhibited a greater spatial movement and are interested in detailed urban exploration, and those inclined to visit only a limited number of attractions. Since our network is composed of flows of one day-trip, differences in movement patterns can also be attributed to the length of stay at the destination. Unfortunately, our study was not designed to investigate those differences. The network also provides an overview of the popularity of attractions in terms of the number of photographs taken (Figure 3). The Three Bridges, together with Prešeren Square, are the most photographed attractions in Ljubljana (2714), followed by Ljubljana Castle (1406), Robba Fountain (1406), Plečnik Market (1357), Dragon Bridge (1322), Congress Square (1078), and Cobbler's Bridge (1055), just to name the places with more than 1000 photos in the cluster. These attractions are also the most visited in terms of tourist flows. The analysis of the structural characteristics of the network provides additional insight into the role and importance of the attractions in the network (Table 2). Due to space limitations, only the structural characteristics of the Plečnik works and the main other attractions are listed in Table 2.

In general, we can see that the attractions in the old city centre have higher values for node centrality and that these values decrease with distance from the centre. This indicates that centrally located attractions play a dominant role in the network (are connected with primary flows) and that the importance of other attractions in tourists' movement behaviour decreases with their distance from the core attractions. Furthermore, if we compare the values of in-centrality and out-centrality, no evident differences emerge. This implies that the attractions are balanced in the inbound and outbound connections (in-out degree) and flows (in-out weighted degree), which means that there are no typical beginning or

Table 2 Node Centrality Measures for Selected Attractions in the Network

Attraction	(1)	(2)	(3)	(4)	(5)	(6)
Three Bridges*	1	92	96	1030	1061	40114
Cobbler's Bridge*	2	63	54	592	575	15010
Robba Fountain	3	55	56	714	709	14612
Ljubljana Castle	5	68	70	490	458	25602
The Dragon Bridge	6	68	58	464	457	19481
Congress Square*	7	78	71	336	332	25329
Plečnik's Market*	8	63	58	683	671	9471
Old Square	9	52	47	319	310	11100
Vegova Street	10	31	32	154	145	2034
National and University Library*	11	33	39	121	115	6195
River banks – Trnovo Quay*	29	13	10	19	19	330
Skyscraper	33	37	41	121	123	6588
Križanke Open-Air Theatre*	49	20	19	30	27	1073
Slovenian National Drama Theatre	52	27	29	68	77	5113
Riverbanks – Sluice Gate*	63	13	14	21	21	521
Plečnik's Žale (area 1)	93	3	1	3	3	27
Roman Wall in Mirje (area 1)*	118	10	9	14	13	29
Roman Wall in Mirje (area 2)*	121	12	15	17	22	3017
Trnovo Bridge*	126	17	17	26	23	436
Plečnik's Žale (area 2)*	152	5	3	5	3	928
The Church of St. Michael*	429	2	2	2	2	0.96
The Church of St. Francis of Assisi*	430	1	2	1	2	0.31

Notes * Plečnik works. Column headings are as follows: (1) attraction ID, (2) in-degree, (3) out-degree, (4) in-weighted degree, (5) out-weighted degree, (6) betweenness centrality.

terminal attractions of the tourist routes. Looking at Table 2 and Figure 3, we can see that the core attractions consist of attractions ID1, ID2, ID3, ID5, ID6, ID7, and ID8. According to the values of node centrality (node degree, weighted degree and betweenness), the most important attraction in the network is the Three Bridges with Prešeren Square (ID1), which is also the most important stopover that connects pairs of other attractions.

Because of their popularity, these attractions are included in many thematic itineraries. In addition, four other Plečnik architectural attractions from the UNESCO WHS are among the top ten attractions in Ljubljana (in terms of node centrality), namely: Congress Square (ID7), the Plečnik Market (ID8), Cobbler's Bridge (ID2), and the National and University Library (ID11). This is a clear indication that the Plečnik architectural heritage is an integral part of Ljubljana's tourism system and plays a very important role in the network of core attractions. Less visited attractions are peripheral in the network and in blocks with low centrality values. In general, we can observe that as the distance from the main attractions in the old city centre increases, all centrality values gradually decrease. Although it is well known in tourism literature that spatial flows within a destination are less sensitive to distance than flows between destinations (Xiao et al., 2013; Liu et al., 2012; Jin et al., 2018), a significant dis-

tance decay effect can be observed in tourist movements in our case. Regarding Plečnik architecture, low centrality values can be observed for some Plečnik works on the water axis (ID126, ID63, ID29) and for Plečnik's architectural attractions at the periphery of the network (ID121, ID152, ID429, ID430).

Discussion and Conclusion

In the research we focused on the behavioural approach to the spatio-temporal behaviour of tourists in the city in relation to the architectural heritage of Jože Plečnik. For this purpose, a set of his works from the UNESCO World heritage list have been considered for interpretation. Movement patterns were identified by analysing temporal sequences of daily photos retrieved from the photo-sharing platform Flickr.

A clearly visible concentration of movements was identified in the relatively limited area with a high agglomeration of attractions, including the banks of the Ljubljanica River and the bridges, Vegova Street with the National and University Library and Congress Square with Zvezda Park. The area around the three bridges has proven to be a primary node which, together with the picturesque Old Town, cultural events, gastronomic establishments and lively social life, forms a cumulative attraction (Lue et al., 1996) with a strong gravitational pull (Park et al., 2020). The friction of distance related to the three 'detached' Plečnik sights – St. Michael's Church, the Church of St. Francis of Assisi, and Plečnik's Žale – despite relatively good accessibility, and popularity as well as promotional exposure of Plečnik's heritage is obviously a more important factor for (non)visitation than the uniqueness, iconic character, aesthetic and cultural value of these attractions (Paulino et al., 2019). Thus, the tourist attractiveness of Ljubljana seems to lie in its overall value, where no single element stands out. As Hernández (in Caldeira & Kastenholz, 2020) would put it, Ljubljana is an 'attraction city' rather than a 'city of attractions.' Indirectly, these results suggest that there is a high degree of compatibility of attractions (including Plečnik's heritage) around the primary node.

Our findings confirmed intuitive expectations regarding the role and degree of integration of Plečnik's architectural heritage into the destination's overall tourism offerings. Although there is undoubtedly a segment of tourists primarily interested in the architectural sites inscribed on the UNESCO World Heritage List, for an average visitor to Ljubljana these attractions seem to represent an organic part of the city's picturesque scenery.

The length of stay at the destination, promoted by Kang et al. (2018) as a factor in attraction visitation decisions, was not included in the empirical analysis as this is beyond the scope of our work. Still, preliminary research using official statistics data (https://pxweb.stat.si) suggests that this factor has some influence on the spatio-temporal behaviour of tourists. In the summer months, when the average length of stay is shorter, daily trajectories tend to be shorter, suggesting that tourists' movements are less dispersed and they visit fewer attractions that are further away. These relations are definitely worth considering in further research.

Of course, there are some limitations to the present study that must be mentioned at the end. One of the main limitations of this study is that it examines the movement patterns of tourists in a newly designated UNESCO WHS. According to previous studies (Khairi et al., 2022), tourists' behaviour, and consequently their movement patterns, are expected to change when they become aware of the UNESCO brand of the city's architectural attractions. With this limitation, the results of this study primarily serve as a situation analysis that can help destination management take measures to ensure timely and sustainable management of tourist flows in the destination.

The small number of photos by domestic visitors and deficiency and inconsistency of the personal information disclosed by Flickr users did not allow us to make comparisons that would show the differences in movements between segments of domestic and foreign tourists. Moreover, the information source itself is likely to be biased – it is virtually impossible to verify how representative the sample of Flickr users is in relation to the population of visitors to Ljubljana. Nevertheless, a brief overview of the tags (the most frequent are: Ljubljana, Slovenia, architecture, Europe, Plečnik, city, castle, river) suggests that these users are relatively 'serious' tourists who focus more on the city's features

than on people or fun. In terms of the potential implications of the findings on destination management, we can note that Ljubljana is already an established destination with established tourist flows and 'roles' of individual architectural attractions. The organic embedding of Plečnik architecture in the city, defined in the UNESCO charter as the central value of its exceptional world heritage, is indeed reflected in the tourist 'consumption' of Ljubljana, which allows for an authentic and sustainable communication of its exceptionality with relatively little intervention.

As Plečnik's scattered attractions were added to the UNESCO list only last year, the destination management can better prepare for development, promotion and mobility measures related to Plečnik's attractions based on our analyses. We suggest that the destination be promoted as a 'new UNESCO World Heritage City,' as Plečnik's attractions are already a key component of tourist tours. This emphasis would increase the visibility and value of the architectural heritage and the city, especially in the eyes of cultural tourists.

The development of tourism products and marketing communication must also take into account the attractiveness/photogenicity of Plečnik's attractions and the existing patterns of their visits/viewing, which can be seen from the frequencies and sequences of visits of intra-destination points. Furthermore, it is also useful to adapt the tourist product and marketing communication to different visitor segments (according to average length of stay, motives and other criteria) and to the season. To this end, it would be useful to conduct additional research to identify differences between visitor groups and movement patterns in different parts of the year.

Finally, the impact of the UNESCO brand and its implementation on the spatial behaviour of tourists in Ljubljana and on the degree of attractiveness of individual Plečnik architectural attractions, especially in remote locations, definitely needs to be measured in the future with some time lag.

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