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Analysis of Tourism-Oriented Spatial Networks Based on Google Maps Data: The Case of Edirne City Center

Turizm Odaklı Mekânsal Ağların Google Haritalar Verilerine Dayalı Analizi: Edirne Kent Merkezi Örneği

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Abstract / Öz

Nowadays, it can be said that studies on the intersection of "big data-network analysis" in the field of tourism have intensified, and the usage of Google and other social media platforms as the main big data sources has increased. This intersection study topic is important for determining tourist attraction centers and tourist routes, optimizing selection-decision systems, monitoring satisfaction and behavior, and thus determining tourist actions and usage patterns. In this regard, the main aim of the study is to analyze the spatial network structure created by the tourist attractions in Edirne city center and to evaluate it using the network analysis method. In this context, the locations defined in the "Things To-Do" category for Edirne city center on the Google Maps platform were considered. Depending on the content of the Google Search Engine Results Page (SERP), the rating level of the locations and the "People Also Searching For (PASF)" information, which is an important content in the field of Search Engine Optimization (SEO) today, were collected. PASF information reveals other places that users are searching for depending on a location, and as a result, a tourism search network is formed. Network analysis was applied, and evaluations were made considering the spatial dimensions of the locations. As a result, tourism places with high centrality value for Edirne city center, thematic neighborhood groups were identified, and route suggestions were presented. It is expected that the study will contribute to literature in terms of method and evaluation perspective.

Günümüzde turizm alanında "büyük veri-ağ analizi" kesişiminde çalışmaların yoğunlaştığı, Google ve diğer sosyal medya platformlarının temel büyük veri kaynakları kullanımının arttığı söylenebilmektedir. Bu ara kesişim çalışma teması ise turistik cazibe merkezleri ve turistik rotaların belirlenebilmesi, seçim-karar sistemlerinin optimize edilebilmesi, memnuniyet ve davranışların izlenebilmesi dolayısı turist davranış ve kullanım örüntülerinin tespit edilebilmesi için önemlidir. Bu bakımdan çalışmanın temel amacı Edirne kent merkezindeki turistik çekici noktaların yaratmış olduğu mekânsal ağ yapısının çözümlenmesi ve ağ analizi yöntemi ile değerlendirilmesidir. Bu kapsamda Google Maps platformunda Edirne kent merkezi için "Things To-Do" kategorisinde tanımlanan konumlar ele alınmıştır. Google Search Engine Results Page (SERP) içeriğine bağlı olarak, konumların rating düzeyi ile günümüzde Search Engine Optimization (SEO) alanında önemli bir içerik olan "People Also Search For (PASF)" bilgisi toplanmıştır. PASF bilgisi, kullanıcıların bir konuma bağlı olarak aradıkları diğer konumları ortaya koymakta sonucunda ise bir turizm arama ağı elde edilmektedir. Konumların mekânsal boyutları da ele alınarak ağ analizleri uygulanmış ve değerlendirmeler yapılmıştır. Sonucunda ise Edirne kent merkezi için merkezilik değeri yüksek turizm noktaları, tematik komşuluk gösteren gruplar tespit edilmiş ve rota önerileri sunulmuştur. Çalışmanın sunduğu yöntem ve değerlendirme açısı bakımından literatüre katkı sunacağı düşünülmektedir.

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1. Introduction

In the contemporary era, internet users were no longer mere passive recipients of information; rather, they were active producers of substantial quantities of data, particularly through social networks. These social networks have facilitated the creation, storage, sharing, and exchange of information with other users. In contrast to the traditional unilateral flow of information observed in media production, they have given rise to a virtual space that is bilateral, simultaneous, open to debate, and subject to control (Giaccardi, 2012; Terras, 2011). In the context of social media

and related digital platforms, the concept of "big data" has emerged as a result of the collective aggregation of user-generated information, opinions, and emotional responses.

It is currently asserted that the utilization of big data-based tourism analyses, also designated as Tourism 4.0 (Iorio et al., 2020, p. 1656; Xiang & Fesenmaier, 2017, pp. 303–305), engenders a new perspective for the determination of tourist attractions and tourist routes, the optimization of choice-decision systems, and monitoring of satisfaction and behaviors. Furthermore, (F. Xu et al., 2020) posits that big data-based studies offer a valuable source of information for decision-making in the context of sustainable tourism. In this context, studies are essentially structured in alignment with three primary objectives (J. Li et al., 2018, p. 302), namely: (1) The collection and analysis of information produced by users on internet platforms, including text, photo, video, and location data (Law et al., 2010; Xiang et al., 2017). (2) The tracking of tourists' route patterns with spatio-temporal data, including GPS data (mobile line and roaming data, sensor data, etc.) (Gao, 2021; Shoval & Ahas, 2016). (3) Identifying patterns of tourist demand and behavior from data sources such as web search, web page visits, search statistics, online maps and navigation movements. (Buhalis & Law, 2008; Gunter & Önder, 2016; Kim, 2017; Plaza, 2011) state that Google-based web analyses (search results, other related searches made by users for a location, web traffic analyses, etc.) provide a suitable data source for determining tourists' preferences and behavior patterns. In recent studies (Dameria et al., 2018; Ginzarly & Teller, 2016; Munar & Ooi, 2012; Stefano, 2017; van der Hoeven, 2018), it was proposed that social media data could also be used to analyze the comments of tourists and visitors, particularly in cultural heritage areas, in order to identify the points of concentration and, consequently, the socio-cultural network patterns within the region. Analyses based on data from social media and internet platforms at the city scale enable the identification of profiles for tourists' preferences (Ginzarly & Teller, 2016). (Höpken et al., 2021, p. 5; Hu et al., 2021, pp. 4–5) conclude in their studies that both behavioral patterns can be identified through Google Trends data, and that future demand predictions can be formulated based on these patterns.

Another area of study for objectives (1) and (3) is to identify spatial networks for tourism using big data. (WTO, 2002) defines tourism networks as follows:

> *"A physical space that includes tourism products such as support services and attractions, and tourism resources… Local destinations incorporate various stakeholders, often including a host community, and can nest and network to form larger destinations. They are the focal point in the delivery of tourism products and the implementation of tourism policy."*

Studies on tourism networks started with analyses based on small and medium-scale focus groups (Debbage, 1991; Fennell, 1996; Pearce, 1996; Tinsley & Lynch, 2001), and have now evolved into a scope that is examined with large-scale data sets and network analyses (Baggio, 2008, pp. 16–18; Baggio & Cooper, 2009; Scott et al., 2008, pp. 15–16; Shih, 2006, p. 1030). (Lew & McKercher, 2006, pp. 414–415) summarizes the movement patterns of tourists depending on geography as shown in Figure 1. Type P1 is presented as one of the most common movement patterns among tourists. This model, which is based on relative movement efficiency, depends on the location of attractions, geographical distances, and the availability of transportation modes. The pattern that these movements will create is a network structure in which the central attraction centers will be the starting/ending point. It is also observed that tourists tend to move individually or in small-scale communities (Lew & McKercher, 2006, pp. 417–419). (Shih, 2006, pp. 1031–1033) put forth the "node-link-node" movement model, expressed in Type P1. However, they also posited that this movement is shaped according to strategic points. In this context, the movement proceeds in the form of ***"core/start-terminal/intermediate stops-core/end"*** Terminal stops are formed by the dependence of some nodes on other nodes in the network. As a result of network analysis, interpretations regarding the motivations and demands of tourists can be developed (J. Li & Cao, 2022, p. 4).

As a preliminary assessment, it can be said that studies on the intersection of "big data-network analysis" are intensified in the field of tourism today, and Google and other social media platforms are used as the main big data sources (X. Li & Law, 2020). The aim of this study is to analyze the spatial network structure created by the touristic attractions in Edirne city center and to evaluate it using the network analysis method. The Thrace Region Tourism Master Plan (2013-2023) designates Edirne city center as the primary historical/cultural tourism, festival/event tourism, and gastronomic tourism destination within the region. One of the plan's primary strategies is *"Preparation of different routes to visit the cultural and historical sites of the city and their inclusion in national/international travel books"* (Trakyaka, 2013, pp. 22–23, 34). Therefore, analyzing the spatial structure created by current tourism demand and trends will be useful in determining optimum routes and creating thematic routes. This study differs from existing literature in that it uses Google Maps data as its primary data source. Furthermore, it aims to contribute to the existing literature on the use of a new data set. The following sections detail the content and findings of the study.

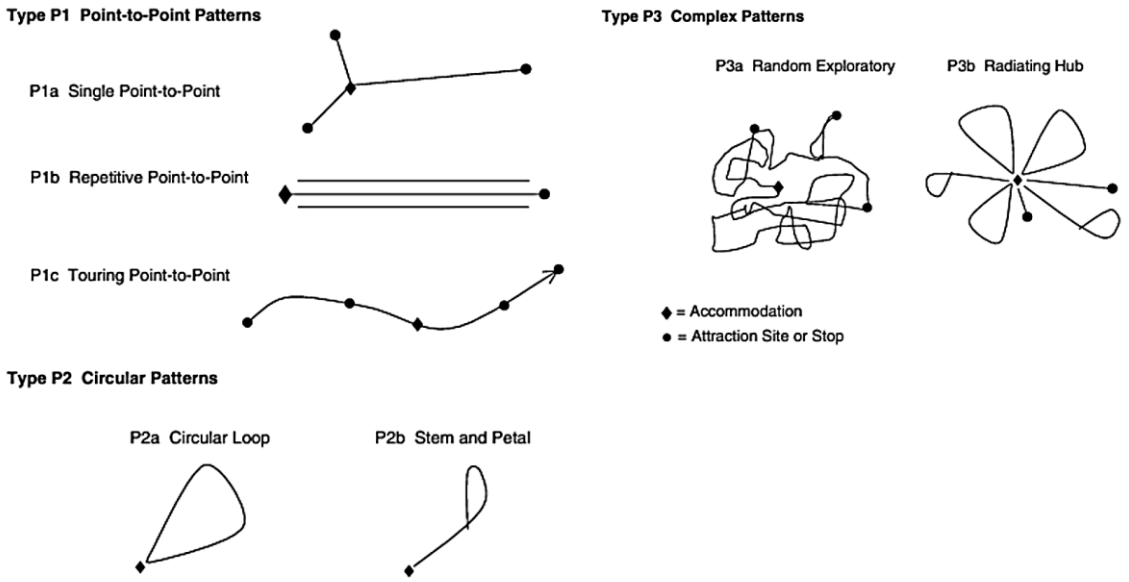

Figure 1. *Route network types based on tourists' behavior*
Source: (Lew & McKercher, 2006, pp. 414–415)

2. Method and Datasets

The location-based data utilized in the study was procured from Google Maps (GMaps) via the web scraping method through the main platform named Apify (Apify, 2024). There are two principal reasons why GMaps is the preferred spatial data source. (1) According to data from August 2023, 80% of mobile users in Turkey use the Android operating system (Statcounter, 2023; We are Social, 2023). (2) According to data from September 2024, 97% of mobile users in Turkey use the Google Maps platform for navigation and location reporting (Builtwith, 2024).

Following the year 2021, the "Things To-Do" platform, developed by Google, provides guidance for travel and touristic route planning in collaboration with GMaps and other Google services (Google, 2024a). The platform enables travelers to identify significant tourist attractions in their selected destinations and to access ratings and review information from GMaps. This has become a significant source of information for the tourism sector, particularly in the post-2021 era[1] (Torres, 2019; Callaghan, 2024). In the context of this study, the locations within the subcategories of Parks, Art, Museums, and Touristic Attractions, as well as Historical Sites, within the main category of "Things To-Do", were compiled for the Edirne city center (in its most status)[2].

Depending on the content of the Google Search Engine Results Page (SERP), the rating level of the locations and the "People Also Search For (PASF), People Also Ask (PAA)" information, which is an important content in the field of Search Engine Optimization (SEO) today, were collected. PASF represents a set of results based on users' frequent searches. These results are automatically generated based on the initial query and other relevant categories searched (Google, 2024b). Another significant attribute of PASF and PAA data is its dynamism, which is contingent upon factors such as location, time, and user profile (Backlinko, 2023). Consequently, it serves as a key repository for discerning the preferences and inclinations of a target audience and elucidating their behavioral patterns (Dakner, 2022; Lekh, 2023; Winter, 2024). In the case of GMaps, PASF provides important information about other places where users search intensively in relation to a main place. The other places searched by the user make it possible to form a prediction about possible route plans. By aggregating PASF information hypothetically linked to locations, a network structure that is shaped according to the demands can be analyzed. Figure 2 provides a graphical summary of the method. The PASF data of each location shown in Appendix-1 is collected and compiled as "place → PASF places" to create a tourism network topology. Network analysis was applied to the topology and evaluations were made. To test the results on the network topology, also publicly available GPS routes on the Open Street Map (OSM) platform were used (2001-2024 for Edirne city center) (OSM, 2024). The route densities in locations with high centrality values were then examined. The data used in the study and their sources are summarized in Table 1.

[1] The source profiles of the data are not specified (locals, tourists, etc.). This situation also represents a limitation of the study.
[2] Featured places are determined by the algorithm based on Google search results.

Table 1. *Summary table of the datasets*

No	Info	Source	Data Range	Data Type	Network Info
1	Things To-Do Places	Google Maps	Up to Date	Point	62 nodes, 124 edges (%33 network density)
2	Public GPS Traces	OSM	Between 2001-2024	Point	47209 GPS point Total 32 routes

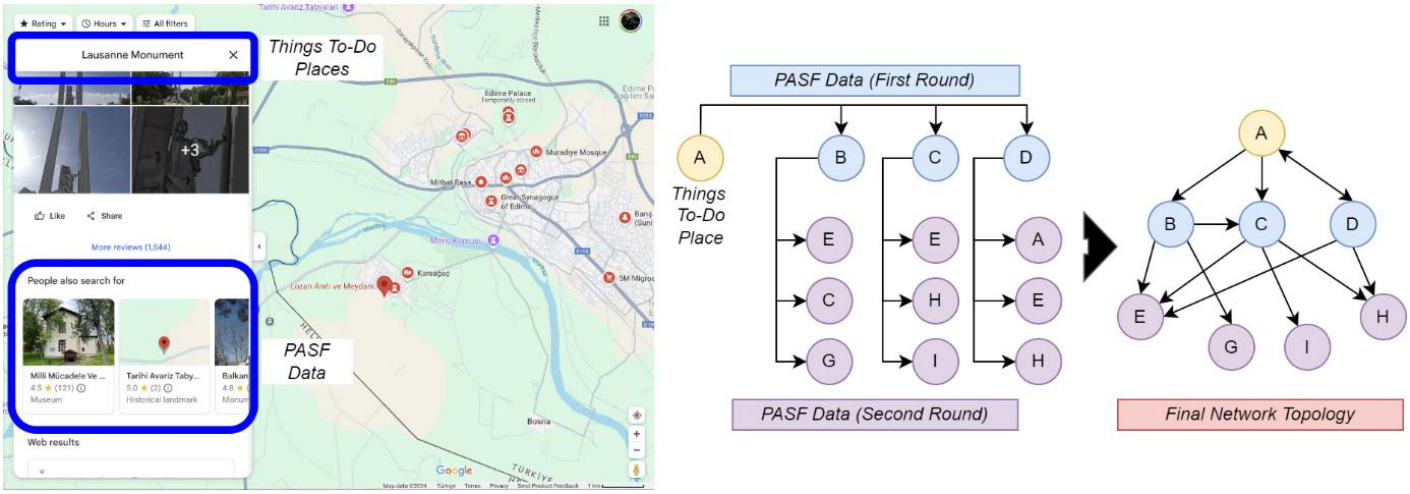

Figure 2. *Graphical summary of the data collection and processing cycle*

In network analyses, basic analyses similar to the relevant literature (D'Agata et al., 2013; Gajdošík, 2023; Höpken et al., 2021; Kuklina et al., 2020; Raisi et al., 2020; SS, 2021; Y. Xu et al., 2021) were used: (1) Clustering Tends, (2) Centrality, (3) Modularity. The analysis values were calculated in Gephi 0.10 software, and their contents are as follows:

A. **Clustering Tends (CC):** This evaluation is based on clustering coefficient analysis. The clustering coefficient represents the potential of a node to connect (form a cluster) with other nodes in the network. This potential can be analyzed at the local and global levels, which allows for the examination of the level of connectivity between nodes (Aguilar-Alarcón et al., 2023; Trolliet et al., 2022, p. 2; Watts & Strogatz, 1998). A high clustering coefficient value indicates a tendency to interact with other nodes and clique points within a network topology. Since a limited dataset was analyzed in this study, the local clustering coefficient was used *(*Formula 1*, Cn: clustering coefficient, Tn: the number of triangles a node is part of, dn: the degree of node)*. As stated by (Du, 2024), low values in the local clustering coefficient are indicative of high centrality, whereas high values are indicative of high connectivity. To be more precise, nodes with low values create the basic centrality effect without being dependent on their neighbors within the network (Kuklina et al., 2020, p. 6). In the context of tourism networks, low-value locations can be conceptualized as potential ***"intermediate stops"***, facilitating the establishment of relationships with surrounding areas. Conversely, high-value locations can be regarded as relatively independent ***"start/end points"***, influencing the structure of the network and, consequently, the route hierarchy (Gajdošík, 2023, p. 182; Raisi et al., 2020, pp. 9–10).

$$C_n = \frac{2T_n}{d_n\,(d_n - 1)} \tag{1}$$

B. **Centrality (Eigenvector Centrality) (EiC):** Eigenvector centrality is a measure of the centrality level of a node, which is determined by the strength of its interactions with other nodes. A node with a high eigenvector centrality does not necessarily mean that it is well connected to all other nodes. Nevertheless, nodes with high values are situated in proximity to pivotal central locations within the topology (Bamakan et al., 2019). Eigenvector centrality can also be conceptualized as a prestige score. Nodes with high scores are linked to other nodes with high scores. Consequently, both the connectivity level of any node and the qualities of other nodes to which it is connected are evaluated (Negre et al., 2018) (Formula 2, *EC(i) = eigenvector centrality value of any node i, λ = eigenvalue of the adjacency matrix, a(i,j)= value in the adjacency matrix corresponding to nodes i and j, x(i) = eigenvector centrality value of node i*).

$$EC\,(i) = \frac{1}{\lambda}\sum_{t\in G} a_{i,j}\,x_i \tag{2}$$

C. **Modularity Class (MC):** The concept of a "modularity" is used to describe the formation of clusters within a network topology. These clusters exhibit a high density of relationships within their own neighborhood group, while this value may be relatively low within the entire network topology. The value is employed in optimization methods to determine the community structure in networks (Newman, 2006; Valverde, 2017, p. 3) (Formula 3, *(ai)^2: probability a random edge would fall into module i, (eii): probability edge is in module i*). Modularity analysis can also be expressed as community detection (Lambiotte & Schaub, 2021, p. 23). Communities show resilience and strong interconnectedness (Kharrazi et al., 2020, p. 6). In terms of tourism networks, communities represent possible travel routes and similar locations in demand (Poisot, 2013; Y. Xu et al., 2021, p. 16; Gajdošík, 2023, p. 187).

$$Q = \sum_{i=1}^{k} (e_{ii} - a_i^2) \quad (3)$$

3. Findings and Discussion

Detailed information on nodes and links is presented in Appendix-1. The findings are as follows in the order given in the methodology section:

A. The network topology comprises 62 nodes and 124 edges, as illustrated in Figure 3. The network depth of the topology was determined to be 33%, indicating that it forms a medium-level tightly woven network structure. The average path length of the network topology was determined to be 3.69 (approximately 4). In other words, the average distance between two nodes is four. Although the path length value is relatively low, the network does not foster a holistic relationship level. It is evident that spatial distances are a significant factor in the node-link relationship. While the connection level decreases in relatively distant locations, the connections in the center are frequent and of shorter distances. (***22) Hidirlik Bastions, (49) Balkan History Museum, (41) Karaağaç Neighbourhood*** represent transition locations between the central network and outsiders.

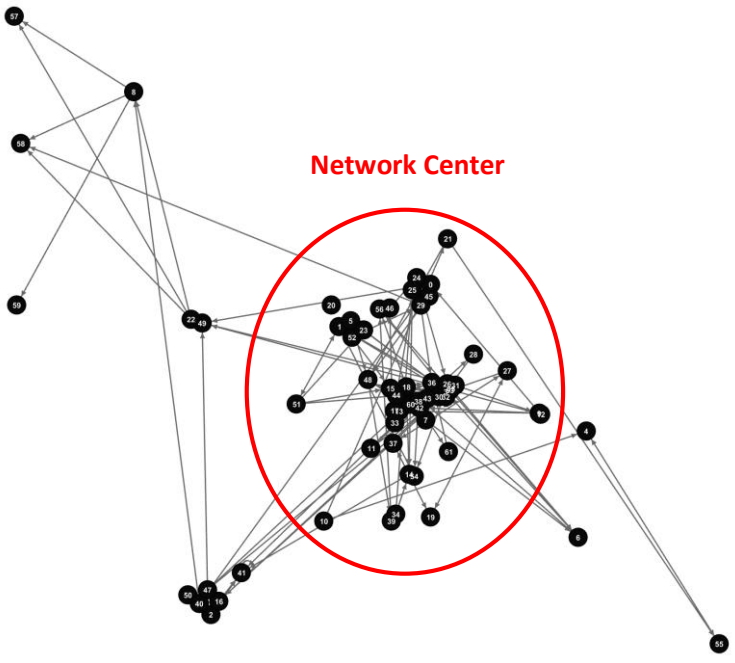

Figure 3. *Network topology based on Thing To-Do Places*
(Nodes are located according to their actual latitude and longitude positions)

B. Upon examination of the clustering coefficient results (Table 2), it becomes evident that intermediate stopover locations and start/end points within the tourism network can be identified. Such locations as ***Selimiye Mosque*** and ***Edirne Palace*** are found to be independent, central points within the network. Regarding the PASF data, locations such as ***Sultan Beyazid II Kulliye, Dar al-Hadith Mosque, Macedonia Tower***, and ***Bedesten*** represent intersection points within the network and serve as crucial intermediate stops for tourism. Upon evaluation with OSM-based user routes, it becomes evident that low-value locations serve as either the starting or ending points of user routes. Conversely, high-value locations represent the intermediate stops along routes that converge towards central locations (Figure 4).

Table 2. *Summary table of cluster coefficient values*

Top 5 Highest Value Locations - Midway Stops			Top 5 Lowest Value Locations - Start/End Points		
ID	**Location Info**	**C(n) value**	**ID**	**Location Info**	**C(n) value**
19	Bulgarian Orthodox Church of Constantine and Elena	1	0	Edirne Balkan Martyrdom	0.0833
23	Bayezid II Mosque	0.667	14	Tunca Bridge	0.0833
11	Dar al-Hadith Mosque	0.6	16	National War of Independence and Lausanne Museum	0.0833
44	Macedonia Tower	0.6	3	Selimiye Mosque	0.0809
60	Bedesten	0.6	24	Edirne Palace	0.05

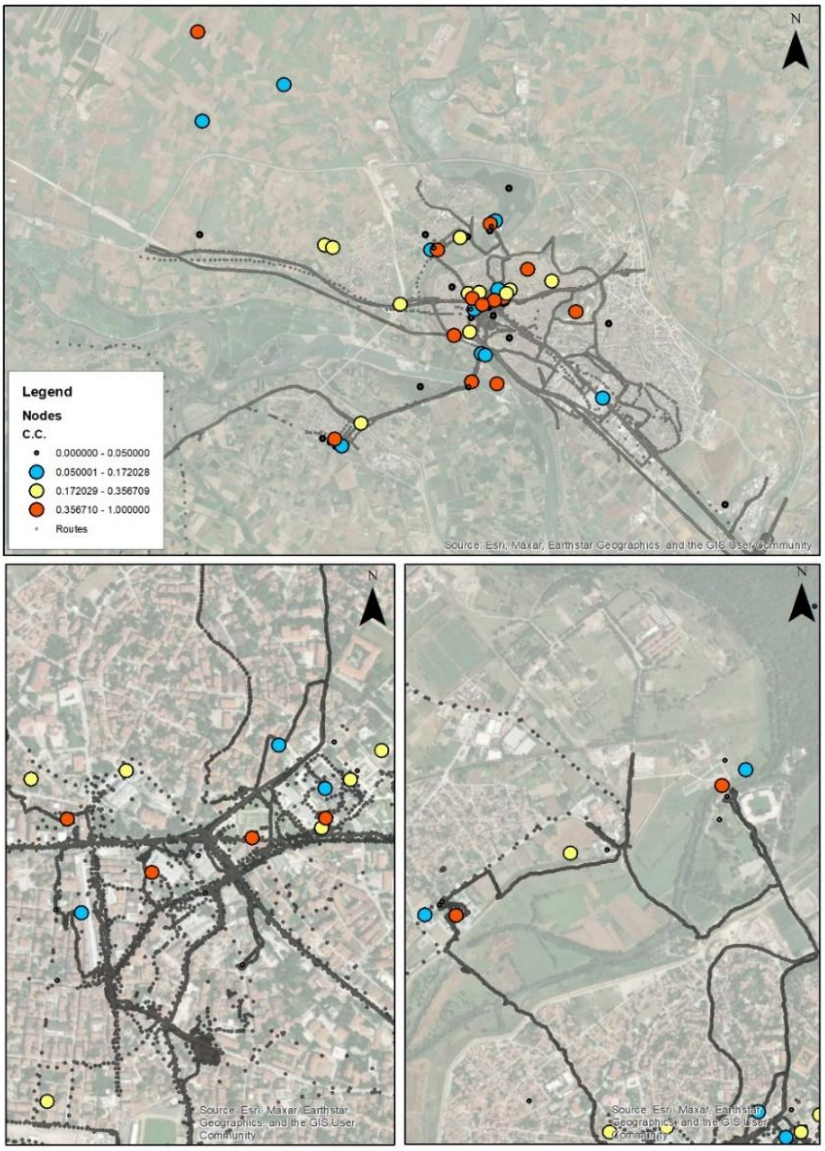

Figure 4. *Clustering coefficient values of Things To-Do locations (zero values excluded)*

C. Upon examination of the eigenvector centrality results (Table 3), it becomes evident that, similar to the clustering coefficient, high prestige locations can be identified. According to PASF data, the most significant tourist attractions in Edirne are the ***Selimiye Mosque, Museum of Turkish Islamic Art, Sultan Beyazid II Kulliye and Health Museum, Edirne City Museum***, and ***Edirne Archaeology and Ethnography Museum***. These locations are interconnected with other areas of high centrality. In other words, these are the locations that users search for the most in relation to each other within the "Things To-Do" category. The high clustering coefficients observed for the ***Macedonia Tower, Bedesten***, and ***Dar al-Hadith Mosque*** are accompanied by low centrality values, which lend support to the comments presented in Section B. When OSM data and central points are evaluated together, a user route can be defined: ***(I)*** *National War of Independence and Lausanne Museum → Karaagac Neighborhood → Suleymaniye Mosque → Selimiye Mosque,* ***(II)*** *Selimiye Mosque → Edirne Archaeology and Ethnography Museum → Sultan Beyazid II Kulliye and Health Museum → Fatih Sultan Mehmet Voyage Zone* (Figure 5).

Table 3. *Summary table of eigenvector centrality values*

Top 5 Lowest Value Locations			Top 5 Highest Value Locations		
ID	**Location Info**	**EC (i) value**	**ID**	**Location Info**	**EC (i) value**
8	Historical Avariz Bastions	0.01641	3	Selimiye Mosque	1.0000
11	Dar al-Hadith Mosque	0.013	53	Museum of Turkish Islamic Art	0.8619
28	Muradiye Mosque	0.012623	1	Sultan Beyazid II Kulliye and Health Museum	0.7183
2	Old Train Station	0.012623	36	Edirne City Museum	0.6254
33	Police Park	0.012623	31	Edirne Archaeology and Ethnography Museum	0.592265

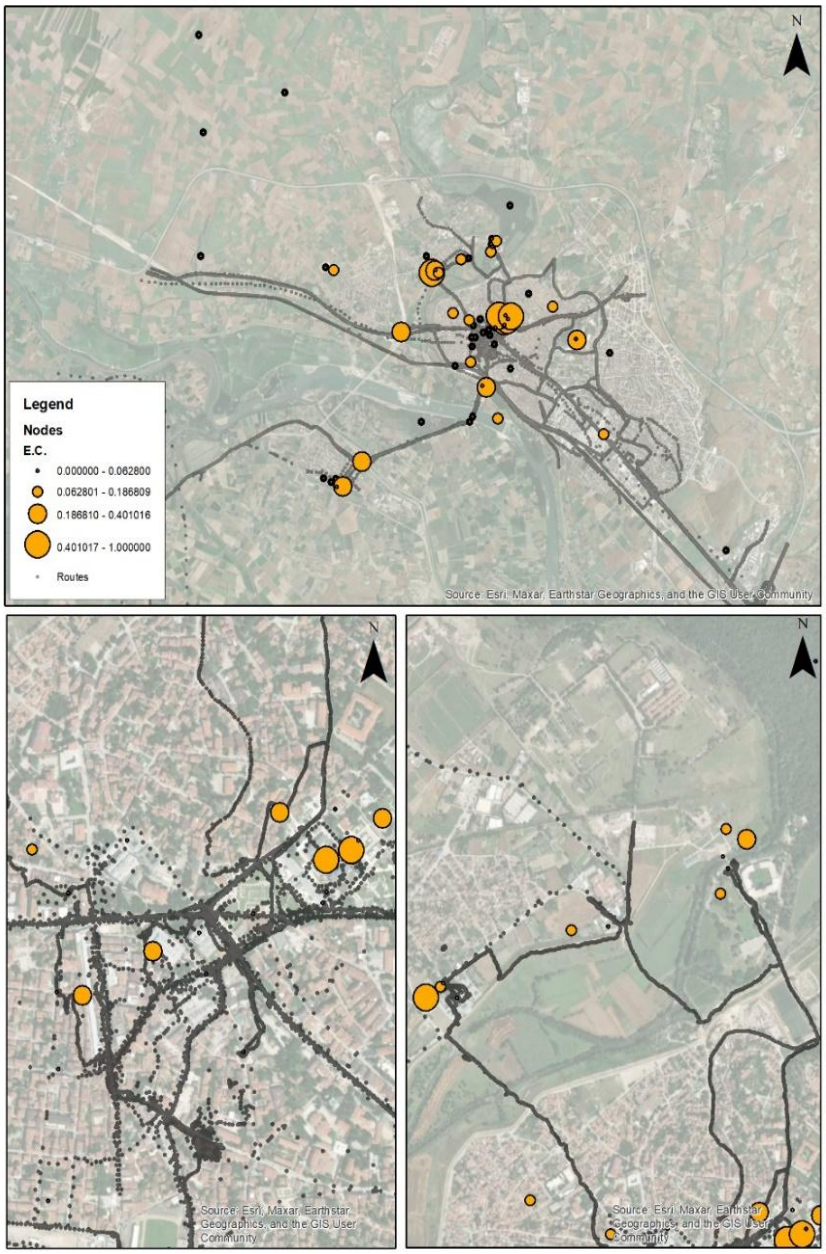

Figure 5. *Eigenvector centrality values of Things To-Do locations (zero values excluded)*

D. When the modularity analysis results are analyzed (Table 4[3], Figure 6), it can be observed that users' searches form thematic travel itineraries.

The Modularity Class (MC)-0 group stands out with its clustering characteristic brought together mainly by geographical location. It can be defined by the important historical and cultural locations in Karaağaç Neighborhood, following the Tunca River and Meriç Bridge in the south of Edirne city center. The MC-1, MC-2, and MC-3 groups represent the primary concentration of historical and cultural monuments. The MC-1 group is the primary group that spatially overlaps with user routes.

[3] The places presented in Table 4 are included in the Google Maps “Things to do” category. Although these places have other functions, they are included in the “To-Do” category in terms of their touristic attractiveness.

Table 3. *Modularity Classes of Things To-Do locations*

ID	Place Name	Gmaps Score	Modularity Class	ID	Place Name	Gmaps Score	Modularity Class
16	National War of Independence and Lausanne Museum	4.5	0	6	Hacilar Azan Namazgah	4	**3**
41	Karaagac Neighborhood		0	56	Historical Dertli Mustafa Pasa Fountain	4.2	**3**
14	Tunca Bridge	4.5	0	48	Pasha Fountain and Pasha Gate		**3**
2	Old Train Station	4.7	0	18	Clock Madrasa	4.7	**3**
40	Lausanne Monument and Square	4.6	0	5	Sinan Aga Fountain	4.2	**3**
50	Karaagac Train Station	4.7	0	7	Historical Fountain		**3**
25	Fatih Bridge	4.4	0	39	Hacı Adil Bey Fountain	4.6	**3**
34	Meric Bridge	4.6	0	35	Ottoman Tombstones Exhibition Area	4.2	**3**
3	Selimiye Mosque	4.9	1	13	Alipasa Bazaar	4.4	**4**
53	Museum of Turkish Islamic Art	4.6	1	60	Bedesten	4.4	**4**
1	Sultan Beyazid II Kulliye and Health Museum	4.8	1	42	Historical Rustempasa Caravanserai	4.5	**4**
36	Edirne City Museum	4.7	1	61	Ekmekçizade Caravanserai	4.4	**4**
51	Fatih Sultan Mehmet Voyage Zone	3.9	1	30	Selimiye Bazaar	4.5	**4**
15	Fatih Sultan Mehmet Museum	4.6	1	9	Şükrü Pasha Monument	4.3	**4**
23	Bayezid II Mosque	4.8	1	55	Edirne Governorate Memorial Forest	4.2	**5**
11	Dar al-Hadith Mosque	5	1	4	Turkish Women's Union Forest	3.7	**5**
28	Muradiye Mosque	4.7	1	21	Chicken Forest	3.7	**5**
32	Selimiye Foundation Museum	4.7	1	10	Edirne City Forest	4.2	**5**
43	Yemiş Kapanı Inn	4.5	1	31	Edirne Archaeology and Ethnography Museum	4.5	**6**
17	Edirne, Kaleici (Old City)	4.5	1	12	Balkan Wars Museum	4.1	**6**
54	Suleymaniye Mosque	4.9	2	0	Edirne Balkan Martyrdom	4.4	**6**
19	Bulgarian Orthodox Church of Constantine and Elena	4.8	2	49	Balkan History Museum	4.8	**6**
27	Sveti Georgi Bulgarian Church	4.5	2	47	Trakya University Natural History Museum	4.9	**6**
37	Edirne Great Synagogue	4.5	2	52	Museum of Contemporary Painting and Sculpture	4.9	**7**
24	Edirne Palace	4.1	2	29	Monument Tree	4.2	**7**
38	Old Mosque	4.9	2	58	Historical Aynali Bastions	3.5	**7**
46	Kirkpinar Oil Wrestling Area	4.6	2	45	Historical Kasr-ı Adalet (Supreme Court of Justice Building)	4.4	**7**
26	Edirne Palace Baths	4.2	2	57	Karagöz Bastion	3	**7**
44	Macedonia Tower	4.4	2	59	Historical Çaytepe Bastions		**7**
				8	Historical Avariz Bastions	5	**7**
				22	Hıdırlık Bastions	4.9	**7**
				33	Police Park	4.1	**8**
				20	Yeniimaret		**9**

The mean eigenvector centrality value for this group is 0.464, which represents the highest centrality value among all groups. The MC-2 and MC-3 groups can be defined as intermediate stops that support the main routes formed by MC-1. This group's (MC-1,2,3) spatial distribution encompasses 49.1% of all user routes. The MC-4 group is primarily comprised of historical commercial centers, while the MC-5 group encompasses large-scale recreational areas. The MC-6 group, on the other hand, is constituted by other museum and martyrdom locations. Furthermore, the clustering effect of close locations can be observed in the MC-4 group. MC-7 is situated outside the primary transportation routes of Edirne, predominantly in the western region of the city, and exhibits minimal connectivity within the tourism network. Amongst this group, the Monument Tree, Museum of Contemporary Painting and Sculpture, and Historical Kasr-ı Adalet (Supreme Court of Justice Building) represent intermediate stopover locations where user density decreases. Police Park and Yeniimaret Neighborhood are not included in any modularity group.

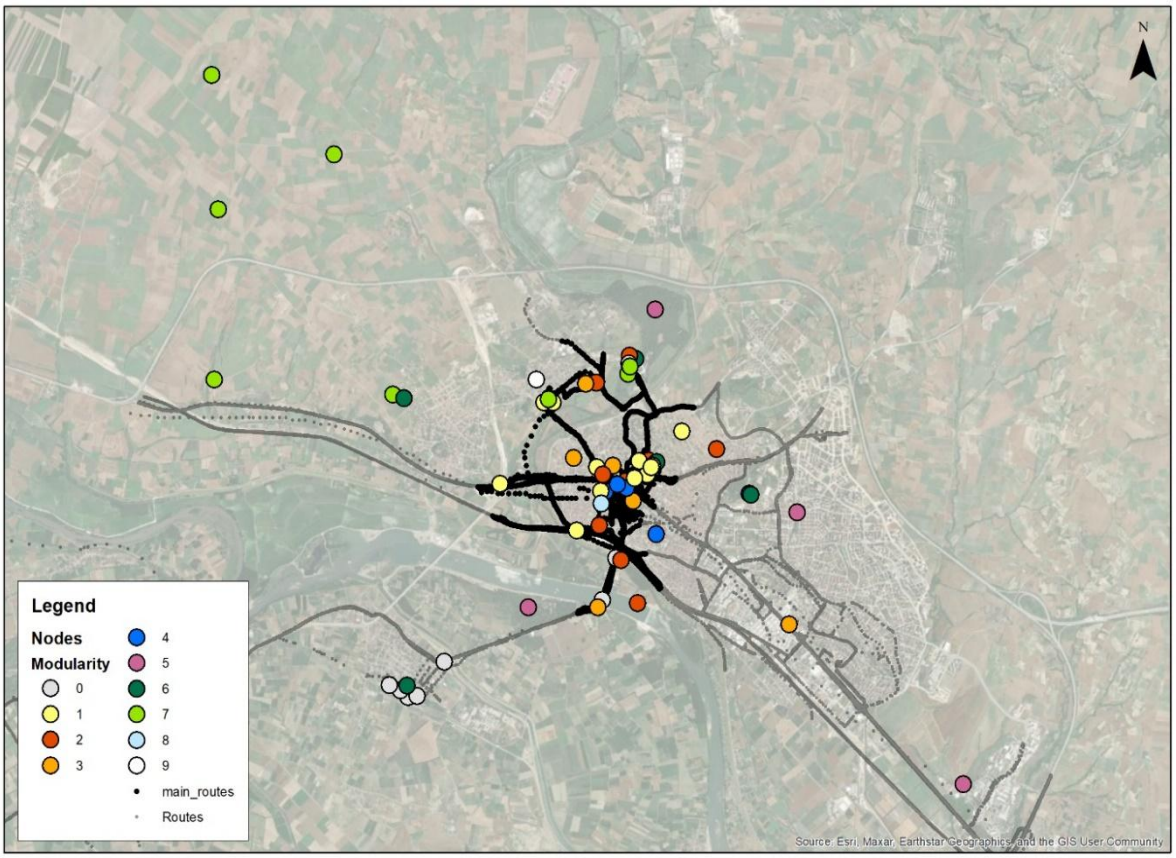

Figure 6. *Modularity Classes of Things To-Do locations*

Once all the results have been analyzed, network analysis evaluations conducted with PASF data allow for the introduction of alternative approaches:

(1) GMaps scores are a numerical value that constitutes the rating value of a location based on users' ratings. Although locations such as Historical Avariz Bastions and Dar al-Hadith Mosque have a rating value of 5, the number of users who rated them is very low (between 1-5 people), whereas Selimiye Mosque has a rating value of 4.9 and a total of 19040 users have rated. In this respect, GMaps score values are potentially misleading data in identifying popular places. In contrast, PASF provides a relatively more appropriate means of identifying popular locations in terms of centrality values created by the relationships in the network topology.

(2) Modularity information in the network topology makes it possible to learn about thematic travel preferences. In order to identify the target audience preferences, it is possible to determine them in parallel with the comments in the sources, as outlined by (Dakner, 2022, Lekh, 2023, Winter, 2024).

(3) By synthesizing PASF, CC, EiC and MC data, alternative tourism routes can be developed (Figure 7). ***The first route*** presents the themes of history-culture-trade with central and high prestige locations (MC1, MC2, MC4, MC6) *(1A-Sultan Beyazid II Kulliye and Health Museum → 1B-Macedonia Tower → 1C-Alipasa Bazaar → 1D-Bedesten → 1E-Old Mosque → 1F-Yemiş Kapanı Inn → 1G-Selimiye Mosque → 1H-Museum of Turkish Islamic Art → 1H-Edirne Archaeology and Ethnography Museum → 1I-Edirne City Museum → 1J-Edirne Balkan Martyrdom)*. ***The second route*** constitutes the history-religion-culture-recreation theme, including the Karaağaç neighborhood (MC0, MC1, MC2, MC5, MC6) *(2A-Old Mosque → 2B-Edirne Great Synagogue → 2C-Dar al-Hadith Mosque → 2D-Tunca Bridge/Suleymaniye Mosque → 2E-Edirne City Forest → 2F-National War of Independence and Lausanne Museum → 2G-Trakya University Natural History Museum)*.

Figure 7. *Alternative routes based on network analytics*

4. Conclusion

This study aims to identify tourism-oriented spatial networks in Edirne city center. In order to achieve this goal, Google Maps data was analyzed, the characteristics of the places were examined, and route suggestions were developed. In contrast to the qualitative methods commonly seen in tourism literature (such as surveys with local and foreign tourists, oral interviews, and so on), this study puts forth a proposal method based on location-based big data. Google Maps data is of particular importance in providing a comprehensive set of user opinions. Unlike the existing literature on big data, the PASF data included in this study demonstrates that user searches form a spatial network structure and reveal priority locations for users. In this respect, it is thought that this study may open a new research area in literature in terms of methodology and dataset.

The findings of this study also have significant practical implications. By examining tourism-oriented spatial networks in the context of the findings, it was possible to compile a list of the touristic attractions in Edirne city center, organized according to their role in guiding and supporting users' routes. The primary attractions that direct user routes are the Selimiye Mosque, Museum of Turkish Islamic Art, Sultan Beyazid II Kulliye and Health Museum, Edirne City Museum, and Edirne Archaeology and Ethnography Museum. It can be reasonably presumed that any regulations that affect accessibility and/or usability in these locations (for example, urban design projects or plan implementations) will also affect the entire network. Due to the dynamic nature of tourism services, it is of great importance for stakeholders and decision makers in the tourism sector to evaluate user preferences in specific periods and cities. The identification of alternative routes that connect the thematic clusters of tourist attractions within the scope of the study may result in an increase in the number of visitors -due to the combination of different travel choices-. The visualization of the modularity structure, which demonstrates both the attractiveness of locations and their spatial interactions, can prove

beneficial in revealing the mutual interactions that occur within the context of tourism.

The scope of the study can be expanded to incorporate supplementary Google Maps data. By analyzing user comments and trend hour (temporal intensity of user activity) information, a more detailed assessment of places with high centrality values can be made. Moreover, the findings of this study also can be applied at the regional level, facilitating the optimization of tourism routes between different cities. Finally, it is thought that the findings of the study can contribute to the field of urban planning as follows: (1) the selection of sites for transportation investments, (2) Increasing spatial use and belonging by evaluating transportation modes that will increase user mobility such as pedestrian and bicycle with tourism attractive places, (3) the establishment of priorities for accommodation facilities and other investments.

Etik Kurul İzni / Ethics Committee Permission:

Bu çalışma Etik Kurul Onayı gerektiren çalışma grubuna dahil değildir.

This study is not included in the study group that requires Ethics Committee Approval.

Çıkar Çatışması/Conflict of Interest:

Yazarlar, kendileri ve/veya diğer üçüncü kişi ve kurumlarla çıkar çatışmasının olmadığını beyan eder.

The authors declare that they have no conflicting interest.

Yazar katkısı/Authors' contribution:

Çalışma tek yazarlıdır.

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Appendix-1: Datasets:

https://bulut.klu.edu.tr/index.php/s/fpFPs2t3gfX3Y5f

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