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Visitor Mobility Patterns in Cultural Destinations: Exploring the Cognitive Maps of San Sebastian and Bilbao, Inspired by Lynch (1960)

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Abstract

Lynch's (1960) Theory of Imageability explores how individuals perceive and navigate urban environments, emphasizing the role of paths, edges, districts, nodes, and landmarks. This theory highlights the significance of these elements in shaping people's mental maps and enhancing their understanding and navigation of urban spaces. However, cultural tourism introduces complexities to Lynch's framework due to its unique motivations, interests, and behaviours. This article investigates the relationship between visitor mobility patterns and urban morphology in the context of two cultural destinations: Bilbao and San Sebastian. The study utilizes Network Analysis of visitors' GPS data to analyse the dynamics of visitor mobility within these urban environments. This data-driven approach facilitates a comprehensive understanding of how cultural destinations operate within their physical territories. Results reveal that both San Sebastian and Bilbao exhibit a distinct "D-shaped" mobility pattern, characterized by a clear and uncomplicated flow of movement. This finding aligns with Lynch's theory (1960), emphasizing the importance of simplicity and legibility in shaping visitors' cognitive maps and mental representations of the urban space. The concentration of cultural landmarks in the Old Town and the challenges of congestion and overtourism are brought to light through the network analysis of GPS data. The accompanying figures visually illustrate how the ease of navigation in these cities significantly contributes to the formation of visitors' cognitive maps.

Highlights for public administration, management and planning:

- The article explores the interplay between visitor mobility patterns and urban morphology (referencing Lynch, 1960) within two cultural destinations: Bilbao and San Sebastian.
- We examine the hypothesis that cultural destinations may deviate from Lynch's (1960) framework.
- To achieve this objective, we employ the following three methodologies in our study: (1) GPS tracking of visitors, (2) Network Analysis of GPS data, and (3) visitor surveys.
- In this article, the emphasis is on "cultural tourist behaviour & urban morphology" rather than GPS technology itself.
- The network analysis of GPS data illuminates the clustering of cultural landmarks in the Old Town, shedding light on challenges related to congestion and overtourism in San Sebastian.

Keywords

Cultural destinations,
Mobility patterns,
Network analysis of GPS data,
Lynch,
Imageability,
Bilbao, San Sebastian,
Cognitive Map

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1 Introduction

Studying the mobility patterns of visitors in cultural destinations is essential for various reasons, including enhancing the visitor experience, planning infrastructure, managing tourism sustainably, boosting the local economy, promoting sustainable transportation, and preserving cultural heritage. Such studies offer valuable insights for effective destination management and foster a harmonious relationship between tourism, the local community, and the cultural assets of the destination.

One crucial aspect to consider is the relationship between cultural tourism destinations and urban design principles. While exploring this connection, it is pertinent to inquire whether these destinations align with established frameworks in urban design. Kevin Lynch's seminal work on urban design, as outlined in "The Image of the City" (1960), offers valuable insights into how individuals perceive and navigate urban environments. Lynch's framework, which includes elements such as paths, edges, districts, nodes, and landmarks, provides a robust foundation for understanding the spatial dynamics of cities.

However, it is important to approach the integration of Lynch's concepts with caution. While his framework offers a valuable lens through which to examine cultural tourism destinations, it is not the only perspective to consider. Therefore, rather than immediately introducing Lynch's framework, it may be more appropriate to pose a broader question about the relationship between cultural tourism and urban design principles. Subsequently, Lynch's conceptualization can be introduced as one of the potential frameworks for analysing this relationship. Additionally, exploring the influence of physical attributes on Lynch's theory of urban design can further enrich our understanding of cultural tourism destinations and their spatial characteristics. Cultural tourists can exhibit different behaviours compared to what is outlined in Kevin Lynch's framework. While Lynch's framework provides valuable insights into urban design and navigation patterns, it may not fully capture the unique behaviours and motivations of cultural tourists. Cultural tourists often have specific interests, such as visiting museums, historical sites, or experiencing local traditions and arts. Their behaviours can be influenced by factors like personal preferences, cultural backgrounds, travel motivations, and the specific cultural destination they are visiting (Throsby 2010).

Cultural tourists might deviate from Lynch's framework in several ways:

Firstly, cultural tourists may prioritize specific cultural attractions or landmarks over traditional urban paths. They might choose alternative routes that align with their cultural interests rather than following the main pathways identified in Lynch's framework.

Secondly, Lynch's framework emphasizes the role of districts, but cultural tourists might be particularly drawn to specific cultural districts/clusters or neighbourhoods that offer a concentration of cultural experiences (Jacobs 1969; Gomez-Vega et al. 2022). These areas might not align with the typical boundaries of urban districts.

Thirdly, cultural tourists often spend more time at cultural attractions, such as museums or heritage sites, compared to the average urban dweller. This extended dwell time might influence their navigation patterns and the importance they place on certain nodes or landmarks (Aranburu et al. 2020).

Fourthly, cultural tourists often seek interactions with local residents and cultural communities. This engagement can influence their movements, as they might actively seek out opportunities to engage with local traditions, attend cultural events, or participate in guided tours led by locals.

Fifthly, cultural tourists may be more open to serendipitous exploration, deviating from predefined routes and allowing for spontaneous discoveries of lesser-known cultural sites or hidden gems that might not be part of established urban design patterns.

It is essential to recognize that cultural tourism adds a layer of complexity to Lynch's framework, as it involves specific motivations, interests, and behaviours. Considering these differences can help urban planners, destination managers, and researchers better understand and cater to the unique needs and preferences of cultural tourists, ensuring that cultural destinations are designed and managed effectively to enhance their experiences and sustainability.

We will evaluate the applicability of Lynch's theory by employing three methods such as (1) GPS tracking of tourists (2) network analysis of GPS data, and (3) visitor surveys. These approaches enable us to examine how visitors navigate cultural tourism destinations and assess whether their mobility patterns align with Lynch's conceptual framework (Lynch 1960).

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1.1 Case Studies: Bilbao and San Sebastian

The issues of tourist mobility patterns and urban morphology are examined through the case of two cities: Bilbao and San Sebastian. Located in Spain's northern Basque region, near the French border, these cities represent two distinct tourism stories. Both cities are considered second-tier cities at the European level but excel as first-tier destinations in specific cultural tourist submarkets.

On the one hand, Bilbao has achieved global recognition with the Guggenheim Museum attracting over 1,000,000 visitors annually (Plaza et al. 2022). It stands as an iconic case study where a museum has been instrumental in urban regeneration efforts in recent years (Heidenreich & Plaza 2015). The city of Bilbao, located within an hour's drive from San Sebastian, has emerged as a model for the revitalization of declining urban and industrial areas (Heidenreich & Plaza 2015; Pipan 2018). Following the inauguration of the Guggenheim Museum in 1997, Bilbao embraced cultural tourism as a means to diversify its economy and address unemployment. Despite its previous reputation as an old industrial city with limited tourism potential, the Guggenheim Museum Bilbao attracted 1,322,611 visitors in 2017. Notably, the total number of visitors to the province of Bizkaia, of which Bilbao is the capital, reached 1,500,237 in 2017, while in the same year there were 1,204,395 visitors to Gipuzkoa, the province where San Sebastian is located.

On the other hand, San Sebastian has become an international reference for Michelin Star Chefs, hosting 50 percent of all three-star Michelin restaurants in Spain. Initially a seaside resort, San Sebastian experienced a significant increase in tourist significance during the 19th century due to its seabathing and spa facilities. It became Spain's leading resort, attracting tens of thousands of visitors by the early 1870s and continued to grow over the next half century (Walton & Smith 1994). Post-1945, the city further developed its tourism offerings by incorporating leisure, art, and culture. It introduced the "San Sebastian International Film Festival" in 1953 and the Heineken Jazz Festival in 1965, both of which have become some of Europe's oldest and most significant cultural events (Franklin 2016). Moreover, San Sebastian was designated as the European Capital of Culture in 2016. Additionally, it has emerged as the top Spanish city for Haute Cuisine, boasting 17 Michelin stars within a 25 km radius from the city centre. By 1997, when the Guggenheim Museum Bilbao opened, San Sebastian was already attracting over half a million tourists annually (516,986 in 1997).

Overall, these two cities exemplify the transformational power of cultural attractions and tourism in shaping their urban development and economic growth (Plaza & Haarich 2017).

The paper is structured as follows: The subsequent section discusses the theoretical hypotheses of the article. It is followed by an explanation of the main applied methodologies used to conduct the empirical analysis. Finally, the obtained results are presented, and the conclusions are provided.

2 Literature review

Kevin Lynch, an urban planner and theorist affiliated with the Massachusetts Institute of Technology (MIT), greatly influenced urban design through his work on urban planning, perception of the built environment, and the concept of "imageability". His 1960 book, "The Image of the City," is a revered classic in urban planning literature and introduced the concept of imageability. Imageability pertains to the quality of a city's physical environment, enabling vivid perception and recall among its inhabitants and visitors, shaping their ability to form mental images of the city's layout, landmarks, and paths (Lynch 1960).

In the context of urban settings, Lynch (1960; 1995) asserts that the ease of mobility and the simplicity of moving around a city play a crucial role in influencing destination consumption and its sustainability. Once tourists arrive at their destination, their overall experience is greatly influenced by their ability to navigate the city with ease.

Lynch's work on perception aligns with Motloch's (2000) notion of perceived distance. Motloch emphasizes that subjective perception of a journey is influenced by various factors, including the quality of the landscape, prior information about the destination, and emotional state. Additionally, Motloch explains that perceived distance is influenced by anticipated difficulties in movement, such as congestion, bad weather, or poor transportation.

In this context, urban cultural landmarks play a significant role in shaping the imageability of a city. Landmarks serve as prominent reference points within the urban fabric, providing distinctive and recognizable features. They can become key elements in individuals' mental maps, serving as anchors or focal points for navigation and orientation. Cultural landmarks, such as renowned museums, historic sites, or iconic structures, often have a strong visual or symbolic presence that enhances their imageability (Ryberg-Webster & Kinahan 2014).

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In line with Scott (1997), Plaza et al. (2022) recognizes the importance of semiotic characteristics of symbolic/cultural goods in shaping spatio-temporal landscape perception. Symbolic goods, including culture, heritage, landscape, and cuisine, play a significant role in creating associations and reconnections that affect the subjective perception of time and distance. This resonates with Asheim et al. (2011), Plaza et al. (2022), Sacco (2017) and Plaza et al. (2024), who discuss the impact of symbolic associations and image reconnections on the perception of the visit experience.

However, in cultural tourism destinations, tourists with a specific interest in cultural attractions or landmarks often exhibit different mobility patterns compared to traditional urban visitors. These cultural tourists prioritize exploring sites that align with their cultural interests, which may lead them to deviate from the main pathways identified in Lynch's framework. Rather than following the predefined urban paths, they seek alternative routes that offer a closer connection to the cultural aspects of the destination (Alvarado-Sizzo 2016).

This deviation from traditional urban paths can be attributed to the unique motivations and preferences of cultural tourists. Cultural landmarks that receive repeated media coverage often gain public recognition and attract visitors, even if they are not centrally located within a destination. The power of media exposure can influence the perception and desirability of a place, leading people to seek out and visit these popularized sites (Plaza et al. 2022).

In some cases, these media-featured locations may be situated in peripheral areas or outskirts of a destination, away from the traditional central areas. However, their prominence in the media creates a sense of intrigue and curiosity among tourists, motivating them to venture beyond the typical city centre and explore these recognized sites (Richards 2018).

The influence of media extends beyond geographical centrality, as it shapes the perception and appeal of a place. Media coverage can generate buzz and create a perception of uniqueness, authenticity, or cultural significance associated with these featured locations (Currid & Williams 2010). As a result, visitors are drawn to these places, driven by the desire to experience or witness what has been portrayed in the media.

As a result, the relationship between visitor mobility patterns and urban morphology in cultural destinations may differ from what is described in Lynch's (1960) framework. The framework, which primarily focuses on the spatial organization and legibility of urban environments, may not fully capture the intricate movement patterns and preferences of cultural tourists. Instead, the study anticipates that cultural destinations will exhibit deviations from Lynch's framework, as cultural tourists seek out unique experiences and prioritize their cultural interests over traditional urban paths (Lorenzen et al. 2008; Plaza et al. 2022).

Understanding these deviations and mobility patterns of cultural tourists is crucial for destination management in cultural cities. It enables tourism stakeholders to identify and promote lesser-known cultural assets, design specialized itineraries, and enhance the visitor experience by providing tailored information and guidance. By acknowledging and accommodating the unique mobility patterns of cultural tourists, destinations can better align their offerings with visitor expectations and create a more enriching cultural tourism experience (Aranburu et al. 2020).

When combining the topics of "network analysis of GPS data" and "cultural tourism," researchers have explored how network analysis techniques can be applied to GPS data collected from cultural tourism contexts. This allows for a deeper understanding of the spatial patterns, connectivity, and interactions within cultural destinations (Aranburu et al. 2020).

3 Data and methods: network analysis of GPS data

This paper focuses on the spatial dimension of visitor mobility to understand which urban spaces are frequented by tourists and which locations serve as central attractions in the city.

3.1 Data

Visitors' movements in Bilbao and San Sebastian were captured using GPS tracking devices. The GPS devices were distributed to visitors staying at hotels of medium to high category, which were selected semi-randomly. Participation in the experiment was voluntary. CICtourGUNE conducted the data gathering process. Visitors carried the GPS devices throughout the day, programmed to record their geoposition every two minutes. The study resulted in a valid sample of 112 trackings, with 51 for Bilbao and 61 for San Sebastian. The research was conducted during the peak months of cultural tourism: July, August, and September 2019, corresponding to the summer period. We can confidently identify them as cultural tourists for three reasons: (1)

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we conducted a survey, (2) visitors during the summer months typically engage in cultural activities, and (3) analysis of GPS patterns subsequently revealed their preferences during the visit. Therefore, the selection of visitors is predicated on the assumption that all tourists staying in the selected hotels during this period were motivated by cultural interests. This assertion was later confirmed through analysis of the GPS data. Additionally, fieldwork was conducted outside key cultural events taking place in the destination. Finally, the selection of respondents was made through a two-stage random selection based on hotel data: Firstly, a random selection of hotels and secondly a random selection of visitors within the selected hotels.

The applied analysis methods were based on five main steps: 1) Pre-processing GPS trackings; 2) Drawing up space consumption heat maps; 3) Detecting visited attractions; 4) Composing the visited attraction networks; 5) Quantifying the importance of network nodes by means of centrality measures.

GPS data collection methods often encounter errors due to incomplete satellite coverage. As a result, it is necessary to clean the GPS tracking data before analysis by removing any invalid data caused by poor signal quality, such as incoherent speeds and missing values (Shen & Stopher 2014). After pre-processing the GPS data, we generated heat map visualizations to examine the spatial consumption within the cities. A heat map is a graphical representation that depicts the density of dots on a map, in our case representing the geolocation of tourists.

The geolocated tracking points on the map do not correspond to specific places. Therefore, it is necessary to identify stop points and associate them with specific locations to extract the visited attractions (Shoval 2008; Grinberger et al. 2014). An algorithm is applied to detect the stop points, considering tracking data as a stop point if a tourist remains in one place (distance threshold) for a minimum amount of time (time threshold).

To identify the visited attractions, the identified stop points are linked with the Open Data Euskadi (Gobierno Vasco 2012). As very brief stops are not of interest, it is considered that a tourist is visiting an attraction only if they spend more than 10 minutes within the area of influence of that attraction. Since many attractions do not have precise boundaries (e.g., the Eiffel Tower), an area of influence is defined based on the attraction's category (monuments, museums, etc.), following a method similar to that used by Bohte & Maat (2009). The determination of the area of influence involves conducting tests and simulations with varying radii to assign an attraction to each detected stop point. If a stop point falls within the area of influence of multiple attractions, the closest attraction is selected (Montoliu et al. 2013; Petrtýlová & Jaššo 2022; Boltižiar 2023).

In some cases, a stop point may not match any attraction in the database. In such situations, a thorough examination of the stop point is required to determine if it should be considered as a new attraction and added to the database.

After identifying the visited attractions, a network was constructed to analyse the spatial interaction among cultural attractions. A network consists of nodes and links, where nodes represent individual entities within the network and links represent the relationships between these entities. Spatial network analysis focuses on understanding the structure of relationships among spatial entities. Derived from graph theory, network analysis aims to describe the relationships within a given network and employs quantitative techniques to generate relevant indicators and results for studying the network's characteristics and the positioning of individual entities within its structure (Shih 2006).

In this study, the nodes in the network represent cultural attractions, and the links between them signify the relationship between those attractions. The assumption is that a connection exists between two attractions if visitors tend to visit both of them. A separate network is presented for each city under study. In the case of Bilbao, the network consists of 9 nodes or attractions with 20 links connecting them. Similarly, in the case of San Sebastian, the network comprises 11 nodes or attractions with 36 links between them. These attraction networks are undirected, meaning the connections do not have a specific direction, and no weights are applied to the links. The primary goal is to identify the presence of interactions between attractions and analyse the overall topology of the network.

To assess the importance of nodes within the networks, four centrality indices were calculated: degree, betweenness, closeness, and eigenvector centralities. According to Freeman (1978), degree centrality is determined by the number of direct connections a node has. Betweenness centrality primarily measures the extent to which a node lies on the shortest paths between other nodes. Closeness centrality is a measure of the distance between a node and all other nodes in the network. Lastly, eigenvector centrality gauges the importance or influence of a node based on its connections to other central nodes (Ruhnau 2000). It is important to note that when calculating eigenvector cen-

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trality, each connected node is weighted differently based on their respective connections.
Among these centrality measures, the ones that best reflect the transaction costs of an attraction are Betweenness Centrality and Eigenvector Centrality. While the shape of the city influences both measures, Betweenness Centrality may be influenced by various factors such as physical barriers (slopes, rivers) or obstacles that affect the accessibility of pathways. Additionally, Betweenness Centrality captures the connection costs of attractions if they are well-connected through different modes of transportation.
Another significant index in the network analysis is the average path length, which is calculated between reachable pairs. This metric represents the average number of steps along the shortest paths between all possible pairs of network nodes. It provides insight into the efficiency of transportation within the network.

3.2 Tools

The GPS data and geolocation of attractions were stored in a PostgreSQL database, utilizing the PostGIS package for spatial analysis. Therefore, the preprocessing and detection of visited attractions were performed within PostgreSQL.
Furthermore, the data on cultural attractions was obtained from Open Data Euskadi (Gobierno Vasco 2012), an open-access database that provides detailed descriptions and geographical coordinates of cultural attractions such as museums and monuments.
To create the space consumption heat maps, Leaflet for R (Cheng et al. 2017), an open-source JavaScript library for interactive maps, was employed. The base map utilized satellite and high-resolution aerial imagery provided by Esri, a supplier of GIS software. Leaflet and Leaflet.Extras libraries were utilized for plotting heat points and displaying attractions on the maps.
Finally, the centrality measures and network representation were obtained using Gephi, a network analysis software (Bastian et al. 2009). Additionally, a GeoLayout plugin was employed, allowing the graph to be displayed based on geocoded attributes and standard projections.

4 Results

Space and mobility are crucial factors for tourists visiting urban destinations, as they significantly impact their overall experience. The spatial centrality of tourism resources plays a vital role, as cultural tourists tend to move and consume mainly within the city centre (Richards 2018). Accessibility and centrality are key determinants of the success and sustainability of an urban destination. Peripheral locations often incur higher transaction costs due to factors such as increased transportation costs, search costs, limited specialized inputs in production, and fewer specialized local consumer goods (Johansson & Quigley 2004). Centrality is influenced by various factors, including information economies, transportation network density, shared infrastructure, lower accessibility costs, and reduced search costs. In this context, centrality refers to both the concentration of cultural tourism assets (historic and cultural values, artistic and architectural pieces, transportation, restaurants, shops, etc.) and spatial centrality within the city centre.
To analyse the spatial consumption of cultural attractions, GPS tracking data has been visualized using a heat map with a purple-to-yellow colour gradient. The colour intensity becomes lighter as the density of visits increases, with the most frequently visited cultural attractions represented by a yellow colour.
As observed in the heat maps of each city (Fig. 1 and Fig. 2), many of the hotspots correspond to the locations of cultural attractions. In San Sebastian (Fig. 2), visitors primarily move around the Old Town, the city centre, and along the seaside promenade of La Concha. The picturesque seafront promenade, adorned with trees, gardens, and benches, offers a highly appealing walking experience, providing scenic views of the waterfront.
Similarly, in Bilbao (Fig. 1), the most popular attractions are situated in the Old Town, along the riverside, and on the main street (including the Guggenheim Museum, Fine Arts Museum, and Plaza Moyua). Notably, these newly developed pedestrian areas in Bilbao are part of a comprehensive urban regeneration plan initiated after the 1983 floods, beginning with the Old Town and continuing in the 1990s with the Abandoibarra area where the Guggenheim Museum is located. This urban regeneration project significantly altered the mobility patterns, enhancing accessibility to the river waterfront and expanding pedestrian walkways along the riverside. As a result, walkability (Fig. 1) has greatly improved, contributing to an enhanced quality of life in Bilbao, with residents and visitors enjoying the vibrant atmosphere and scenic views offered by the revitalized waterfront.
Both Bilbao and San Sebastian have relatively small city centres, making travel times, even by foot,

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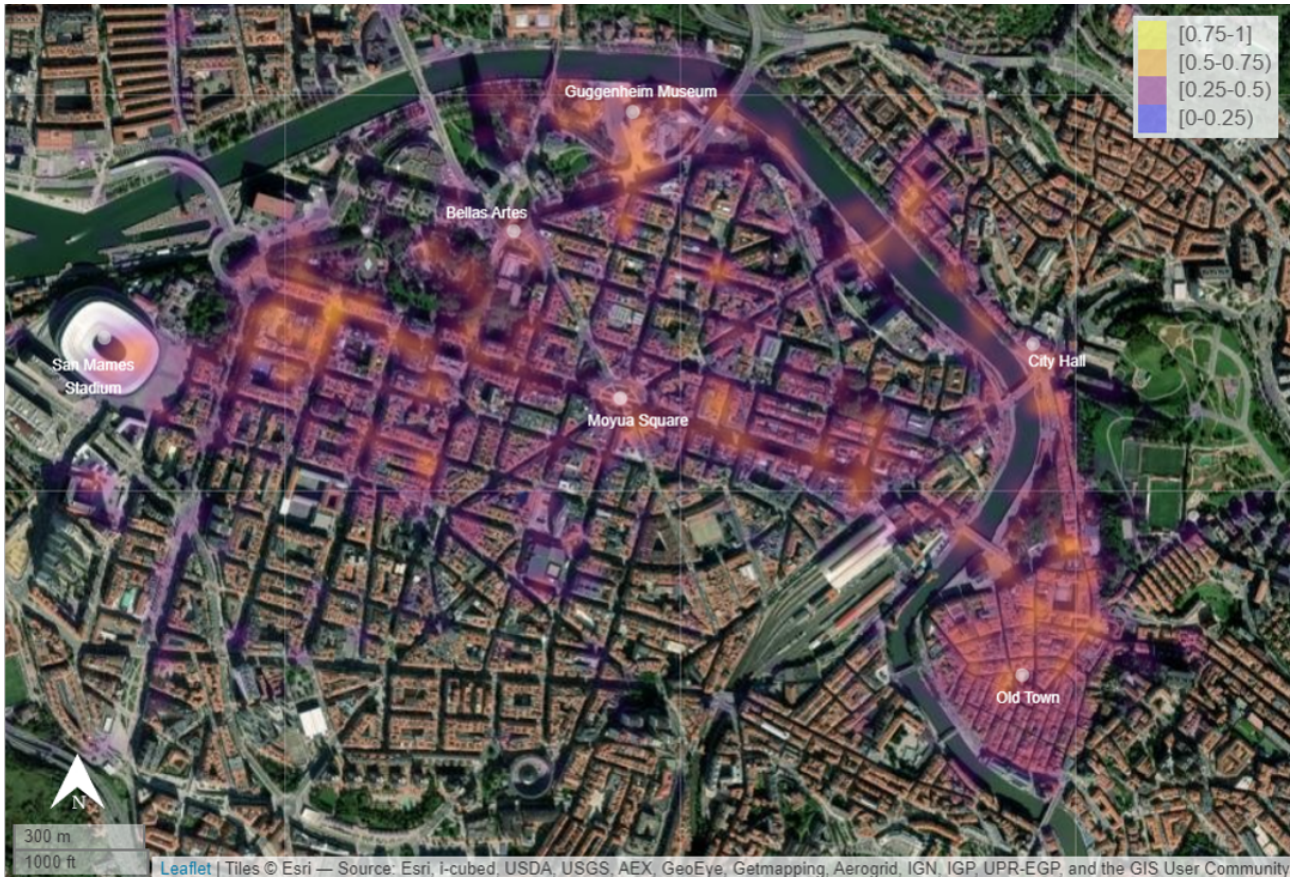

Fig. 1 Space consumption by visitors in the city centre of Bilbao (GPS data)

short. Cultural sites and amenities are easily accessible within a 30–45 minute walking distance from any important point in the city centre (Fig. 1 and Fig. 2). Moreover, local authorities have made substantial efforts to cater to the needs of individuals with restricted mobility, including the elderly, people with disabilities, and families with children. Regarding the shape of mobility, both destinations exhibit a simple and easily navigable mobility pattern, often referred to as a "D-shaped" silhouette, aligning with Lynch's theory (Lynch 1960). This implies that as tourist destinations, San Sebastian and Bilbao possess legible and uncomplicated mental maps, making navigation straightforward and reducing transaction costs.

The transformation of Bilbao's waterfront through an urban regeneration plan, for instance, not only altered mobility patterns but also contributed to creating a more legible and navigable urban environment. The deliberate design choices in San Sebastian's seafront promenade similarly enhance the legibility of the city, providing residents and visitors with recognizable landmarks and pathways that contribute to a sense of place. In this way, the GPS mobility analysis not only underscores the significance of urban waterfronts, but also provides empirical evidence supporting Lynch's theory by showcasing how intentional waterfront urban planning shapes the legibility and functionality of cities.

4.1 Network analysis of GPS data

The combination of GPS tracking data and network analysis offers valuable insights for city managers to enhance their understanding of the centrality of urban attractions, as depicted in Fig. 3 and Fig. 4. It is worth noting that the size of the nodes in the figures is proportional to their Degree Centrality, representing the number of direct connections each node has. Additionally, the color of the nodes represents their Betweenness Centrality value. The results reveal that the Old Town holds the highest popularity and centrality in both cities, as indicated by its highest Betweenness Centrality (Table 1 and Table 2). Betweenness Centrality signifies the number of shortest paths that pass through a node.

The calculated network parameters yield similar results for both cities, as indicated in Table 1 and Ta-

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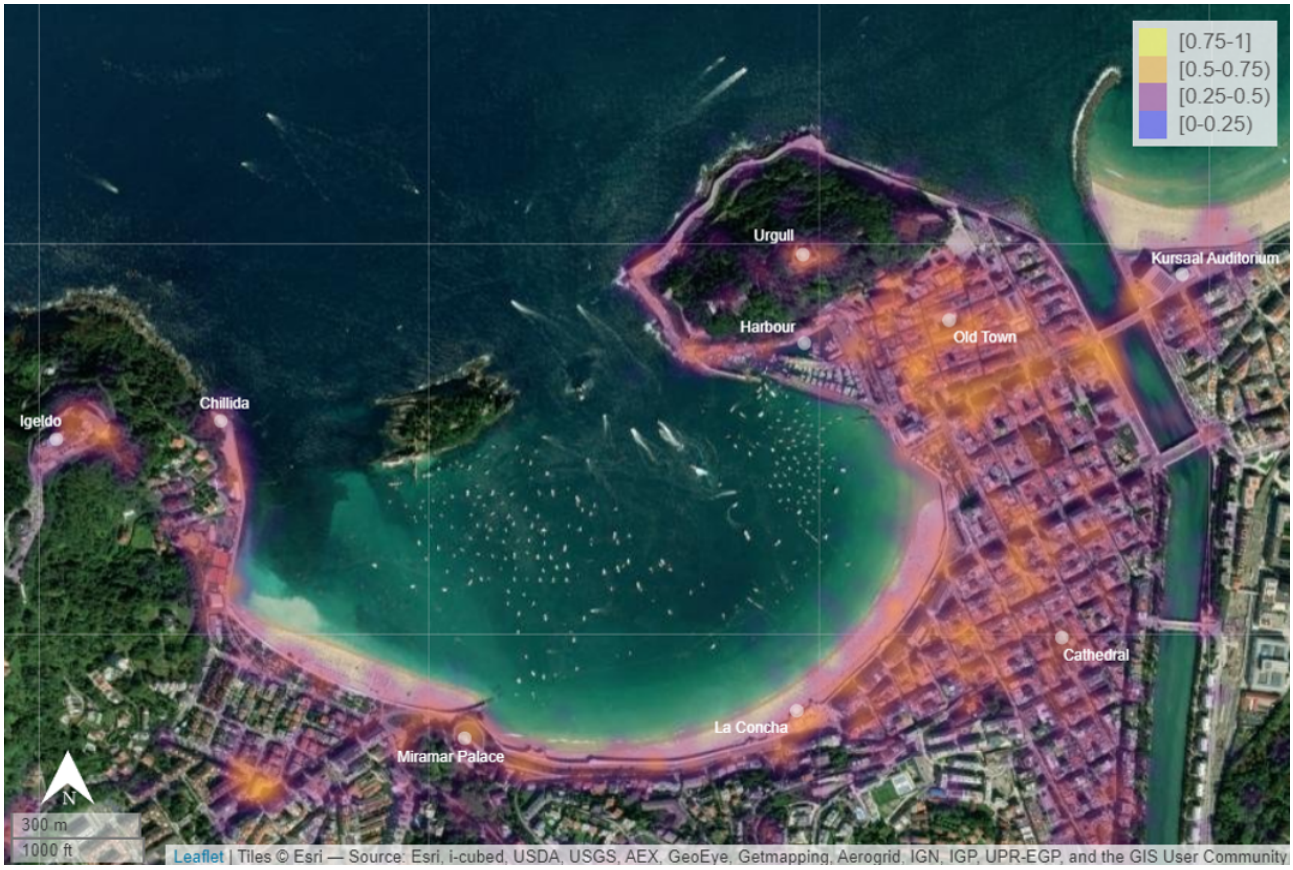

Fig. 2 Space consumption by visitors in the city centre of San Sebastian (GPS data)

ble 2. These findings emphasize the significance of cultural and heritage assets in Bilbao, alongside the natural assets present in San Sebastian.

Table 1 Centrality measures of the visited attractions in Bilbao

Attraction	nDegree	nCloseness	nBetweenness	Eigenvector
OldTown (n1)	100.00	100.00	13.52	1.000
La Concha (n7)	100.00	100.00	13.52	0.999
Buen Pastor (n8)	80.00	83.33	2.78	0.906
Puerto (n2)	80.00	83.33	4.07	0.892
Miramar (n9)	80.00	83.33	5.37	0.865
Kursaal (n5)	70.00	76.92	0.37	0.845
Zara (n13)	70.00	76.92	0.37	0.845
Maria Cristina (n15)	60.00	71.43	0.00	0.742
Igeldo (n12)	40.00	62.50	0.00	0.510
Urgull (n3)	30.00	58.82	0.00	0.392
Chillida (n14)	30.00	58.82	0.00	0.388

In terms of Degree Centrality, the Old Town in Bilbao has the highest nDegree (70 out of 100), indicating that 70% of the visitors who visit the Old Town also visit 70% of the other attractions within a short walking distance (considered one step in network language). Similarly, in San Sebastian, the Old Town and "La Concha," the iconic beach and seaside of the city, both have the highest nDegree (100 out of 100).

Regarding Closeness Centrality (which reflects how close a node is to all other nodes), the results are similar for both cities. The nodes show relatively similar nCloseness values, which is understandable considering that the city centres of Bilbao and San Sebastian are not large territories, and even walking distances are relatively short.

Regarding Betweenness Centrality, the Old Town in Bilbao has the highest nBetweeness (53.3 out of 100), meaning that 53% of visitors who take the shortest path-length pass through the Old Town at some point. In San Sebastian, the Old Town also has the highest nBetweeness (13.5 out of 100). Betweeness Centrality measures the connection costs of nodes within the routes.

Eigenvector Centrality indicates the influence and economic centrality of a node. Nodes with eigenvector values above 0.5 are considered influential. In Bilbao, the most influential attractions

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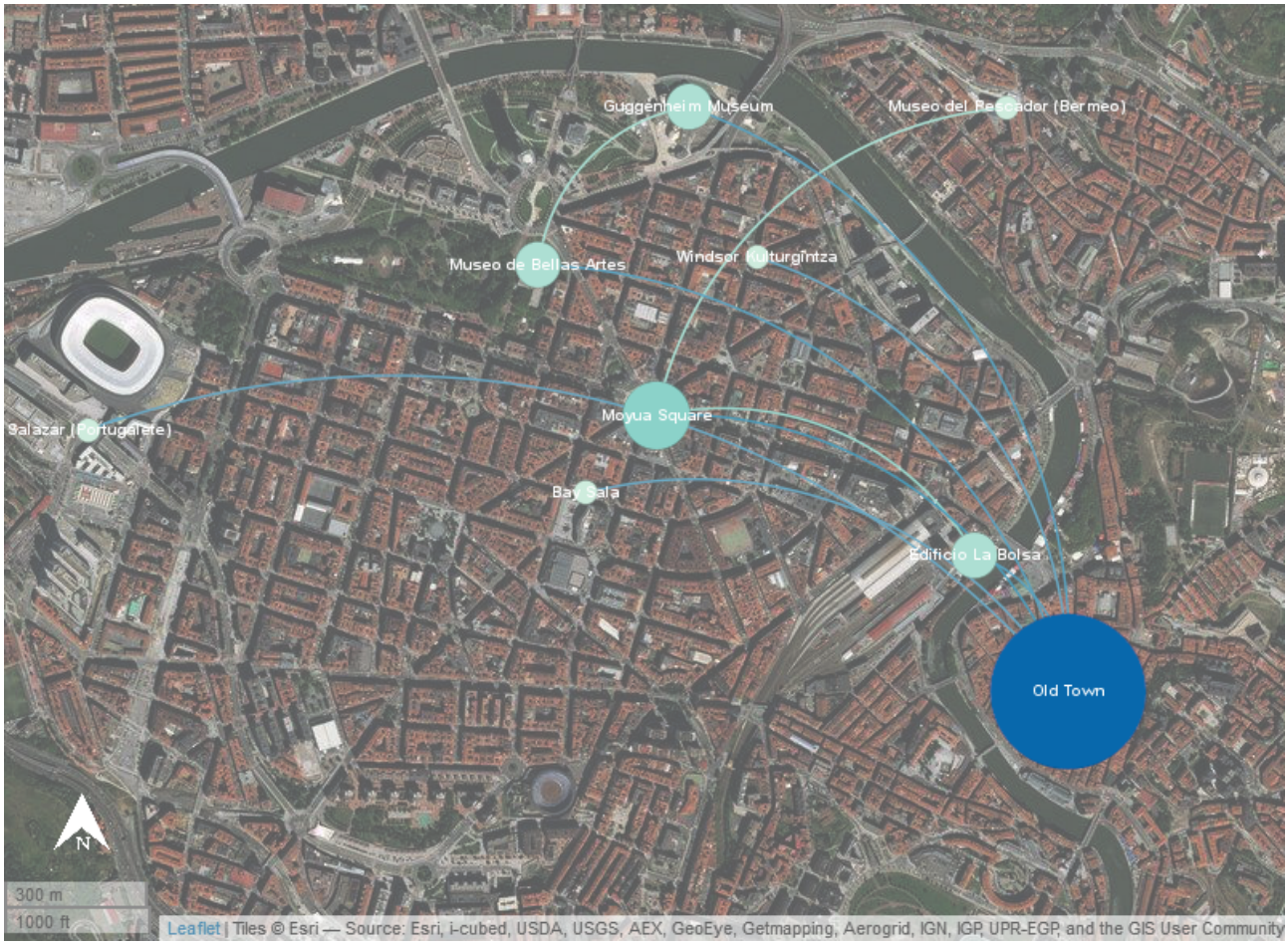

Fig. 3 Network of the most visited cultural attractions in Bilbao

Table 2 Centrality measures of the visited attractions in San Sebastian

Attraction	nDegree	nCloseness	nBetweenness	Eigenvector
Old Town (n2)	70.00	58.80	53.30	1.000
Moyua Square (n4)	30.00	47.60	15.60	0.561
Edificio La Bolsa (n11)	20.00	45.50	0.00	0.515
Guggenheim Museum (n10)	20.00	43.50	0.00	0.489
Museo de Bellas Artes (n7)	20.00	43.50	0.00	0.489
Bay Sala (n1)	10.00	41.70	0.00	0.329
Torre Salazar (n14)	10.00	41.70	0.00	0.329
Windsor Kulturgintza (n15)	10.00	41.70	0.00	0.329
Museo del Pescador (n8)	10.00	35.70	0.00	0.186

are the Old Town (n1), Moyua Square (n4), and Edificio la Bolsa (n11). The Guggenheim Museum and ”Bellas Artes” Museum have eigenvector values close to 0.5. In San Sebastian, the most influential attractions include the Old Town (n1), La Concha (n7), Buen Pastor (n8), Puerto (n2), Miramar (n9), Kursaal (n5), Zara (n13), and Maria Cristina (n15).

The Average Path Length is relatively small in both cities: 1.86 steps for Bilbao and 1.33 for San Sebastian. This suggests that most attractions are concentrated in a small area, specifically the city centers, and are easily reachable by walking. There is a positive correlation between public space use and walkability in both cities.

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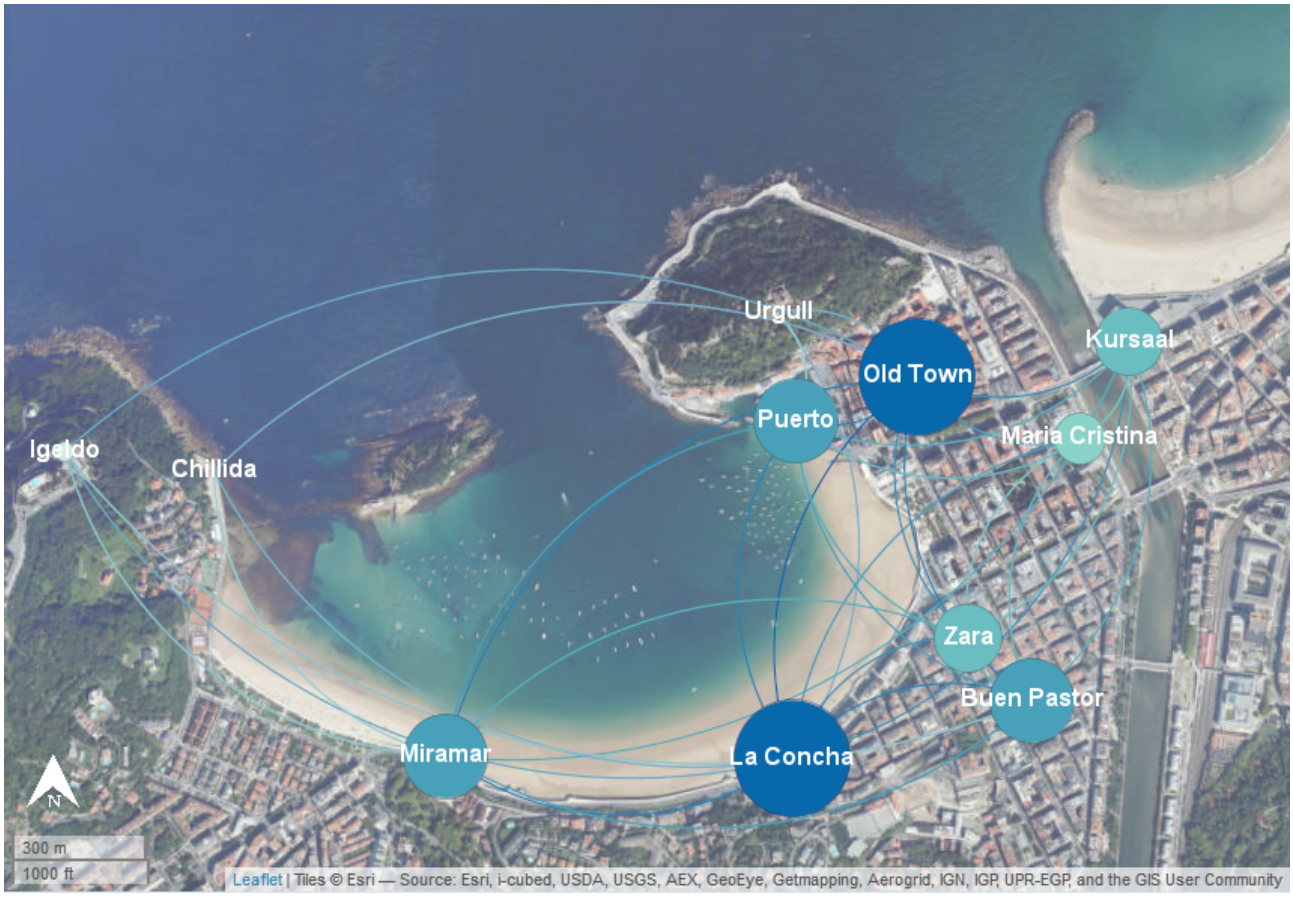

Fig. 4 Network of the most visited cultural attractions in San Sebastian

To summarize, in the case of Bilbao, despite the Guggenheim Museum Bilbao being the international magnet attracting tourists, the most visited part of the city is actually the Old Town, as shown in Fig. 1, and also acknowledged by the City Council. Similarly, the Old Town is the most visited site in San Sebastian. Both pedestrian Old Towns in Bilbao and San Sebastian offer a concentration of architectural heritage buildings, commercial services, accommodation, and gastronomic delights, enhancing their cultural vitality.

5 Methodological limitations and implications of this research

While the study provides valuable insights into the role of space and mobility in shaping cultural tourists' experiences, there are several methodological limitations to consider: (1) Although we have performed a survey, the reliance on GPS tracking data may introduce bias as it captures movement patterns but may not fully account for the qualitative aspects of tourists' experiences. For example, it may not capture the reasons behind tourists' choices or their emotional responses to different attractions. (2) The network analysis focuses on identifying patterns of mobility within the city but may not capture other factors influencing cultural tourism, such as cultural events, marketing strategies, or changes in urban policies (limited scope of Network Analysis). (3) The study emphasizes walking distance as a key factor, potentially overlooking the impact of other transportation modes (bikes, public transportation, cars) on cultural tourists' experiences. A more comprehensive analysis of various transportation modes could provide a more nuanced understanding. (4) The study appears to be cross-sectional, providing a snapshot of tourists' behaviours. Longitudinal data could offer insights into how mobility patterns and preferences change over time and in response to external factors. (5) The study assumes that Lynch's framework is universally applicable to cultural destinations. However, this might not hold true for all destinations, and the study could benefit from exploring alternative frameworks or considering modifications based on specific contexts. (6) The study does

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not extensively address the influence of cultural diversity on tourists' preferences and behaviours, which could be a significant factor in shaping cultural experiences in different destinations. Addressing these limitations in future research could enhance the robustness and applicability of the findings, providing a more comprehensive understanding of the dynamics influencing cultural tourism.

In terms of the research implications, this study emphasizes the significance of the Cultural Economics framework (Throsby 2010), which recognizes potential behavioural variability among cultural tourists compared to Lynch's framework. Contrary to the prevailing belief that Cultural Tourists diverge from Lynch's theory, the study challenges this notion by suggesting that their behaviours align with Lynch's patterns. This perspective underscores the continued relevance of Lynch's theoretical framework in understanding cultural tourist behaviours, highlighting the importance of established urban design and navigation patterns. In sum, despite methodological limitations, Lynch's (1960) Theory of Imageability remains crucial for comprehending individual perceptions and navigation in urban cultural environments.

The deliberate selection of Bilbao and San Sebastian as case studies holds significance for several reasons. Firstly, both cities represent prominent cultural destinations, each renowned for specific attractions—Bilbao for the iconic Guggenheim Museum and San Sebastian for its picturesque beach and gastronomy. This intentional diversity in cultural offerings ensures a comprehensive exploration of Lynch's framework within varied cultural contexts.

Secondly, the incorporation of Network Analysis using visitors' GPS data adds a data-driven layer to the analysis, allowing for a nuanced understanding of how cultural destinations operate within their physical territories. This approach not only aligns with contemporary methodologies but also enhances the robustness and depth of the study.

Thirdly, the revealed "D-shaped" mobility pattern in both San Sebastian and Bilbao, characterized by a clear and uncomplicated flow of movement, serves as a significant finding. This alignment with Lynch's theory underscores the universal relevance of simplicity and legibility in shaping visitors' cognitive maps and mental representations of urban spaces.

Fourthly, analysing GPS data through network analysis reveals the concentration of cultural landmarks in the Old Town, providing insights into challenges associated with congestion and overtourism, particularly in San Sebastian.

To visually complement these findings, Fig. 1 to Fig. 4 offer illustrative representations, emphasizing the ease of navigation within these cities and its crucial role in forming visitors' cognitive maps. In essence, the selection of Bilbao and San Sebastian as case studies enriches the analysis, providing valuable insights into the intricate interplay between cultural tourism, urban morphology, Lynch's Theory of Imageability and prospective overtourism in San Sebastian partially due to the concentration of cultural landmarks in the Old Town.

6 Conclusions

This study has demonstrated the crucial role of space and mobility in shaping cultural tourists' experiences and the duration of their stays in a destination. The findings highlight the following key points:

Firstly, space and mobility can have a significant impact on tourists' overall experience and the time they spend in a destination. Cities with simple and easily understandable mental maps tend to facilitate efficient and rapid exploration of the cultural attractions. In the case of San Sebastian and Bilbao, the shape of mobility patterns in both cities can be described as "D-shaped," indicating a clear and straightforward mobility pattern. Lynch's theory (1960) is fulfilled, as the simplicity and legibility of these cities, as demonstrated in Fig. 1 and Fig. 2, play a crucial role in the formation of cognitive maps or mental maps for visitors. This, in turn, enhances their understanding and active involvement with the environment in which they reside.

Secondly, the hypothesis that cultural destinations may deviate from Lynch's (1960) framework suggests that the study expected to find differences or variations in the relationship between visitor mobility patterns and urban morphology in cultural destinations compared to Lynch's framework. However, the research findings did not support this hypothesis, indicating that cultural destinations in San Sebastian and Bilbao align with Lynch's framework and exhibit a consistent relationship between visitor mobility patterns and urban morphology.

By occupying prominent locations within the urban fabric, these cultural assets fulfil Lynch's theory, which emphasizes the importance of easy access and navigation within the urban environment. They contribute to creating an environment that facilitates seamless access and navigation for cultural tourists, enhancing their overall experience and en-

abling them to fully immerse themselves in the destination's cultural offerings.

Thirdly, network analysis of GPS data aids in identifying patterns of mobility within the city. Combining GPS tracking data with network analysis techniques allows city managers to gain valuable insights into various aspects of urban attractions. This includes measuring the centrality of cultural attractions, understanding the centre of gravity of tourist-related economic activities, analysing the interconnections between different tourist assets, optimizing the use of urban space, and improving the alignment of the transport network. By leveraging these tools, city managers can make more informed decisions to enhance the overall tourism experience and effectively manage urban resources.

Fourthly, cultural tourists, who are typically well-educated individuals with a significant opportunity cost of time, exhibit a heightened level of selectivity in their choice of cultural destinations and how they allocate their time and engage with physical spaces. They tend to consume places and experiences intensively, often within limited timeframes such as short weekends. To capture the attention of cultural tourists, it is crucial for cultural sites to be easily accessible, ideally located within a 30–45 minute walking distance from key points in the city centre.

Fifthly, the network analysis of GPS data in both Bilbao and San Sebastian reveals that the Old Town, particularly in San Sebastian, stands out as the most visited cultural zone. While tourists are initially drawn to Bilbao for its renowned landmark, the Guggenheim Museum, and San Sebastian for its picturesque beach, La Concha, it is noteworthy that visitors tend to allocate more time exploring the Old Town in both Bilbao and San Sebastian, reflecting a preference for the utilization of space. This popularity, however, raises concerns about congestion in San Sebastian. Despite the magnetic pull of iconic attractions, the Old Towns in both cities captivate tourists with their historical charm, cultural heritage assets, pedestrian-friendly streets, and a diverse and high-quality gastronomic scene. These factors underscore the challenges associated with managing congestion in these culturally rich areas, particularly in San Sebastian.

Sixthly, the revitalization of Bilbao's waterfront through urban regeneration not only transformed mobility patterns but also played a pivotal role in crafting a more legible and navigable urban landscape. Likewise, the purposeful design decisions evident in San Sebastian's seafront promenade have heightened the city's legibility, offering residents and visitors recognizable landmarks and pathways that foster a distinct sense of place. The GPS mobility analysis serves as a compelling tool, not only emphasizing the importance of urban waterfronts but also offering empirical support for Lynch's theory. It demonstrates how deliberate urban planning of waterfront areas can significantly influence the legibility and functionality of cities, providing valuable insights into the intricate dynamics of urban spaces.

In summary, this study highlights the importance of space/urban morphology and spatial centrality in cultural destinations, by understanding these dynamics and incorporating insights from network analysis of GPS data of visitors' mobility. Future studies should place a specific emphasis on investigating the mobility patterns and dynamics related to bikes, public transportation, and cars within cultural destinations. Understanding how these modes of transportation influence visitor experiences and movement can provide valuable insights for enhancing accessibility and sustainable cultural destinations.

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