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Article

Sustainable urban dynamics in coastal cities: A comparative study through digital footprints

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Abstract: This research conducts a comparative urban analysis of two coastal cities with analogous tourism models situated in distinct geographical regions: Balneário Camboriú in Brazil and Benidorm in Spain. The study delves into two critical urban phenomena impacting the sustainability of tourist cities, utilising social network data to gather insights into economic and urban activities (Google Places) and spatio-temporal patterns of citizen presence (Twitter). The spatial analysis explores the municipal and, to a more detailed extent, the coastal strip extending 500 m inland from the coastline, spanning the entire length of each city to their municipal boundaries. The analysis uncovers both similarities and differences between the two destinations, offering insights that could inform future development strategies aimed at fostering sustainable urban environments in these well-established coastal tourist areas.

Keywords: tourist city; urban sustainability; social media data; Google places; Twitter

1. Introduction

One of the main challenges of sustainable urban tourism is to achieve a balance between the quality of life of the resident population —a sense of place, affordable housing, facilities, etc. and the development of the cities themselves for the benefit of the tourism industry (Aall and Koens, 2019). The diagnosis of urban sustainability in coastal tourist areas that have been subject to pressures due to growing demand and its consequent mass urbanisation is of interest in order to identify possible intervention strategies (Chen et al., 2024). These strategies aim, on the one hand, to understand the capacity of these receiving spaces in relation to their demand and, on the other, to provide guidelines for a better balance to be achieved between tourist activity and the local activity of the resident population in these cities (Ivars-Baidal and Vera-Rebollo, 2019). To this end, several authors stress the relevance of carrying out diagnoses on the aspects that influence the urban sustainability of coastal tourist areas (Kontopyrakis et al., 2024), such as the relationship between density and diversity in the supply of economic activity (Martí et al., 2017) or the presence and activity of people in the urban spaces of these areas (Vu et al., 2020).

Social network data offer valuable clues to identify and understand socially relevant physical aspects of the environment and thus contribute to measuring urban sustainability (Martí-Ciriquián et al., 2022). In particular, geolocated social media data allow continuous monitoring of users' activities and preferences, becoming powerful sources of information for understanding behaviours and experiences in tourism settings (Salas-Olmedo et al., 2018).

This research advances this line of knowledge, establishing relationships between the physical environment —the amount and types of urban and economic activity on

offer and the behaviour of people in the urban environment —the spatio-temporal patterns of people's presence. To this end, data from the social networks Google Places and Twitter (now known as "X"), respectively, are used to identify and analyse the similarities and differences in relation to the aforementioned urban phenomena (Martí et al., 2019) in the coastal strip of two tourist destinations located in very different geographical areas: Balneário Camboriú in Brazil and Benidorm in Spain. These areas have previously been the subject of comparative studies due to the similarity of their urban tourism model, their economy based on the service sector and their commitment to sun-and-beach tourism with strong demand from domestic and foreign tourists (Soares et al., 2015). This study builds upon previous research conducted by the authors within the same case study cities (Serrano-Estrada, et al., 2024).

1.1. Urban complexity and citizen presence as the cornerstones of sustainability in the tourist city

Studies developed in the 1960s argued that cities were the nodes of origin of tourism to other less urbanised areas. However, many urban areas globally are nowadays tourist destinations due to the high concentration of activity they host and the experiences they offer to their visitors (Hinch, 2010). Given the growing phenomenon in which more and more new, environmentally unplanned, territories are under pressure from tourism, the sustainability of these environments has become a priority issue for public policies worldwide (Zamfir and Corbos, 2015).

Given the unique features of tourist cities in terms of their urban form, activities, and meeting spaces (Martí et al., 2017), their status as nodes of economic and human activity is of particular interest for several reasons. One of them is the overlapping of two different types of demand: 1) the tourist demand for services, infrastructures, facilities, and attractions; 2) the traditional urban demand of its residents (Fistola et al., 2019). Although this duality is a major challenge for tourist cities, the capacity of the environment to satisfy these demands has a direct impact on the experience of the tourist city and therefore on its capacity to attract people. Specifically, the balance between a good quantity and variety of supply in urban economic activities, services, and land uses referred to as Urban Complexity, according to the AEUB (2012) is considered a fundamental characteristic of urban vitality (Gonçalvez et al., 2018), which, in turn, has an impact on the competitiveness of tourist destinations (Crouch, 2010).

Crises such as the COVID-19 pandemic in the early 2020s, and the impact it had on economic and urban activity, have shown that dense and diverse environments are more resilient and that the presence of people in the busiest urban spaces before the pandemic has been decisive in the ability of environments to recover their activity (Serrano-Estrada et al., 2022). This is also especially important in tourist cities whose economic drive includes economic activities related to hospitality, leisure, and commerce, which were precisely the three sectors most affected by the restrictions during the pandemic. Areas with a diverse offer of economic activities means 1) maintaining a certain amount of activity during the day and night – alluding to the concept of 24-hour cities; 2) allowing for the generation of other exploitation models in addition to tourism, so that tourism is not the only economic engine of the cities.

Therefore, the simultaneous existence of different types of economic and urban activity in the environment, aimed at different types and profiles of users and not only at tourist consumption (Maitland, 2013) contributes to the construction of more cohesive societies among residents and visitors of all ages, while fostering citizen presence that, in a feedback effect, attracts more visitors, and leads to a prolongation in time of the vitality of the urban space (Poruthiyil and Purandare, 2023). Addressing the temporality of presence and the patterns that lead to keeping the city active day and night is a necessary line of work to identify opportunities (e.g. more competitive vital cities) and challenges (e.g. negative impact on residential environments with night-time tourism (Nofre, 2020) in order to inform decision making and prioritise actions.

Given the above ideas, the main contribution of this research lies in building knowledge on methodologies for diagnosing the quantity and diversity of urban and economic activity and the spatial-temporal patterns of citizen presence in consolidated tourist environments.

1.2. Technology-based sources for the diagnosis of the tourism phenomenon

The sustainability of tourist cities has been widely studied from a variety of perspectives, ranging from physical and morphological aspects such as land occupation, complexity of activities, and open spaces (Martí et al., 2017) to the opportunity represented by the intensive use of technology in the implementation of tourist destinations for the continuous measurement of sustainability-related aspects (Perles-Ribes and Ivars-Baidal, 2021). In contrast to information provided by static data from official sources, recent research adopts dynamic information provided by virtual sources, especially social networks, as they provide a glimpse of, among others, aspects related to how people interact with their environment (Ghermandi et al., 2023), offering a useful view of social reality (Flores-Ruiz et al., 2021).

Several studies have used geolocated data from social networks and other web services to address a wide variety of urban phenomena, demonstrating their usefulness for observing both, issues related to the physical characteristics of the city and less tangible aspects related to citizen behaviour and preferences (Serrano-Estrada et al., 2022). Therefore, they are considered sources of great potential for addressing tourism areas (Salas-Olmedo et al., 2018) and promoting sustainable coastal development (Perillo et al., 2021). Regarding physical issues, platforms such as Google Places offer a list of points of interest (POIs), enabling the analysis of location patterns, distribution, and diversity of POIs in a given urban environment. This includes differentiating between various urban spaces parks, squares, paths, avenues, boulevards, promenades, etc. (García-Mayor and Nolasco-Cirugeda, 2023) and different categories of urban and economic activity (Martí et al., 2021). In terms of behavioural aspects, social media data, such as that from TripAdvisor, can help to estimate the number of visitors and the flow of people within the city (Fistola et al., 2019) or identify tourist areas of interest when contrasted with data on citizen preferences from Foursquare (Nolasco-Cirugeda et al., 2022). Information from Twitter has also proven valuable for examining experiences and emotions associated with specific environments (Flores-

Ruiz et al., 2021), and for identifying patterns in the presence of people in diverse urban tourist spaces (Salas-Olmedo et al., 2018).

Leveraging these sources, this research utilises data from Google Places and Twitter to analyse, respectively, the amount and diversity of urban and economic activity and the spatial patterns of citizen presence in the two selected case study tourist environments.

2. Case study cities and methodology

2.1. Case study cities

We propose to carry out a comparative analysis of two tourist cities that have similarities both in their location and their tourism model but are geographically very distant from each other: 1) Balneário Camboriú, located on the coast of the state of Santa Catarina, in southern Brazil; and 2) Benidorm, in the province of Alicante, on the southeast coast of Spain (**Figure 1**). In previous research, coastal cities in Brazil and Spain have already been the subject of interest for their evolution as consolidated tourist destinations (Soares et al., 2015), for the uniqueness of their public spaces and recreational infrastructure (Dos Anjos et al., 2009), and for the phenomena of mobility and migratory or tourist flows that occur in these enclaves (Gonçalvez et al., 2018). In particular, these are two of the main sun-and-beach tourist destinations in their respective countries, with a high concentration of accommodation and an economy based on the service sector (Soares et al., 2015).

Figure 1. Panoramic view of the coastal skyline of Benidorm (left) and Balneario Camboriú (right).
Source: Comunitat Valenciana (left) and ABC (right).

Although both municipalities have a similar territorial extension of around 40 km^2 (38.5 km^2 Benidorm and 45.2 km^2 Balneário Camboriú), there are differences between the two destinations that should be highlighted (as extensively detailed in Soares et al. (2015) within their respective political and social contexts). Firstly, in terms of their urban growth model, despite a similar area, Balneário Camboriú has a more extensive city model and a more compact urban core. Its population, according to census data from 2021, is 149,227 inhabitants, which is more than double that of

Benidorm, with 69,118 inhabitants (Instituto Brasileiro de Geografia e Estatística, 2021; Instituto Nacional de Estadística, 2021).

Secondly, despite extensive development in the Brazilian municipality, a portion of the territory still maintains large well-preserved natural areas and rustic land. In the case of Benidorm, in addition to natural areas such as the Serra Gelada and the tourist offer of theme parks and golf courses, there are cropland parcels together with other activities linked to tourism and recreation, such as campsites.

Thirdly, in terms of building typologies, both cities are characterised by high-rise buildings or skyscrapers, especially on the coastline. In the case of Balneário Camboriú, these skyscrapers are concentrated in the first 600 m from the coastline, with the rest of the urban area being lower density neighbourhoods where buildings, except in isolated cases, do not exceed four floors. Benidorm, on the other hand, has a historic and compact block extension in the urban centre, from the coastal edge inland in the central part of the municipality and from where two areas emerge that make up the eastern extension and the developments to the west. These areas are characterised by residential developments with high-rise buildings, in addition to other low-density developments and detached single-family buildings located in more peripheral areas towards the interior of the municipality.

Fourthly, the two cities have different urban structures and morphology of the urban blocks (**Figure 2**). In Balneário Camboriú, the blocks maintain the shape of the original rustic plots, with a frontage of approximately 50 m and a depth that can reach 500 m in some cases. The road network comprises main parallel axes to the coast which intersect with others that run in a perpendicular direction, with smaller streets within blocks. In the case of Benidorm, the blocks are irregular and adapt to the existing road network, which does not follow any specific grid. These blocks are subdivided into larger plots with isolated high-rise buildings, allocating large community open spaces with sports facilities and/or swimming pools.

Figure 2. Same scale comparison of the urban structure of Benidorm (top) and Balneario Camboriú (bottom) with detail of block size.

Lastly, it is noteworthy that tourist influxes in both locations vary across different months of the year (**Figure 3**). Benidorm experiences its peak during the summer months, with the highest number of tourists observed in August. Conversely, for Balneário Camboriú, the peak month, notably January, stands out as the period with the significantly highest tourist numbers.

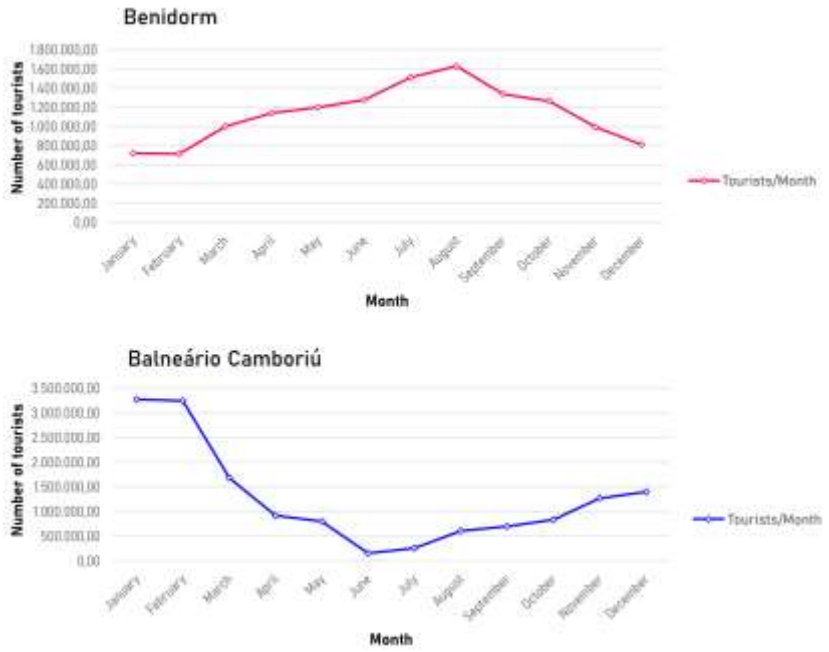

Figure 3. Temporal evolution of the number of tourists per month throughout the year 2019.

Source: Authors, based on data from Instituto Nacional de Estadística (Benidorm) and Sistema de Inteligência Turística de Santa Catarina (Balneário Camboriú).

2.2. Methodology

The methodology encompasses five stages: 1) selection of sources; downloading and filtering of data; 2) delimitation of the area of study (coastal strip); 3) quantification and spatial distribution of data for the municipality and the coastal strip; 4) analysis of the density and diversity of urban and economic activities; and, finally, 5) analysis of the spatio-temporal patterns of citizen presence.

2.2.1. Source selection and data preparation

Two types of data sources were used in this study. First, cartographic information was useful for the delimitation of the area of study, which comprises the coastal strip of both cities. Specifically, the coastline was obtained from the Instituto Geográfico Nacional (IGN) for Benidorm and from the Instituto Brasileiro de Geografia e Estatística (IBGE) for Balneário Camboriú. The road network for both cases was obtained from the OpenStreetMap database.

Second, building on the methodological basis initiated in previous studies, geolocated data from the social networks Google Places and Twitter, respectively, were used to analyse the density and diversity of urban and economic activity (Serrano-Estrada et al., 2020) and spatio-temporal patterns of citizen presence (Adelfio et al., 2020). The information from Google Places and, more specifically, the

detailed list of activities was considered as an indicator of the supply of urban and economic activity. The geolocated tweets, with the temporal information of when they were shared, were considered digital traces of citizen presence. The databases of both platforms for the entire municipal area were retrieved through their API—Application Programming Interface through a self-developed application called SMUA (Martí et al., 2019). The Google Places data download date was March 27, 2023, for Balneário Camboriú and March 30, 2023 for Benidorm. For Twitter, tweets corresponding to the time period of the two months of high tourist occupancy in summer were obtained through recurring requests to the API: July–August 2022 for Benidorm, and December 2022–January 2023 for Balneário Camboriú.

The data preparation process consisted of the verification, classification, and cleaning of the databases to facilitate their analysis. This started with an initial verification that included the elimination of duplicate records and the manual review and relocation of data when required. The Google Places data, initially classified into 128 different activity types, were then recategorised by adopting the standard venue classification proposed by the social network Foursquare (Serrano Estrada et al., 2020). The classification adopted comprised eight out of the ten categories of venues: Arts and Entertainment, College and University, Food, Nightlife, Outdoors and Recreation, Professional and Other places, Shop and Services, and Travel and Transport. Foursquare also includes two other categories (Residence and Events) that have not been considered in this work because they do not refer to urban or economic activity in the Google Places databases. Once the Google Places data had been categorised, those records that did not represent economic or urban activities were discarded (mostly related to street and square names, or administrative boundaries, for example). In the case of Twitter, tweets were categorised according to the day of the week (Monday to Sunday) and the time they were sent, establishing six time periods: three for the weekdays (1) morning; 2) afternoon and 3) evening); and three for the weekends (4) morning; 5) afternoon and 6) evening).

Once downloaded and recategorised, the databases, as well as the cartographic information layers coastline and roads were visualised in the QGIS Geographic Information System. All the analyses of the study were performed using this program.

2.2.2. Delimitation of the area of study: The coastal strip

The area of study is the coastal strip of 500 m from the coastline, a distance that is frequently used for the definition of management areas, or the territorial and urban planning legislation in coastal areas (Rullan, 2011; Scherer et al., 2009). To achieve this, a 500-metre buffer area was delimited from the coastline and adjusted to the closest road network axes to encompass all blocks intersecting with the area of influence. Given that a Google Places entry could be located anywhere on a plot (front or back), the approach of including entire blocks was chosen to ensure all urban and economic activities within the delimited area were covered.

2.2.3. Quantification and spatial distribution of social media data for the municipality and the coastal strip

Initially, the data was quantified, and its spatial distribution was described, first for the entire municipality and then within the 500-metre coastal strip. To do this, the Google Places and Twitter data located within the area of study were isolated and

quantified either by categories (type of activity in Google Places) or by time periods (Twitter tweets). These were then compared with the entire municipality to calculate the percentage of each category or time period relative to the total. Consequently, the proportion of the municipality's urban and economic activity and citizen presence concentrated within the first 500 m from the coast was determined.

2.2.4. Density and diversity of urban and economic activities

Considering exclusively the data located within the area of study, the offer of activities was analysed by calculating their density (quantity) and diversity (different categories of specialisation). To this end, a reference grid of hexagonal cells, each 25 m high, was created. Previous research has shown hexagonal cells to be more effective for precise analyses compared to rectangular grids, as they maintain equal distances to adjacent cells in all directions and align better with urban fabric morphology, avoiding the limitations of orthogonal grids (Birch et al., 2007). The chosen 25-metre threshold facilitates observation of small-scale urban phenomena due to its granularity, previously employed in studies on accessibility (Borzacchiello et al., 2010) and economic and human activity at neighbourhood scale (Serrano-Estrada et al., 2022). After establishing the reference grid, the number of activities (density) and the variety of categories (diversity) in each cell were quantified. These parameters were then visualised using a colour scale, allowing for a comparative analysis of the activity location and the diversity of its surroundings.

2.2.5. Spatiotemporal presence patterns

To examine the spatiotemporal presence in the area of study, a dual analysis was conducted: firstly, the progression of tweets was depicted in a quantity-time graph across the week and throughout each day; secondly, tweets were mapped according to the designated time periods, differentiating between weekday and weekend activities, and morning, afternoon or evening periods. The first analysis facilitated an understanding of people flow dynamics within the area of study, while the second identified location patterns where a certain number of people are present at various times during the day and week.

3. Results

3.1. Quantification and spatial distribution of the data for the municipality and the coastal strip

Table 1 displays the number of entries by category and time slot in the Google Places and Twitter databases for both cities. This initial quantification reveals that Balneário Camboriú has over three times the Google Places data economic and urban activities and twice the Twitter data compared to Benidorm. However, it is remarkable that for such a significant difference, the proportion of Shop and Services activities is predominant in both areas, indicating similarities in their tourism models. Food is the second most relevant economic activity for Benidorm and Professional Activities and Other Places for Balneário Camboriú. The categories in Benidorm that outnumber Balneário Camboriú in terms of relative percentage are Arts and Entertainment, Transport and Tourism and Nightlife.

The Twitter data, segmented in time periods, reveal notable differences in terms of citizen activity between Benidorm and Balneário Camboriú. Greater activity is observed during the morning in Benidorm and during the afternoon and evening in Balneário Camboriú, both on weekdays and at weekends, despite a lower proportion of nighttime leisure activities in the latter.

Table 1. Number of Google Places and Twitter data by category for both case studies (municipal scale).

	Benidorm	**%**	**Balneário Camboriú**	**%**
Google Places Total	4665	100.0%	14,792	100.0%
Arts and Entertainment	35	0.8%	103	0.7%
College and University	5	0.1%	63	0.4%
Food	1102	23.6%	1700	11.5%
Nightlife	64	1.4%	53	0.4%
Outdoors and Recreation	59	1.3%	245	1.7%
Professional and Other places	558	12.0%	2652	17.9%
Shop and Services	2396	51.4%	9206	62.2%
Travel and Transport	446	9.6%	770	5.2%
Twitter Total	395	100.0%	832	100.0%
Weekdays | Morning	119	30.1%	98	11.8%
Weekdays | Afternoon	81	20.5%	167	20.1%
Weekdays | Evening	39	9.9%	192	23.1%
Weekends | Morning	50	12.7%	51	6.1%
Weekends | Afternoon	72	18.2%	167	20.1%
Weekends | Evening	34	8.6%	157	18.9%

As for the spatial distribution (**Figure 4**), while both municipalities exhibit economic and urban activity across most urban areas, there are notable concentrations along the coastline and some main axes in both case studies. In Benidorm, there is a significant concentration of economic and urban activity along the coastline and inland, especially in the central part, from the traditional town centre to the tram station and, to a lesser extent, towards the Levante extension. This pattern highlights areas where building typologies facilitate ground-floor urban activity. In Balneário Camboriú, economic and urban activity is widespread, covering practically the entire municipality, with heightened intensity along the axes parallel to the coast. Contrasting with economic and urban activity, citizen presence, inferred from tweet locations, is concentrated in specific areas or points within the municipalities, notably the coastal strip, aligning with zones of intense economic and urban activity and certain tourist landmarks in both cases.

In areas beyond the coastal strip, tweet presence in Benidorm is noted at locations like the tram and bus stations, Illa de Benidorm Sports Palace, Guillermo Amor Municipal Stadium, La Aigüera Park, Mirador de la Cruz, and KU Discotheque. In Balneário Camboriú, tweet concentrations are tweet concentrations are found around UNIAVAN private university, Vale do Itajaí University, Centro Comunitário João

Gerônimo Vicente, Mirador Cristo Luz, Rodoviária de Balneário Camboriú (train station), and the 'Balneário Shopping' shopping centre.

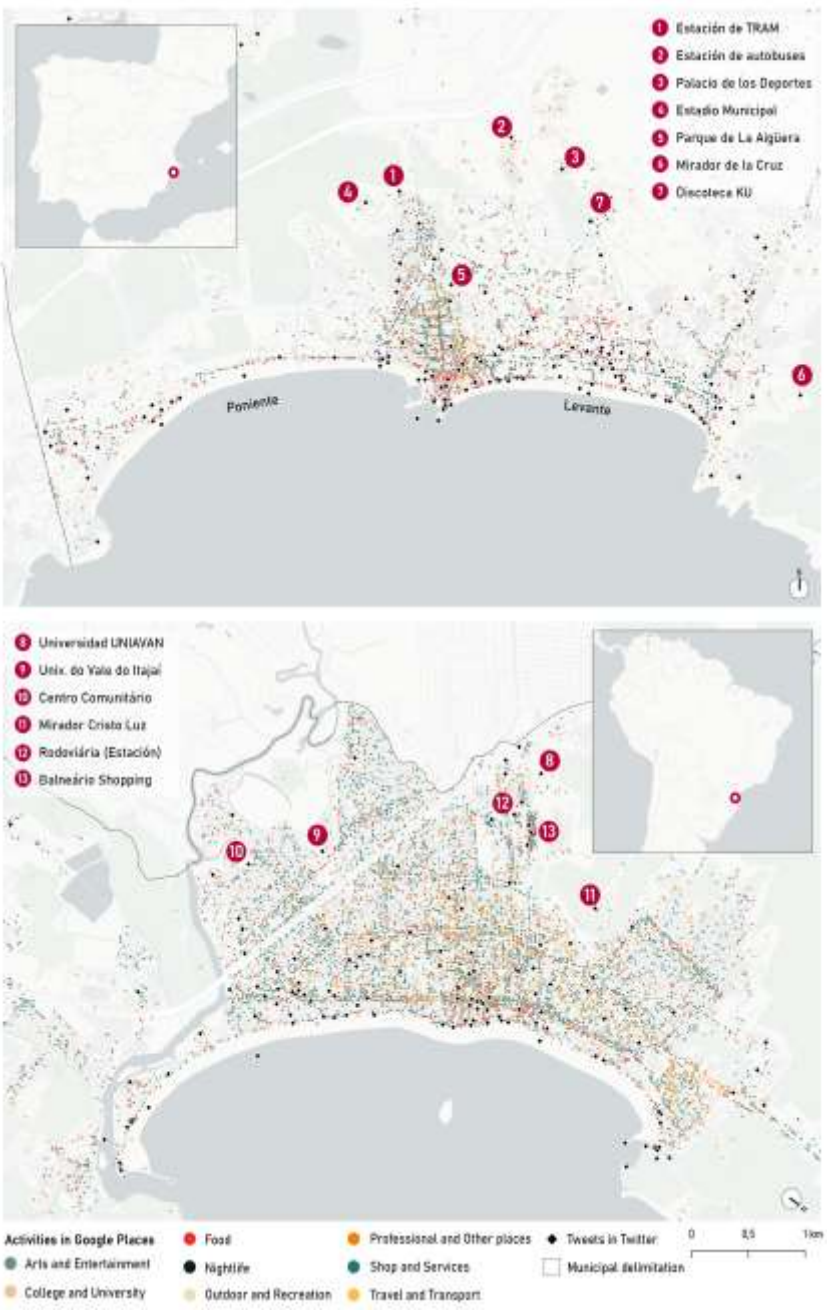

Figure 4. Geolocated Twitter and Google Places data by type of urban or economic activity in Benidorm (top) and Balneário Camboriú (bottom).

Focusing on the coastal strip data, it is notable that this area concentrates half of the economic and urban activity in the case of Benidorm (**Table 2**) including 60% of the Food-related registers and 50% of the municipality's Shop and Services. Likewise, this area also concentrates around 45% of the activity related to Travel and Transport (a category which includes hotel activity and 48% of Nightlife). The rest of the categories are less represented in this area.

Table 2. Number of Google Places data in the coastal area compared to the rest of the municipality of Benidorm.

Category	Municipality data	Data within 500 m of the coast	Percentage difference
Arts and Entertainment	35	12	34.3%
College and University	5	1	20.0%
Food	1102	678	61.5%
Nightlife	64	31	48.4%
Outdoors and Recreation	59	18	30.5%
Professional and Other places	558	211	37.8%
Shop and Services	2396	1288	53.8%
Travel and Transport	446	207	46.4%
Total	4665	2446	52.4%

In Balneário Camboriú, the coastal strip accounts for only 38% of the economic and urban activity (**Table 3**) but there is a greater variety in the offer. Predominant activities in this area are Arts and Entertainment, with a representation of 56%, and Food with 45%. Outdoors & Recreation activities, with 37%; Shop and Services, 37%; and Professional activities (which are the most relevant at the municipal level) are also represented in this area with 32%. Similar to Benidorm, this area concentrates 48% of places within the Travel and Transport category, including hotels.

Table 3. Number of Google Places data in the coastal area compared to the rest of the municipality of Balneário Camboriú.

Category	Municipality data	Data within 500 m of the coast	Percentage difference
Arts and Entertainment	103	58	56.3%
College and University	63	10	15.9%
Food	1700	760	44.7%
Nightlife	53	16	30.2%
Outdoors and Recreation	245	91	37.1%
Professional and Other places	2652	849	32.0%
Shop and Services	9206	3400	36.9%
Travel and Transport	770	372	48.3%
Total	14,792	5556	37.6%

In the case of Twitter, 70% of the tweets registered in the municipal area of the two cities are concentrated in the first 500 m of the coastline. This suggests a higher people presence in this area in both Benidorm and Balneário Camboriú (**Table 4**), despite differences in the quantity and types of urban and economic activities available. Specifically, while in the first case, it is more common to find messages during the evening, approximately 90% of tweets are shared both on weekdays and weekends–, in the Brazilian city the morning slot during weekends stands out. Even so, between 60% and 70% of the tweets recorded for all time slots are located in areas closely linked to the coastline.

Table 4. Twitter data in the coastal area compared to the rest of the municipality of Benidorm and Balneário Camboriú.

Time slot	Municipality data	Data within 500 m of the coast	Percentage difference
Benidorm			
Weekdays | Morning	119	74	62.2%
Weekdays | Afternoon	81	55	67.9%
Weekdays | Evening	39	36	92.3%
Weekends | Morning	50	33	66.0%
Weekends | Afternoon	72	54	75.0%
Weekends | Evening	34	30	88.2%
Total	395	282	71.4%
Balneário Camboriú			
Weekdays | Morning	98	73	74.5%
Weekdays | Afternoon	167	116	69.5%
Weekdays | Evening	192	142	74.0%
Weekends | Morning	51	44	86.3%
Weekends | Afternoon	167	121	72.5%
Weekends | Evening	157	115	73.2%
Total	832	611	73.4%

3.2. Density and diversity of urban and economic activities

The analysis of urban and economic activity using the reference grid has identified specific axes and areas with higher density and/or diversity in economic activities. In Benidorm, the central coastal strip area is notably dense in activities (**Figure 5**). Specifically, the axes where more activities are concentrated per grid cell are the pedestrian street Pg. de la Carretera up to Plaça de la Creu at its intersection with Avenida de Ruzafa, and nearby axes like Calle Tomás Ortuño, Avenida de los Almendros or Calle de Santo Domingo. Other central areas, such as around Plaça Constitució, also show occasional activity clusters. Outside the city centre, it can be observed that the Levante area is more active than Poniente. Notably, sections of Avenida del Mediterráneo and Calle Gerona show increased activity density linked to commercial areas and/or galleries located on exclusive plots or ground floors of residential buildings. Along the coastline, activity continuity is observed on seafront promenades, but these are not areas with a significant density, with between one and three activities per cell. However, when comparing activity density with diversity, it can be observed that the densest areas hardly include more than two establishments of different categories. For example, in the central area, where many of the grid cells included between five and ten activities, there are only one or two types of activity (Shop and Services and Food) – with the exception of some activity nodes where there are three or four categories per cell, such as in the area around Plaça de la Creu or the Municipal Market.

In the case of Balneário Camboriú (**Figure 6**), similar patterns to Benidorm are observed. Firstly, the urban centre, particularly between Avenida de Brasil and 3rd

Avenue, shows higher activity density. Avenida de Brasil maintains a significant density along practically its entire length, with some commercial nodes standing out. Secondly, on the coastal strip, Avenida Atlántica maintains a low density (one or two activities per cell) except in the section that runs through the urban centre, where the number of activities increases moderately. Regarding the diversity of activities, some scattered cells have up to four categories. In the urban centre, except for some specific areas, most cells have one or two activities related to Shop and Services and Food, as well as Professional and Other places, standing out. This is repeated in the rest of the coastal strip to a significant extent. The greatest diversity is found in areas and axes with the highest density, such as Avenida de Brasil, at the segment running along the urban centre. The coastal area, despite continuous activity density, shows limited functional diversity, with establishments mostly linked to tourism.

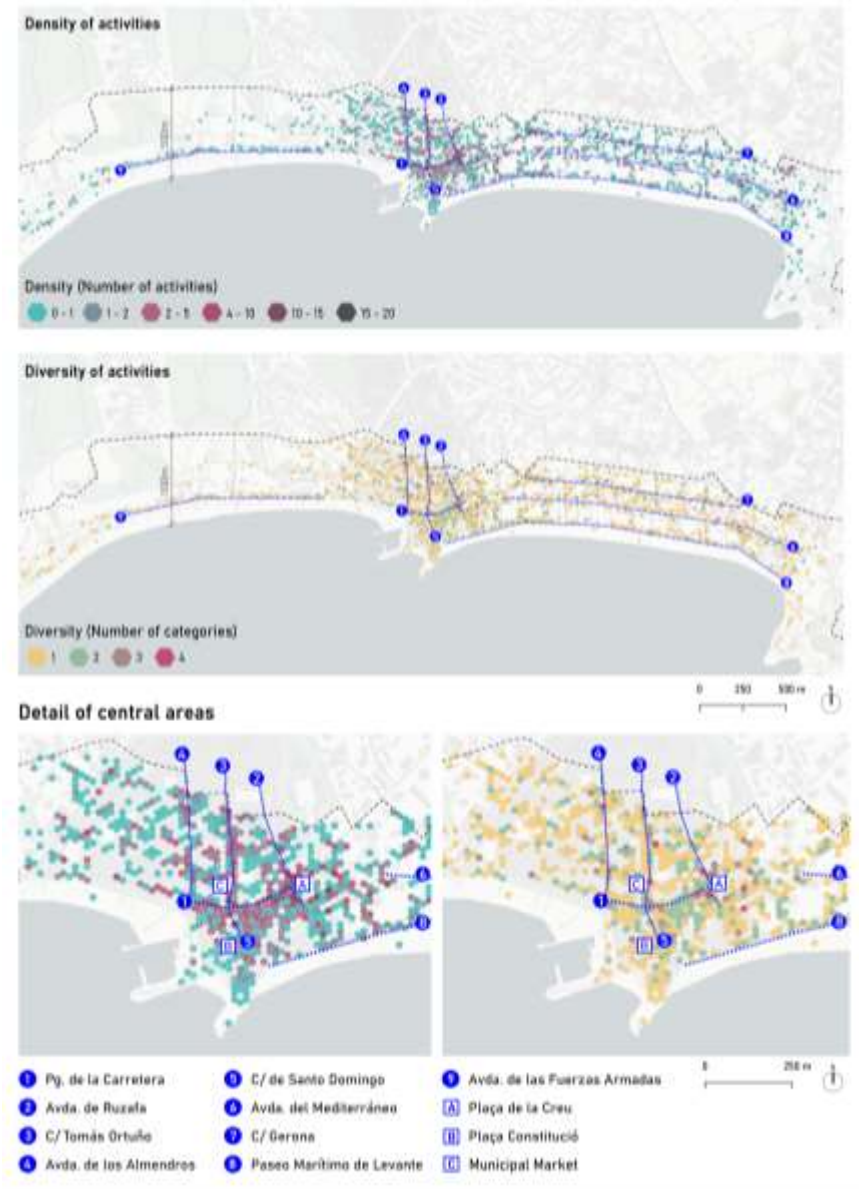

Figure 5. Hexagonal grid with the number of activities (top) and different categories of urban and economic activity (middle) per cell in Benidorm with details of central areas (bottom).

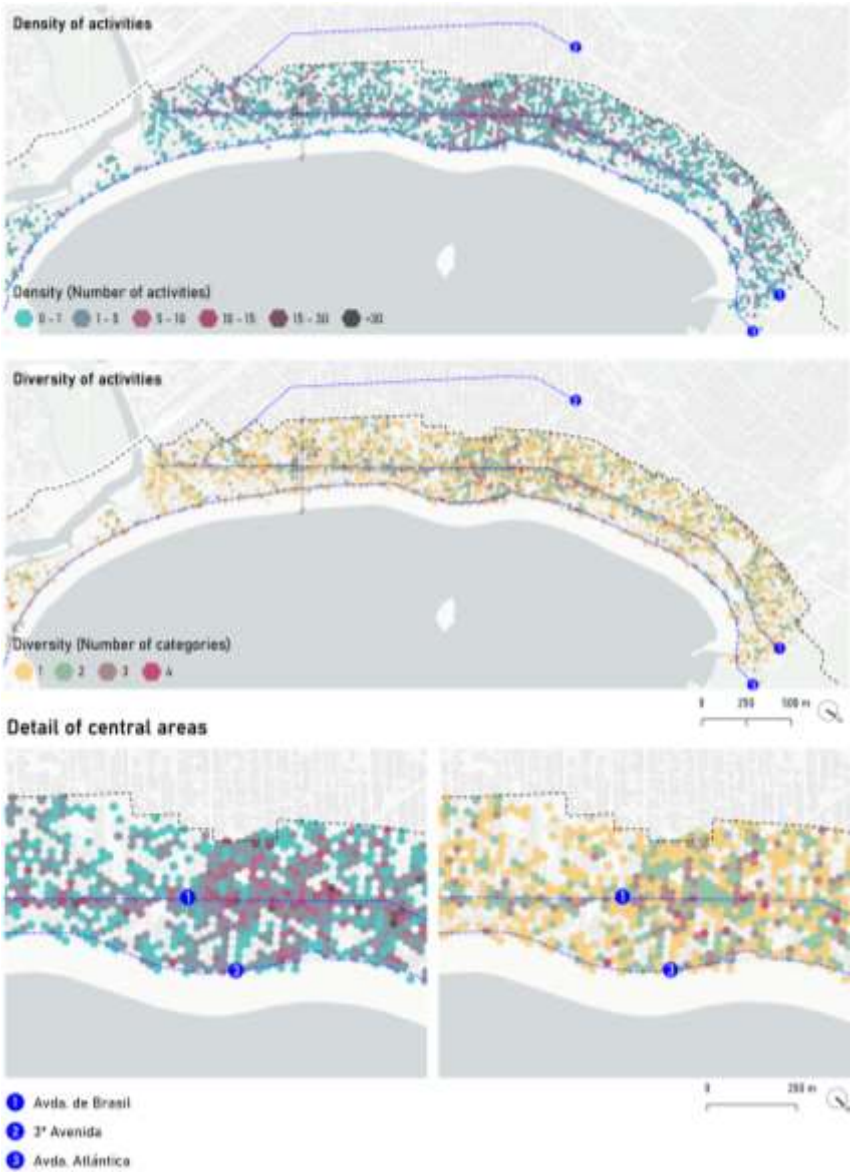

Figure 6. Hexagonal grid with the number of activities (top) and different categories of urban and economic activity (middle) per cell in Balneário Camboriú with details of central areas (bottom).

3.3. Spatio-temporal patterns of human presence

The analysis of temporal dynamics in the coastal strip based on Twitter messages, reveals distinct patterns (**Figure 7**). In Benidorm, presence is steady at the beginning and end of the week, with a drop between Wednesday and Thursday. As for the evolution throughout the day, the influx varies, peaking in the early morning, mid-morning and afternoon-evening. Moreover, while during the morning and from midday to late afternoon the flow is constant, during the night and early morning hours the activity is practically non-existent.

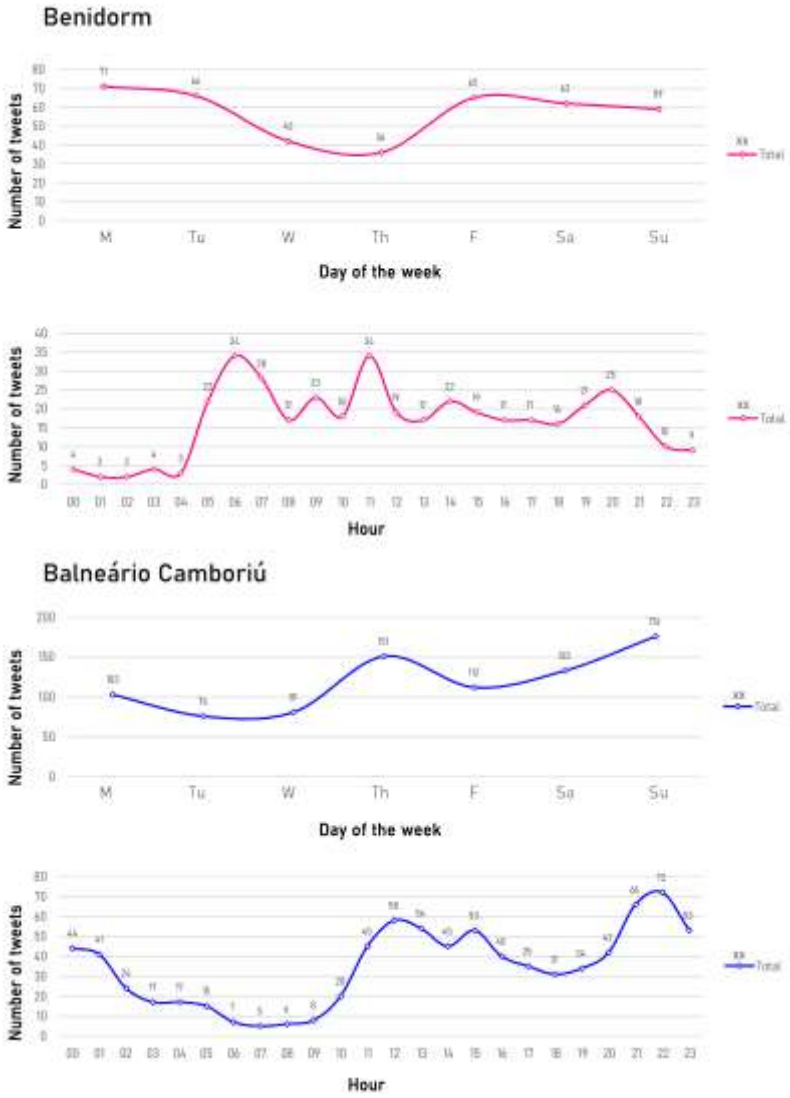

Figure 7. Temporal evolution of the number of tweets per week and per hour throughout the day in the months considered (summer period).

In Balneário Camboriú, the trend throughout the week is the opposite of Benidorm, with a progressive decrease at the beginning, a significant increase in the middle of the week and a progressive increase from Friday to Sunday. The daily people flow is smoother, starting mid-morning, peaking at midday, then gradually decreasing until 18:00, followed by a rise in the afternoon-evening around 22:00, and remaining active until the early morning, with a slight decrease after that.

Finally, regarding tweet location patterns (**Figure 8**), there are notable differences between the two cases analysed. In Benidorm, the area of the historic centre where Plaza Castelar, Plaza Santa Ana, and the Balcón del Mediterráneo—an important tourist landmark in the city are located, activity is identified in all weekday and weekend slots. The Levante seafront promenade, especially in nightlife-rich areas and along axes like Av. de Mallorca and Av. de Filipinas, also shows significant tweet presence. Other tweets, more scattered, are linked to hotels, pubs/restaurants, or public spaces in the city centre, with the former more active during the week and the latter

on weekends. A notable tweet concentration is observed at a central location on the Poniente promenade.

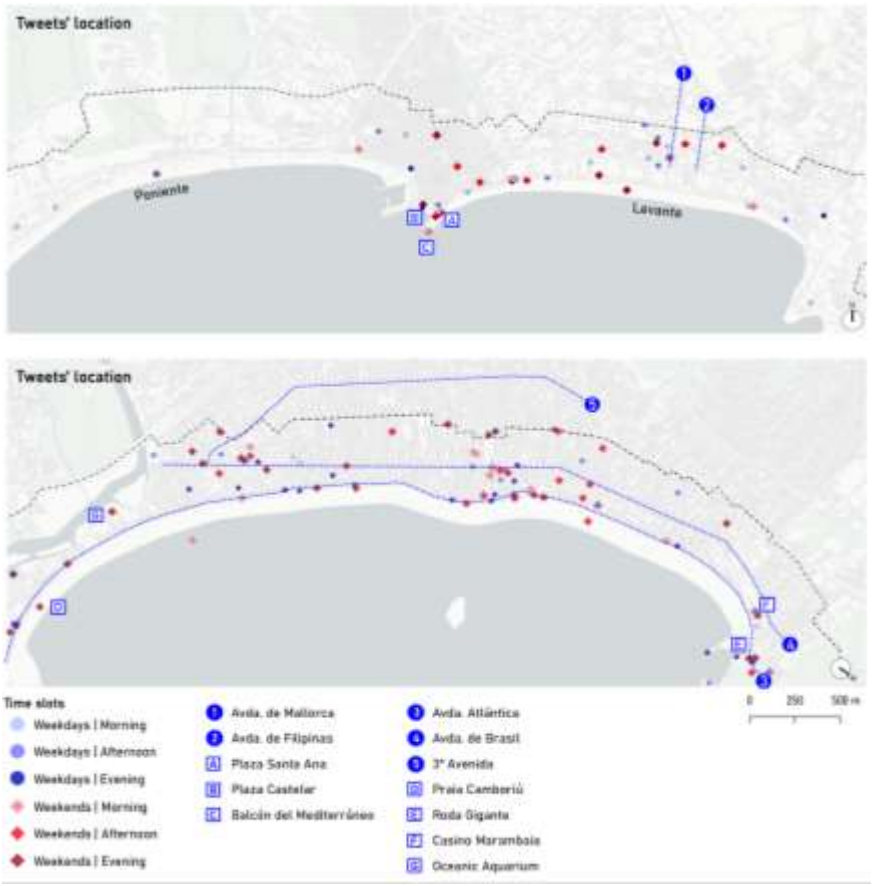

Figure 8. Location of tweets by time slot in Benidorm (top) and Balneário Camboriú (bottom).

In the case of Balneário Camboriú, the presence of tweets is more widely distributed along the coastal strip than in the case of Benidorm. Particularly noteworthy is the presence of people at weekends on axes such as Avenida Atlántica and Avenida Brasil as they pass through the city centre and their intersection with 3rd Avenue to the south, where activity is also identified during the week, especially in the afternoon and evening. The coast is also a relevant environment at several points, especially in those places linked to tourist activity, such as Praia de Camboriú or Roda Gigante. Other leisure activities such as the Casino Marambaia or the Oceanic Aquarium also concentrate activity on weekends. The rest of the tweets are linked to hotels or commercial areas.

4. Discussion

Prior research indicates that coastal tourist destinations like Benidorm, possess key attributes contributing to urban sustainability, notably the density and variety of urban and economic activities (Nolasco-Cirugeda et al., 2020; Soares et al., 2015). These factors significantly influence citizen presence and urban life, enhancing the competitiveness of tourist destinations. This study, through a comparative analysis of quantity and diversity of urban and economic activities and the spatio-temporal

patterns of citizen presence in Benidorm and Balneário Camboriú, based on data from Google Places and Twitter, yields insights beneficial for decision-making to improve social and economic sustainability in coastal sun-and-beach tourism environments. This approach aligns with the study conducted by Robertson, et al. (2023) whose objective was to introduce a metric and an associated interpretation of urban complexity relying on commercial amenities. Such an initiative established a foundation for innovative analyses concerning the origins and impacts of urban transformations, urban policies, and the welfare of inhabitants.

A primary finding is that, despite a certain density of economic and urban activities within the first 500 m from the coastline, there is limited diversity in their offer. In areas with the highest economic activity density, only four of the eight activity types considered in this study are present, with commercial activity, restaurants, and tourist accommodations being predominant. Benidorm is notable for its significant nightlife offer, whereas Balneário Camboriú features numerous professional activities. This highlights two distinct models of tourist cities: In Benidorm, tourism is the primary economic driver, while in Balneário Camboriú, tourism complements other local activities. This study aligns with Soares et al. (2015) in advocating for a balance between tourism-oriented economic activity and local needs, and diversification of the offer more effectively achieved in Balneário Camboriú as key to promoting sustainable tourist cities. Ensuring year-round activity and presence of people, not just during peak months, is crucial for maintaining active local economies.

Regarding the location of urban and economic activities, it's observed that activity is not concentrated in the first line closest to the coast but rather in the "second line", parallel to the seafront in both cities Avenida del Mediterráneo in Benidorm and Avenida de Brasil in Balneário Camboriú. These axes have higher establishment densities but are not the most diverse. Even in these sun-and-beach tourist cities, urban centres exhibit a higher ratio of activity number to diversity. In Benidorm, the urban centre coincides with the historic centre, where pedestrian streets and squares are the densest and most diverse activity nodes, highlighting the importance of public space in Mediterranean cities' historic fabric (Martí et al., 2017).

These are compact urban areas whose building typology makes it possible to accommodate activities on the ground floor, while maintaining a uniformly distributed residential density, unlike the isolated tower buildings in the urbanisations of the urban extensions, which have a higher proportion of open spaces. Identifying the concentration of activities on the ground floor in central areas supports, in agreement with Rueda Palenzuela et al. (2022), the notion that such configurations contribute to urban diversity and vitality. In Balneário Camboriú, where the limits of the urban centre are more diffuse due to the continuity of the fabric, it is the axes parallel to the coast, and specifically the areas close to the centre, that concentrate activity. Similar to Benidorm, activity density is favoured in certain areas, with commercial premises often located on the ground floors of residential towers or annexed buildings (**Figure 9**). Buildings exclusively residential or predominantly tourist accommodations do not encourage economic and urban activity proliferation, leading to a decrease in establishments within the urban fabric. Numerous studies have demonstrated that tourist-oriented structures, exemplified by Airbnb, exert a significant influence on economic growth (Ioannides et al., 2019; Perez-Sanchez et al., 2018). Although high-

rise buildings could facilitate activities on upper floors, increasing density and diversity, most premises are on the ground or first floors.

Figure 9. Examples of axes with high density and diversity on the ground floor of high-rise buildings in Benidorm (top) and Balneário Camboriú (bottom).

The presence of people is concentrated in each municipality's most touristic areas, like beaches, landmarks, or accommodations, confirming the importance of these spaces in attracting people. However, the relationship between economic and urban activities (Google Places data), and citizen presence (tweets) is not as evident in Benidorm as in other less singular tourist contexts (Martí and Serrano-Estrada, 2022). In Balneário Camboriú, some correlations are observed between tweet concentrations, especially on weekends, and dense, diverse urban and economic activity areas in the urban centre and along the coastline. This spatio-temporal method, utilizing Twitter data, adds to the broader methodological approaches that numerous other researchers have developed over decades (Sun et al., 2020).

This research suggests methodological directions and potential research avenues. Firstly, using geolocated Twitter data during high-demand periods helps identify spaces representative of specific social activities; for instance, tweets in shopping centres in Balneário Camboriú or urban axes in Benidorm with numerous restaurants and nightlife establishments. Secondly, as only tweets whose geolocation is shared

voluntarily are available, the complete picture of people's presence in the cities is limited. Extending the period for obtaining geolocated Twitter data for more representative diagnoses, or adopting complementary sources like Foursquare and Instagram, could enrich conclusions. Thirdly, once a general diagnosis has been obtained on a municipal and coastal strip scale, a detailed analysis of existing urban and economic activities in even more specific areas is considered as a future line of work. This aims to identify deficiencies in certain activity types in selected axes and public spaces and to design proposals to improve the diversity of the offer on a micro-scale basis.

5. Conclusions

In conclusion, the comparative analysis of Benidorm and Balneário Camboriú, focusing on economic quantity, diversity, and spatio-temporal patterns of citizen presence using social media data (Google Places and Twitter), provides valuable insights for enhancing social and economic sustainability in coastal sun-and-beach tourism environments. The study reveals distinctive models of tourist cities, with Benidorm relying primarily on tourism as its economic driver, while Balneário Camboriú integrates tourism with other local activities. The importance of balancing tourism-oriented economic and urban activity with local needs and diversifying offerings is emphasised, particularly evident in Balneário Camboriú.

Notably, the study highlights that economic and urban activities in both cities are not concentrated on the immediate coastline but are more prominent in parallel axes. Urban centres, particularly in Benidorm's historic centre and Balneário Camboriú's central areas, emerge as dense and diverse activity nodes, underscoring the significance of public spaces in Mediterranean cities' historic fabric (Bernabeu-Bautista et al., 2023).

The compact urban areas, with ground-floor activities and a uniformly distributed residential density, contrast with the isolated tower buildings in urban extensions, which have more open spaces but lower economic activity proliferation. Balneário Camboriú's diffuse urban centre sees activity concentration in parallel coastal axes, emphasising the need for balanced development. While high-rise construction could increase activity density, the study notes that most premises, accommodating commercial activities, are on the ground or first floors. Indeed, the findings highlight the importance of promoting year-round activity and citizen presence to sustain local economies, advocating for a balanced approach between tourism and local needs.

All in all, this research contributes valuable insights into the dynamics of coastal tourist cities, offering a foundation for future urban planning and policymaking aimed at achieving a sustainable balance between tourism and local life. The findings underscore the importance of economic diversity, spatial distribution of activities, building typology, and the balance between tourist and local needs in shaping sustainable urban environments.

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