From overtourism to overall-mobility

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A B S T R A C T

Drawing from the New Mobility Paradigm, tourist cities embody more complexity than mere dichotomies of 'hosts' versus 'guests.' They are the result of multiple users of urban space overlapping in a highly mobile and hyper-nomadic society. By combining mobile positioning-based data, various official surveys, and the interpolation of census data, this article measures the relative weight of the different users of the city of Barcelona in 2019 and their distribution both temporally and spatially. Results indicate that the absolute value of different types of visitors is much higher than official data suggest, but their relative value is conditioned by the high volume of other forms of mobility. The tension between users generates very diverse spatial responses, ranging from coexistence to exclusion.

1. Introduction

Cities have been places where people from many nations and cultures have met and settled together, while population flows and density have had a significant impact on urban dynamics (Nuvolati, 2003). Several cities – following a top-down fashion - have revitalized historic areas, such as by reshaping and restoring former industrial areas for cultural activities, shopping, and loft living, building iconic attractions in spectacular and monumental redesigned buildings, and planning major events in their communities (Freytag & Bauder, 2018). The high density of social, cultural, and business amenities, alongside everyday services not specifically designed for tourists, attracts a diverse range of city users who interact with locals (Bock, 2015). This interaction, facilitated by the coordination of city rhythms and community porosity, shapes their urban experience (Amin & Thrift, 2002).

From one side, recent literature focuses on the shift in urban tourist experience from 'having' a holiday through 'doing' activities to 'becoming' a local, by experiencing a part of daily life with transformative effects, and in time coming to seen as an integral part of it (Maitland, 2010). On the other hand, there is a debate on the 'tourististification of everyday life' (Franklin, 2003: 206), where middle- and upper-class urban dwellers display attitudes and behaviors that are virtually indistinguishable from those of visitors, acting 'as if tourists' (Ferreira, Silva, & Loureiro, 2020; Judd, 2003; Novy, 2018), visiting attractions and enjoying the same activities. With the advent of globalization, modern society has undergone a radical transformation that has altered mobility patterns within it, blurring the boundaries between

tourism and everyday life, work and leisure, and "hosts" and "guests" (Moscardo, Konovalov, Murphy, & McGehee, 2013; Novy, 2018). Additionally, the presence of other 'temporary city' users, such as commuters, digital nomads, international students, second home owners, and migrants (Cocola-Gant & Lopez-Gay, 2020; Huete, Mantecón, & Estévez, 2013), contributes to a more complex transformation of tourist cities.

Traditional locality is replaced by new processes of constructing and producing locality, stretching out as it adapts to a range of mobilities interconnected across spaces (O'Regan, Salazar, Choe, & Buhalis, 2022). The complexity in understanding urban transformation as well as the increasing coexistence between various types of city users has resulted in a number of conflicts (Nuvolati, 2003) related to space occupation, including gentrification processes in some areas and marginalization of expelled residents to peripheral areas (López-Gay, Andújar-Llosa, & Salvati, 2020; Maitland, 2010; Mendoza & Russo, 2022), accessibility to available resources and services (Moscardo et al., 2013), cultural conflicts over how to maintain the local place-based identity (Nilsson, 2020), a growing polarisation of the population, and fiscal conflicts relating to tax payment. With every conflict, accusations and self-defenses are exchanged, and in order to identify the main factor responsible, two concepts have been identified, touristification and overtourism.

Touristification or the re-qualification of space so as to meet the tourist industry's interest, has been highly investigated (Freytag & Bauder, 2018; Novy, 2018), focusing on the management of place transformation. Overtourism, on the other hand, describes how the

impact of tourism is spiraling out of control (Koens, Postma, & Papp, 2018), particularly through the use of platform like Airbnb (Mendoza & Russo, 2022; Nilsson, 2020) and leading to perceived social density or overcrowding, exceeding physical carrying capacity of a destination, and subsequently to a negatively perceived quality of citizen life and/or visitor experience (Goodwin, 2019; O'Regan et al., 2022; Papadopoulou, Ribeiro, & Prayag, 2023). The excessive influx of tourists has shifted the discourse from 'host' and 'guest' to 'victim' and 'villain' (O'Regan et al., 2022). However, this binary view is misleading as it overlooks the dynamic and heterogeneous nature of city users (Bauman, 2000; Novy, 2018; Quinn, 2007; Sheller & Urry, 2006; Zillinger, 2007).

In considering urban boundaries and tourism's impact on urban and territorial dynamics, a complex methodological challenge is raised in terms of measuring the spatial and temporal behavior of visitors and relating it to the behavior of the rest of the 'users' of the city. This article aims to estimate the significance of various city visitor categories by combining census data, survey data, and mobile phone data (Panczak, Charles-Edwards, & Corcoran, 2020). Thus, the article aims to measure the volume of all forms of users in a city, including unobserved tourism (De Cantis, Parroco, Ferrante, & Vaccina, 2015), day-trip tourists, and excursionists, and to calculate the behavior of these visitors over time (daytime) and in space (districts). The analysis has been carried out in the city of Barcelona, which is one of the urban spaces most strained by the rapid growth of tourism over the past two decades and by the extreme concentration of tourist flows within a confined area (Cocola-Gant & Lopez-Gay, 2020).

2. Literature review

2.1. The good old 'New mobilities paradigm'

About two decades ago, Sheller and Urry (2006) proposed a new paradigm in social sciences related to the study of the behavior of different city users over time and space. The New Mobility Paradigm combined the speed and intensity of various current flows – be they people, ideas, information, images, objects or capital and a broader theoretical project that reaches beyond fixed geographic containers (Gustafson, 2009) or movement typologies like physical, virtual, imaginative, social and cultural (Büscher & Urry, 2009; Moscardo et al., 2013).

Understanding mobility and its constellations basically refers to identifying its various facets, being the motive force (voluntary or enforced movement), velocity of movement, frequency and duration of mobility or immobility, route, experience, friction to movement, place attachment (Cresswell, 2011; Moscardo et al., 2013) in association with phenomena like tourism and migration, as well as the blurred distinctions between residents and visitors. Related research in tourism has focused primarily on the lifestyle and consumption styles of the population, with the objective of detecting population mobility styles (Dang & von Arx, 2021) and tourist movement patterns (Zhao, Lu, Liu, Lin, & An, 2018; Zheng, Huang, & Li, 2017). These patterns are primarily based upon time and space variables (Miller, 1991; Hall, 2005), constituting Hägerstrand (1973) time geography, to assist in more effective tourism management decisions, from transport development to destination planning (Ferreira et al., 2020). Time and space parameters like short-term vs. long-term, one-off vs. seasonal, circular vs. ongoing, single vs. multiple localities (Carson, Carson, & Lundmark, 2014) have been constructed to categorize movement patterns and assist research.

Spatial mobility, which refers to the connections between different places as well as the relationship between the origin and destination of the tourists, was firstly concerned with inter-destination movements (Raun, Ahas, & Tiru, 2016; Zheng et al., 2017; Zillinger, 2007) and later on with intra-destination ones (Kang, Ma, Tong, & Liu, 2012; Zhao et al., 2018). It analyzes the uneven distribution of travel possibilities based on economic time factors, including seasons, days of week, and time of day (Freytag & Bauder, 2018), relation between traveled distance and

numbers of visiting days or first visiting day vs. the rest (Zillinger, 2007), tourist spatial flow in terms of circulation, direction and centrality (Chua, Servillo, Marcheggiani, & Moere, 2016), the variations of tourist flows during a day (Chua et al., 2016; Kang et al., 2012; Xu, Li, Xue, Park, & Li, 2021), the influence of party size of visitors (Zhao et al., 2018) as well as the spatial separation between clusters of visitors based on their number and size (Brandajs & Russo, 2021), urban morphology (Kang et al., 2012), urban proximity (Marquet & Miralles-Guasch, 2015), focusing on the locations of tourist sites, such as remote areas (Carson et al., 2014) or tourist districts in the center (Freytag & Bauder, 2018) and their distance from tourists' residence location in an intra or inter level (Sugimoto, Ota, & Suzuki, 2019; Zhao et al., 2018), also known as the distance decay effect, where the shorter the distance from the starting location, the better.

Within the New Mobility Paradigm, spatial mobilities should be understood in relation to emotional geographies (Yang, Yao, Ding, Tan, & Ran, 2019), in which the city user senses place and movement through experiences and performances as an affective vehicle. Some sites reflect higher attractiveness and invite more interest and thus time spent, such as cultural heritage attractions vs. theme parks and landscapes (Zhao et al., 2018), or walkable urban environments (Usang & Muslim, 2014). Tourists upon moving, they create various links with several places as they interact with a wider spectrum of contexts (Nuvolati, 2003), while taking multi-destination trips such as round tours (Zillinger, 2007), or choosing to visit some more frequently than others (Kang et al., 2012), based on the number and/or quality of additional activities offered in these sites (Orama, Huertas, Borràs, Moreno, & Anton Clavé, 2022; Sugimoto et al., 2019).

Tourists' temporal and spatial movement patterns are, however, influenced by residents' patterns, emphasizing the importance of understanding the interdependence between city users. Residents and tourists perform similar activities in the city, such as eating, but their behavior varies in terms of time and space (Ferreira et al., 2020). It was found in Barcelona, for example, that residents were more present than tourists in central gastronomic establishments during the evenings, but not in the mornings (also confirmed in Venice by Quinn, 2007) or in less attractive tourist areas (Brandajs & Russo, 2021), whereas residents in Paris are willingly sharing touristized areas with visitors (Freytag & Bauder, 2018). Additionally, residents and short-term travelers tend to travel more on weekdays than on weekends, and residents contribute a higher number of trips than short-term travelers and transfer trips combined (Yang et al., 2019). Another factor that determines tourists' and residents' city paths through time and space is technology. Applications tailoring routes and itineraries to tourists' individual preferences and budgets (Ferreira et al., 2020) reduces the 'information divide' (Bock, 2015: 14), in which locals have an advantage in knowing what is happening in their city (Novy, 2018).

Therefore, it is imperative to understand the mobility patterns of all city users. The temporal rhythms of flows are crucial, as movements follow specific, time-dependent patterns. For instance, in Shanghai, both residents' and tourists' mobility peaks vary on weekdays and weekends, with inner-city movements intensifying around midday (Jiang, Chen, & Zhang, 2021; Xu et al., 2021). In Chongqing, Zheng, Xia, Chen, and Sun (2019) observe that commuters leave home in a concentrated manner in the morning, whereas their return journeys are more staggered, a dynamic that Plyushteva (2021) further explores in nighttime commuter mobility in Brussels. In cities like Barcelona, residents are willing to travel longer distances for work but seek shorter travel times for everyday tasks, such as shopping (Marquet & Miralles-Guasch, 2015). In contrast, studies in Rio de Janeiro reveal a tendency for residents to travel further distances compared to tourists, mainly due to the city's size (Ferreira et al., 2020). In addition, Xu et al. (2021) further discuss the "metabolic rate" in tourism flows, reflecting how cities absorb and emit travelers, complicating the calculation of real users of city services.

Despite extensive research on the spatial patterns of mobile groups (tourists, commuters, day-trippers) and their urban impact, few studies

address the complex interaction between these mobile "users" and their simultaneous coexistence with residents. This article analyzes the volume, spatial distribution, and temporal rhythms of different city users in Barcelona, where residents, tourists, metropolitan flows, commuters, and day-trippers converge, highlighting how these diverse groups shape and share the urban space.

2.2. Sociotemporal population modeling

Traditionally, spatial distribution representations of the population and its components have relied on static data within fixed geographical boundaries (Martin, Cockings, & Leung, 2015). However, people usually travel to training centers, offices and work centers, shopping malls, sporting events, protest rallies, worship centers or parks and open spaces. This distance between the theoretical population and the effective population (Rigall-i-Torrent, 2010) has affected risk and emergency management, transportation management, public services or the supply of private goods. For this reason, efforts to measure the spatio-temporal behavior of the population have a long tradition, which has given rise to shared methods and a common ontology.

Panczak et al. (2020) have carried out a comprehensive review of the literature on temporal population estimation. There is no single measurement formula, as it depends on both the available data and the geographical context, as well as the research questions that are being addressed. In essence, there are three main method families. The earliest approaches utilize census data to infer population distribution by comparing residential locations with the locations of schools and workplaces. These methods estimate population flows based on the assumption that such flows are primarily driven by mandatory displacements. These estimates consider that the flows are essentially explained by forced displacements and represent them in a grid, with variable intensities according to the users of each cell for each temporal unit. Bhaduri, Bright, Coleman, and Urban (2007) enhanced the LANDSCAN model by including non-mandatory flows, such as those from tourists and business travelers, to refine the estimates of users in each grid cell. This approach relies on weighted values for each cell rather than direct empirical measurements. This method has been used by Jochem et al. (2013) to estimate the floating population per time unit at airports and cruise terminals. Jochem et al. (2013) applied this method to estimate the floating population per time unit at airports and cruise terminals.

The second group of methods consists of surveys of users concerning their patterns of use of space and time. This method enables us to identify the characteristics of mobility (origin and destination, means of transportation, average time, frequency, motivation) and relate them to sociodemographic factors. For example, Collins and Greaves (2007) have used this method to estimate the impact of an emergency or pollution exposure in Sydney. These models can also be used to understand travel behavior for leisure reasons, as in the case of Happel and Hogan (2002) for snowbirds, the flows of residential tourism from colder to warmer areas during winter. This direct method can be combined with the use of symptomatic variables, which collect variations in certain services (water, energy…), as proposed by Rigall-i-Torrent (2010). The primary issue stems from the fact that the average energy and water consumption, as well as waste generation, of a visitor far exceeds that of a resident.

In recent years, mobile data records have made a new methodological contribution. The use of mobile position data is one of the most used tools to understand spatio-temporal behavior of the mobile population, since it facilitates extensive coverage, both spatial and temporal. Despite its limitations (the density of the triangulation mesh, the degree of use of mobile phones, the difficulty of accessing the data), this method allows obtaining effective data on the use of space. It has been applied by Eesti Pank (the central bank of Estonia) since 2008 to calculate the national balance of payments and publish tourism statistics. Saluveer et al. (2020) compare the statistics obtained from mobile positioning data

with accommodation statistics, finding a strong correlation between the two for incoming visits, indicating that mobile positioning data allows generating detailed tourism statistics. It is possible that in the future the use of interrelated sensors (camera data captures, traffic sensors, parking space occupancy, mobile data…) may facilitate the gathering of more extensive and refined mobility data, both in terms of quantity and quality.

Mobile position data have been identified as one of the most effective technologies for studying tourists' spatiotemporal behavior (Shoval & Isaacson, 2007; Shoval & Ahas, 2016). This method has been applied to analyze the behavior of wine tourists (Lewis, Hardy, Wells, & Kerslake, 2021), tourists in Estonia (Raun et al., 2016), and urban usage patterns in cities (e.g., Birenboim & Shoval, 2016). They also enable the comparison of spatial and temporal patterns between users. When data are collected longitudinally, as Tominga et al. (2023) did for Estonia, spatial behavior can be more effectively analyzed. Using call logs and data from a mobile network operator in Estonia, the authors identify the spatial and temporal patterns of seven population groups: residents, temporary residents, workers, frequent visitors, domestic tourists, inbound tourists and transit visitors. Studying the spatial parameters of different users allows investigators to compare usage patterns and identify clusters or population groups with similar behavioral patterns.

Three factors make the study of the volume and spatial distribution of tourists in cities critical to the analysis of tourism impact. Firstly, official data do not identify unobserved tourism (De Cantis et al., 2015) so these data tend to underestimate the real weight of tourists and, therefore, their impact on the dynamics of the city. Secondly, the number of effective users of urban space is also usually undervalued, especially during the day, so the pressure on urban space or the relative weight of tourism over the total number of users in the city is generally biased. Finally, the spatial behavior of different urban users is very different and their patterns are related to processes of attraction and expulsion, which is why it is vital to know the spatial and temporal patterns of tourists and non-tourists to plan urban tourism and measure the impact of tourism on a city (Klepej & Marot, 2024). This article suggests a calculation for estimating the number of users in Barcelona's districts by combining census data, survey data, and information derived from mobile phones.

2.3. Why Barcelona city?

In the last three decades, Barcelona has experienced exponential growth as a tourist destination. Unlike other large cities, with a consolidated tourist tradition, Barcelona's growth in visitors began suddenly after the 1992 Olympic Games and doubled every decade:1.7 million in 1990, 3 million in 2000, 7 million in 2010 and 17 million in 2019. The tourist offer is highly concentrated in the historic neighbourhoods: 55 % of hotel beds are located in the districts of Ciutat Vella and Eixample (Observatori de Turisme a Barcelona, 2021). Residents' negative assessments of the city have increased due to this concentration. In 2017, tourism was considered the city's main problem and since 2016 there are more residents who believe that the city's tourist carrying capacity limit has been reached than those who consider that the city should attract more tourists (Ajuntament de Barcelona, 2022). For this reason, the special urban plan for tourist accommodation in the city, approved in 2021, presented for the first time the scenario of a decrease in tourist accommodation supply.

The success of Barcelona's urban brand has drawn new users to the city. In 1991, foreigners made up 1.5 % of the registered population, which grew to 5 % in 2001. In 2021, they made up 22.4 % of the population, the highest percentage in history, of which a third were Europeans (Observatori de Turisme de Barcelona, 2021). Despite this migratory pressure, the population has remained stable at around 1.6 million throughout this century, because of the residents' high mobility. Each year, around 100,000 people change their address within the city and around 120,000 people move to another municipality, which is

offset by a similar number of arrivals from other regions. In addition, the city hosts a growing number of temporary visitors. In 2019, Barcelona hosted 12,500 international students, ranked fourth in the world in the number of international congresses, and developed 248 coworking spaces, hosting some 12,000 entrepreneurs and digital nomads (Coworking Spain, 2020). Lifestyle immigration and transnational populations in highly touristified areas, represent a new part of residents who have a high educational and economic level, feel comfortable along tourism and find the cultural and leisure stimulus they are looking for, without mixing with local communities (Cocola-Gant & Lopez-Gay, 2020).

The economic, cultural, and demographic activities of the city of Barcelona have acquired a metropolitan character. The Metropolitan Area of Barcelona is made up of 36 municipalities and represents some 3.3 million people, that is, twice the population of the city of Barcelona. Outside Barcelona, the commercial port, the airport, the International Fair, and the ALBA Synchrotron are located within the Metropolitan Area of Barcelona. This makes it one of the main economic, logistics and research poles in southern Europe.

3. Study methods

While much of the existing literature has focused on in-depth analyses of some basic segments of mobility flows in tourist destinations, fewer studies have considered the heterogeneity of diverse urban populations (Yang et al., 2019). This study aims to measure the volume of the various users in the city of Barcelona, during 2019, the last year before the COVID-19 pandemic. The temporal unit is the daytime, while the geographical unit is the ten districts in which the city is divided. Based on Tominga et al. (2023) users' typology, the UNWTO recommendations for tourism statistics (2008) and the population ontology used in articles on sociotemporal population modeling, the identified city user types are defined in Table 1.

Census data capture only legally registered residents, missing some actual residents and including others who live elsewhere. Mobile Phone Data's record individuals based on their regular overnight presence in a municipality, thus redefining residency from an administrative to a practical occupancy basis. According to UNWTO, a visitor must leave their usual environment, often interpreted as an administrative boundary, such as Barcelona's Metropolitan Area (36 municipalities). In Barcelona, tourists are visitors who stay overnight, while same-day visitors return to their usual residence. Previously, Barcelona's Data Office classified only leisure-motivated day visitors as same-day visitors. However, following UNWTO (2020) recommendations, this study includes all types of visitor motivations. This broader approach has led to a significantly higher number of same-day visitors compared to previous local statistics. Within the category of same-day visitors, two groups emerge: those who return to their own homes for the night, and those who stay overnight in tourist accommodations. While the latter are counted as tourists in their accommodation municipalities, they still add to Barcelona's overall tourist density. Commuters and metropolitan

residents have been estimated in terms of volume and spatial behavior. Commuters are individuals who regularly travel to Barcelona for work or educational reasons, exhibiting a distinctly patterned temporal movement both throughout the day and over the week. In contrast, metropolitan inhabitants dwell within the Barcelona Metropolitan Area, considering it their "usual environment", sporadically visiting the city for various purposes, but unlike commuters, such visits are not part of their regular routine.

The study's aim is to quantify the daily user count for each district in order to ascertain the relative importance of tourism and different mobility forms in urban dynamics. Table 2 presents the data upon which the model is constructed, combining a) information gathered from various censuses and the dysametric interpolation of flows according to the spatial distribution of elements, b) displacement information acquired through surveys of residents and tourists, and c) the use of Mobile Phone Data, which facilitates the spatial localization of device users. The data provide information across different spatial and temporal units and for specific users, which do not always coincide. Some of the data have been used to test the consistency of the results, as similar values are obtained through different methods.

The starting point was the estimated population data provided by the Barcelona Data Office. Data used in this study are obtained from the mobile networks of a mobile phone operator, primarily from mobile devices with SIM cards and the antennas with which they communicate. The location of mobile phones is estimated by their antennas, meaning the device's location is not determined with absolute precision. Mobile devices (powered on and within coverage) continuously communicate with the antennas they are connected to. Each antenna is assigned a theoretical geographical coverage area or cell, and all the operator's mobile devices physically present within a cell connect to that antenna. When the device is active and moves, it generates records of the antennas it connects to, marking its new location. The quality of the results depends on the density of the antenna grid, which facilitates cellular localization, and the precision of the algorithm that interpolates overall results. The data are organized by the Barcelona Data Office into four categories: (a) residents, individuals who spend the night in the city for more than half of the days in the year; (b) commuters, individuals who do not spend the night in the city but travel to Barcelona regularly; (c) nationals, individuals who do not reside in Barcelona, are not commuters, and their mobile is linked to a Spanish number; (d) internationals, individuals who do not reside in Barcelona, are not commuters, and their mobile is associated with a non-Spanish number.

Individuals identified as residents are those who, according to mobile data, have spent the majority of the year overnight in the municipality of Barcelona. To understand the internal and external mobility of residents, that is, movements between districts or flows outside the municipality, results from the mobility survey conducted by the Metropolitan Transport Authority have been considered. Similarly, the number of commuters detected by mobile signals has been calculated, and these results have been compared with estimates provided by the Metropolitan Transport Authority based on the mobility survey. This survey also provided information on commuter locations in each city district. The challenge lies within the remaining two categories: city users classified as 'nationals' or 'internationals,' who may encompass tourists, same-day visitors or metropolitan residents.

To identify the number of tourists, two complementary sources are available: data from the district-level survey collected by the Barcelona Data Office and the experimental statistics developed by the Spanish National Statistics Institute, based on mobile data capture, using a methodology similar to that applied in Estonia (Saluveer et al., 2020), with data available since the summer of 2019. Given that the latter only includes overnight stay data within the municipality, and the Data Office's figures do not account for unobserved tourists (De Cantis et al., 2015), web scraping (both from Spanish National Statistics Institute and Airbnb) was used to obtain estimates for tourists staying in unlicensed tourist accommodations. These estimates in non-commercial private

Table 1
User definitions applied in the study.

Resident	Person who in the last year has spent most of the days in the municipality, regardless of their census status
Visitor	A traveler taking a trip to a main destination outside his/her usual environment, for less than a year, for any main purpose (business, leisure or other personal purpose) other than to be employed by a resident entity in the country or place visited
Tourist	Overnight visitor
Same-day visitor	Visitor who spends the night at their habitual residence
Commuters	Person who travels periodically to the municipality
Metropolitans	Person who resides in the usual environment linked to the municipality (metropolitan area), visits the city, but spends the night in his or her usual residence.

Table 2
Data Sources of the Model.

Data	Source	Data model	Time unit	Space unit	Users
City users	Barcelona Data Office	Mobile Phone Data	Hour	City	Residents Commuters Internationals Nationals
International tourists	Spanish National Statistics Institute	Mobile Phone Data	Month	City	International tourists
Domestic tourists	Spanish National Statistics Institute	Mobile Phone Data	Month	City	Domestic tourists
Tourists Survey	Barcelona Data Office	Survey	Year	City District	Tourists
Mobility survey	Metropolitan Transportation Authority	Survey	Year	City Metropolitan Area	Commuters Same-day visitors
Stay tax in tourist accommodations	Government of Catalonia	Census	Semester	Cities Region	Tourist accommodation users
FRONTUR International tourists	Spanish National Statistics Institute	Survey	Year	Province Country	International tourists
Barcelona visitors	Tourism Observatory of the province of Barcelona	Survey	Month	District	Visitors
Accomodation units	Tourism Observatory of the province of Barcelona	Census	Year	District City Metropolitan Area	Accomodation units
Short-rent accommodation tourists	Spanish National Statistics Institute	web scraping	Month	Province	Short-rent accommodation tourists
Short-rent accommodation tourists	Insideairbnb	web scraping	Year	District	Short-rent accommodation tourists
Visitors	Barcelona Data Office	Mobile Phone Data	Month	Point of Interests	Visitors
Sagrada Familia visitors	Sagrada Familia Data	Census	Day	Sagrada Familia	Visitors
Cruise passangers	Port of Barcelona	Census	Month	City	Cruise passangers

homes or in establishments that provide inflated data were interpolated based on survey results through interception in Barcelona and FRONTUR data (Spanish National Statistics Institute). Visitor distribution data were generated using dasymetric interpolation based on the location of tourist accommodations and points of interest. These results have been validated against those obtained by an experimental methodology, based on the anonymous localization of mobile application users and visitor data for the Sagrada Familia, the city's most visited monument.

Commuters have been calculated using data captured from mobile devices. This category is easily identifiable due to the regular behavior patterns typically associated with work or educational criteria. Data on metropolitan users (those who reside in the Metropolitan Area of Barcelona and travel to the city for any reason) has been obtained through the survey conducted by the Metropolitan Transportation Authority, which allows us to identify the municipality of origin, the destination district, and the motivation for the trip.

Same-day visitors are those who visit the city during the day but do not stay overnight. This category is divided into two main subcategories: same-day visitors who return home overnight and same-day visitors who stay in a tourist establishment outside the municipality. These categories have been derived through two different methods: by adding data obtained from sources that allowed us to understand each subcategory and by subtracting data obtained from mobile signals that do not fall into the previous categories (tourists, metropolitan visitors, and commuters). The fact that both methods provide similar values demonstrates the consistency of the data.

The first subcategory, same-day visitors who return home overnight, includes excursionists or same-day visitors who reside outside the Metropolitan Area of Barcelona and engage in activities not related to work. Based on the usual criteria of distance and motivation, this group has been estimated through the mobility survey. These criteria, which follow UNWTO recommendations, are much broader than the criterion previously used by the Barcelona Tourism Board, which only considered people traveling for leisure purposes as excursionists. It has been estimated that the spatial behavior of this typology (distribution by districts) follows the same logic as tourists staying in the city of Barcelona.

There is a significant discrepancy between the data on tourists' overnight stays recorded by mobile signals and those collected by the Spanish National Statistics Institute records compared to the data on tourists visiting the city estimated from the Barcelona Municipal Data Office's mobile phone records. This discrepancy arises from the presence of visitors who are staying in other locations and are thus absent from both the official data and Spanish National Statistics Institute records. This phenomenon is under-researched, despite its substantial impact on tourist cities; that is, the same-day visitors who stay in a tourist establishment outside the municipality. It encompasses three distinct groups: metropolitan visitors, cruise passengers, and coastal tourists. Metropolitan visitors are those who stay in one of the 35 municipalities that make up the Metropolitan Area of Barcelona, except Barcelona. The estimation of the number of day-tourists has been carried out by means of interception surveys of visitors in the city of Barcelona (which enabled the calculation of the relative weight) and an analysis of official occupancy and tourist tax (which provides the absolute value). Cruise passengers represent a significant portion, with the number of cruise passengers reaching a record level of 3 million in 2019, of which 1.3 million are transit passengers and 1.7 million are turnaround passengers (Port de Barcelona, 2020). Eighteen percent of turnaround cruise passengers are excursionists, while the rest spend the night in the city or embark directly. Therefore, the number of excursionist cruise passengers includes both transit cruise passengers and turnaround cruise passengers who visit the city but do not stay overnight. Coastal tourists form the largest group, consisting of tourists who stay in one of Catalonia's coastal areas (Costa Brava, Costa de Barcelona, Costa Daurada) and visit the capital, although they return to their coastal destination. An estimation based on the official surveys carried out on tourists in these destinations was conducted, as well as the experimental use of data from mobile positioning apps, which makes it possible to establish the origin of one-day visitors to the city of Barcelona.

4. Results

4.1. Barcelona incoming city users

This study identifies not only a large number but also a wide range of daily temporary users, which alters urban dynamics. Although there are 1.6 million registered residents in 2019, mobile data indicates that city users average 2.6 million throughout the day. This suggests that on an average day, approximately 1 million non-resident users enter the city of Barcelona. However, only a small percentage of this user group stays overnight and this is represented by tourists (6,4 %), which according to the existing academic debate is directly related to the impact of overtourism in Barcelona. Thus, in a hypernomadic society, where the various forms of mobility determine cultural, social and spatial logic, cities are not stressed only by the presence of tourists, but by the coexistence of different forms of mobility.

More particularly, as seen in Fig. 1, this study shows that the city receives daily three basic types of incoming users, separated among visitors (any traveler taking a trip to a destination outside their usual environment, for any motivation besides employment), commuters, and metropolitan city users. The highest number of daily incoming city users (456.000) on an average basis is represented by metropolitan users (17,1 % of total city users), followed by commuters (12,1 %), and finally by visitors (11 %). Commuters and metropolitan city users represent a volume equivalent to half of the residents, where every day almost 800,000 people enter the city for a broad spectrum of motivations (professional, personal, recreational, …).

The impact of tourism on Barcelona is not in question, however. After reviewing the official data, the total number of tourists in 2019 has increased to 17.3 million. This is mainly due to tourists staying in private homes without financial compensation, which accounted for 1.8 million tourists in 2019 and over 9 million day stays, one seventh of the total number of tourists. The consolidation of this typology implies, in addition to a statistical challenge (De Cantis et al., 2015), a symptom of new forms of relationship with the tourist space that are close to the practices of the residents. Tourism 'camouflage' in the form of 'locals' (Maitland, 2010), the urban dynamics of a nomadic city, such as student tourism, lifestyle migration, and digital nomadism (López-Gay et al., 2020; Novy, 2018), and the rise in personal motivations, beyond leisure or employment, can explain the growth of these new forms of tourist mobility.

The pressure on the city of Barcelona is due to the coexistence of various types of users in both time and space. Although the city received 17 million tourists in 2019, the number of same-day visitors is significantly higher, due to the presence of people returning home as well as those staying in tourist accommodations in other municipalities. Overall, the city receives 56 million annual visitors, adding to the rest of the users. However, while tourists spend several days in the city, same-day visitors are only present for a single day. Tourism statistics use the concept of "night," but this value does not allow for a proper comparison with the temporal units of other users. To calculate the impact of commuters, metropolitan residents, or same-day visitors, we consider their presence in the city during a part of the day. Since one overnight stay generates two days, we have used the analysis unit of "day-stay" (the number of arrivals multiplied by the average stay plus one). This explains the paradox that Barcelona has more daily tourists than the maximum occupancy capacity of all the city's accommodations. Sixty percent of the total daily stays of visitors are tourist stays, while the rest correspond to same-day visitors. In 2019, this amounted to more than 100 million visitor stays, significantly increasing the impact of the various types of visitors on the city. Although the debate has focused on tourism, non-tourist visitors also have a considerable impact on the city. On an average day, there are approximately 278,000 visitors in the city out of a total of 2.6 million users, exceeding 10 % of the total (see Table 3).

The tourism dimension has traditionally been related to the resident population, as if the first was a dynamic variable and the second was a static component. Cities would be subjected to the pressure (overtourism) of a supervening population that alters daily life, economic structure, internal mobility patterns and social and cultural relations.

Table 3
Barcelona visitors 2019.

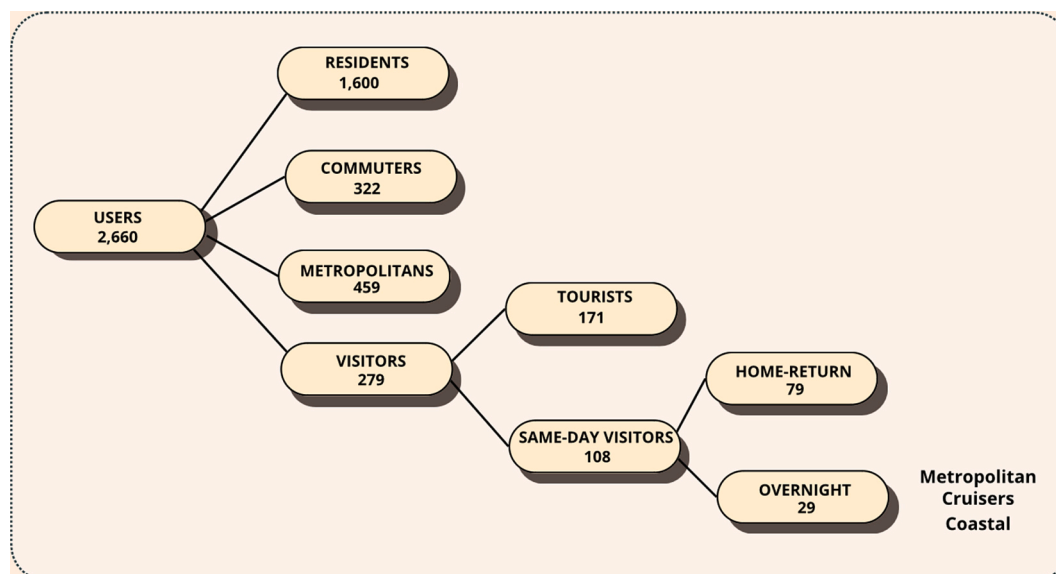|	Arrivals	%	Day-stay	%	Visitors per day	%
Tourists	17.355.003	30,6	62.370.802	61,3	170.877	61,3
Same-day visitors	39.397.413	69,4	39.397.413	38,7	107.938	38,7
Overnight same-day visitors	*10.497.443*	*18,5*	*10.497.443*	*10,3*	*28.760*	*10,3*
Home-return same-day visitors	*28.899.970*	*50,9*	*28.899.970*	*28,4*	*79.178*	*28,4*
TOTAL	56.752.416		101.768.215		278.815	

Fig. 1. Barcelona city users (000).

However, in this study visitors are only part of the dynamic component of the city, with commuters and metropolitans generating a significant daily flow. Moreover, residents themselves exhibit extreme mobility both externally and internally. Every working day there are 420,000 trips from Barcelona to other municipalities. Approximately 300,000 of them are destined for the Metropolitan Area of Barcelona (Autoridad de Transporte Metropolitano, 2020), while the remainder are destined for destinations outside the Metropolitan Area of Barcelona. A similar number of trips are taken for work reasons (commuters) as for personal reasons. In other words, every working day, the city receives 1 million users (commuters, metropolitans and visitors), but sends away 400,000. Additionally, in Barcelona, many residents move from one district to another daily, which confirms the significant presence of intra-destination movements in understanding spatial mobility (Raun et al., 2016; Zheng et al., 2017; Zillinger, 2007).

4.2. The distribution of users in time and space

There are a variety of flows that come together in the city and have very diverse spatial and temporal dynamics. Occasionally, arrivals and departures complement each other, such as in the case of commuters, since some arrivals are offset by residents working outside the municipality. In other cases, the movements of the various users coincide in time and space, which generates a spatial concentration of multiple actors (Kang et al., 2012). Fig. 2 represents the daily activity of the various users of the city throughout 2019, with the exception of March, because the data could not be accessed. There is a clear weekly frequency, which affects commuter entrances in particular, but also explains Barcelona residents' leisure outings to outdoor recreation areas.

Barcelona tourism also has annual rhythms marked by many factors that operate simultaneously. Certain sectors, such as cruises, are highly seasonal and concentrate their activity during a few specific months. The MICE sector is also very sensitive to event programming. Fira de Barcelona organized activities in 2019 that attracted 1.8 million visitors,

with two arrival peaks in spring and autumn, and the impact of large international fairs such as the Mobile World Congress. Unlike other European cities, Barcelona experiences its greatest tourist activity between July and August, while activity drops sharply during the winter months, as Graells-Garrido, Serra-Burriel, Rowe, Cucchietti, and Reyes (2021) have shown. However, while tourism in Barcelona exceeds the threshold of 200,000 reaching its annual maximum in July and August, some 400,000 Barcelona residents spend the night in another tourist destination. This means that the moment of maximum tourist pressure in the city is offset by an output of tourists much greater than the input of tourists. A similar situation occurs during Easter and Christmas.

Barcelona has a highly concentrated tourism market. Two out of ten districts are home to almost two thirds of tourists (Elorrieta, Cerdan Schwitzguébel, & Torres-Delgado, 2022). The Ciutat Vella district (Old Town) is the urban area delimited by the old walls where the city's history took place until the creation of the Eixample (expansion) in the 19th century. As well as the majority of the city's hotels, the Eixample district is home to some of the greatest examples of Catalan modernism, such as the Sagrada Familia, Park Güell, and La Pedrera. In addition to these two districts, the city's tourist activity has been spread in recent years to three districts that act as decompression spaces for tourist activity: Les Corts, Gràcia and especially, the district of Sant Martí. In the latter, the post-industrial area of Poblenou is located, where old factories from the 19th century have been converted into centers of attraction for new tertiary activities, coworking spaces, and residential areas for emerging urban classes and tourists.

The spatial distribution of same-day visitors accentuates the city's concentration. While metropolitan tourists behave similarly to tourists who spend a night in Barcelona, cruise excursionists have a very short average stay in the city (4 h), limiting their exploration of the city mainly to Ciutat Vella. Furthermore, coastal tourists tend to concentrate and limit their activity near the main sights of the city, located in Ciutat Vella and Eixample. In contrast, the study of home-return same-day visitor behavior patterns shows a much more dispersed use of the city,
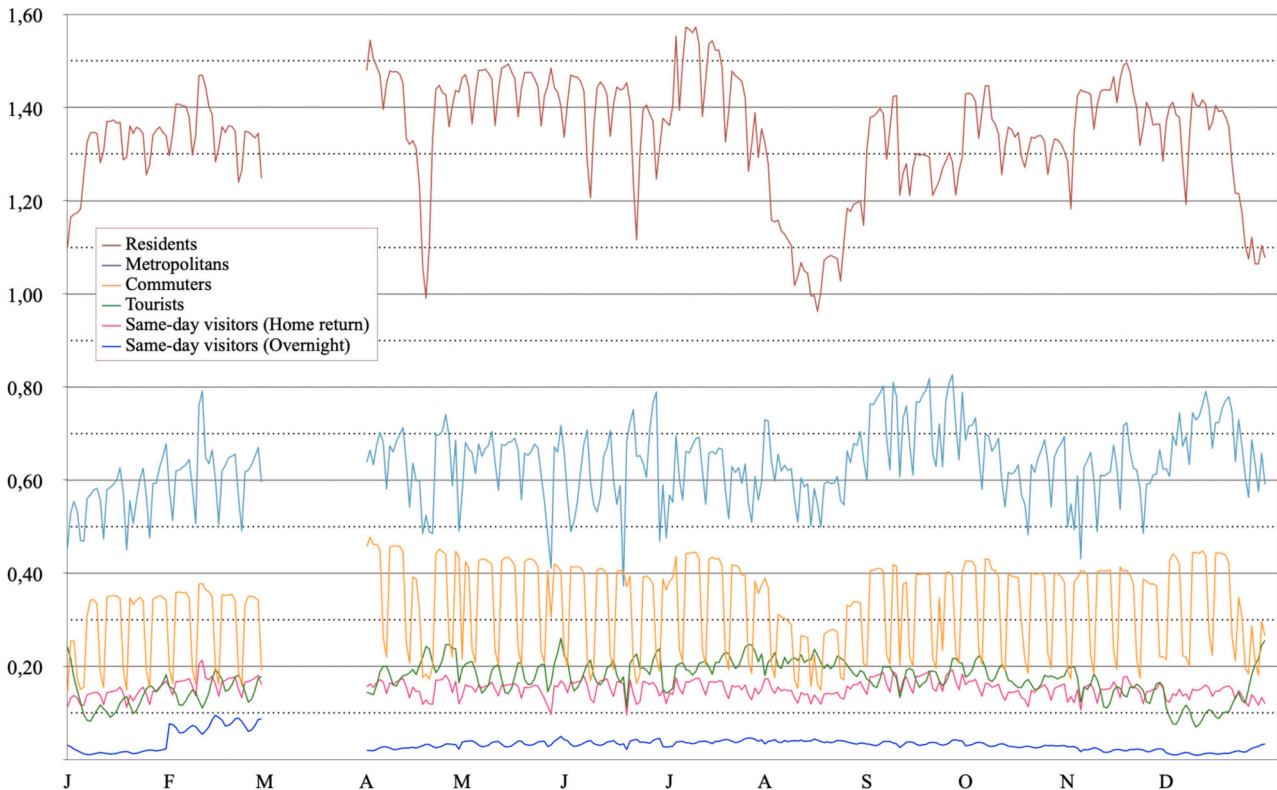

Fig. 2. Users in Barcelona throughout the year (million).

with a higher prevalence of activity in Eixample.

From the spatial and temporal study of city users' behavior, their daily distribution in each Barcelona district has been measured (see Fig. 3). Table 4 shows the average relative weight of tourists and visitors in the various areas of the city. Tourism is a principal component of the use of Ciutat Vella, not only because it is the district with the second smallest population but also because other activities in this space are much less intense than other urban areas. Unlike other districts, Ciutat Vella is not a main destination for commuters, metropolitans, or day-trippers. A positive balance is only detected in Barcelona's residents' internal movements, meaning there are more Barcelona residents who move to Ciutat Vella during the day than there are movements out to other urban areas. Consequently, the district is not only one of the most active touristically in the city, but it is also not extensively used by the rest of the city's inhabitants, resulting in a higher degree of tourism specialization.

On the contrary, the Eixample district shows the highest positive balance of internal movement of city residents, attracting the largest number of commuters, metropolitans, and day-trippers. The touristic activity in this district, coinciding with other productive activities, makes Eixample act simultaneously as a Recreational Business District and a Central Business District. However, the touristic activity in this neighborhood is relatively small, representing only 8 % of the district's users, slightly above average. In Gràcia and Sant Martí, districts that have recently served as areas of tourist deconcentration, the relative weight of tourism, especially that of visitors, is above average. The Sants-Montjuïc district has become the second ring of tourist activity. In the rest of the city's districts, the relative weight of tourism is very

Table 4
Tourists and visitors as a percentage of total district users.

Districts	Tourists	Visitors
Ciutat Vella	22.8	32.1
Eixample	8.3	13.3
Sants – Montjuic	5.1	8.8
Les Corts	3.7	6.5
Sarrià Sant Gervasi	1.2	5.2
Gràcia	7.7	11.1
Horta Guinardó	0.8	3.4
Nou Barris	0.5	2.7
Sant Andreu	0.4	3.2
Sant Martí	6.6	9.6

marginal, below 5 % in all cases. Finally, tourists account for 1 % of total users in four districts.

5. Discussion and conclusion

Previous investigation has highlighted that understanding and making sense of tourism and its changing forms so as to conceptualize the impact it generates on a territory, requires accepting tourism as part of a wider set of mobilities (Maitland, 2010; Novy, 2018). The New Mobility Paradigm emerged from the acknowledgment of the complexity of networking and exchanging in place and, particularly, city shaping and reshaping (Sheller & Urry, 2006), questioning the simplistic 'host' and 'guest' dualism while referring to a blurring boundary between them or to a third category of other city users (Maitland, 2010). In order to assess the performance of each city user within the context of
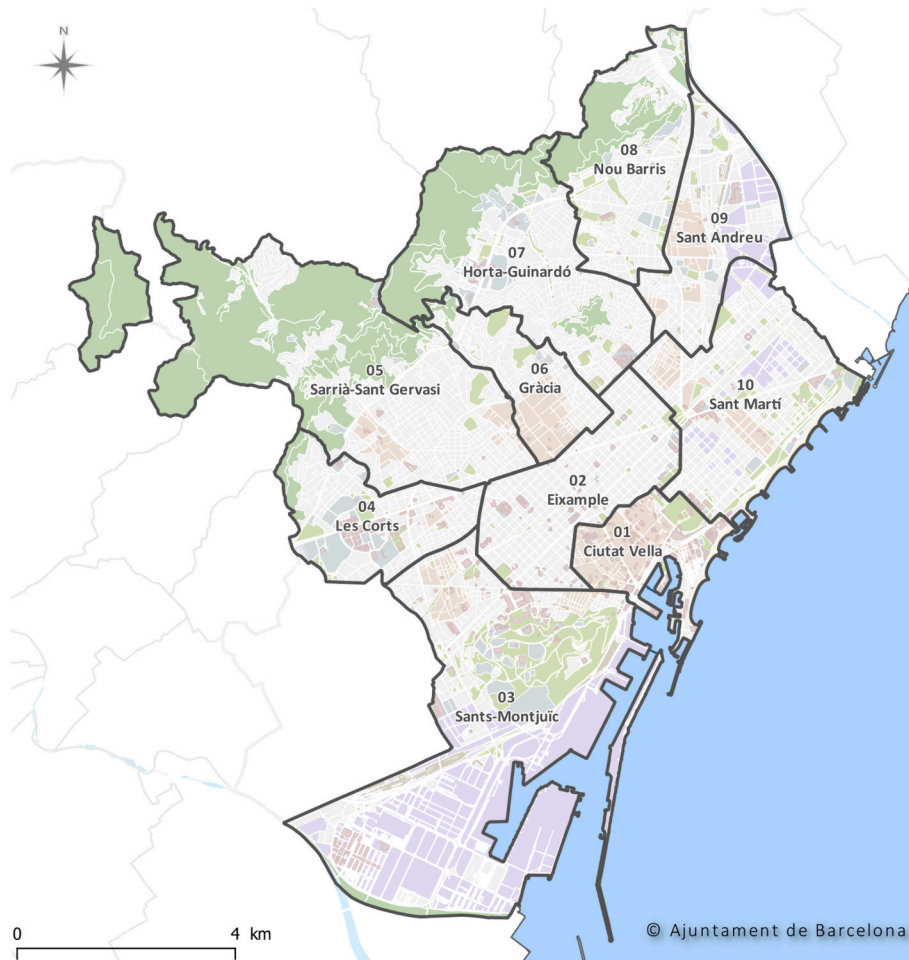

Fig. 3. Map of districts of Barcelona.

the dynamism of place, it is necessary to identify who that user is. Many tourism academics that have applied the New Mobility Paradigm in their research analyze and categorize the heterogeneity of tourists as well as of residents (Quinn, 2007; Moscardo et al., 2013; Carson et al., 2014; Novy, 2018; Brandajs & Russo, 2021) so as to demonstrate the multi-dimensional demand for experiencing a city. A major objective of this study has been to identify the 'other city users' that take part in urban regeneration, allowing for a deeper understanding of the complexity of defining space beyond spatially fixed terrains with blurred boundaries, as suggested by the New Mobility Paradigm (Novy, 2018; Sheller & Urry, 2006). This article shows that a high number of users converge daily in the city of Barcelona, which significantly increases the weight of the mobile population in the city. Furthermore, a significant number of residents engage in internal and external displacements adopting mobile logic.

To estimate the number of users per day and district, various methods analyzing spatial behavior have been combined. Given that the sources used correspond to different temporal and spatial units and that the ontology of the users does not always match, it was necessary to integrate the data into a single model based on estimates. The results show that the absolute value of tourism and visitors is underestimated in official data, because it does not account for unobserved tourists and only includes tourists staying within the municipality. Day-trippers are also undercounted because official data only capture leisure-related travel. In relative terms, the impact of tourism is minor because, in addition to residents, the city hosts daily a million people coming to the city for a variety of reasons.

In this context of diverse city users, this study does not support that overtourism is a misperception of the urban complexity of a tourist destination like Barcelona. It rather positions overtourism as a component of a broader process, called overall-mobility. This can be defined as the simultaneous presence of mobile users of various kinds in an area, with a significant relative weight compared to its non-mobile users. In this definition, two conditions must be met. Firstly, and unlike overtourism, overall-mobility does not consider the carrying capacity of the host space, but rather the proportion between the mobile population and the set of city users. The concept of overall-mobility arises when mobility has such a relative weight that it has a profound effect on a city's daily life, its demand for goods and services, its transport network, and, above all, its system of social and cultural relationships, that is, when mobility is inherent to the city's dynamics. Secondly, it is necessary that mobile users are diverse and respond to differentiated spatial logics. Users of metropolitan origin, those living in a dense Catalan urban and territorial network, and international tourists visit Barcelona every day. Each of these scales generates a genuine system of relationships, which produces specific spatial needs, interactions, uses and practices. Overall-mobility is the simultaneous space and time coexistence of different mobility systems: ordinary, metropolitan, regional, tourist. Accordingly, the resulting city can be considered a *heterotopia* in the sense that Soja (1989) defines it based on Lefebvre's concept: the juxtaposition of spatial categories on a single plan. City mobility creates a superposition of various systems, which creates a spatial reality with imprecise boundaries and complex territorial dynamics. It is not about the transformation of local cities into global cities, but about the simultaneous presence of the local, the metropolitan, the regional and the global city.

Just like overtourism, overall-mobility is a locally determined phenomenon which should not be generalized uniformly to the entire city of Barcelona. Agreeing with previous investigation, (Elorrieta et al., 2022; López Palomeque, 2015), this study shows that overtourism occurs in only a few districts, such as Ciutat Vella, while overmobility prevails in others like Eixample or Gracia, resulting in significantly different urban dynamics. The spatial differentiation of mobility patterns throughout Barcelona is, however, accompanied by a temporal differentiation as well. The latter is not only detected during particular months of the year, like July and August, where the city maintains its attractiveness by balancing incoming and outgoing users, as seen in other cities (Xu et al., 2021); it's also suggested in the variety of time invested in experiencing the city in situ, ranking from resident stay, to tourist stay, to a short stopover, confirming Carson et al. (2014) and Zhao et al. (2018) importance of time parameters to detect mobility patterns.

With the progressive generalization of 'mobile' analysis methods, it has become possible to identify more complex spatial patterns. Studying overall-mobility requires sources which are capable of identifying spatial patterns among various users of the city, in addition to conventional data based on immobile categories (residence, accommodation, municipality, district…). As a result of the monitoring of the activity of the various users from the records of the mobile phones, it has been possible to identify these invisible, to official data, users, and also to determine the volume of the various categories of flows. As this data becomes more accurate, it will be easier to identify the volume of users and the spatial and temporal patterns of their behavior. In this regard, it is essential to use a more precise geographic scale that allows the identification of the city's spatial usage patterns. This likely involves transcending administrative boundaries and utilizing more accurate units such as a raster grid or a Hierarchical Hexagonal Spatial Index (H3).

Tourism's impact on the economy, society, and the territory of a destination is not negated by the change in interpretation from over-tourism to overall-mobility. In light of this, it is necessary to examine cities from a new perspective, as in Barcelona, that considers the overlap of mobile users, a complex relationship between static and dynamic users, and a multiscalar logic that simultaneously connects metropolitan connections, regional flows, and the global dimension of the city. Through this overall-mobility, interactions are multiplied, information can be exchanged, cultural systems are interconnected, and the contemporary city becomes more dynamic through this exchange of information. On the other hand, it produces negative externalities due to the tension in limited resources, gentrification of urban areas, and saturation of spaces, leading to the emergence of contrasting models, such as the 15-min city.

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