Diagnostic of the Balance and Equity of Public Transport for Tourists and Inhabitants

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Abstract. The significant development of tourism as an economic activity in some cities has led to the need to integrate potential demand for public transport generated by tourists into planning decisions. Public transportation is considered a critical factor of tourism competitiveness and plays a fundamental role in the promotion and maintenance of a sustainable tourist destination. Ensuring equity of public transport services requires specific methodological tools for diagnosis and optimization. There are few references regarding the need to integrate tourism demand in the planning of public transport of cities or the development of methods and techniques to facilitate this task. A method for evaluating potential public bus transportation demand including both residents and tourists is presented. The method uses geographic information systems and statistics, namely, the Gini coefficient, to diagnose imbalances between supply and demand and the degree of equity in transport services. The city of Palma (Spain) is selected as a case study. The results show a significant imbalance in the public transport of the city. There is a large concentration of tourist facilities in areas where the level of bus service is not sufficient for the demand of the resident population and tourists.

Keywords: Public transport · Equity · Tourism transport

1 Introduction

In recent years, the tourism sector has experienced extraordinary growth. The economic activity associated with tourism can reach between 5 and 9% of GDP (including its effects, direct, indirect and induced) [37]. The OECD average stands at just over 4% of GDP, but it accounts for 11.7% of the GDP in Spain and 44.8% of the GDP in the Balearic Islands [16]. Tourism is an expanding activity in the region, growing 3.3% per year. The displacement forecasts for 2030 foresee approximately 1.8 billion travellers [37]. Urban tourism (city tourism) has experienced a considerable rise in recent decades [36] and constitutes an economic activity with remarkable expectations. This fact has been encouraged by accessibility of low-cost airlines.

Evans and Shaw note that in recent decades, there has been a strong revival of tourism in the centre of cities, which presents a challenge for developers, operators and

local authorities [15]. This has been brought about by the rise in the supply of urban hotels in many cities and especially by the development of rent tourist platforms on the internet. It is easy to access a universal market of houses and apartments via the internet, eliminating intermediaries and simplifying rent procedures.

Infrastructure and transport services, shapers of territorial accessibility, are key factors in the competitiveness of cities as tourist destinations [35]. In this sense, public transport is essential to providing access to all facilities and services that urban tourists desire. Hall categorizes tourist mobility services into three groups: providing mobility and access to a destination area, providing mobility and access within an actual tourism attraction, and facilitating travel along a recreational route which is itself the tourism experience [21].

Negative externalities on the environment arising from tourism transport should be considered in planning tourist destinations, encouraging the use of lower polluting modes of travel. In this regard, encouraging the use of public transport by tourists is considered a fundamental strategic for ensuring the sustainability of tourism activities [35]. The increase in urban tourists can create certain stress, depending on the volume and seasonality, for the public transport system, which must provide services to tourists and the resident population.

Although the symbiotic relationships between transport and leisure are generally described as benign, analyses of public transport and leisure activities are scarcely treated. The scientific literature that analyses the integration of tourist transport with public transport planning is quite limited in journals of transport or tourism [1, 13, 15, 24, 26, 28–31, 33].

The planning and management of public transport in cities are usually performed through public or private companies that must reconcile the provision of services in an equitable manner with economic feasibility and benefits [7, 11, 17, 18, 21, 27, 32, 34].

The transport planning process should be based on an integrated analysis of the potential demand, considering the different needs of the population and the location of economic activities. This should be coordinated with the distribution of land uses and the urbanistic city model. Sustainable urban mobility plans abound in this regard and consider the use of public transport as a key element of planning.

In seasonal tourist destinations, such as the city of Palma (Mallorca, Balearic), some type of support for shuttle service is common during peak season (increased frequencies of certain lines, launching of new routes or creation of new stops). These are specific actions that seek to solve the problem temporarily but do not constitute structural integration strategies of transport tourism demand.

Sometimes the high profitability of some bus lines with the preferential use of tourism is a fundamental argument used by managers for its potentiation. This could involve deficiencies at other lines more oriented to responding to social demand. The main argument put forward is that the high effectiveness of touristic lines can equilibrate deficit lines and enable better performance of the service. This circumstance can generate inequity risks because the public transport needs of tourists are overvalued respect the social needs of the population of the city.

While on that subject, new residential tourism based on e-commerce and social networking is changing geographic patterns of tourist accommodation and also modifying the potential demand for public transport. We refer to the supply created by internet portals such as airbnb.com. In recent years, the deconcentration of supply and direct interweaving of tourists with resident have restructured transport demand models. Residential tourist, usually have less purchasing power than those staying at the regulated supply (hotels and apartments). They reach practically all the sites of the city and make use of public transport in a more homogeneous way. This softens the touristic profile of some bus lines, but the entire transport system is subjected to greater stress. As indicated by Dickinson, Robins and Lapko [12, 23] the car is the most common mode of transport used by tourists on the move, which leads to problems and externalities (congestion, parking stress, visual intrusion, noise and air quality).

Albalate et al. note that mobility is an essential question for tourists of large cities and that its planning and development have a direct effect on expanding the benefits of the tourism activities throughout the city. Tourism is a driving factor in the economic and social dynamism of a city and configures the transport demand. However, cities do not uniformly increase their transport service to give support to the tourism demand. In cities with traffic congestion problems, there is already high competence between tourism and residents in the use of public transport. In this case, tourism increases the stress of the service and generates externalities negatives [1]. In this regard, Dallen analyses a multipurpose model of tourism trips and leisure, which results in different patterns of demand and pressure on transport infrastructure [9].

Antoniou and Tyrinopoulos analyse the factors affecting the use of public transport in tourist areas by tourists and residents. They conclude that tourists base their choice on the basis of the frequency and the reliability of service, whereas residents value most other qualitative aspects. This also stresses the need to rethink policy analysis of transport demand and encourage efforts in marketing strategies, transparency and quality properly integrating tourist demand [3].

Le-Klähn indicates that public transport sometimes is promoted as a marketing strategy of tourist destinations, considering the preferences of tourists in destinations or in reducing fares [23–25]. However, Gronau and Kagermeier note that while the main focus of sustainable transport policy focuses on reducing motor vehicles and private vehicles and promoting an attractive public transport supply, that effort is not so clear when the problem is addressed for tourist transport. The main purpose is to build a supply adapted to the demand, considering all preferences and adopting a bottom-up approach [19]. Guiver et al. explains the need to adapt transport models to the needs of tourists and the important need to develop target group identification of transport needs (nature, family, sports-oriented, catchment areas, etc.) [20]. Lumsdon also focuses on this approach, stressing the need for bus transportation routes to incorporate the vision of tourists in their travel expectations [28].

This conceptual framework notes that the integration of tourism demand in the planning of public transport are still incipient. The public transport preferences of tourism are analysed and the negative externalities of not including tourism demand in a public transport system planning are identified.

In general, there is a need for further development of integrated methodologies that involve tourism demand in the planning of public transport and provide reasonable solutions within the framework of sustainable mobility.

In this paper, we carry out an integrated analysis of the potential demand for the public transport of residents and tourists. The relationship between the potential demand and the level of service is assessed by detecting geographic imbalances and calculating the level of equity using the Gini coefficient. Geographic information systems and statistical tools are combined in a specific diagnostic methodology. The city of Palma (Balearic Islands) is selected as a study area.

The questions we want to answer are as follows: What is the potential demand of public transport for residents and tourists? What is the level of public transport service in the city? Are there imbalances in public transport (i.e., in the supply-demand relationship)? Where are imbalances and inequalities located?

2 Case Study

The study case selected is the city of Palma. Palma is the capital of the Autonomous Community of the Balearic Islands (Spain). The planning and management of bus public transport of the city is developed by Empresa Municipal de Transports (EMT), which is a public company dependent of the city council.

The transport service of the city tries to cover the needs of 421,708 residents [22] in approximately 19,524 hectares. The municipality is divided into 88 neighbourhoods delimited by historical criteria. To simplify the territorial analysis carried out in this research, a grouping of neighbourhoods into seventeen homogenous urban areas that respond to a functional division criteria of the territory was performed (Fig. 1).
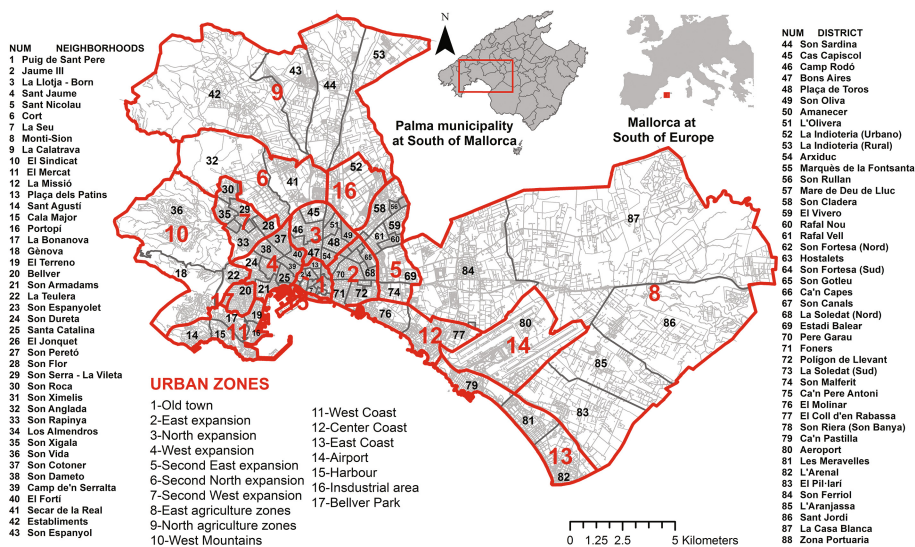

Fig. 1. Location of Palma city and division of neighbourhoods and urban zones

The supply of public transport in Palma has two subway lines: an underground city railway line (recently build, 2007) and the railway system of the island. In addition, the bus fleet cover 31 bus lines. The overall transport network is spread over 822,5 km and has 957 stops.

The road system of the city of Palma is structured in a radio network-concentric morphology, developed around the old town. The city centre is surrounded by two perimeter rings of roads. The first is formed by the roads that replaced the old walls and the other is an exterior beltway that encloses the city. This road network predetermined the development of a peripheral circulation that include radial roads to access the core of the city.

The city of Palma has had a Sustainable Urban Mobility Plan (SUMP) (developed under the project CIVITAS DYN@MO, http://www.civitas.eu/content/dynmo) since 2014. Among the main objectives of this plan is emphasizing improvements in public transport by bus and increasing the level of shuttle services to the tourist population. Measures proposed for the improvement of public transport and tourism mobility include the following: adapting the system to the public transport demand, restructuring the bus service covering the hotel industry, and improving the integration of tourism in public transport. The focus of this work is adapted to the objectives of the Palma SUMP and can provide support for decision making in this field.

3   Methodology

The method used in this investigation consists of the following phases:

- Analysis of the potential public transport bus demand of the resident population.
  The potential demand of public transport of population is represented by the resident population by geographic unit of analysis. In that respect, we used two geographic units: the urban block and the urban zone. The urban block level representation is used solely for the purpose of cartographic visualization. The source of data was the Population Census 2015 Palma (Ajuntament de Palma).
- Analysis of the potential public transport demand derived from tourism seats.
  The tourism potential demand is analysed at two levels: seats of regulated supply (hotels and apartments) and seats of non-regulated supply (individual homes and apartments) by geographical unit of analysis (urban block level and urban zones level). The representation of urban blocks serves only mapping purposes.
  The information about the regulated touristic supply was obtained from two sources: the Dirección General del Catastro (DGC) del Ministerio de Economía y Hacienda (Gobierno de España) and the Department of Tourism (DT) of the Government of the Balearic Islands.
  The data from DGC includes geographical information (shape file) and alphanumeric information of the touristic uses (table file) of each cadastral parcel. The DT has information about the total number of seats of hotels and apartments of Palma city.
  First, we made a proportional allocation of touristic seats to cadastral parcels according to its surface of touristic use. Second, using GIS tools, a cartographic

overlay was made between the cadastral parcel layer and the geographical analysis layers to obtain the number of touristic seats by urban block and by urban zone.

The non-regulated tourist seats are obtained from data provided by Airbnb.com. A shape point file represents the location of houses or apartments that have an associated attribute with the total number of touristic seats.

Another cartographic overlay was created between the layer of points of the supply and the geographical study unit layers to obtain the number of touristic seats by geographical unit (urban block and urban zone).

Finally, all the touristic seats, regulated and unregulated, were added for each geographical analysis unit (urban bloc and urban zone) to obtain the Potential Public Transport Demand of Touristic Seats.

– Integrated Demand Analysis of public transport: resident population and tourist seats.

First we proceed to normalize the potential data for each of the urban zones on a 0–1 scale according to the demand expression:

$$Normalized\,value = (Original\,Value - Minimum\,Value)/(Maximum\,Value - Minimum\,Value) \tag{1}$$

Then, the values of the potential demand (PD) of tourism seats are integrated according to expression (2):

$$Potential\,Demand\,of\,Population\,and\,Tourism \\ = PD\,resident\,population + PD\,of\,tourism\,seats \tag{2}$$

The results of (2) are also standardized according to expression (1).

– Analysis of the level of bus public transport by urban area.

First we proceed to locate bus stops from the information provided by the Municipal Transport Company (EMT) of Palma. Then, the 959 bus stops were digitalized. Second a buffer of 400 metres was generated for each bus stop. Each buffer was assigned to a service level value based on the number of buses passing by it for a period of 12 h. This assignment takes into account the buses that pass through each bus stop considering their frequency. Finally, we calculated the bus service level by urban zone using expression (3) [8]:

$$Service\,Index_{Urban\,zone} = \sum_{1}^{n}\left(\frac{Area_{Buffer\,n}}{Area_{Urban\,Zone}} * SL_{Buffer\,n}\right) \tag{3}$$

The autocorrelation analysis of the geographic pattern of the supply was performing using the Moran index with the program GeoDa vers. 1.6. [2].

• Analysis of imbalances and equity of public transport by bus

A comparative analysis of the geographic distribution of the potential demand and supply of public transport service by geographical unit (urban zone) was performed. To contrast the different magnitudes of demand and supply, the first task was to normalize the values of each variable of the urban zones using expression (1).

The values matrix obtained is then subjected to an analysis of correlations between the different variables. In addition, a new variable "Level of Balance" is calculated for each urban area according to expression (4)

$$Level\ of\ Balance\ =\ \%\ Service\ Level\ -\ \%\ Potential\ Demand \qquad (4)$$

Positive values indicate excess transportation service, whereas negative values show high values of potential demand.

– Analysis of the equity of public transport bus in relation to the population and tourist seats.

The Gini coefficient is obtained from the level of service and the resident population and tourist seats of each urban zone using expression (5):

$$GINI = 1 - \sum_{i=0}^{n} (\delta Y_{i-1} + \sum_{i=0}^{n} \delta Y_i)(\delta X_{i-1} - \delta X_i)$$

$$i\ =\ row;\ n\ =\ number\ total\ of\ urban\ zones;\ Y\ =\ accumulated\ service\ level; \qquad (5)$$
$$X\ =\ accumulated\ population/touristic\ seats$$

The GINI coefficient was developed to measure the degree of inequality of a variable in a distribution of its elements [10]. The GINI coefficient ranges between 0, i.e., no concentration (perfect equality), and 1, i.e., total concentration (perfect inequality).

We used the ArcMap v.10.3 (© ESRI) software for the mapping and spatial analysis of data and Microsoft Excel and SPSS software v.22 (© IBM) for statistical analysis and graphical representation of the information.

4   Results and Discussion

4.1   Analysis of Potential Demand of Bus Public Transport

Potential demand of the resident population

The resident population of the city of Palma shows a heterogeneous pattern of geographic distribution in which areas with high population density and sparsely populated areas (Fig. 2) are combined.

The old town located at the city centre has a low population density, which shows the consequences of the progressive abandonment of residential use and its replacement by service use (preferably commercial, offices and catering establishments).

There are high levels of population in the prime concentric ring of the old town, at the widening of the city (Fig. 2). The main neighbourhoods in this area (Fig. 1) are Bons Aires, Camp Rodó, Plaça Toros, Pere Garau, etc. The population is very concentrated. The second highlighted area includes the suburbs located in the second belt of the city. They have residential uses of low and medium density maintaining the model of a dormitory town.

The Coastal urban areas also have significant populations, although lower densities; these include Arenal (east) and Cala Major (west). In these areas, tourism (hotels, apartments, complementary offers) competes with residential uses. On the west coast, the concentration of the resident population it is higher than that of tourists.

The demographic dynamics of the city in recent decades have varied greatly. Population growth continued until 2010 on the order of 10%; however because then the effects of the crisis have slowed that trend.

It is important to call attention to the fact that most of the increases of the previous decade were due to non-EU foreign immigration.

We must also mention the phenomenon of European tourists as residents that are not registered at the census but increase the permanent population of the city and generate more demand on public transport.

The transport potential demand of the resident population is oriented to pendulous travel from the periphery to the centre and directed to downtown areas with work activity (tourism, industrial and commercial). This also highlights mobility to large facilities and infrastructure (hospitals, universities, port, and airport) without neglecting mobility for leisure.
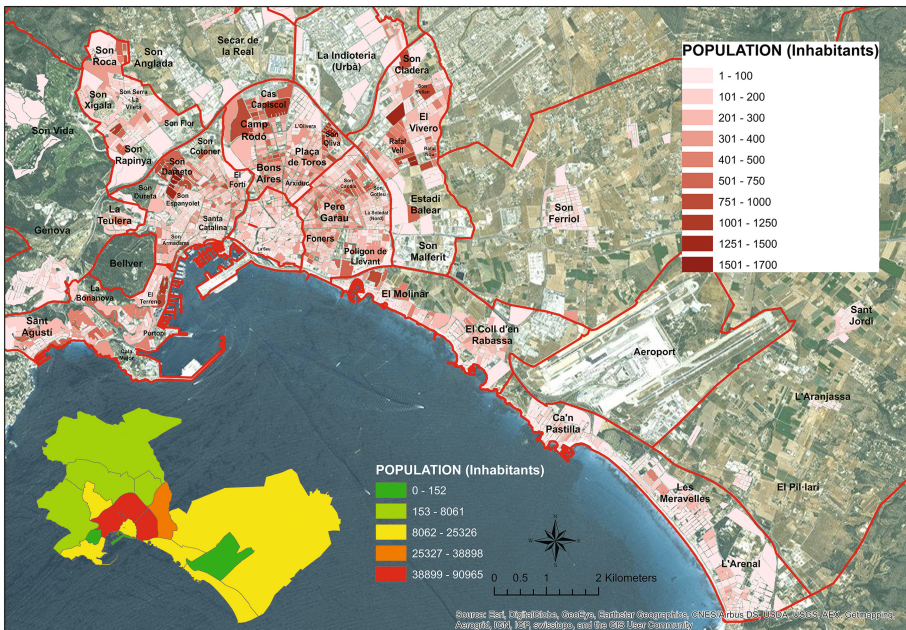

Fig. 2. Distribution of the resident population by urban block and urban zones.

Potential demand of tourism

We are going to relate the demand for transport with the location and the number of tourist seats as both regulated and non-regulated supply.

The regulated tourism supply in the city of Palma comprises a total of 237 establishments (apartments, hotels) with a total of 46,000 seats (Conselleria de Turisme, Govern de les Illes Balears, 2015) located mainly in the coastal urban areas in the east and west (Fig. 3a). They are two mature tourist destinations of the city that began their activities in the 50 s. Currently they are in a process of reforming and restructuring. They receive a majority of tourism for "Sun and Beach", which presents strong seasonality that determines its economic dynamics and transportation needs.
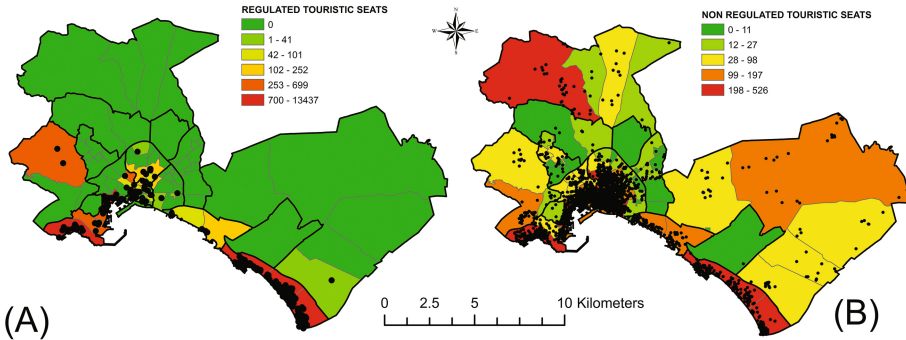
Fig. 3. Location of regulated tourist seats (a) and un-regulated seats (b)

The most central urban areas of the city, including the historic centre, have urban tourism, with high purchasing power staying in hotels, many of them newly built. This tourism sector is more oriented to shopping activities, dining and cultural activities. It is less seasonal and is more constant throughout the year. This tourism generates continuous economic activity in the city and has a moderate impact on bus transport demand.

The supply of apartments and houses for rent through the internet in Palma has experienced significant growth in recent years. This type of residential supply represents a total of 9,246 seats (only on the AirBnb platform) that are geographically much more dispersed than the regulated tourism supply (Fig. 3b). In this case, its location is not concentrated only in coastal urban areas; rather, it covers larger areas of the city. Specifically, the historical district and the first urban expansion are the preferred location. They also highlight the extensive developments located in the northwest area of the city.

Figure 4 shows the integration of the regulated and non-regulated tourism supply. A large concentration is observed in coastal areas but the supply is also widening to the West, extending into rural and natural areas of the municipality.
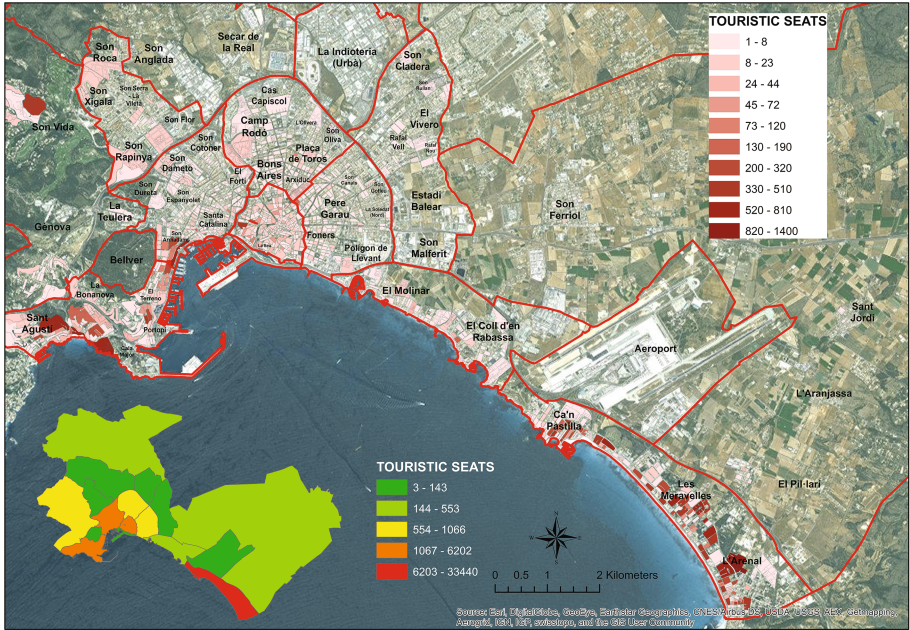
Fig. 4. Tourist seat supply, regulated and non-regulated

The occupancy rate of regulated tourism in the summer months can reach 75% capacity (Tourist occupation tables, Balearic Islands Institute of Statistics, Autonomous Community) so it is a burden of some 35,000 more people in the city who are potential users of the public transport
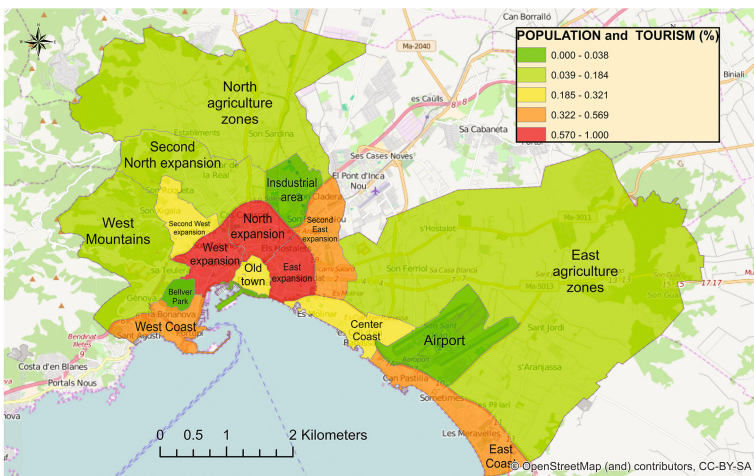

Fig. 5. Integrated potential demand for public transport: population and tourism.

Integrated potential demand: resident population and tourists seats
Figure 5 shows the potential demand for public transport integrating the resident population and tourist seats. First, the demographic burden of the neighbourhoods of the expansion appears to be high, which would represent the strong demands of the resident population. The coastal urban areas that show strong potential for tourism demand. The lowest values of potential demand are given in outlying rural areas.

4.2   Analysis of Bus Service Level Public Transport

The geographical distribution of public bus services in Palma is inhomogeneous; some areas have high levels of service where others have less. The concentric radio mode of the city configures the graph of the roads of Palma. This geographic pattern concentrates a high level of service at the city centre (Fig. 6).
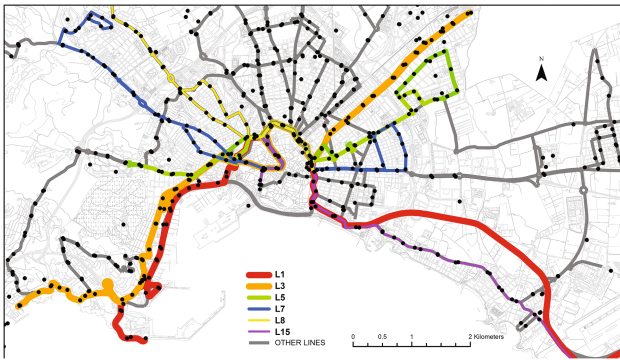

Fig. 6. Main bus lines of the city

The Moran index analyses the spatial autocorrelation of the pattern of a variable. In the case of service level, the Moran index reaches a value of 0.8, which indicates a remarkably concentrated pattern.

The low-level values of service appear at the peripheral rural areas of the city. The West Coast and the East and West zones of the second city beltway have slightly higher levels of service (Fig. 7).

4.3   Analysis of Imbalances and Level of Equity of the Bus Public Transport

Imbalances between supply and demand
Remarkably, the distribution of bus services in the city of Palma is adjusted to the potential demand of the resident population. A Pearson correlation value of 0.873 between the level of service in urban areas and the population (Table 1) is obtained. However, significant gaps are observed with excess service in the old town due to the concentric arrangement of bus lines in sparsely populated areas of the Northwest area
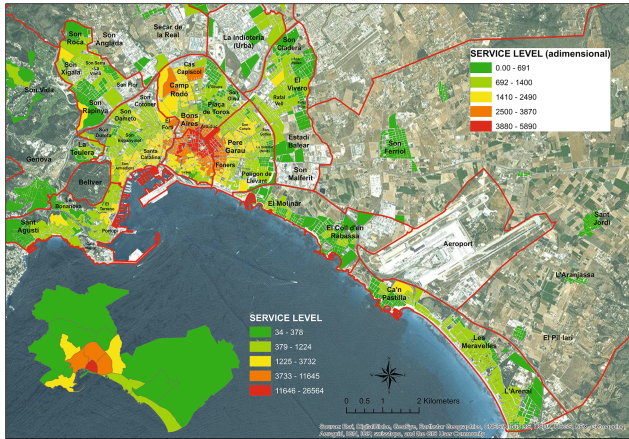
Fig. 7. Bus service level

of the city (Fig. 8A). High service needs are detected in the urban zones of the city that are more densely populated.

The balance is different for regulated tourism and non-regulated tourism. The first has less of a correlation with the level of service (r = 545), and deficits appear in the tourist coastal areas. In contrast, the service is more suited to the range of non-regulated tourism supply (r = 681). In this case, there are no significant deficits observed. This occurs because these areas largely fit with the geographical distribution of the resident population, and many of them are concentrated mainly in the old town.

The integrated potential demand (population and tourism) shows imbalances and deficits in all coastal tourist areas. The historic centre and less populated areas continue to have excess service.

The results show that the tourism potential demand is not sufficiently covered by the service supply, so an overload is generated in the system. This has special relevance during peak season.

Table 1. Pearson correlation coefficients for urban areas: analysis of variables.

	Service level	Potential demand population	Potential demand regulated touristic seats	Potential demand no regulated touristic seats	Potential demand touristic seats	Integrated potential demand population and touristic seats
Service level	1.000	0.873	0.545	0.681	0.654	0.825
Population	0.873	1.000	0.488	0.694	0.632	0.917
Tourist_Seats	0.545	0.488	1.000	0.860	0.934	0.575
AirBnb_Seats	0.681	0.694	P0.860	1.000	0.956	0.730
Tot_Tourism	0.654	0.632	0.934	0.956	1.000	0.671
Tot_Pop	0.825	0.917	0.575	0.730	0.671	1.000
Commercial	0.855	0.902	0.637	0.747	0.708	0.855
Sum_Commercial	0.830	0.840	0.489	0.607	0.543	0.790

The urban tourist areas account for nearly 85% of the tourist destinations. However, it is found that bus services for all these areas do not reach 7% (Table 2). The east and west coasts account for 73.77% of the regulated tourist destinations and have a service level of 1.82%. The resident population in tourist areas (10 of the municipality) does not reach the levels of service in other urban areas in more central urban areas.
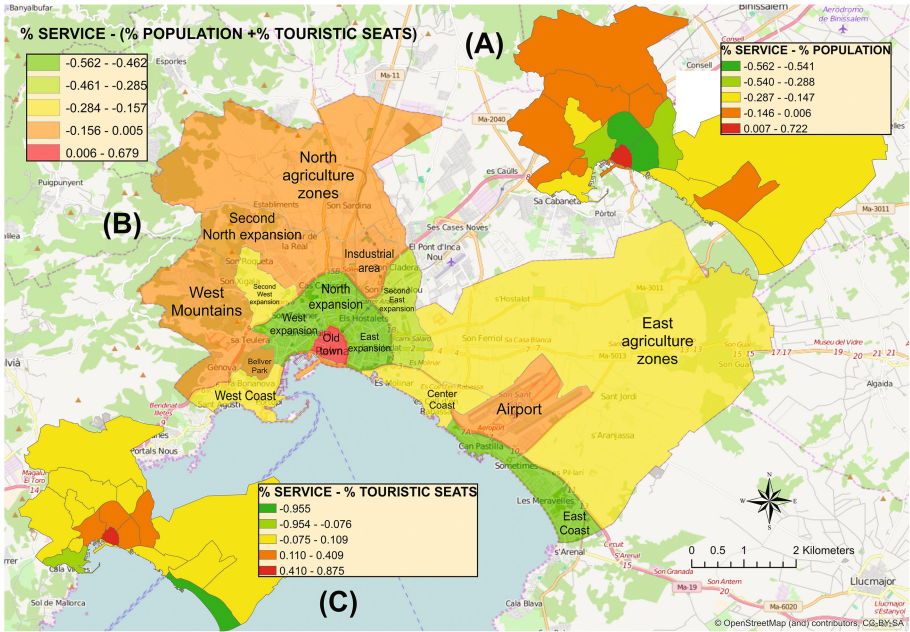

Fig. 8. Distribution of imbalances between service level and potential bus demand

Equity in the level of service

The Gini coefficient results show that the transport service for the resident population has a moderate level of equity (0.399) because bus services are concentrated in the centre of the city but the population has heterogeneous distribution patterns. Greater equity is observed in the relation between service levels and the pattern of unregulated tourism (0.253). The largest imbalance is shown for regulated tourism and level of service (0.692) because the supply is concentrated mainly in coastal areas. This confirms that the concentration of hotels and apartments in coastal urban zones unbalances the public transport model of the city. Conversely, non-regulated tourism gives stability to the transport service of the city. Its dispersed pattern is more adapted to the current transport supply. The integration of both variables (resident and tourism) does not yield significant equity results (0.424), but instead confirms the above results.

Table 2. Level service and potential demand in urban zones (%)

	Service level	Potential demand population	Potential demand regulated touristic seats	Potential demand no regulated touristic seats	Potential demand all touristic seats	Integrated potential demand population and tourist seats
Old town	39.44	6.01	3.41	28.73	7.81	20.48
East expansion	17.29	21.60	0.44	8.37	1.82	5.64
North expansion	10.73	17.53	0.91	7.18	2.00	24.63
West expansion	12.60	15.85	8.51	13.65	9.40	22.80
2nd east expansion	5.54	9.24	0.00	0.82	0.14	6.06
2nd north expansion	0.35	1.25	0.00	0.28	0.05	0.00
2nd west expansion	4.50	5.85	0.00	1.55	0.27	2.49
East agriculture zones	0.14	3.90	0.09	5.11	0.96	0.59
North agriculture zones	0.26	1.91	0.00	3.14	0.55	0.21
West mountains	0.56	1.11	1.18	2.39	1.39	0.14
West coast	4.37	5.55	11.39	12.75	11.63	2.49
Centre coast	1.64	4.83	0.59	3.19	1.04	12.92
East coast	1.82	4.48	73.47	11.41	62.70	1.52
Airport	0.05	0.04	0.00	0.03	0.01	0.00
Harbour	0.29	0.01	0.00	1.15	0.20	0.00
Industrial area	0.26	0.83	0.00	0.06	0.01	0.03
Bellver Park	0.17	0.00	0.00	0.18	0.03	0.00

5 Conclusions

Public transport planning in tourist cities should include both potential demand for the resident population as well as the potential demand from tourism, both regulated and non-regulated.

Tourist activity generates additional pressure on certain lines of public transport that need to be analysed and properly managed to ensure fairness of service.

The morphological structure of the road network of cities greatly affects public transport models and can lead to structural imbalances in the supply of services that can be increased with the location of the hotels in outlying areas.

The regulated tourism tends to be concentrated at certain places, especially in coastal cities, causing specific needs of public transport. The tourist supply non-regulated tends to have a more balanced distribution model in the territory so it is better suited to the existing transport supply.

In any case, tourism demand can overload the public transport system if is not properly planned and lead to imbalances in the service.

The results obtained in this study may have implications for transport planning at a strategic and operational level. The social equity and service level indicators proposed could help decision-making in transport planning by detecting territorial imbalances in the service level for the resident population and for the tourist population (regulated and non-regulated) also taking into account the seasonality of the tourist activity. It is important to note that the integration of the demand for public transport generated by the tourism sector requires the revision and redefinition of the concepts of public service and social equity by planners and managers. It is necessary to provide transport services to tourists without any decrease of the quality of transport service for the resident population. Tourist planning and public transport planning must be properly coordinated by adapting the service to the true needs of residents and tourists [4–6, 14]. This adaptation must necessarily include a model of economic management shared between the public administration and hotel companies.

Sustainable and innovative solutions must be provided to seasonal demand increases, avoiding spatial and temporal imbalances. The dynamic design of routes, the optimization of stops, the adaptation of the size of the bus fleets, the management of frequencies and headways, the promotion of intermodal transport, etc. are actions to be considered in order to provide flexibility to the service of public transport and improve the integration of tourist transport. The main objective is to guarantee the social, economic and environmental sustainability of public transport through a participative governance model that optimizes the integration of the tourist activity within the city without impairing the services to the resident population.

In the case study of the city of Palma, we can point to the following conclusions:

- The radio-concentric city structure determines a radio-diametrical transport service that generates imbalances between central and peripheral areas. There is a strong correlation between the level of public transport and the potential demand resulting from the resident population; nevertheless, significant differences exist in terms of excess service (the Old Town) and default service (in the beltway zones and the largest area in terms of tourist resort concentration in the east of the city).
- The potential demand generated by tourism shows imbalances with the current supply of transport. The location of tourist facilities in outlying areas of the city requires a higher level of service and disrupts the transport model.
  In this sense, we see imbalances generated by the supply of regulated tourism and competition between residents and tourists for the use of the public transport. The urban area that makes this problem more evident is the east coast of the city (s'Arenal), which was the first area of tourist concentration in the municipality of Palma, developed beginning in the 50 s.
- The demand for transport from unregulated tourism is distributed more evenly in the city and fits with the existing transport model. The tourist seats are located in

dwellings scattered throughout the municipality, which mitigates the effects of this seasonal tourist population on public transport.

Finally, it should be noted that geographic information systems combined with statistical analysis are a powerful methodological tool to diagnose the transport model of a city, integrate supply and demand and support decision making.

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