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A GIS-Based Evaluation of the Effectiveness and Spatial Coverage of Public Transport Networks in Tourist Destinations

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Abstract: This article develops a methodology for evaluating the effectiveness and spatial coverage of public transport in tourist cities. The proposed methodology is applied and validated in Cambrils municipality, in the central part of the Costa Daurada in Catalonia, a coastal destination characterised by the concentration of tourism flows during summer. The application of GIS spatial analysis tools allows for the development of a system of territorial indicators that spatially correlate the public transport network and the distribution of the population. The main novelty of our work is that this analysis not only includes the registered resident population, but also incorporates the population that temporarily inhabits the municipality (tourists). The results of the study firstly permit the detection of unequal spatial accessibility and coverage in terms of public transport in the municipality, with significant differences between central neighbourhoods and peripheral urban areas of lower population density. Secondly, they allow observation of how the degree of public transport coverage differs significantly in areas with a higher concentration of tourist accommodation establishments.

Keywords: public transport; spatial coverage; tourism; seasonality; geographic information systems

1. Introduction

The extensive growth of cities in recent decades, combined with the sustained increase in daily mobility, has meant a rise in the use of mechanised means of transport in urban areas, as well as the generation of high levels of traffic congestion and a severe environmental impact. At a time of growing concern for global warming, an increased use of public transport is seen as part of the solution [1], and an effective way of reducing external costs and the negative effects of motorised travel [2]. The relationship between transport and environmental, social and economic sustainability has been explored by a number of researchers [1,3–8].

In this context, one of the strategic objectives of many city governments is to promote the substitution of the use of private motorised vehicles with other systems that have a lower impact on the environment, the economy and public health, such as public transport, walking or cycling [9]. However, organising an alternative user-friendly transport system that is effective in providing services and facilities that can guarantee the shortest possible travel and waiting times [10] is not a simple process. A public user-friendly transport system requires consideration of crucial aspects such as accessibility to stops/stations, system mobility and connectivity with other transport modes [11]. The spatial equity of transport systems impacts on economic dynamics, personal opportunities and, ultimately, the quality of life of the population [12,13]. In other words, poor planning of territorial coverage can lead to situations of social disadvantage. In this regard, the contribution of GIS in the field of Transport Geography is more than a simple control of generic functionality [14]. GIS offer key possibilities in transport modelling [15], facilitating the storage, updating and processing of spatial data and allowing the planning, analysis, control and management of transport networks.

Numerous and widely varying research studies have used GIS tools to analyse and organise transport networks. Blythe et al. [16] examined the wide range of emerging technologies and techniques capable of integrating different public transport modes and services at urban and inter-city scale in order to improve the attractiveness and competitiveness of public transport networks to the detriment of the use of private vehicles. Arampatzis et al. [15] presented a GIS-based decision support system (DSS) to analyse and evaluate different transport policies with the purpose of improving environmental and energy efficiency in the supply of transport. Different characteristics of public transport, including spatial coverage, frequency, comfort or fleet adaptation for disabled persons, may require special analysis, given that they provide an understanding of the efficacy and equity of the service provided for the citizens. Along these lines, Murray [7] identified the inefficiencies of the coverage of access to public transport in the city of Brisbane using GIS-based spatial analysis techniques. Moro and Villaescusa [17] studied spatial accessibility to primary schools in Bilbao, basing their work on the hypothesis that the criteria used to assign students to schools were not the most appropriate, with some students possibly being forced to commute for longer spatial and temporal distances than necessary. Salado et al. [18] proposed a set of indicators related to measurements of the equity and efficiency of the urban public transport service of the city of Alcala de Henares (Madrid). Saghapour et al. [2], in the city of Melbourne (Australia), developed a new measure of accessibility to public transportation that integrated transport service frequencies and population density. The results show that the use of public transport is substantially higher in areas with a higher rate of accessibility. Delmelle and Casas [19] evaluated the spatial equity of the express bus transport service in the city of Cali (Colombia) by means of exploration patterns of accessibility in relation to the socioeconomic level of the city neighbourhoods. They demonstrated that transport network accessibility was higher for middle-class neighbourhoods than for those of higher and lower socioeconomic classes. Cardozo et al. [20] analysed the relationship between urban and socioeconomic variables and the demand for public transport in the subway system of Madrid.

Other interesting and particularly innovative applications have been developed by Benenson et al. [21] and Stenneth et al. [22]. The first presented an extension of ArcGIS©, Urban.Access, which allows to estimate and compare the accessibility of different modes of transport to the workplace and other places of interest. Meanwhile, the second proposed a methodology for identifying user mode of transport by means of GPS sensors in their mobile devices and knowledge of the transport network (real-time bus location; spatial information of the railway line, and spatial data about bus stops and stations).

However, limited research exists involving the use of GIS tools for studying the impact of floating populations in mobility analyses and transport planning. This is mostly due to the difficulty of quantifying tourist population flows and the areas where they tend to be concentrated. Among recent works that have incorporated this perspective, special mention should be given to the Xue et al. [23] study in the city of Singapore, where automatic learning techniques were applied using public transport data provided by the Terrestrial Transport Authority of Singapore to identify tourists using public transport. In another study, Rendeiro and Suarez [24] proposed a methodology to assess the impacts of tourist mobility on the island of Lanzarote, and the implantation of a tourist route that would reduce contamination while at the same time satisfying the mobility needs of the tourists.

The pressure on urban and regional transport systems has become a critical issue in tourist cities [25,26]. The concentration of users in periods of greater influx entails a strain on services and an in-depth reconfiguration of urban and regional mobility patterns. For instance, tourist activity along the European Mediterranean coast, given its natural conditions as a "sun and beach" destination, is principally concentrated in the summer period. There are very significant differences between high season and the rest of the year in terms of number of passengers and mobility patterns. Any strains on the system and any negative externalities are heightened by this concentration and polarisation, which become a major challenge for public transport operators. In this regard, the main challenges associated with tourist mobility at tourist destinations can be categorized into three key areas for consideration: (1) the strategic importance of local public transport to guarantee the competitiveness of the tourist destination [27,28]; (2) the impact of tourism on local transport and the need to implement measures to guarantee that it does not imply a decrease in the quality of the service provided to the local population [29]; and (3) the contribution of local public transport to promote more sustainable mobility patterns in tourist destinations which help to mitigate any environmental impact that may be caused by the increased flows [8,30–32].

From this context, the aim of this study is to validate a methodological proposal to assess the effectiveness and spatial coverage of public transport in tourist destinations. Coverage analysis of public transport networks has diverse applications in transport planning [33]. Generally, spatial coverage analyses the physical accessibility of the supply and the adequacy of the distribution of stops or stations to cover the demand [34]. The more people that reside and/or are employed in close proximity to a bus stop or station, the greater the likelihood that the service will be used [35,36]. In this sense, several studies have been developed to evaluate the spatial coverage of public transport networks and to assess the distance-measure impacts on the calculation of transport service areas [33,37,38]. Other studies, such as the ones developed by Murray, propose models for identifying inefficiencies in public transport access coverage in order to improve the use of public transport provision [7,39]. Some theoretical and ex-ante approximations have underlined the importance of considering the impact of tourism on local transport systems [26,40,41]. However, as mentioned previously, there is a notable lack of studies which focus on public transport networks at inframunicipal scale and which specifically analyse the relationships between tourism and the effectiveness of public transport at tourist destinations using spatial coverage approximation. Even more specifically, there is a lack of studies that include the floating (tourist) population in their calculation of public transport coverage. Hence, the main novelty of our study is the incorporation into the analysis of both the resident and floating (tourist) populations. For this, we used data on the registered resident population by means of the geolocation of their postal addresses, as well as data concerning the occupancy of the different official tourist accommodations in the case study area (hotels, camping sites and tourist apartments). Using GIS, an analysis was made of the extent of the public transport network coverage for the two population groups. The municipality of Cambrils (Camp de Tarragona, Spain) on the Costa Daurada (one of the main coastal destinations of the Spanish Mediterranean) was used as a case study.

The literature analysing the effect of seasonal tourism on mobility in European cities has tended to focus on the study of large urban areas. Some case studies have been used to analyse mobility and public transport in cities with a significant tourism pressure [28,29,42–45]. However, the impact of tourism seasonality on public transport networks in coastal tourist cities remains a field that has been studied little [26,27]. Coastal tourist cities have become established during recent decades as the territories with the greatest capacity to attract new residents and economic activity, especially that related to the services sector [46]. Within these urban areas, tourism activity has become a key variable that determines their evolution and, furthermore, the reconfiguration of metropolitan dynamics [47]. Previous studies on mobility and regional dynamics in Camp de Tarragona (the region in which Cambrils is found) have shown that the number of passengers in summer on the intercity bus lines increases by 441% (data from 2013 [48]) compared to winter [31]. Moreover, the marked seasonality of tourism requires reformulation of the functional hierarchies of the whole region, placing the coastal towns as the epicentre of regional mobility flows as they become not just mass tourist destinations, but also the main regional job and leisure centres [48].

In this sense, the present study aims to contribute to this field using evidence gathered in the case of Cambrils, a coastal municipality that in summer experiences a growth of 553% (data from 2013 [48]) in public transport users compared to winter. The study is based on the following initial hypotheses:

(1) The public transport network of Cambrils offers a territorial coverage which differs between the various areas of the municipality. This implies unequal conditions of accessibility to public transport services for the residents and tourist population.
(2) The seasonality of tourism activities in Cambrils implies a significant increase in demand for public transport services during summer. This situation alters the efficacy and spatial coverage of the public transport network.

Following the Introduction, we present the scope of this case study (the municipality of Cambrils) (Section 2). Subsequently, in Section 3, we explain in detail the data used, the treatment given to the data to allow geolocation, and the indicators that have been applied. In Section 4 we present and discuss the results. Finally, the article ends with the main conclusions derived from these results.

2. Methods

An efficient spatial coverage of public transport is understood to be one that favours the access of citizens to transport services and ensures the connection between journeys at intra and inter-city scale. In order to study the level of achievement of these findings in a tourist destination, an evaluation system has been designed of the spatial coverage of public transport facilities in relation to the amount of potential population that can access them. Specifically, in the designed evaluation system (see Table 1), indicators have been incorporated to evaluate public transport conditions in terms of the spatial coverage of the network for the resident and tourist population (supply and quality), and to measure the degree of network accessibility (interconnectivity, intermodality). These indicators were previously proposed by Salado et al. [18] and were applied in the evaluation of the Alcala de Henares (Spain) public transport network. In our case, we have updated their proposal by incorporating the seasonal population in the analysis and by including a new indicator of interconnectivity (number 4: Drift Index), which allows measurement of the extra time that the urban buses require to connect the different transport areas (see Figure 1) compared to the shortest possible route with the use of private transport.

Table 1. Indicators system.

Typology		Indicator
Supply/Quality	1	Stops/1000 inhabitants
	2	Population percentage with bus stop/s at less than 200 m
Interconnectivity	3	Population percentage with multimodal stops at less than 200 m
	4	Connectivity between TA (Transport Areas): Drift Index
Intermodality	5	Population percentage at less than 500 m from an intercity bus stop

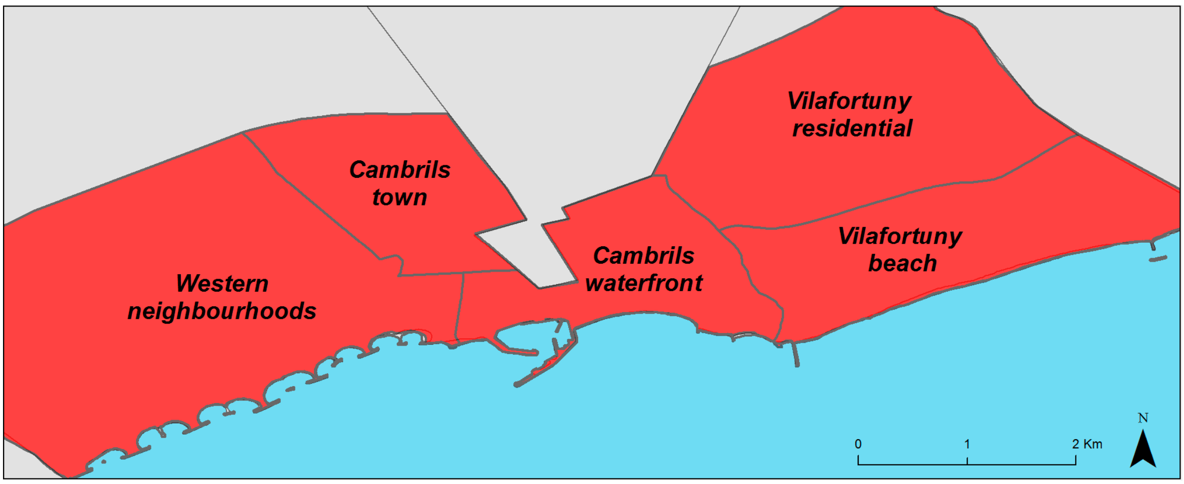


Figure 1. Transport Areas (TA) of Cambrils. Source: Own elaboration.

Although seasonal population has been taken into account before in other studies to estimate its impact on the demographic and economic structure of rural areas [49], and also to examine the impact of second-home developments on the socio-demographic structure of the population of coastal tourist destinations [50], a lack of studies has been detected on public transport networks at inframunicipal scale that specifically analyse the relationships between tourism and the effectiveness of public transport at tourist destinations using spatial coverage approximation. The present study contributes to this field.

With the objective of allowing a comparative analysis between the different areas of the city, we defined five functional and spatial units (see Figure 1) consisting of Transport Areas (TAs). We have used four main criteria for their definition. First, they correspond to five areas clearly differentiable in terms of urban morphology and functionality. Second, the characteristics of the housing and the built environment are especially differentiated between the established zones. Each has been developed in a different historical context (the more peripheral the neighbourhood, the more recent its development). Third, the distribution of the regulated tourist accommodation in the city is diverse. It is concentrated mainly along the waterfront, which suggests it should be split from the rest of the city in each area. Finally, the five TAs correspond to the delimitation of districts defined by the City Council, which also determines that the public transport network is articulated through a radial system based on its five neighbourhoods conception (see study area, Section 3, for more detail).

All the proposed indicators, except number 4, were applied twice, firstly only taking into account the resident population and secondly also including the seasonal population.

Below is a summary of the characteristics, the calculation method and the meaning of the interpretation of the numerical values for each of the indicators.

Type of indicator	Supply/quality
Indicator 1	Stops/1000 inhabitants
Description	
Discriminates between different supply levels. If the differences between transport areas are slight, this would indicate that Cambrils enjoyed relative spatial coverage in terms of access to the public transport service. $$\text{Ind } 1 = \frac{\text{No.of stops\_TA}}{\text{total population\_TA}} \times 1000$$	
Data gathering procedure	
1. Each bus stop is assigned the TA where it is located. From the resulting information, we extracted the total number of stops for each TA, and these data were associated in the *zonas_transporte.shp* layer. 2. Similarly, each TA is assigned its potential demand. 3. Finally, the indicator is calculated.	
Observations	
The results provided by this indicator do not take into account the typology of the stop, urban or intercity, nor do they contemplate the frequency of the bus passing through each stop.	

Type of indicator	Supply/quality
Indicator 2	TA population percentage with bus stop/s at less than 200 m
Description	
To the time consumed during a bus journey, a user adds the time needed to arrive on foot to the nearest bus stop. For this reason, this indicator of spatial coverage includes the percentage of the population within each TA located at less than 200 m (about 2 min on foot) from any bus stop. $$\text{Ind 2} = \frac{\text{total population 200 metres}}{\text{total population\_TA}} \times 100$$	
Data gathering procedure	
1. For each bus stop, we calculated a walkable distance of 200 m (service area) through the road network using the "Network Analyst" of theArcGIS 10.3© software. We decided to calculate a service area through the road network in order to avoid overestimation errors (Gutiérrez and García-Palomares 2008). 2. Subsequently, we quantified the population (residents + tourists) at the postal addresses within these 200 m areas. We then added the information to the table of attributes of the transport zones. 3. After adding this information to the TA layer, we calculated the percentage of the population within each TA located at less than 200 m (about 2 minutes on foot) from any bus stop.	
Observations	
Similar to the previous indicator, this also did not establish differences between typologies of services, nor did it consider the bus frequency. In addition, it assumed that the nearest stop belonged to the bus line that the user needed.	

Type of indicator	Interconnectivity
Indicator 3	TA population percentage with multimodal stops at less than 200 m
Description	
In a similar manner to the previous indicator, this indicator shows the proportion of the inhabitants of each TA with easy access to bus stops used by two or more bus lines.	
Data gathering procedure	
1. For each multimodal bus stop, we calculated a walkable distance of 200 m (service area) through the road network of Cambrils using the "Network Analyst" of the ArcGIS 10.3© program. 2. The analysis only takes into account multimodal stops. 3. We quantified the existing population at the addresses included in these 200 m areas. We then added the information to the table of attributes of the transport zones. 4. After adding this information to the TA layer, we calculated the percentage that it represented over the total population.	
Observations	
This indicator complemented the two previous indicators. This study decided not to consider the multimodal stops in function of the frequencies and destinations of the different urban and intercity services. This would be an interesting option for studies with a special focus on intermodal practices.	

Type of indicator	Interconnectivity
Indicator 4	Connectivity between TA: Drift Index
Description	
This indicator measures the extra time that urban buses require to connect the different TAs in comparison to the shortest possible journey if using a private vehicle. For its calculation we used, for both the public transport network as well as the road network, the minimum possible time between the centres of gravity of the TAs. The formula applied is called the modified Drift Index: $$\text{Ind.4} = \frac{\text{Txy}}{\text{TVxy}}$$ where Txy is the actual travel time by public transport + the average walking time from the postal addresses to their assigned bus stop; and TVxy is the minimum journey time by means of the road network using a private vehicle + the parking time	
Data gathering procedure	
1. Calculation of two centres of gravity for each TA by means of the distribution of addresses weighted by the number of resident and tourist inhabitants and using the "Location-Allocation" tool of the Network Analyst (Figure 9 shows the centres of gravity of each TA.). Each centre corresponds to a bus stop and every postal address has a stop assigned depending on the TA to which it belongs and its location inside this TA. 2. Calculation of the average time walking from each postal address to its assigned stop, only taking into account those located at less than 500 m. 3. Creation of the time matrix using the "Shortest Path Network" procedure (which allows calculation of the time between all origins/destinations). To calculate the shortest route by private vehicle we considered the entire Cambrils road network, and to calculate the shortest route by bus we considered the public transport network bus itineraries. Travelling time should take into account the number of stops that have to be made along the route, the waiting time at each stop, and the number of metres that a user must walk from the centre of gravity to the nearest bus stop. 4. Calculation of the Drift Index.	
Observations	
When people travel by bus they tend to include in the total journey time the time spent on foot to reach the bus stop and the destination. For this reason, we decided to add to the time travelled by bus, the average walking time covered by the user from the centre of gravity to the bus stop and vice versa.	

Type of indicator	Intermodality
Indicator 5	TA population percentage at less than 500 m from an intercity bus stop
Description	
Application of this indicator allows determination of how easy it is for the resident population of the different areas of the city to access intercity transport. We considered a walkable distance of 500 m from each stop (approximately 8 minutes on foot). The longer distances and times employed for this indicator compared to those used for urban buses (200 m and 2 min) reflect the longer journey times and distances associated with intercity mobility.	
Data gathering procedure	
1. For each multimodal bus stop, we calculated a 500 m service area using the "Network Analyst" of the ArcGIS 10.3© program. 2. Subsequently, we quantified the existing population (residents + tourists) at the addresses included in these 500 m areas. We then added this information to the table of attributes of the TAs. 3. After adding this information to the TA layer, we calculated the percentage that it represented with respect to the total population of each TA.	

3. Study Area

In just over 30 years, the population of Cambrils has increased threefold to a total of 33,660 registered inhabitants in 2014. Along with this increase in the resident population, Cambrils has attracted an ever growing number of tourists, becoming a major centre for tourism on the Costa Daurada in Catalonia (Spain). The seasonal character of tourism in the area is a structural feature of the economy of the Mediterranean coast and a defining characteristic of the municipality. The increase in tourist activity during the high season (June to September) generates an important influx of tourists that significantly increases the population load that the municipality has to handle.

Cambrils forms part of an urban region known as the central area of Camp de Tarragona, comprised of 23 municipalities totalling approximately 375,000 inhabitants and which includes two cities with more than 100,000 inhabitants (Tarragona and Reus). The Tarragona-Reus axis forms a central space for the development of economic activity and the concentration of infrastructures (airport, port, main highways and railways). Nevertheless, during the last three decades, the urban centres of the coast have experienced a rapid growth [51], which has led to a redefinition of the historical polarities of this complex urban region, consolidating the Cambrils/Salou/Vila-seca urban continuum as the third most important area in the region (Figure 2b). The coastal centres form part of the so-called Costa Daurada, one of the leading tourist destinations along the Spanish Mediterranean coast. In this context, the towns of Cambrils, Salou and Vila-seca have a high concentration of tourists and make up the area known as the Central Costa Daurada. According to data published by the Costa Daurada Tourist Studies Foundation, these coastal centres welcomed more than 4.6 million tourists in 2014.

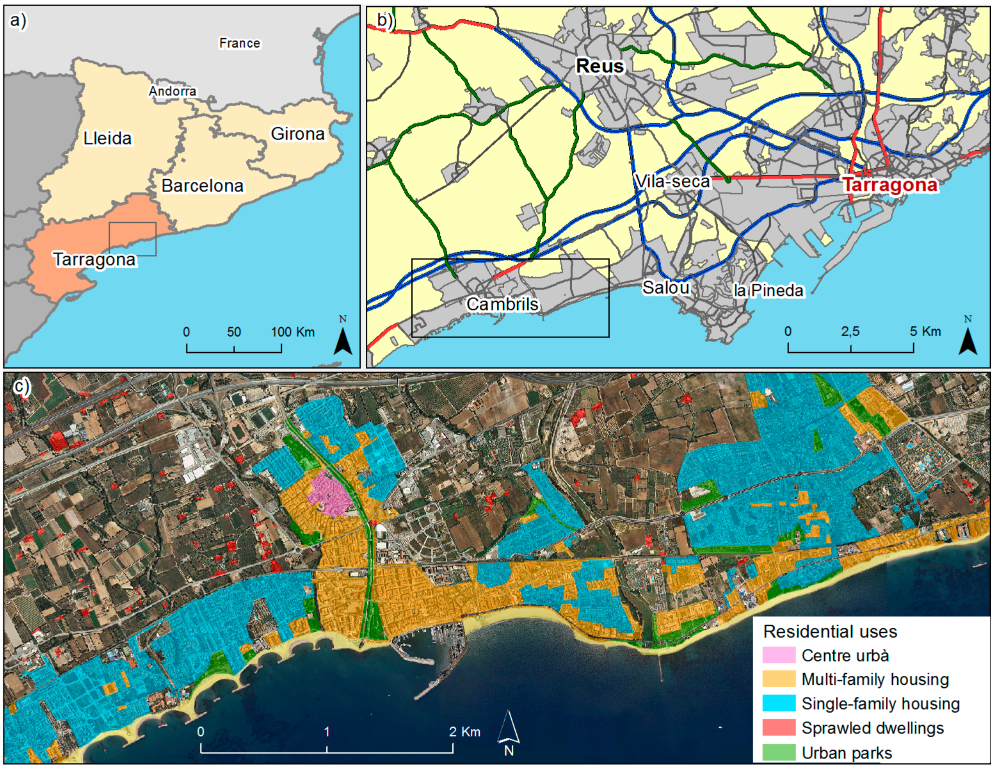


Figure 2. Study area: (**a**) The province boundaries of the Autonomous Community of Catalonia (Spain)—the study area is located in the southern province, Tarragona; (**b**) the Central Costa Daurada area; and (**c**) the characteristics of the urban fabric of Cambrils.

The city of Cambrils extends along the coast. It is characterised by a more compact urban fabric in the centre, where multi-family housing units predominate and therefore higher population densities, and by a more sprawled urban fabric at the peripheries, where single-family residences are located in neighbourhoods to the east and west (see Figure 2c). These urban peripheries correspond to suburbs developed during the last three decades. As can be seen in Figure 3, the eastern coastal area (Vilafortuny beach) is characterised by the presence of a large number of hotels and tourist apartment buildings for holiday use, while "Vilafortuny residential" and the "western neighbourhoods" are areas of lesser population density and with a clear predominance of single-family housing. The main difference between these two areas is the greater predominance of primary residences in "Vilafortuny residential", whereas in the west, holiday residences predominate. As we shall see, clearly diverging population distribution patterns between the different Cambrils neighbourhoods can be derived from these characteristics.

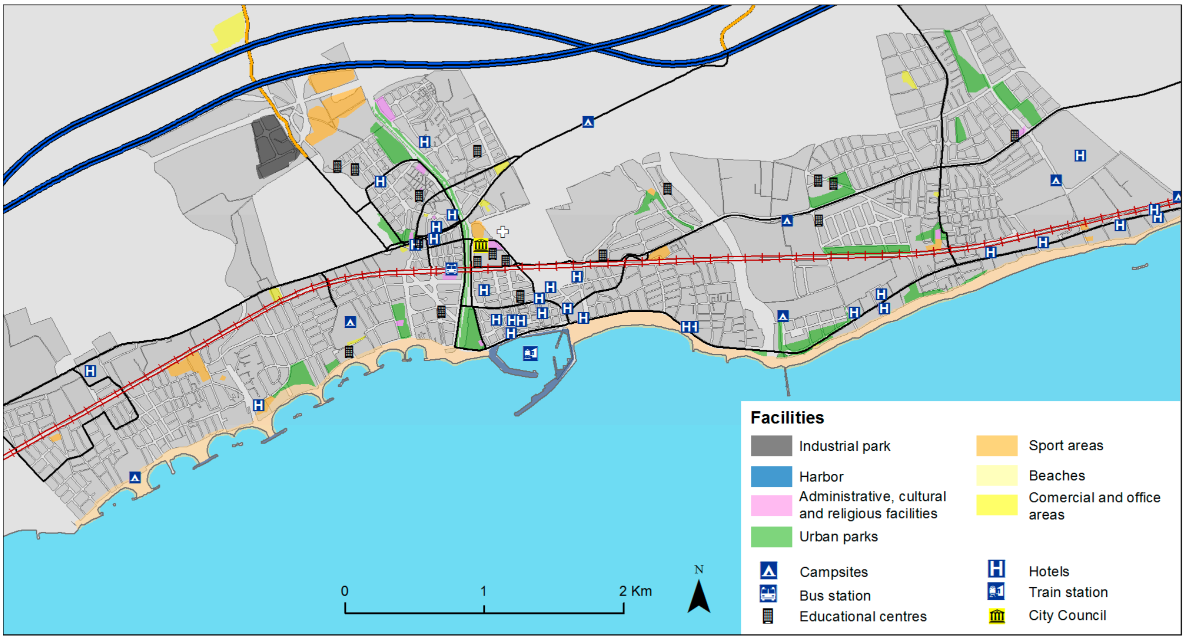


Figure 3. Representation of the different facilities in Cambrils.

In the centre, where the urban fabric is more compact, there is a higher accumulation of facilities for the residential population, including schools, administrative, cultural and religious centres, as well as health care facilities and shopping areas.

4. Data

4.1. Urban and Intercity Georeferenced Bus Stops

The first version of the mapping of urban stops was provided by the municipal company APARCAM, while the intercity stops were provided by the Territorial Mobility Authority of Camp de Tarragona (ATMCdT). However, neither mapping system had been adapted to the necessary spatial analysis requirements. Therefore, initially, three shapefiles were available:

1. Stops on the eastern urban route, in both directions.
2. Stops on the western urban route, in both directions.
3. Stops on the intercity route, one direction.

The shapes of the urban stops were simplified by maintaining only one point per stop. Furthermore, we added a feature indicating that we were dealing with urban stops. Similarly, we added to the shape of intercity stops a field indicating the typology of the service. We subsequently merged the three layers. The result was a single layer that contained urban and intercity stops that allowed quickly detecting duplicate stops which were used both for the local and intercity bus services. The duplicate stops were then manually removed and we proceeded to the following classification:

- Unimodal stops: Those used for only one type of bus, named either urban or intercity.
- Multimodal stops: Those used for both services, the city bus and the intercity bus.

4.2. Municipal Register of Inhabitants and Reference Map

The Municipal Register of Inhabitants of 2014 was provided by Cambrils Town Council. This record allowed the association of each registered inhabitant with a postal address. In order to associate the corresponding records of each of the 33,660 inhabitants, it was necessary to standardise the database and the reference map. Organising the data in this way, it was possible to count the number of people registered at each postal address.

Subsequently, we linked the data to the open access map provided by the *CartoCiudad* project run by the National Geographic Institute of Spain, which is freely available for download (http://centrodedescargas.cnig.es/CentroDescargas/). The layers provided by the project are detailed below:

- municipio.shp: Base map of polygonal type showing the municipal boundaries.
- tramo_vial.shp: Linear map representing road networks.
- manzana.shp: Polygonal type map representing the urban structure of the municipalities by blocks.
- portal_pk.shp: Points map indicating the exact location of the postal addresses and kilometric points.

Afterwards, using the fact that the *tramo_vial.shp* and *portal_pk.shp* layers had a common category (*id_tramo*), they were connected by means of a join. This join made it possible to obtain a single layer with collective information about the road and postal address. Nevertheless, the resulting layer, called vial_portal.shp, contained information about the road and address in separate categories. Therefore both categories were merged. This allowed us to obtain an identical format to that of the Municipal Register of Inhabitants and it was subsequently possible to connect the two sets of data. The new layer (*vial_portal_cambrils.shp*) had 11,258 geolocated records that represented the postal addresses and kilometric points of roads crossing the municipality of Cambrils where habitable buildings could exist. Of these 11,258 records, some had to be discarded and some merged. The reasons and actions taken are described below:

(a) A total of 498 mapped postal addresses did not contain information about the road or simply were not of interest for the study:

- 374 were manually deleted using the "Editor" tool because:
    1. They were in areas that had still not been urbanised but had been assigned a postal address.
    2. They were not of interest for the study since they were isolated buildings outside the urban fabric.
    3. They were postal addresses where no resident population was registered, either because they were business buildings or because the entrance to the building was from another road.
    4. Detailed information was not available for that postal address.
- 124 contained information about the postal address, but not about the road where they were located.

5. For 61 postal addresses, the information of the road was introduced because a housing unit existed and there might have been registered population.
6. A total of 63 were eliminated because no housing unit existed and, therefore, nobody could be registered there.

After these operations, the layer now contained a total of 10,821 records.

(b) Some postal addresses were found to be duplicated. The easiest way to eliminate these duplicates was to "dissolve" them in one register. In this way, the remaining 10,821 postal addresses were reduced to a definitive total of 9600.

Finally, the two databases (the Municipal Register of Inhabitants and the *vial_portal_cambrils.shp* layer) were given the same format, which allowed linking the two tables, with a total of 32,754 inhabitants being satisfactorily linked. The remaining 2.7% lived in rural territory outside the urban fabric, and were not geolocated.

4.3. Seasonal Population

In Spain, the seasonal population data provided by the National Institute of Statistics allow approximate calculations of annual and quarterly averages aggregated at the municipal level. However, the present study was at infra-municipal scale, which meant the distribution of the seasonal population had to be broken down by postal address. For this purpose, we used the occupancy data of Costa Daurada tourist accommodation establishments published by the Tourism Observatory of the Science and Technology Park of Tourism and Leisure of Catalonia. According to these data, and those from the Cambrils Tourist Accommodation Guide, a total of 21,049 tourists could be accommodated each day in the municipality, with 77% of this accommodation being provided by hotels and campsites (see Table 2 for more information).

Table 2. Number of tourist accommodations and their daily offer of beds in Cambrils. Data provided by the Cambrils Tourist Accommodation Guide 2013 and the Tourism Observatory of the Science and Technology Park of Tourism and Leisure (PCTTC).

Type of Accommodation	Number	Beds/Day
4 Star Hotels	8	4867
3 Star Hotels	9	3268
2 Star Hotels	4	498
1 Star Hotels	1	77
Hostels and guesthouses	5	98
Rural cottages	1	35 [1]
Campsites	5	7428
Housing rented for tourist use	1365	4778 [1]
Total	1398	21,049

[1] An average overnight stay of 3.5 people per housing unit has been assumed for tourist use and 2.5 per rural cottage room.

By means of fortnightly surveys, the Tourism Observatory recorded the occupancy rate of licensed tourist accommodation establishments: campsites, tourist apartments, hostels, guesthouses and hotels. Data for occupancy rates of second homes and housing used for tourist use were not reported in the survey and therefore not included in our research. The data on second homes available from the last Population and Housing Census (2011) are aggregated at municipal level. This means that it is not possible to geolocate them at postal address level, as required to apply our method. It could be possible to geolocate most of the unlicensed apartments rented for tourism use (e.g., via AirBnb), but there are no data regarding occupancy rates. Thus, in our study, we used data related to tourist accommodation occupancy in Cambrils during 2014 (the same year as the Municipal Register of Inhabitants) broken down by fortnights and units for each tourist accommodation. The original database was divided into the following 7 categories for each tourist accommodation (see Table 3):

Table 3. Categories of the original database of fortnightly surveys recorded by the Tourism Observatory of the Science and Technology Park of Tourism and Leisure in Catalonia (PCTTC).

Accommodation	Type	Report	Total Capacity	Accommodation Offered	Days Open	Occupancy Rate
Name_Campsite1	Campsite	199	800	800	7	25%
Name_Campsite2	Campsite	199	1050	1050	15	30%
...	...	...	...	...	...	...

The fortnightly data were then grouped together on a monthly basis and three new categories were added with a view to identifying the daily seasonal population occupancy rate of each tourist accommodation for each month:

- Total beds offered: We multiplied the number of beds offered each day by the number of days that the accommodation was open.
- Total overnight stays: With the occupancy rate category, we calculated the total number of overnight stays divided by the total number of beds offered.
- Daily overnight stays: We divided the total number of overnight stays by the number of days in each month to obtain the number of tourists staying on a daily basis in a tourist accommodation establishment in Cambrils.

Using the data from the survey, it was determined that over the course of 2014 a total of 2,072,127 overnight stays were made in licensed tourist accommodation establishments in Cambrils. The seasonal nature of the tourist activity in this region can be observed in the following Figure 4.

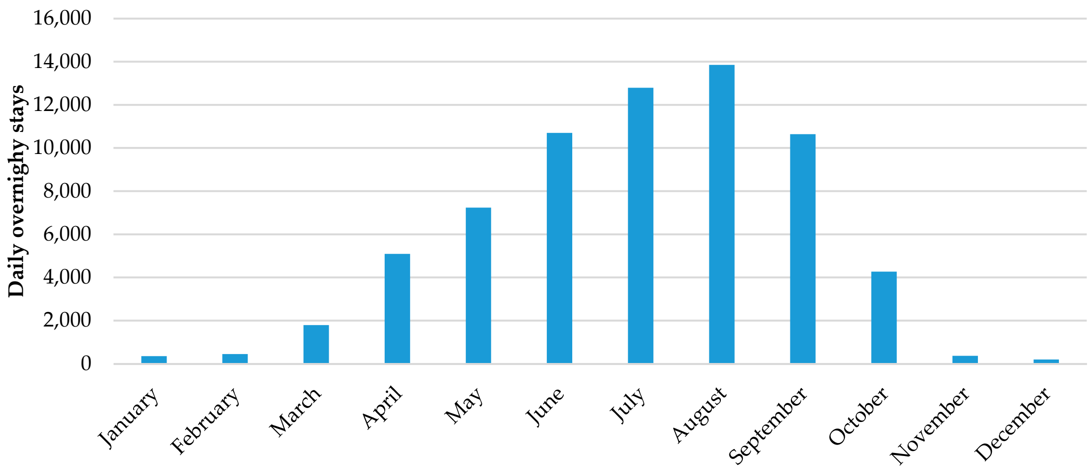


Figure 4. Daily overnight stays per month (2014). Data provided by the Tourism Observatory of the Science and Technology Park of Tourism and Leisure in Catalonia (PCTTC).

The average daily number of overnight stays in summer was about 14 times higher than that in winter. The highest daily occupancy was in August (13,852) and the lowest in December (198).

As the location of each tourist accommodation establishment was known (see Figure 3), as well as the numbers who had stayed at each establishment over the course of the year, it was possible to identify the areas of highest seasonal tourist occupancy.

Figure 5 represents by urban blocks (Figure 5a) the demographic distribution of residents and (Figure 5b) the same distribution with the addition of the extra seasonal population staying in licensed tourist accommodation corresponding to the average overnight stay during the three months of the high season (June, July and August). During the summer of 2014, a total of 1,146,886 overnight stays were made, equivalent to a floating population of 12,447 extra residents for this three month period. The spatial allocation of this floating population was made using the postal addresses of the tourist accommodation establishments and the survey data for occupancy rates.

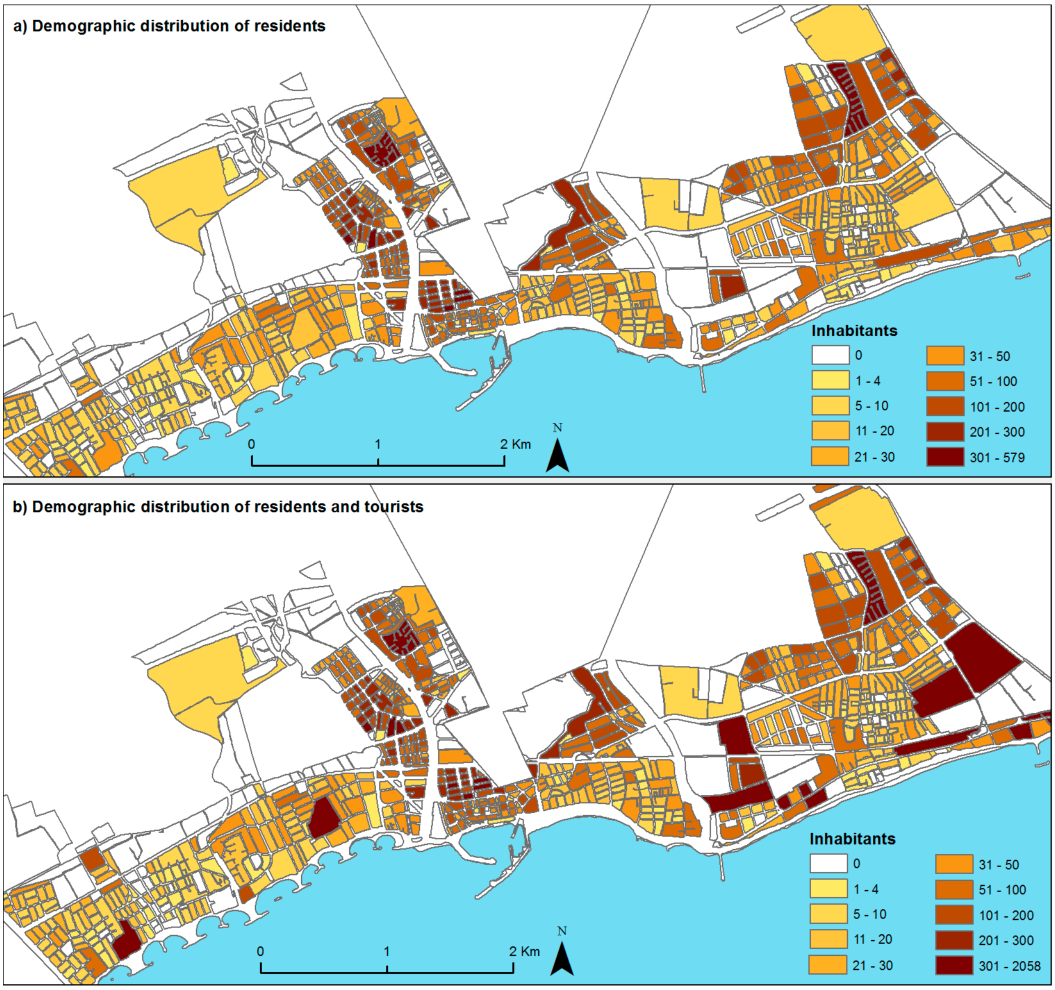


Figure 5. Demographic distribution of Cambrils residents (**a**); and with the inclusion of tourists staying at licensed accommodation establishments (**b**). Note: For reasons of confidentiality, the exact number of tourists staying at each establishment has not been included. Data were obtained from the municipal register of inhabitants (Cambrils City Council), the occupancy survey (Tourism Observatory of the PCTTC) and cartography of "CartoCiudad" project (National Geographic Institute of Spain).

An uneven population distribution can be seen in Figure 5a,b, due to differences in the urbanisation model which fostered the coexistence of a compact urban model and a dispersed model of low population density. The compact urbanisation that can be seen in the central area implies a greater presence of multi-family buildings and a high demographic concentration. This is the case with the town centre, and the waterfront districts. On the other hand, peripheral neighbourhoods in the eastern and western part of the city present a dispersed urban model, with single-family housing and more open spaces. These developments were constructed more recently, and the resident (registered) population is significantly smaller. The seasonal effect in terms of population numbers is particularly noticeable in these areas, and especially to the east where a large number of campsites and hotels are concentrated near the coastline.

5. Results

The urban morphological characteristics of Cambrils condition the structure of its public transport networks and, therefore, the spatial organisation of the service (see Figure 6). The compact morphology of the centre and the radial structure of the transport routes facilitate greater connectivity of the TAs located in the central areas of the city, Cambrils town and Cambrils waterfront. Conversely, the peripheral neighbourhoods (the three TAs located in the areas to the east and west), with a more dispersed urban form, have less accessibility, especially in terms of interconnectivity between them, since the urban bus travel time is much greater. Likewise, the intercity stops, and therefore connection with the outskirts of the municipality, are located in the central and eastern areas, meaning that the population that inhabits the western neighbourhoods remain relatively disconnected from this transport network.

Figure 6. Cambrils public transport network. Source: Own elaboration.

5.1. Public Transport Supply and Quality Indicators

5.1.1. Indicator 1: Stops/1000 Inhabitants

According to the results of Indicator 1, shown in Table 4, Cambrils has an overall ratio of 1.9 stops per 1000 inhabitants if we only take into account the residents, and 1.4 stops per 1000 inhabitants when the seasonal population is added.

Table 4. Results of Indicator 1: Stops/1000 inhabitants.

	Inhabitants			Results	
	Residents (1)	**Residents + Tourists (2)**	**No. of Stops**	**1**	**2**
Cambrils town	12,866	12,980	14	1.09	1.08
Cambrils waterfront	8720	9548	10	1.15	1.05
Vilafortuny residential	4996	5132	7	1.40	1.36
Vilafortuny beach	3033	12,121	11	3.63	0.91
Western neighbourhoods	3139	5425	20	6.37	3.69
Total	32,754	45,206	62	1.90	1.37

Generally, it is considered that a public transport system is spatially equitable when the relationship between network supply and demographic distribution is similar in the different TAs. In the case of Cambrils, if the public transport network is to be considered spatially equitable, all areas should have a ratio of stops per 1000 inhabitants close to the municipal average. However, it can be seen that this ratio varies considerably and even more so if we only consider the registered population when applying the indicator.

Given the radial structure of the Cambrils urban transport system, it can be supposed that the best level of provision will be achieved in the centre. It should also be remembered that the centre is where the highest population densities are found. The values obtained when applying the first indicator, whether considering the tourist population or not, for the two central TAs (Cambrils waterfront and Cambrils town) are around one stop per 1000 inhabitants. In both cases the decrease in rates when the floating population is included is slighter than that experienced for the whole municipality. Nevertheless, Cambrils waterfront TA experiences a higher decrease in the level of provision (from 1.15 to 1.05 stops/1000 inhabitants) when the tourist population is added to the calculations compared with the decrease of Cambrils town TA.

The Vilafortuny residential TA has the lowest number of stops (only seven), but also the lowest population density. Along with the presence of only a few hotels, the subsequent ratio of stops/1000 inhabitants is 1.36. In this case, there is a clear deficit in the service for an area of low population density and less number of stops and, therefore, connectivity of this residential area with the city centre is limited.

The TA where seasonality can most clearly be seen is that of Vilafortuny beach. It has a relatively low registered population (3033), but a significant number of hotels along the coast. When the tourists staying at these establishments are included in the indicator model, the population actually quadruples. As a result, the ratio of stops per 1000 inhabitants decreases from 3.6 to 0.9, and falls below the average. Here, we encounter a different type of problem: tourist activity is concentrated in a TA with a number of stops below the municipal average.

The western neighbourhoods' TA has the highest ratios for this indicator of 3.7 and 6.4 for registered and registered and floating populations, respectively. These high values can be explained as a result of the low population density and small number of tourist accommodation establishments. Nonetheless, since it is an extensive area parallel to the coastline (3.5 km), it requires 17 urban stops and three intercity stops to cover the entire area.

5.1.2. Indicator 2: Population Percentage with Bus Stop/s at less than 200 m

The average percentage of resident population in the municipality that is located at less than 200 m from a bus stop is 43%, while when Indicator 2 is applied to residents and tourists it increases to 47% (see Table 5 and Figure 7 for more statistical and visual details).

Table 5. Results of Indicator 2: Population with easy access to bus stops.

	Inhabitants		**Indicator 2 (%)**	
TA	**Residents (1)**	**Residents + Tourists (2)**	**1**	**2**
Cambrils town	7037	7074	54.69	54.50
Cambrils waterfront	3446	3961	39.52	41.49
Vilafortuny residential	967	1019	19.36	19.86
Vilafortuny beach	757	5978	24.96	49.32
Western neighbourhoods	1786	3134	56.90	57.77
Total	13,993	21,166	42.72	46.82

Significant differences can be seen between various TAs. Whereas the percentage values for the central TA and western neighbourhoods TA are considerably higher than the municipal average, neither of the two Vilafortuny TAs reaches 25% if considering only the residential population. Although inclusion of the floating tourist population for Vilafortuny beach TA does see this value rise to 49% (since the bus stops are near the tourist hotels), Vilafortuny residential TA continues to have much lower values than the other TAs. As with Indicator 1, a problem has been clearly identified for Vilafortuny residential TA.

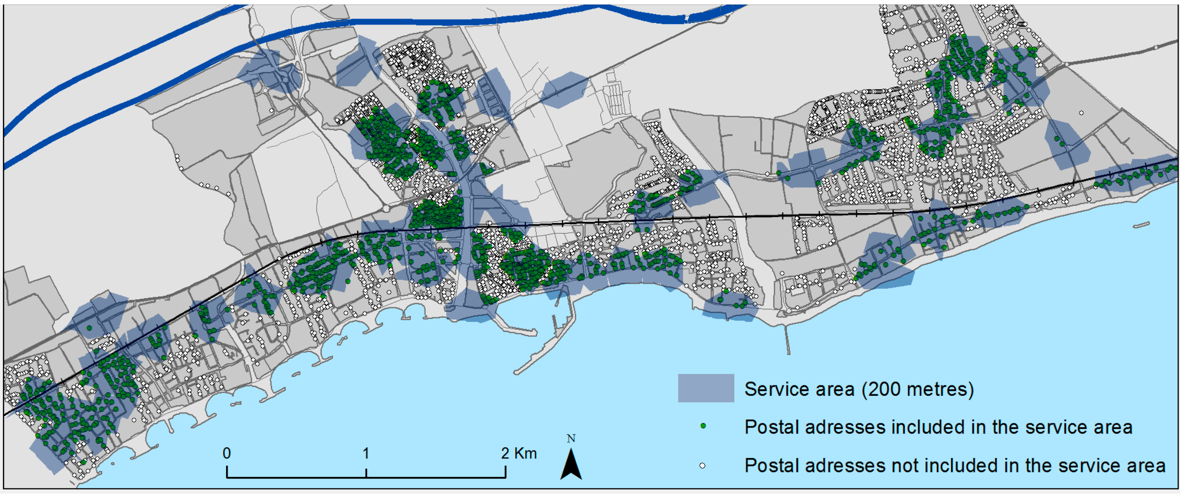


Figure 7. Results of the Indicator 2: Population with easy access to bus stops.

This indicator does not consider the typology of the service (urban or intercity) of each stop, nor the frequency of the bus. In this regard, it should be noted that the population of the western residential TAs have good accessibility to the urban transport network, but deficient access to the intercity network, whereas the deficit observed in the Vilafortuny TAs is particularly evident in the urban transport network.

5.2. Indicators of Interconnectivity

5.2.1. Indicator 3: Population Percentage with Multimodal Stops at less than 200 m

To shed further light on the analysis discussed above, Indicator 3 only takes into account the location of multimodal stops (for both urban and intercity buses). Cambrils railway station was included in the analysis as it is a multimodal stop (bus and train). In this case, the percentage of the population with easy access (less than 200 m) to a multimodal stop decreases considerably compared to Indicator 2. Only 17% of the registered population have access to multimodal stops, and when the floating tourist population is included this percentage falls even further to 14% (see Table 6 and Figure 8 for further information).

Table 6. Results of Indicator 3: population with access to multimodal stops.

	Inhabitants		Indicator 3 (%)	
TA	**Residents (1)**	**Residents + Tourists (2)**	**1**	**2**
Cambrils town	2892	2892	22.48	22.28
Cambrils waterfront	1686	1999	19.33	20.94
Vilafortuny residential	473	473	9.47	9.22
Vilafortuny beach	165	586	5.44	4.83
Western neighbourhoods	333	333	10.61	6.14
Total	5549	6283	16.94	13.90

The radial configuration of the Cambrils public transport network means that the central TAs, where the two urban lines intersect with a number of intercity lines, have the highest population percentage with access to multimodal stops: specifically, 22% of the population of the Cambrils town TA and 19% of the Cambrils waterfront TA. Conversely, the lowest values are concentrated in the peripheral neighbourhoods. Although Vilafortuny residential TA has slightly better access to multimodal stops (fundamentally because the eastern urban line and several intercity lines share stops that run along Cavet road), Vilafortuny beach TA (5.4% in application 1; 4.8% in application 2) and the western neighbourhoods TA (10.6% in application 1; 6% in application 2) have the worst accessibility to multimodal stops.

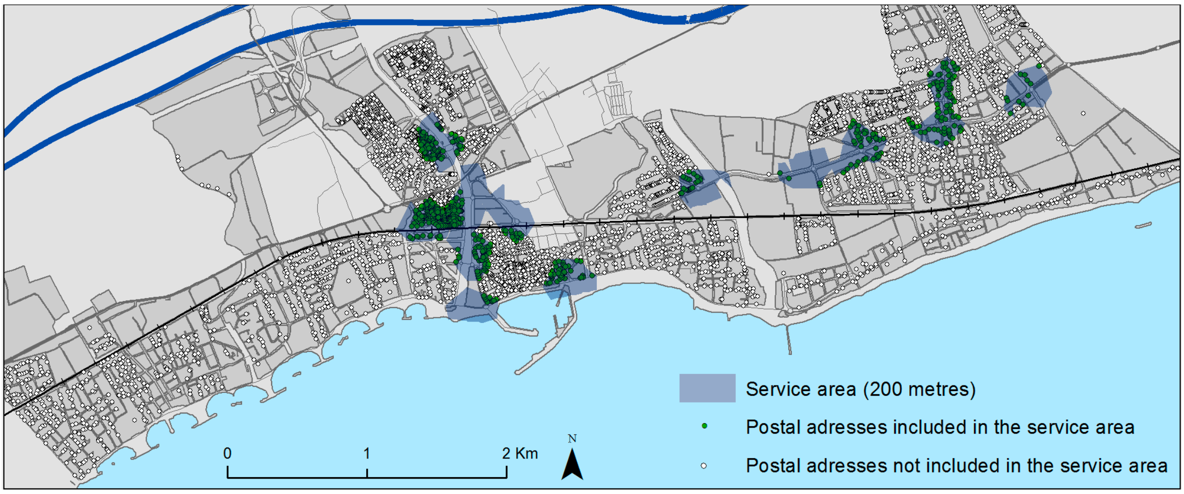


Figure 8. Results of Indicator 3: Population with access to multimodal stops.

5.2.2. Indicator 4: Connectivity between TAs: Drift Index

The centres of gravity defined for each TA (see Figure 9) allowed the finest calculation of overall connectivity between TAs, since they are strategically located to cover the maximum number of population in their surroundings. The population assigned to each centre of gravity is defined on the basis of their proximity to each one. A total of 57% of the population of Cambrils (including residents and tourists) is located less than 500 m from these centres of gravity. However, significant differences can be identified between TAs. Those located in areas with a higher concentration of population (such as centres of gravity 1, 2, 4 and 8) have a coverage greater than 60% assuming a walkable distance of 500 m, while those located in the peripheral and more sprawled neighbourhoods have lower rates (see Figure 10).

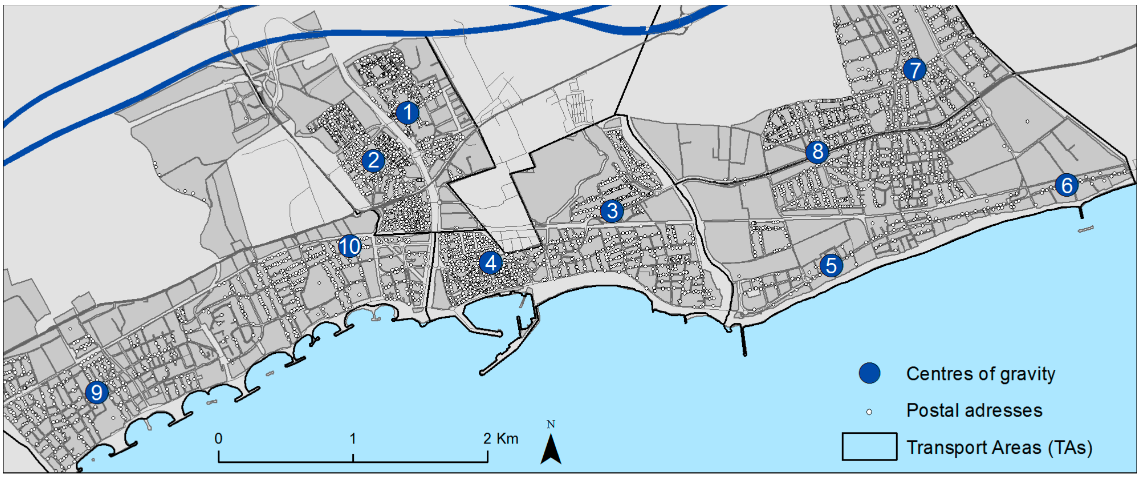
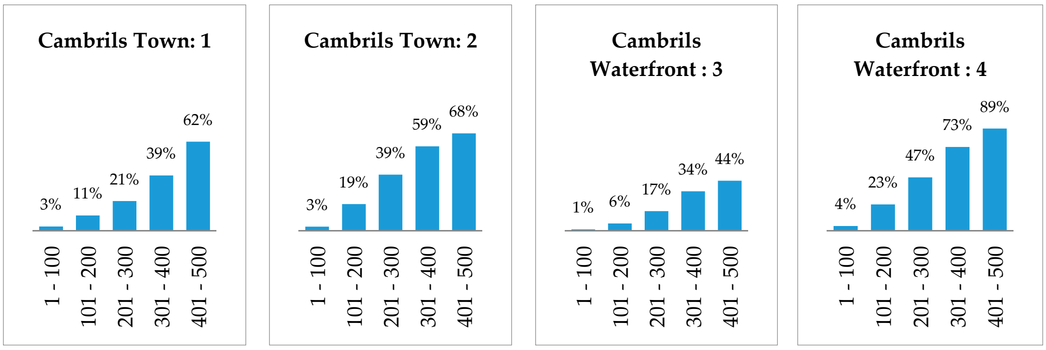
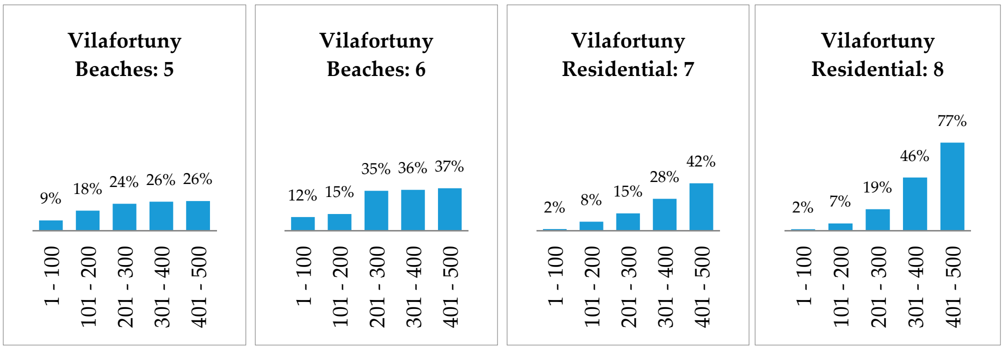


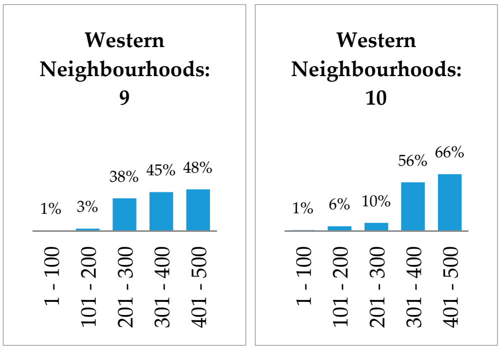
Figure 9. Location of centres of gravity.



Population assigned to each centre of gravity			
Cambrils Town: 1	Cambrils Town: 2	Cambrils Waterfront: 3	Cambrils Waterfront 4
3685	9295	2302	7246



Population assigned to each centre of gravity			
Vilafortuny Beaches: 5	Vilafortuny Beaches: 6	Vilafortuny Residential: 7	Vilafortuny Residential: 8
6178	5943	3720	1412



Population assigned to each centre of gravity	
Western Neighbourhoods: 9	Western Neighbourhoods: 10
2431	2991

Figure 10. Accumulated percentage of population (residents and tourists) covered by centres of gravity. Note: Expressed in intervals of distance (metres) from respective centres. Source: Own elaboration.

The average travel time between the TA centres of gravity using the public transport network (Table 7a) is 32 min, which also includes the average time walking from the residence to the bus stop assigned in each case (calculated on the basis of an average distance walking of 377 metres from the doorways located less than 500 m from the centres of gravity). The corresponding travel time when using a private vehicle (Table 7b) is 13 min (including parking time). Hence, there is a difference of almost 20 min in the average time between the two means of travel. In other words, the average time travelled using the public transport network exceeds by 150% the time travelled when using a private vehicle. This results in an overall Drift Index of 2.5 (Table 8).

Table 7. Distance in time (min) between centres of gravity when using: the public transport network (**a**); or private vehicle (**b**). Source: Own elaboration.

(a) Public Transport											
		C.T		C.W.		V.B.		V.R.		W.N	
		1	2	3	4	5	6	7	8	9	10
C.T	1	-	7	25	19	24	28	53	56	51	28
	2	*	-	21	15	21	24	49	24	47	24
C.W	3	11	14	-	27	51	54	14	7	58	35
	4	10	13	9	-	12	16	37	12	34	11
V.B	5	21	24	36	11	-	9	100	75	44	19
	6	24	27	39	15	9	-	103	78	47	22
V.R.	7	17	20	10	33	37	40	-	7	64	41
	8	14	17	7	30	34	37	11	-	61	38
W.N	9	34	37	71	27	30	33	83	58	-	17
	10	19	22	40	12	40	43	68	43	25	-
(b) Private Vehicle											
		C.T		C.W.		V.B.		V.R.		W.N	
		1	2	3	4	5	6	7	8	9	10
C.T	1	-	8	12	11	15	18	13	15	12	10
	2	8	-	13	13	17	20	15	17	12	10
C.W	3	10	12	-	9	10	13	10	9	15	11
	4	10	13	11	-	12	16	14	14	14	9
V.B	5	14	16	9	11	-	9	10	9	19	15
	6	17	19	12	15	9	-	9	10	22	18
V.R.	7	13	14	10	14	10	11	-	8	17	16
	8	13	14	7	11	9	11	7	-	17	14
W.N	9	13	12	15	14	18	22	17	18	-	10
	10	11	10	13	9	16	19	14	16	10	-

C.T. = Cambrils Town; C.W. = Cambrils Waterfront; V.B. = Vilafortuny Beaches; V.R. = Vilafortuny Residential; W.N. = Western Neighbourhoods. * Not applicable: The user has to make an exceedingly long journey (60 min) if travelling by bus from the centre of gravity # 2 to the centre of gravity # 1. The distance walking between the two centres of gravity is only 500 m, which means that it can be done without the use of the bus.

The structure of the two urban bus lines facilitates commuting in a periphery-to-centre direction that can be covered in a competitive time (see Table 7). In fact, the average of all the possible journeys connecting peripheral areas to the central TAs does not exceed 25 min of travel time, including the average walking time and that spent in bus transfer (if required), whereas the average time for these trips by private vehicle is 12 min. However, there are more difficulties in the periphery-to-periphery connections. These require an average 44 min of travel time, which contrasts with the 14 min required on average for the same journey by private vehicle. As a consequence, this notable difference contributes to fomenting the use of motorised private transport.

Similarly, the results of the Drift Index (Table 8) clearly show the differences in connectivity between TAs. Thus, the central TAs have the best connection indexes, especially gravity centre 4 of Cambrils Waterfront TA, which only exceeds by 30% the optimum travel time by private vehicle. The TA with the highest Drift Index and, therefore, the lowest quality in terms of accessibility to the other TA centres of gravity, is that of Vilafortuny beaches. The travel distance by public transport, on average, exceeds by 240% the optimum travel time by private vehicle (Drift Index: 3.4). The other peripheral TAs, western neighbourhoods (Drift Index: 2.7) and Vilafortuny residential (Drift Index: 2.3), also have high global Drift Indexes, which confirms problems of connectivity between the peripheral neighbourhoods.

Table 8. Results of the Drift Index.

		C.T		**C.W.**		**V.B.**		**V.R.**		**W.N**	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
C.T	**1**	-	0.9	2.1	1.7	1.6	1.6	4.1	3.7	4.3	2.8
	2	*	-	1.6	1.2	1.2	1.2	3.3	1.4	3.9	2.4
C.W	**3**	1.1	1.2	-	3	5.1	4.2	1.4	0.8	3.9	3.2
	4	1.0	1	0.8	-	1.0	1.0	2.6	0.9	2.4	1.2
V.B	**6**	1.5	1.5	4.0	1.0	-	1.0	10.0	8.3	2.3	1.3
	5	1.4	1.4	3.3	1.0	1.0	-	11.4	7.8	2.1	1.2
V.R.	**7**	1.3	1.4	1.0	2.4	3.7	3.6	-	0.9	3.8	2.6
	8	1.1	1.2	1.0	2.7	3.8	3.4	1.6	-	3.6	2.7
W.N	**9**	2.6	3.1	4.7	1.9	1.7	1.5	4.9	3.2	-	1.7
	10	1.7	2.2	3.1	1.3	2.5	2.3	4.9	2.7	2.5	-
Overall Drift Indexs											
		C.T		**C.W.**		**V.B.**		**V.R.**		**W.N**	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Gravity Centres		2.0	2.0	2.6	1.3	3.4	3.4	2.3	2.3	2.8	2.6
TAS		2.0		2.0		3.4		2.3		2.7	
Overall		2.5									

* Not applicable: The user has to make an exceedingly long journey (60 min) if travelling by bus from centre of gravity # 2 to centre of gravity # 1. The distance walking between the two centres of gravity is only 500 m, which means that it can be done without the use of the bus.

5.3. Intermodality Indicator

Indicator 5: Population Percentage at less than 500 m from an Intercity Bus Stop

The results of Indicator 5 (Figure 11 and Table 9) show that a significant part of the Cambrils population has easy access (less than 500 m) to a multimodal stop with these characteristics (over 75%). This result shows a high accessibility, whether it refers only to the registered resident population or if the floating population (tourists) is included. The central TAs are, once again, those with the highest values (over 80%), while problems are again seen in the western neighbourhoods TA where there is only one intercity bus stop near residential areas. As a result, there is a coverage of just 30% of the resident population, and a mere 20% if the tourist population is included.

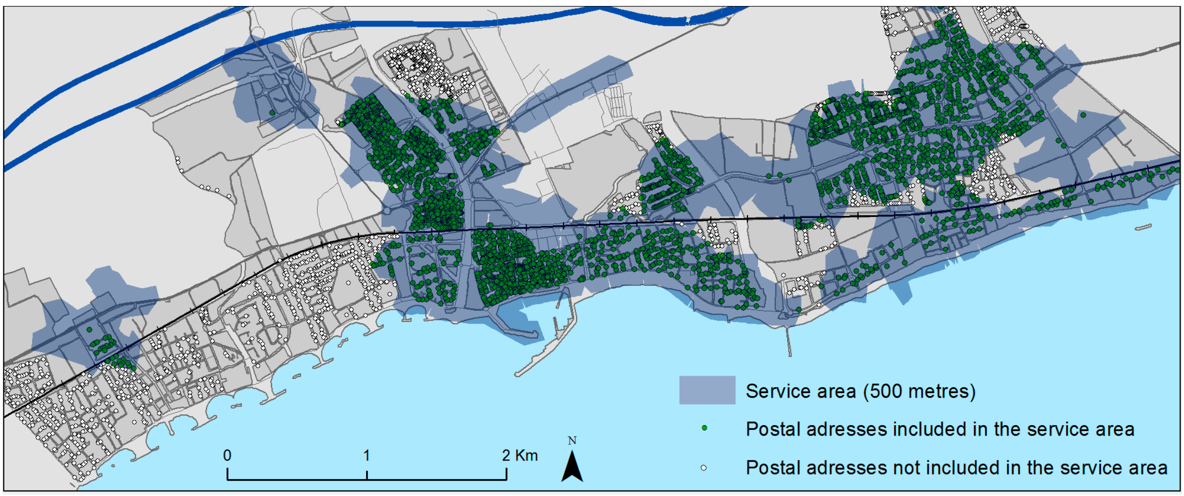


Figure 11. Results of Indicator 5: Population at less than 500 m from intercity stops.

Table 9. Results of Indicator 5: Population at less than 500 m from an intercity stop.

	Inhabitants		Indicator 5 (%)	
TA	**Residents (1)**	**Residents + tourists (2)**	**1**	**2**
Cambrils town	10,771	10,885	83.72	83.86
Cambrils waterfront	8366	9194	95.94	96.29
Vilafortuny residential	3397	3533	67.99	68.84
Vilafortuny beaches	2118	9764	69.83	80.55
Western neighbourhoods	939	1111	29.91	20.48
Total	25,591	34,487	78.13	76.29

6. Discussion and Conclusions

6.1. About the Methodology

There is vast literature on the analysis of the effectiveness of public transport networks through spatial coverage methodologies [34–39]. However, previous studies have not included the tourist population as an internal variable in their analysis of the effectiveness of public transport at tourist destinations. In this sense, the main novelty of the proposed methodology with respect to previous studies is the inclusion of seasonal population in the study of accessibility to public transport networks. This has allowed us to develop an analysis of the efficiency and spatial coverage of a public transport network, focusing not solely on the resident population, but including all potential users of the service. This question is particularly relevant in cities that receive large numbers of tourists, as in the case of Cambrils with more than two million overnight stays each year. It has enabled us to analyse the real efficacy of the network by taking into account the temporary users, which represent an added pressure on the public transport system. This issue is not only important in terms of examining the quality of the service provided, but also because efficacy and comfort in transport mobility are key factors in the competitiveness and sustainability of tourist destinations.

It should also be noted that there are two constraints linked to the available data sources that have conditioned the study. Firstly, there were no available data for the precise location and level of occupancy of second residences and housing dedicated to tourist use that is not officially registered. While the indicators that were used have proven useful in combining the resident and floating (tourist) population, it would be interesting to include in the model tourists staying in second residences, since these represent about 40% of the housing stock (according to the population and housing census of 2011). Secondly, no data were available concerning the distribution of travellers by bus stop (the data provided by the public transport operator is for the use of each bus line, not each bus stop). The availability of passenger use data for each bus stop would have allowed cross-referencing of the results of the different indicators with the actual volume of travellers at each stop. In this way, potential demand could be correlated with actual passenger use. Both questions are identified as future lines of research once such data become available.

6.2. On the Results of the Indicator System

The degree of coverage and accessibility to the various TAs as defined in this study varies considerably. This supposes the validation of the first research hypothesis of this work: that there are unequal conditions of accessibility to public transport services for the residents and tourist population in different neighbourhoods of the city. In the central area (Cambrils town TA and Cambrils waterfront TA), there is a greater density of the public transport network and, in overall terms, this is the area of highest accessibility for the resident population. It is also the area with the highest concentration of multimodal stops, meaning that intercity connectivity is also higher. The main facilities and public services, which serve the whole town, are also concentrated in this area. Hence, the connection serves not only its residents but also the entire population that travels to the city centre. Conversely, the peripheral neighbourhoods (west and east) have a purely residential function, and so the transport network structure is conceived with a centre-periphery hierarchy. It follows that the degree of coverage of the periphery is much lower. To this situation has to be added a key determining factor. The western neighbourhoods and Vilafortuny residential TAs are two suburban areas of low population density (large presence of family housing), and thus they form a built environment in which it is particularly difficult to deploy a service that allows coverage of an area with a more scattered population than that of the urban centre. This results in levels of unequal spatial coverage and efficacy in all the indicators that were used. Finally, the inclusion of the floating population (tourists) especially affects the waterfront TAs (notably Vilafortuny beach TA and, to a lesser extent, western neighbourhoods TA and Cambrils waterfront TA). As a result, the Vilafortuny beach TA, where hotel activity is concentrated, has a ratio of bus stops per 1000 inhabitants and a population percentage with access to multimodal stops considerably lower than the municipal average. These findings validate the second hypothesis of our research: that the incorporation of a large floating population component during summer alters the efficacy and spatial coverage of the public transport network.

On the other hand, a close relationship has been revealed between urban morphology and accessibility to public transport. We have found that compact and functionally diverse areas have a better supply of public transport and promote the level of accessibility of the population to this mode of transport to a greater degree than monofunctional and less dense residential areas.

6.3. Policy and Practical Implications

Mitigating the environmental impacts of tourism through the reduction of the carbon footprint generated by tourist mobility by the adoption of more sustainable means of transport is a common requirement of local governments in tourist cities [8,30]. In coastal destinations, tourism clearly tends to be a seasonal activity, which makes it more difficult for local authorities to match the demand for and supply of transport services when tourist numbers are high as the supply still has to cover as much of the resident population as possible. Therefore, this work contributes to a growing literature that considers as crucial the analysis of tourist activities and movements to improve public transport planning and foment more environmentally friendly mobility practices at tourist destinations [8,25,30,31,44].

As has been shown in this paper, the urban morphology, the characteristics of the transport network, the way that the public transport infrastructure is organised and the seasonality of tourism activity can greatly influence the volume of potential public transport users and, therefore, its use. In this sense, there is a major challenge for public administrations and stakeholders in the tourism sector to properly adapt public transport links and to encourage its use in order to reduce the footprint generated by private vehicle journeys at the tourist destination. On the one hand, the adequacy of public transport connections has to guarantee connectivity from the areas with the highest tourist accommodation concentration to the areas of major tourist interest, as well as ensuring that routine activities can be carried out by local residents. An interesting solution would be to introduce during the high season (June to September), or for particular events, a tourist transport line (similar to the proposal of Rendeiro and Suárez [24]) that would allow connection of the different tourist accommodation areas with the main tourist elements or with the main transport nodes (as the central station) to other destinations. At the same time, a simplification of the already established routes would ensure resident mobility and increase their efficacy. Additionally, the provision of more information on public transport services and bus stop distribution could be a useful action for those areas where there is a special tourist concentration and relatively weak coverage has been detected. Such provision should be included in a general promotional strategy associating public transport as an inseparable element of the tourist image of the destination. This would not only allow greater competitiveness of the tourist destination in question, but would also promote more sustainable tourist mobility patterns.

6.4. Future Prospects

In this paper, we have analysed the efficiency and spatial coverage of public transport in Cambrils from an infrastructure-based perspective, taking into account the amount of resident and tourist population with a potential use of the public transport service. Despite the fact that all residents and tourists of any city have the right to free movement and equal access to all goods and services, regardless of their social or economic status [52,53], the use of public transport is higher in low-income social groups, women, students, dependent population (older and younger) and tourists [54]. A study developed by Gutiérrez and Miravet [31] shows that the profile of the tourist is also important in the decision to travel by public transport. For this reason, pending for future investigation is the determination of both resident and tourist populations with a profile of greater predisposition to use public transport in the examined tourist destination (Cambrils). It will then be necessary to analyse the social equity and efficiency of the public transport structure to meet their mobility needs, as Delmelle and Casas [19] Cardozo et al. [20] or Ruiz et al. [54]. To develop this approach additional information will be needed on tourist profiles, which means that other sources (e.g., tourist surveys) will be required as current sources used here allowed us to determine the spatial distribution of accommodation for tourists, but provided no data on their profile.

In addition, the indicators that have been applied for the present study do not allow an interpretation of the level of attraction of the different municipal spaces or whether they are for daily use, work, leisure or tourism, although they do measure the level of coverage of the public transport system, the interconnectivity between transport zones and network intermodality. Therefore, future investigations should consider the value of each stop in terms of the attraction of the possible destinations, in addition to taking into account service capacity and frequency [55,56] as well as impedance measurements between origins and destinations [57–59]. Even more complex approaches could be developed in the future for the Costa Daurada tourist destination as a whole to measure the efficiency of public transport systems, taking into account fares, schedules, capacity, frequency and other features of the system through measures of transit connectivity as proposed by several authors [60–64].

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