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# Resilience of Interurban Public Transport and Impact of COVID-19 on Rural Connectivity in Sparsely Populated Regions

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**Abstract:** The aim of this research consisted of assessing the effects of the COVID-19 pandemic on the interurban public transport system in a rural region with a sparse population density, considering the number of tickets sold and passengers in each locality, as well as the different connecting lines. From a methodological point of view and with the intention of identifying patterns to explain the behaviour of both the routes and passengers, a series of variables were selected, becoming determining factors that sought to offer a solution to the search for a common trend. Additionally, data processing by the means of statistical analysis and the application of Geographic Information Systems (GIS) tools complemented the procedure. The results obtained in the investigation were provided both by municipality and by interurban routes. An interesting finding of this research was the uneven recovery of the municipalities. The localities closest to the attractor nucleus have recovered more quickly to pre-pandemic mobility levels due to their geographical proximity, larger populations, higher incomes per household, and need to access certain public services. In terms of routes, all the lines showed significant decreases in ticket sales, although with variations. Although passenger numbers have shown a gradual recovery, the initial loss was considerable, and pre-pandemic normality has not been completely achieved. This research provides a comprehensive overview of the changes in interurban mobility over a four-year period. The incorporation of critical variables and the segmentation by municipality and route provide a way to identify discernible patterns of mobility. However, the lack of previous research focusing on the impact of the pandemic in rural areas of low population density restricts the possibility of establishing a comparison and to generalise the findings. The authors consider that future research should include other alternative means of transport in these interurban areas and incorporate variables to characterise passengers, such as age, gender, etc.

**Keywords:** public bus transportation; rural areas; demographic challenge and depopulation; patterns of displacement mobility; accessibility to basic services; COVID-19



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## 1. Introduction

The pandemic caused by COVID-19 spread around the world from 2020 onwards, causing a significant impact on many sectors, with transport being one of the most affected areas. The free movement of people, personal mobility alternatives, and the opportunity to travel or choose where to live within the borders of a single state is a fundamental right reflected in Article 13 of the Universal Declaration of Human Rights [1]. Similarly, Article 12 of the International Covenant on Civil and Political Rights recognises not only freedom of movement within a state but also the freedom of movement between states [2]. However, this right may be temporarily withdrawn or limited for reasons of public order, public health, and public security. Nevertheless, the evolution of personal mobility has undoubtedly been a distinctive feature of globalisation. However, none of the contemporary crises, such as the 1973 oil crisis, the economic and financial crises of the 21st century, or

the security crisis experienced in Spain after 11-S, have seen such a drastic disruption of mobility as has been evident recently [3].

The advent of COVID-19 represented a moment of change, where urban and interurban mobility had been diminished or reduced in many parts of the world [4–6], mainly through the various nationally decreed closures or quarantines in Europe, as seen in Italy [7], France [8], the United Kingdom [9], and Spain [10]. In addition, the closure of all external European borders to non-essential travel with the intention of curbing the spread of the virus is included in [11,12]. In the African continent, restrictions would come later [13], and evidence from studies of the mobility patterns in the American continents is in [14]. Worldwide, the transport sector has been negatively affected as a direct consequence of the pandemic [15,16]. In 2003, in the Chinese city of Taipei [17], there was an outbreak of the severe acute respiratory syndrome (SARS) epidemic, which led to a drop in the number of metro passengers (around 1200 passengers for each new case of SARS reported). Since then, the presence of a new disease has been noted, which is rapidly transmitted in confined spaces between people, causing a new fear of the shared use of essential services such as public transport (an enclosed space), where the transmission of the disease could be encouraged among the population [18–20]. Consequently, rapidly transmitted infectious diseases are found to significantly affect people's lifestyles and mobility [21].

The COVID-19 pandemic has drastically transformed global mobility, altering travel patterns and social dynamics around the world. The public transport sector has been particularly hard hit [22], experiencing a massive reduction in ridership due to restrictive policies imposed by governments and widespread fears that these spaces represent a high risk of contagion [23]. Measures taken to curb the spread of the virus, such as confinement orders [24], cancelling public events, limiting transport capacity, closing workplaces, and implementing remote work policies [25], have led to a significant decrease in out-of-home activities and available travel options. These restrictions have impacted both the perceived safety and quality of transport systems, reinforcing the perception of public transport as a potential transmission vector [26]. In many cities, this perception, together with social distancing policies, has led to a marked decline in the use of public transport, creating a trend that has only been partially and unevenly reversed. Thus, the pandemic has highlighted the vulnerability of public transport to global health crises, underlining the need for long-term adaptations to ensure the safety and sustainability of this essential sector.

In Spain, intercity bus transport, particularly in rural areas with low population densities, has experienced unprecedented challenges [27]. This sector, already facing challenges due to depopulation and the lack of adequate infrastructure, has seen its difficulties exacerbated by the health crisis, further reducing the demand for services and jeopardising the economic viability of many routes. The confinement and social distancing measures implemented during the pandemic have led to a drastic decrease in the number of public transport users in general. According to research, during the first months of the pandemic, public transport mobility decreased by more than 90% in some areas of Spain [28]. This situation particularly affected rural areas, where the frequency of bus services was already limited, exacerbating the isolation of smaller and more dispersed communities. In addition, the fear of contagion led to a change in behaviour among users, who began to avoid public transport in favour of private means of transport when it was possible to use them [29]. This disproportionately affected rural areas, where dependence on interurban transport increased due to the lack of alternatives.

The combination of reduced demand, increased operating costs for mobility service concessionaires due to health safety measures, and dependence on public subsidies put the sustainability of interurban transport in many rural regions of Spain at risk. This situation has generated a debate on the need to reconfigure and subsidise this type of transport more effectively in order to prevent rural areas from becoming even more disconnected [30]. In Spain, several research projects have been carried out to find out the impact of the COVID-19 pandemic on society, habits and behaviour after the pandemic, on the economy, on the way people relate to each other, on the new profile of users of public

transport, etc. [31–33]. In [34], the behaviour of public transport during the pandemic in several medium-sized Spanish cities is analysed, and it is concluded that there was a decrease in the use of public transport during the pandemic, followed by a gradual recovery. Although the city of Cáceres (the focal point of our study of interurban public transport) has a smaller population than the cities analysed, certain results could be comparable and serve as a basis for this research. The research carried out in [35] indicates that, due to the impact of SARS-CoV-2 confinement [36], urban mobility, modal split, and reasons for travel have been investigated. Several studies carried out in the community of Madrid have shown that the pandemic has led to changes in mobility patterns, such as an increase in telematic activities, the fear of contagion, the adoption of healthier modes of transport, and changes in the reasons for travelling, as reported in [37]. In addition, in [38], the study concludes that lower income groups were the highest users of public transport during the pandemic, showing smaller reductions in its use. On the other hand, in [39], the short-term future demand for public transport is estimated and predicted, with the aim of providing an efficient service and avoiding congested areas.

Other locations in Spain outside the Madrid region have also been analysed. In [40], the impact of the pandemic on regular public passenger transport was analysed in two different periods, one during the pandemic and the other post-pandemic over 12 months. In both periods, the results showed a decrease in the number of passengers; however, with the arrival of the new normal, a partial recovery in bus use was observed. On the other hand, in [41], a study was carried out in which the use of private cars and personal mobility vehicles had increased, together with the increase in soft transport, to the detriment of bus use. In [42], bus transport services were also a focus of attention where the impact of COVID-19 confinement meant that urban mobility, and hence bus use, changed. They also stated that the bike sharing system regained a higher percentage of use than the bus system. Another study on the impact of COVID-19 on the use of public transport in Spanish cities was carried out in [43], where a project was developed to determine areas of high and low traffic demand during the state of alarm, with inconclusive results on the relationship between traffic intensity and average speeds for the periods chosen by the authors. However, it could be corroborated that the number of trips made on urban roads had decreased by 22.6% compared to pre-pandemic values.

Most of the works consulted have analysed the problem of the effects of the COVID-19 outbreak on public transport using two sources of information to obtain data; big data technology has been used to define and quantify interprovincial mobility through the positioning of mobile phones and surveys. Firstly, information has been collected through mobile phones [44] with Google Mobility Reports, Apple Mobility, and Moovit, deriving from mobility reports carried out by the Spanish Ministry of Transport, Mobility and Urban Agenda [45]. However, this type of methodology has the disadvantage that the data provided by these applications do not represent real public transport journeys or the mode of transport itself [38]. Secondly, the development of surveys often fails to achieve the desired approach when the data obtained in the sample is not representative of the percentage of the population analysed and public transport users. Another procedure or type of data used to determine the evolution of and impact of the pandemic on public transport services is to quantify the number of passengers who purchase a ticket or use contactless cards, which makes it possible to count the number of passengers. This type of approach has been carried out by the authors of [34,38–40,42], who conclude that the method has been satisfactory from the point of view that it has been possible to identify the real impact of COVID-19 in medium-sized Spanish cities using quantitative data.

There has also been a shift in mobility patterns towards reducing the number of trips, as well as a shift towards more using sustainable transport modes such as public transport and active or soft modes [46]. This shift in mobility patterns is centred on strong trends such as teleworking, commuting patterns, the fear of contagion, and the adoption of healthier modes of transport [47]. These developments have been enhanced as a result of COVID-19, as telework and the fear of contagion have been the triggers for a modal

shift. In addition, authorities increased the frequency of services and implemented vehicle sanitation measures to avoid the loss of passengers, including fare subsidies, to help make public transport more attractive and thus compensate for fuel increases [37,48]. The change in mobility experienced with the arrival of the coronavirus is in direct conflict with the guidelines of the 2030 Agenda, in terms of the increase in the use of private vehicles in interurban areas. In the case of public transport, goal 11 of the 2030 Agenda refers to ensuring access to safe, affordable, accessible, and sustainable transport systems for all [49]. However, the fear of temporarily existing in enclosed spaces with strangers, not respecting safety distances, etc., would lead to an imminent refusal to use public transport.

This research emerges from the concern of evaluating the impact of the pandemic caused by COVID-19 on interurban public transport in the area of influence of a medium-sized city, understood as a rural area with a low population density where public transport is positioned as the essential mode of transport for the inhabitants of this area. The main objective of this research is to identify the impact of the pandemic on the mobility habits of regular public transport users in rural areas, taking as a reference the number of tickets sold and passengers in each locality, as well as the different connection lines. In addition, it is considered essential to identify six key variables that, together with the implementation of GIS tools, allow us to explain the patterns of behaviour in the use of public transport. In this way, we seek to understand the possible changes in mobility in rural areas during the onset of health crises.

The following are considered key aspects of this article's contribution to the research gap: the length of the research period (4 years), the selection of critical variables, and the analysis of interurban public transport mobility both by municipality (considering additionally the number of tickets sold) and by route. In order to understand the impact of the pandemic on interurban transport, a meticulous selection and analysis of variables was carried out. A multidimensional perspective was chosen, considering geographical, demographic, economic, and socio-cultural factors. In this sense, variables such as the use frequency of public transport, perception of risk during the pandemic, and changes in mobility patterns were evaluated. Network analysis techniques were applied to gain a deeper understanding of the relationships between the variables and the trends observed. These analyses made it possible to identify patterns and correlations not evident at the outset, providing a more holistic view of the factors that influenced mobility during the pandemic period. The present research is structured as follows: Section 2 details the methodology employed, including the selection of the study area, data collection, and statistical treatment. Section 3 shows the results obtained, considered at both the municipal and public transport route levels. Section 4 then discusses the findings in the light of the existing literature, and Section 5 contains the conclusions of this study.

## 2. Materials and Methods

The methodology developed in this research consists of six distinct parts: (1) a literature review, (2) obtaining reference data by searching in institutional repositories with open access information, (3) the acquisition and request of interurban public transport data from public administrations, (4) the selection of variables, (5) data processing by statistical analysis, and (6) the application of Geographic Information Systems (GIS) tools. Figure 1 shows the methodological process carried out in this research.

This study is based on a detailed methodological process designed to analyse the impact generated by the COVID-19 pandemic on interurban bus transport in a metropolitan area consisting of small municipalities with a markedly rural character. This research followed a logical sequence of stages, beginning with an exhaustive bibliographic review that allowed us to identify and select the key articles related to the subject under study. This review focused on the search for previous works that explored how mobility has developed in rural and urban areas, how public transport has been used during the times of pandemics, and what effects confinement policies have had on the mobility of populations.

In this regard, scientific academic sources, specialised databases, and case studies were reviewed in order to establish a solid theoretical framework.

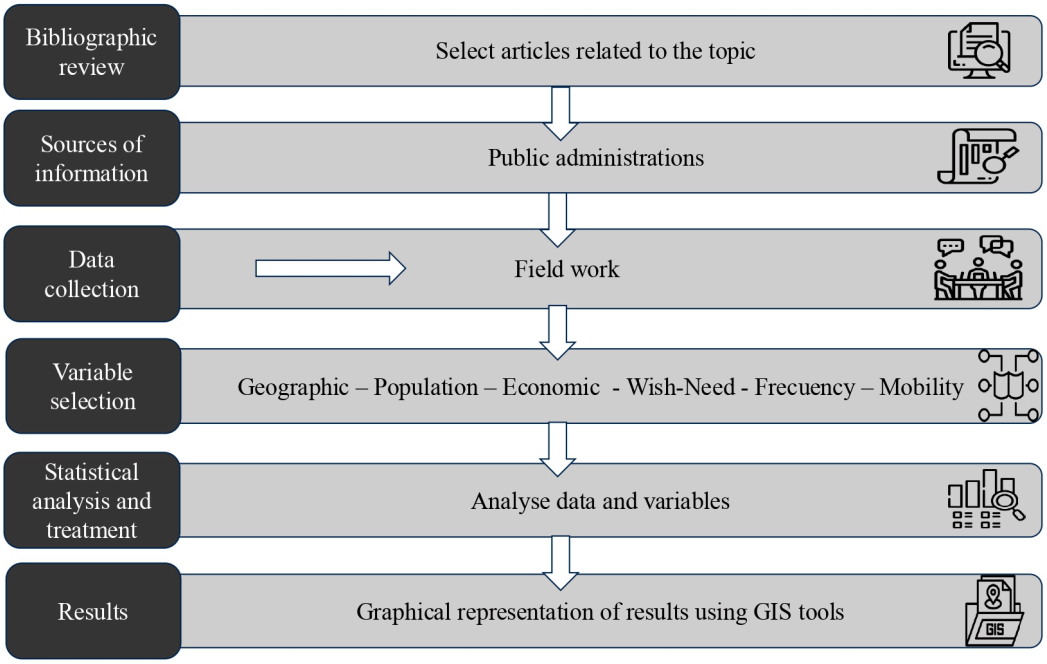


**Figure 1.** Methodology flowchart.

Subsequently, the main sources of information were identified, including open access public data made available by local and regional administrations, as well as information obtained through direct contact with intercity transport concessionaires. In addition, public administrations provided the researchers with crucial data on policies and mobility restrictions implemented during the pandemic and public transport usage statistics. In addition, extensive information was collected on bus routes, service frequencies, and possible variations in transport demand prior to the pandemic in the study area, during the critical period of infection, and afterwards.

A really significant part of the information analysed was provided by the Directorate General of Mobility and Transport (attached to the Department of Infrastructure, Transport, and Housing of the Regional Government of Extremadura). This administration, at the formal request of the researchers, provided a database reflecting the study period from 2019 to 2022, structured in such a way as to show the 365 days of the year and the times of each service provided by the interurban transport concessionary companies, i.e., at what time of day each bus crossed a municipality and made a stop on its route. They also provided the following: the direction of the line (outward or return), the route (origin and destination), the cost of the service, and the code and name of the route, as well as the company that managed the line for each concession in the interurban area of Cáceres.

The data sources consulted in institutional repositories included, firstly, the National Statistics Institute (INE) [50], from which the demographic data necessary to ascertain the real situation of the population in each of the municipalities in the area under study were obtained. These data were segregated according to age, in five-year age groups, and by sex (differentiating between men and women). In addition, economic data were also extracted in relation to the average net income per household for each of the localities and the economic activities and percentage of the population employed in each sector. Secondly, through the General Directorate of Traffic (DGT), the number of vehicles in each of the municipalities was obtained in order to obtain the motorisation rate. Thirdly, the Sustainable Urban Mobility Plan (PMUS) developed by the Cáceres Provincial Council served as a source of information to obtain the reasons for journeys, possible links between the municipalities, etc.

In the variable selection phase, a series of critical factors were identified and analysed in order to understand the potential impact of the pandemic on interurban transport. In this sense, it was decided to include parameters that would allow for the evaluation of geographic, demographic, and economic aspects. Similarly, it was also decided to consider criteria related to the needs and desires that the population might express regarding the use of public transport, such as, for example, the frequency of the use of this means of transport before and during the pandemic, the perception of risk in relation to its use, and changes in mobility patterns.

On the other hand, the execution of the statistical analysis and data processing constituted a key stage in the research process. The authors carried out a selection of key variables (economic development, travel need, distance, mobility, frequency, and demographics) to analyse the behaviour of the interurban public transport users. These variables were correlated with ticket and passenger sales data, using 2312 version spreadsheet software to identify patterns and trends. The data were normalised by considering the total annual sales and population of each municipality, allowing for more accurate comparisons between the bus lines. Additionally, network analysis was employed to further explore the relationships between the variables and observed trends. This methodology allowed the following: (a) By identifying hidden patterns by visualising the connection networks between variables, relationships not evident in a traditional statistical analysis could be detected. (b) To optimise the routes, network analysis can be used to generate more efficient bus routes, minimising costs and improving service quality. (c) To assess accessibility, it is feasible to analyse how public transport infrastructure affects accessibility to services and opportunities in different areas. The combination of statistical techniques and network analysis has provided a more complete and detailed view of the behaviour of interurban public transport users, enabling the identification of opportunities to improve the efficiency and quality of the service.

Finally, the results obtained were represented graphically using Geographic Information Systems (GIS) tools, specifically 3.3.0 version ArcGIS Pro, which makes it possible to carry out spatial analyses. These tools facilitated the visualisation of the changes experienced in mobility at a territorial level, making it possible to identify the areas most affected by the decrease in the use of public transport. The maps generated made it possible to illustrate the relationship between the decrease in demand and the variables analysed. In addition, the graphic representation was used to effectively communicate the results of the analysis, facilitating the interpretation of the data and allowing for an eminently visual evaluation of the impact of the pandemic in the different localities.

### *2.1. Study Area*

In order to identify the impact experienced by interurban public transport as a result of the COVID-19 pandemic in the Network of Sustainable Municipalities of Cáceres (RMSC), the study area defined in Figure 2 was established.

It can be seen that the RMSC is made up of those municipalities in the province that border the municipality of Cáceres. This medium-sized city is the focus of the daily trips made from the surrounding municipalities to the provincial capital, which acts as the true socio-economic, administrative, and commercial axis of the study area. The study area is made up of a series of municipalities that are annexed to the functional urban area of the city of Cáceres: Alcuéscar, Aldea del Cano, Aliseda, Arroyo de la Luz, Botija, Brozas, Cáceres, Casar de Cáceres, Casas de Don Antonio, Garrovillas de Alconétar, Herreruela, Malpartida de Cáceres, Montánchez, Plasenzuela, Santa Marta de Magasca, Santiago del Campo, Sierra de Fuentes, Talaván, Torremocha, Torreorgaz, Torrequemada, and Trujillo.

It is appreciated that the city of Cáceres is positioned as a cultural, touristic, and economic reference point in the study area, which is articulated by the means of a communications network that facilitates intermunicipal travel. These include the A-66, which links the whole province from north to south, and the A-58, which connects Cáceres and Trujillo with the A-5 dual carriageway. Apart from the high-capacity roads, there is also a

network of national and regional roads linking the municipalities of the RMSC with the city of Cáceres. Finally, it is worth mentioning the road network belonging to the Cáceres Provincial Council, which establishes a larger network of interconnections between the smaller municipalities.

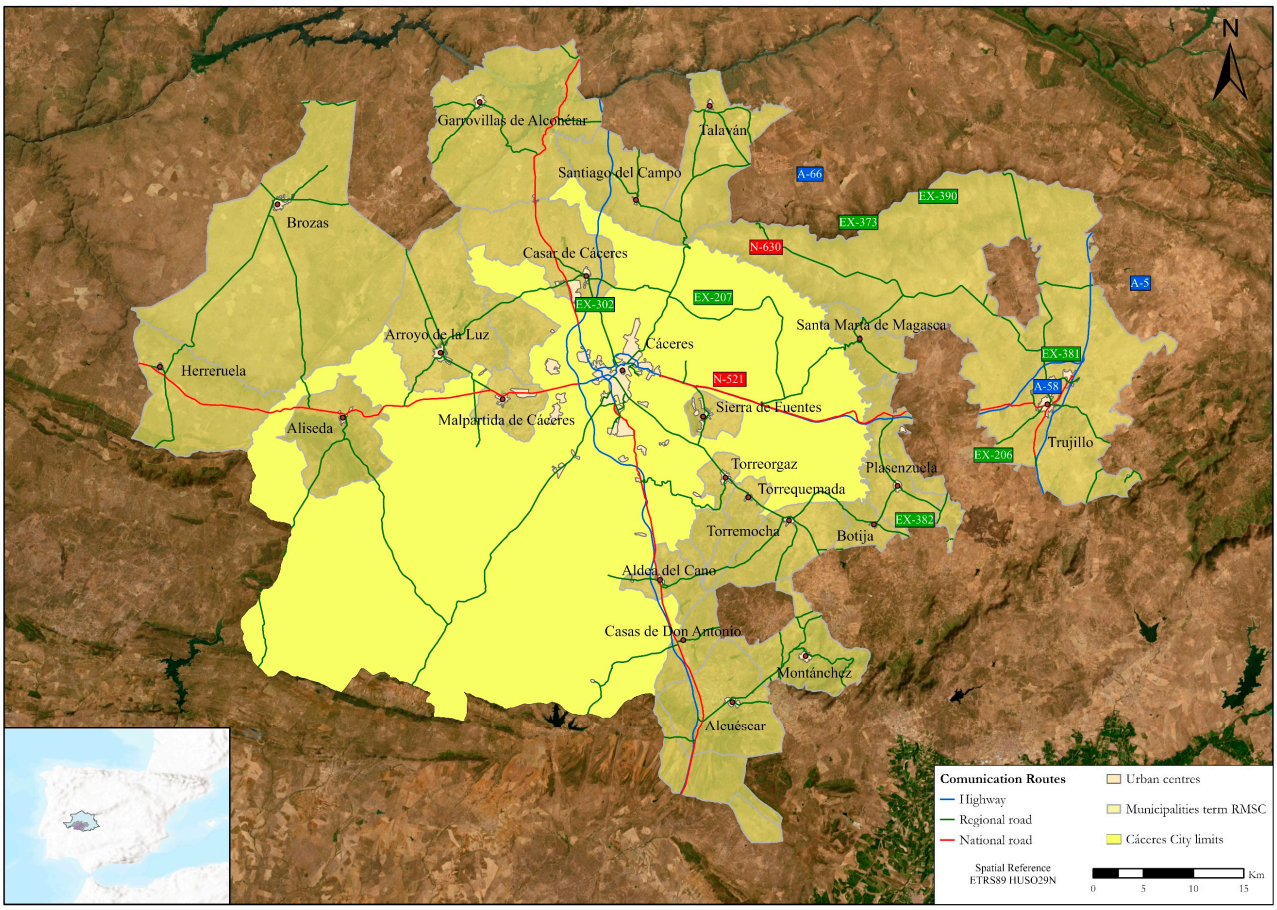


**Figure 2.** Location map of the study area.

2.1.1. Demographic Data of the RMSC

With regard to population data [51], the RMSC is made up of 21 municipalities bordering the municipal district of the city of Cáceres, with a total of 40,276 inhabitants, distributed as shown in Figure 3.

As can be seen in Figure 3, the most populated municipality is the provincial capital (Cáceres), with over 95,000 inhabitants. It is followed by the municipalities of Arroyo de la Luz, Malpartida de Cáceres, Casar de Cáceres, and Trujillo. It should be noted that a large part of the population in the RMSC is elderly. By analysing the demographic data using a population pyramid (Figure 4), it can be seen that most of the residents in the municipalities of the RMSC are over 50 years of age, with a predominance of the male gender. However, as age increases, women show a higher life expectancy. It is important to note that births are very low, with only 2.97% of the population in the 0–4 age group. On the other hand, in the city of Cáceres, a higher figure is observed in comparison to the localities studied, with 3.62% of the population corresponding to children between 0 and 4 years of age.

In the population pyramid of Cáceres, there is no narrowing at the base, indicating the presence of a young population, thanks to a constant flow of births. However, the majority of the population is in the middle age bracket, between 35 and 39 years of age, reflecting a mature community. Despite this, the proportion of older people continues to grow, resulting in an increasingly ageing society.

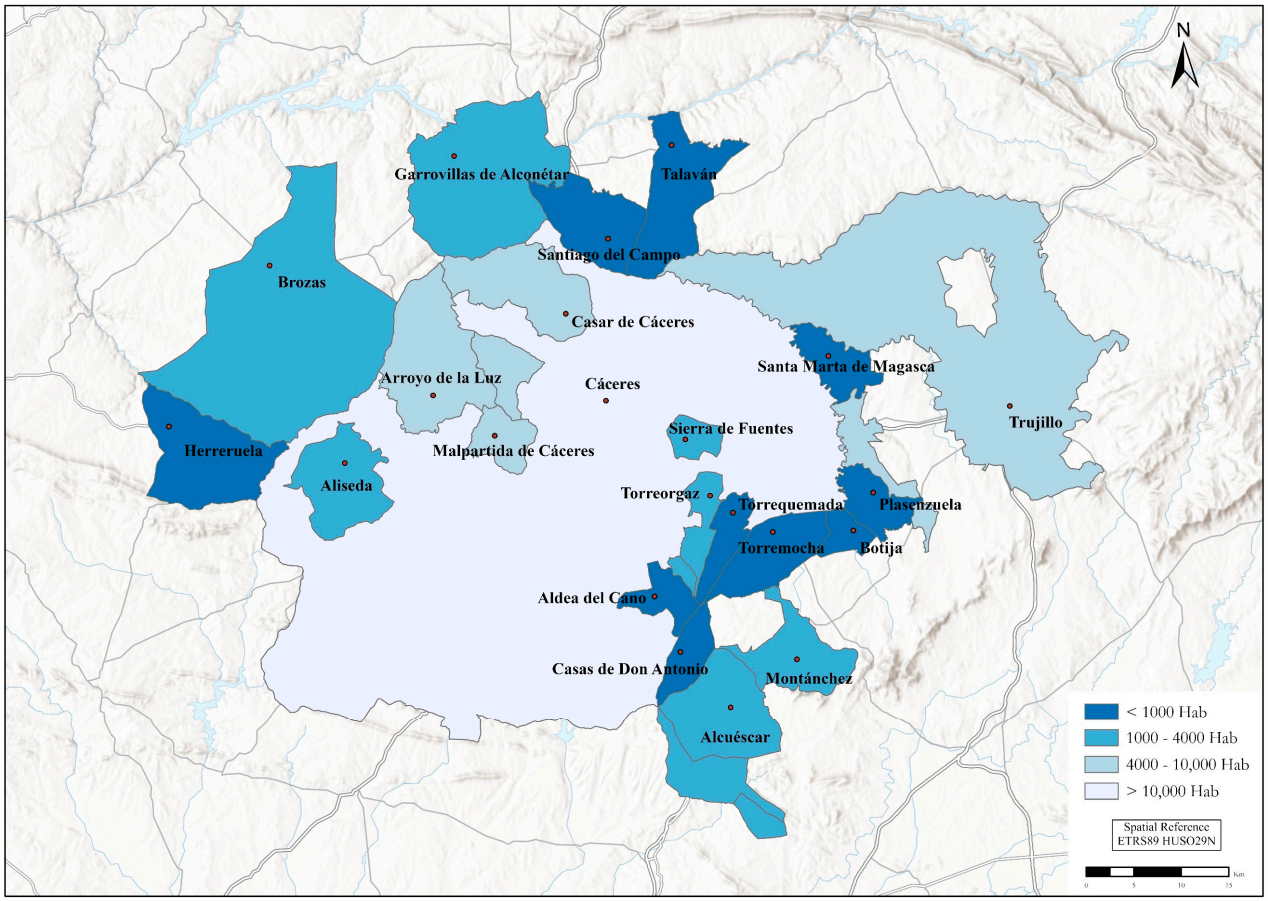


**Figure 3.** Representation of municipalities based on population.

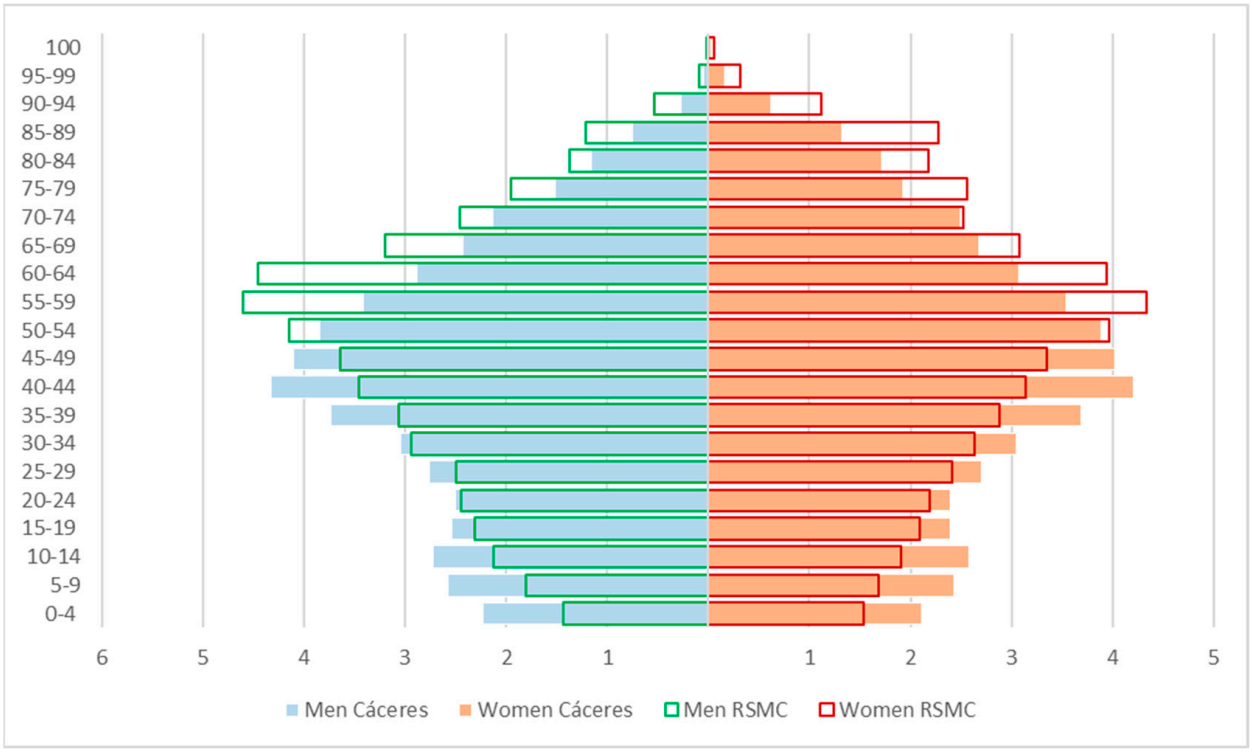


**Figure 4.** Population comparison between the RMSC and the city of Cáceres.

It can therefore be stated that, both in the municipalities of the RMSC and in Cáceres, society is characterised by a regressive population pyramid, marked by a generalised ageing due to a low birth rate, which leads to negative vegetative growth and poses potential socio-economic and demographic challenges.

#### 2.1.2. Economics of RMSC

Economic development in the study area characterised as a rural environment could be expected to focus on the primary sector, with activities such as farming livestock, agriculture, and fishing, due to the extensive agroforestry and grazing areas. However, the predominant sector is the service sector, driven mainly by tourism. This sector does not behave uniformly throughout the territory, with Cáceres standing out as an economic and cultural centre, recognised as a World Heritage City by UNESCO in 1986 and home to numerous festivities of tourist interest. In addition, other localities have protected natural spaces and historical–artistic sites, attracted a large number of tourists, and consolidated the service sector as the predominant segment both in Cáceres and in the municipalities of the RMSC.

In the case of the research carried out, the average net income per household has been considered as a key economic variable [38,52,53] in the selected localities, since it can be related to the predominant economic activity in each municipality. Taking as a reference the employed population (those persons over 16 years of age, of working age), four groups have been identified, taking into account the average net income. The first group includes Cáceres, with an income above €30,000. In the second group, with incomes above €25,000, are Malpartida de Cáceres, Sierra de Fuentes, Torreorgaz, Casas de Don Antonio, and Trujillo. The third group includes towns with incomes between €20,000 and €25,000, such as Aldea del Cano, Casar de Cáceres, Torrequemada, Arroyo de la Luz, Torremocha, Brozas, Talaván, Plasenzuela, Montánchez, Alcuéscar, Botija, Garrovillas de Alconétar, and Santiago del Campo. Finally, the fourth group is made up of localities with incomes below €20,000, these being Aliseda, Herreruela, and Santa Marta de Magasca.

#### 2.1.3. Motorisation Rate

The "motorization rate" [54] is understood as the ratio between the number of private vehicles and the total population in a given territory. Based on this definition, in our research, this rate or index has been calculated taking into account only private vehicles (passenger cars) and taking as a population criterion those persons of driving age. As a result, three different groups were identified. In the first group, with a rate between 60% and 80%, are the towns of Santa Marta de Magasca and Santiago del Campo. The second group, with values between 80% and 100%, includes the towns of Torremocha, Torrequemada, Herreruela, Plasenzuela, Casas de Don Antonio, Talaván, Malpartida de Cáceres, Torreorgaz, Botija, Brozas, and Montánchez. In the last group, there are municipalities with an index higher than 100%, such as Alcuéscar, Sierra de Fuentes, Aldea del Cano, Garrovillas de Alconétar, Trujillo, Arroyo de la Luz, Casar de Cáceres, and Aliseda.

#### 2.1.4. Links with Cáceres

Relations between municipalities [55–57] are often marked by dependencies in areas such as health, education, and public administration (including services such as tax collection offices, tax offices, and courts). These dependencies may be functional, based on geographical proximity or the services offered, or they may arise because the municipalities are located in the same region or community. It should be noted that the territorial and administrative structure of the regions does not have a consensus among experts and, in fact, the regions have no official administrative recognition or regulation. However, commonwealths or Local Action Groups (LAG) represent a form of voluntary association between municipalities with similar characteristics, allowing them to offer goods and services to a wider population and promote a more efficient territorial development, considering the communications network and the orography of the area.

Connections between municipalities and the provincial capital decrease in intensity as populations move away from it. These connections can be classified at different levels, such as administrative, educational, health, commercial, and leisure. On the administrative level, the dependence is evident, since most of the regional and state delegations are located in the capital. However, there are also the regional offices of various regional ministries in municipalities, such as Montánchez, Trujillo, and Arroyo de la Luz, and other offices, such as the offices of the Autonomous Collection Body of the Provincial Council of Cáceres, which are located in Trujillo, together with tax offices and courts of first instance. In addition, notary and land registry offices are located in municipalities such as Montánchez and Trujillo.

The relationships are not limited to the administrative sphere, but also include educational and health aspects. For example, a secondary school in a municipality may serve students from the entire area, or a doctor's office may depend on a health centre with 24 h emergency services.

These dependency relations serve to establish the zoning of the study area of our research, since traditional divisions such as regions or communities are not always applicable to all the municipalities of the RMSC. In the case under study, the zoning criterion used was the population of the localities, dividing them into four ranges, as shown in Figure 3.

Although it can be seen that this classification is neither perfect nor definitive, given that there could be other distributions that better reflect the relationships of the dependence on or proximity to the capital, it should be understood as a practical tool for the objectives of this research, which contemplated examining the relationships between the municipalities and the capital of Cáceres in relation to the use of the bus as a means of transportation, considering the existing dependencies and the services available. For this reason, in Figure 5 is displayed a zoning based on the factors previously mentioned.

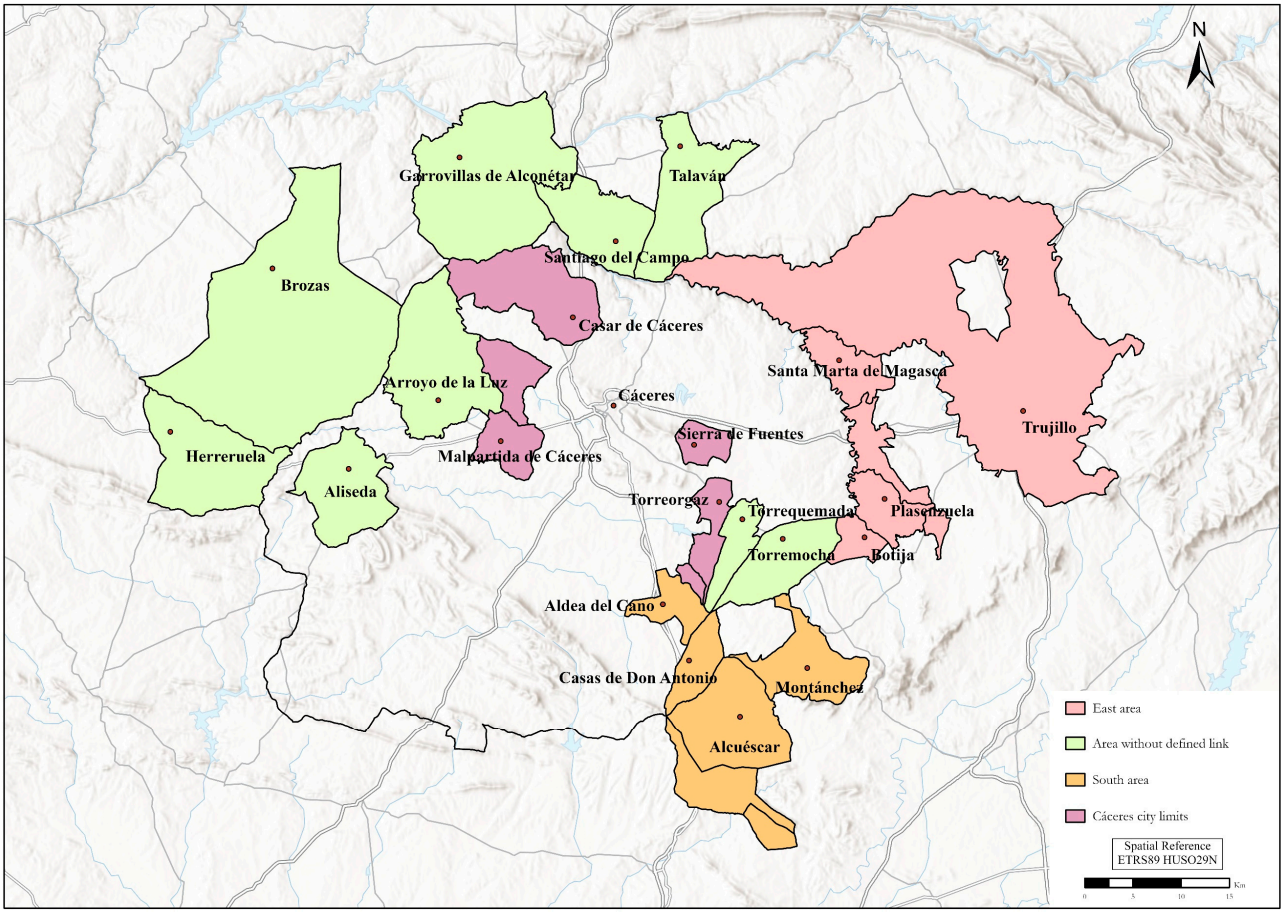


**Figure 5.** Proposed zoning in the RMSC based on the dependency relationships between municipalities.

In Figure 5, a zoning is proposed into four functional areas. The eastern, southern, and Cáceres zones stand out for having clear interdependent relationships, with evident links between the municipalities in health, administrative matters, etc., either with the capital, in the case of the Cáceres zone, or with other municipalities with a higher hierarchy in their area, such as Trujillo in the eastern zone and Montánchez in the southern zone. On the other hand, the fourth zone groups together localities where relations are weaker or non-existent or are oriented towards municipalities outside the network.

### *2.2. Description of Intercity Bus Routes and Other Means of Transport*

In the RMSC study area, a total of 12 interurban bus transport lines were identified that connect the surrounding municipalities with the city of Cáceres. Of these lines, eight originate in municipalities within the RMSC itself, while the remaining four begin outside the autonomous community of Extremadura. Each of these lines is designated by a route code, regardless of the name, indicating its origin and destination. Figure 6 below presents these lines graphically, showing their route through the territory studied.

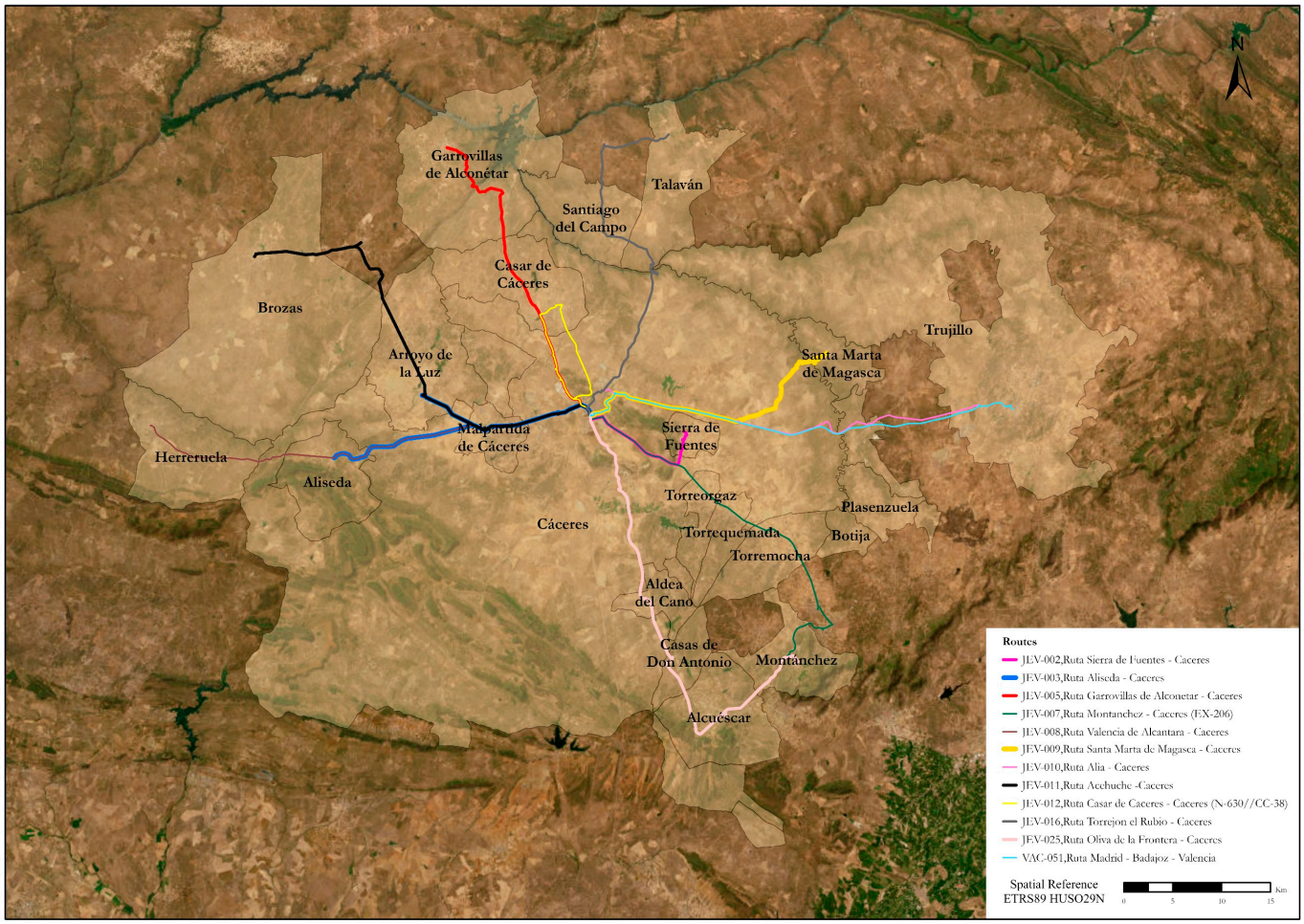


**Figure 6.** Representation of bus routes on the interurban area of Cáceres.

Looking at Figure 6, there are a dozen lines with a total of 501.5 km of bus connections between all the towns that make up the area of influence of Cáceres. However, the extension and route of these lines is greater, since the starting point of each route is not always located in these towns. Most of the lines cross Local Action Groups such as Sierra de San Pedro-Los Baldíos, Tajo-Salor-Almonte, Miajadas-Trujillo, and Montánchez-Tamuja, although they do not cover all these areas.

The layout of the routes, represented in the form of a "cross", leaves the southwest area without coverage by the network's buses. This is due to the presence of the N-523 road, which connects both provincial capitals but does not cross any locality or neighbourhood belonging to the Network of Sustainable Municipalities of Cáceres.

A more detailed explanation of the lines, considering the concessionaire of the service, the localities through which they run, their length, etc., can be found in Appendix A.

In addition to considering the bus routes operating in the area of influence of Cáceres, several authors such as those in [55–57] highlight the presence of other means of transport in the study area. These include the use of private vehicles, walking, and cycling, as well as a growing trend towards the use of Personal Mobility Vehicles (PMVs).

### *2.3. Data*

Using the data provided by the different public administrations, it was feasible to obtain a solid database, where the total number of passengers for each year within the period analysed was recorded, as well as the number of tickets sold from each locality to the city of Cáceres and vice versa. It was also feasible to know the total number of passengers travelling on each of the exposed lines in order to know the resulting impact of the COVID-19 pandemic on interurban public transportation in the RMSC. However, it should be noted that of the twenty-one municipalities studied, there are two from which it was impossible to obtain complete information during the four years: Botija and Plasenzuela.

### *2.4. Variables Selection*

In order to identify patterns that explain the behaviour of both the routes and travellers, a series of variables or indicators were selected to characterise mobility by interurban public transport. These parameters are as follows: economic development (economic variable), the desire or need to go to the capital (need to travel), distance (geographical variable), mobility, frequency, and demographics (population variable). These are determining factors that seek to offer a solution to the search for a common trend. Each parameter analysed is then defined more precisely:

- Economic development: this is determined using the average net income per household, in order to establish the economic development of the RMSC.
- Need to travel: this involves the requirement to go to the provincial capital in order to satisfy demands for public services that cannot be met in the locality of origin. This variable is calculated from the number of tickets sold to Cáceres.
- Distance: the distance in kilometres from each municipality to the capital is considered, taking into account the bus routes available as a means of communication.
- Mobility: this examines the number of vehicles (private cars) per inhabitant in each locality of the RMSC.
- Frequency: this parameter evaluates whether the bus passes through each municipality on a daily basis, including weekends.
- Demography: this carefully analyses the total population of each locality.

Figure 7 shows each of the variables previously mentioned in the methodology.

Each variable under analysis is represented by a different colour in a graduated manner (from lighter to darker), as can be seen in Figure 7. The selection of the variables was supported by the existing literature on mobility in rural areas. The distance to the city, frequency of service, household income, motorisation rate, and demographic characteristics were included because of their recognised impact on modal choice. The distance influences travel time, affecting the convenience of public transport. The income limits access to private vehicles, while the motorisation rate reflects the reliance on individual transport. The service frequency determines the accessibility of public transport, and demographic characteristics, such as population and employment levels, influence the demand for mobility and the availability of local services.

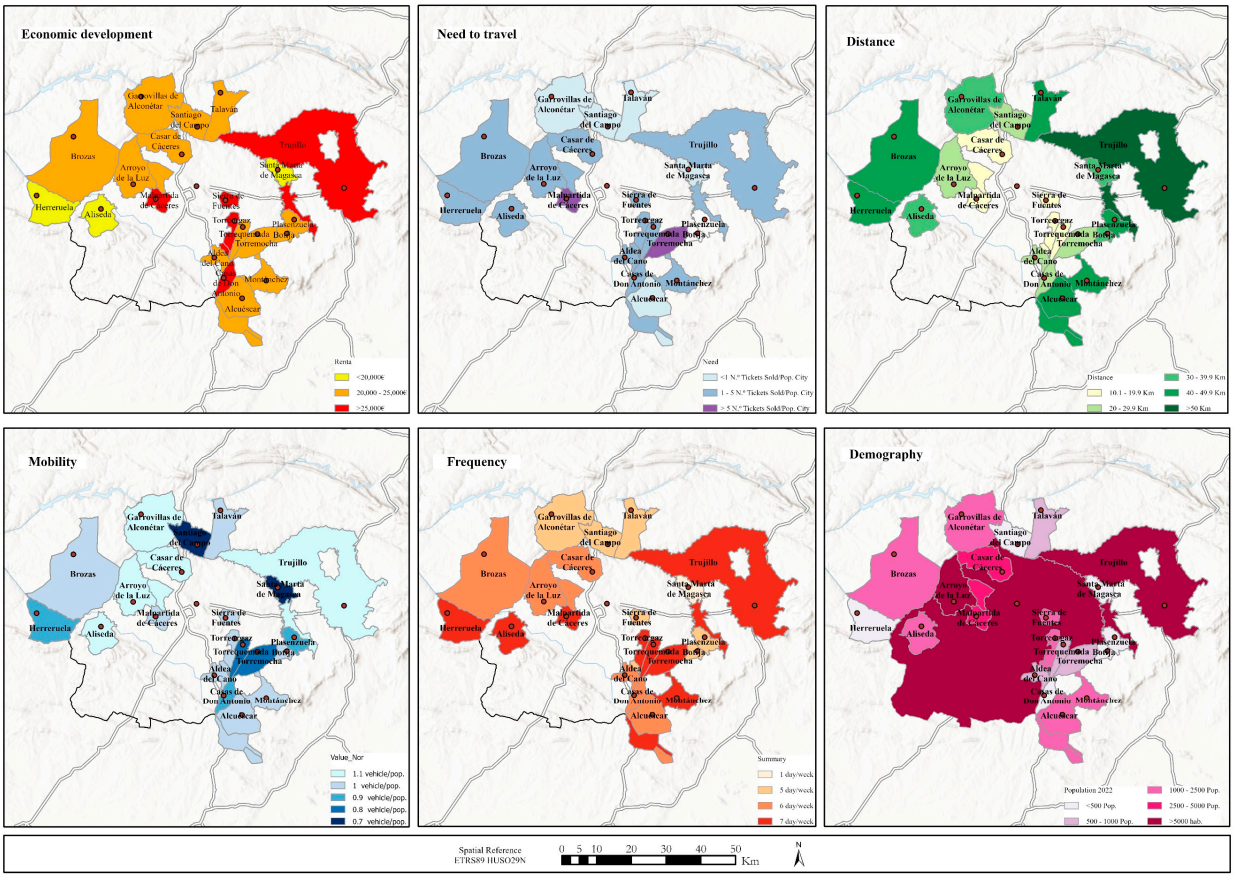


**Figure 7.** Representation of the analysed variables.

## 3. Results

The results obtained in this research are provided in two complementary ways: (1) by municipality, in relation to the six variables described (the most and least affected municipalities are analysed, those that recover more and less quickly and those that recover worse and better after the pandemic), considering additionally the number of tickets sold; and (2) by route, where the interurban bus lines with the greatest affluence of the RMSC and the impact that COVID-19 had on them are made known.

### *3.1. Analysis by Municipality*

In this context, the first line of research based on the number of tickets sold and the joint analysis of the six variables reveal that, although all the municipalities of the RMSC have recovered travellers after the pandemic, previous levels have not yet been reached. According to the analysed data of the total number of travellers, in 2020 ticket sales decreased by 51% compared to 2019 (considered as a benchmark year). In 2021, 64.3% of tickets were sold, and in 2022, sales reached 81.7%, compared to 2019. These results show a gradual recovery in the use of the bus as a means of transportation in the rural area analysed, although the demand prior to the health crisis has not yet been fully recovered.

However, the recovery has not been uniform in all the municipalities. The analysis of the aforementioned variables has made it possible to identify how the recovery has been in each locality, yielding diverse results. These studies highlight differences in the number of passengers recovered, the speed with which demand has been reestablished, and other specific factors evaluated during each year of the study period. The first analysis obtained (Figure 8) focuses on the most and least affected municipalities during the year 2020 (when the pandemic caused a significant reduction in the use of public and collective transportation, due to social distancing measures and restrictive policies on non-essential travel implemented to mitigate the spread of the virus in the region).

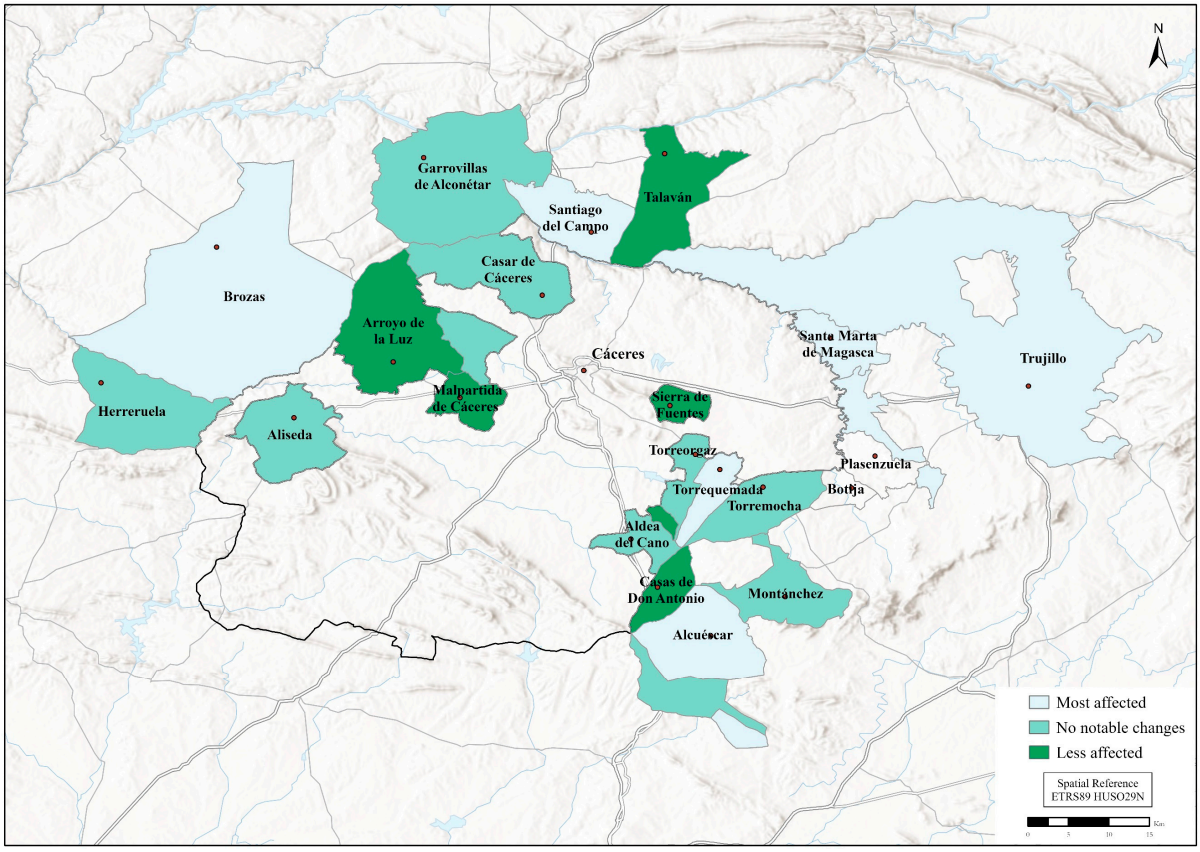


**Figure 8.** Municipalities that have been most and least affected by COVID-19.

Looking at Figure 8, three groups can be distinguished, represented by different shades of colour. The darker shades correspond to municipalities less affected by COVID-19, while the lighter shades indicate localities that suffered a greater negative impact on bus use during the pandemic. The intermediate shades represent municipalities that did not show significant changes.

The municipalities in the darker shades share a common pattern: their strong dependence on or link to the capital. This group, composed of localities located less than 20 km from the capital and with a larger population (between 2000 and 5000 inhabitants), stands out for having suffered less from the effects of the pandemic. An exception is Aldea del Cano, which, despite having a smaller population, maintains a strong connection with the capital, which has mitigated the impact of the health crisis. Proximity to the capital and a high average net income per household are common factors in these municipalities, which have recorded ticket sales slightly above 50%, with a maximum of 61.6%.

On the other hand, the municipalities in the lighter shades have been the most affected, with ticket sales below 50%. These localities, generally more remote, with smaller populations and less dependence on the capital, do not show a clear pattern in the variables analysed.

Finally, the municipalities represented in the intermediate shades have suffered the impact of the virus, although less severely than the others. Their balanced situation between the capital and their nearby localities has allowed them to meet their needs without depending exclusively on a single urban centre. In short, their intermediate position has allowed them to mitigate the effects of the pandemic to a greater extent than the most affected municipalities.

The variables of frequency and mobility also play an important role. The municipalities close to the capital do not have at least one vehicle per person. However, the daily frequency of the bus in these areas encourages its use rather than private transport. In contrast, the more distant municipalities have a higher motorisation rate because the bus frequency is not daily, forcing their residents to rely more on private vehicles.

The second analysis obtained (Figure 9) is related to the locations that recovered faster in 2021 than in 2019, again finding three differentiated groups.

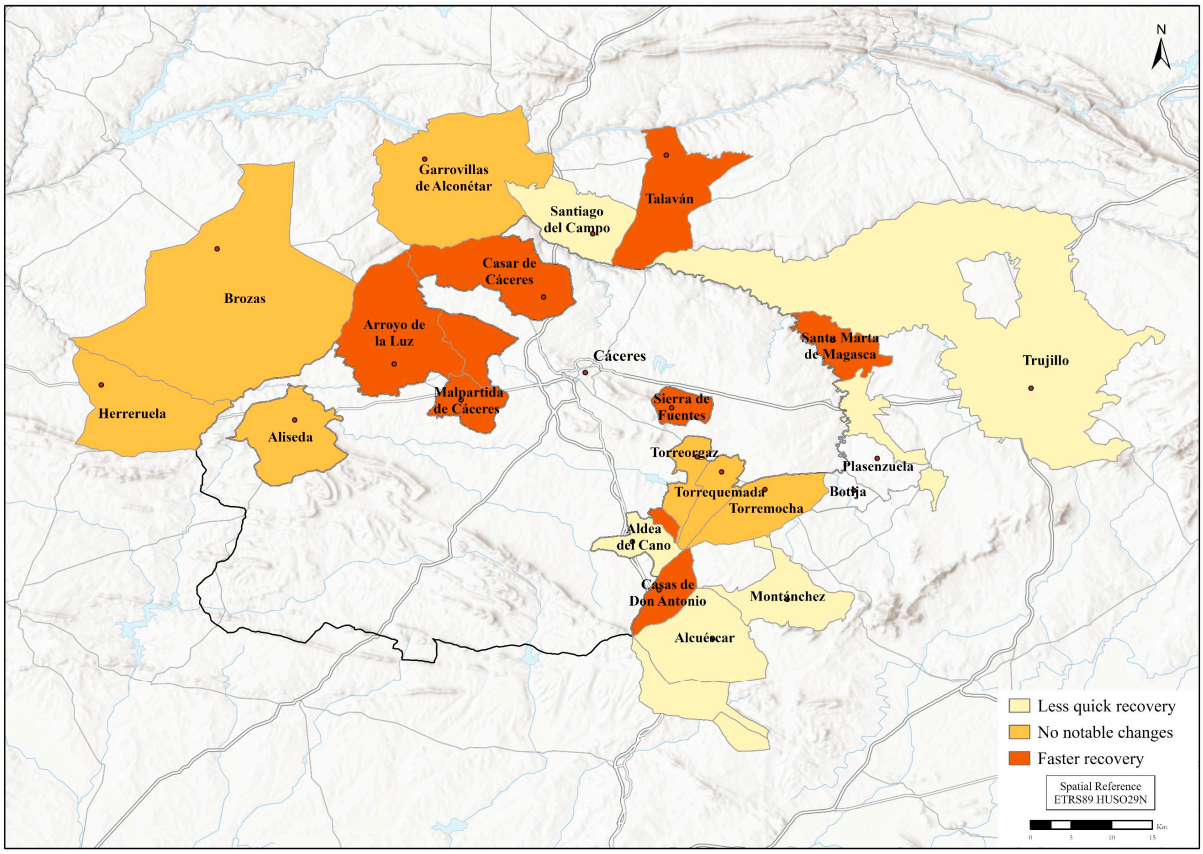


**Figure 9.** Municipalities that recovered fastest from COVID-19.

The localities closest to the capital are represented in the darker tones, these being the ones that experienced a faster recovery one year after the pandemic, with ticket sales exceeding 65% during that year. In addition to geographic proximity, factors such as a larger population (except in the case of Aldea del Cano) and the need to access services in the capital influence the rapid recovery, even in localities that are not so close to the capital but depend on public transport to access these services.

On the other hand, the localities represented in the paler shades are those that have taken longer to recover. These share a distant location from the capital, a smaller population and average net income, and an ill-defined need to commute to the main city. In these areas, ticket sales do not exceed 50%, indicating that they are still suffering the consequences of SARS-CoV-2.

The municipalities in the intermediate shades do not show significant changes. These areas are characterised by diffuse intermunicipal relations since, although they are closer to smaller municipalities than the capital, their needs are covered locally, which decreases their dependence on public transport and, consequently, reduces the number of users in these areas.

Once again, the variables of frequency and mobility are fundamental. The localities close to the capital recover quickly due to the high frequency of buses. In contrast, in the more distant and intermediate areas, where the motorisation rate is medium–high, the use of private automobiles for trips to nearby localities is more common. This is due to the fact that public transportation in these areas has a limited frequency, which does not adequately cover the demand for intermunicipal mobility.

The third and final analysis (Figure 10) reflects the worst and best recovering localities in the year 2022, two years after the onset of the COVID-19 pandemic, which significantly disrupted mobility and public transportation use.

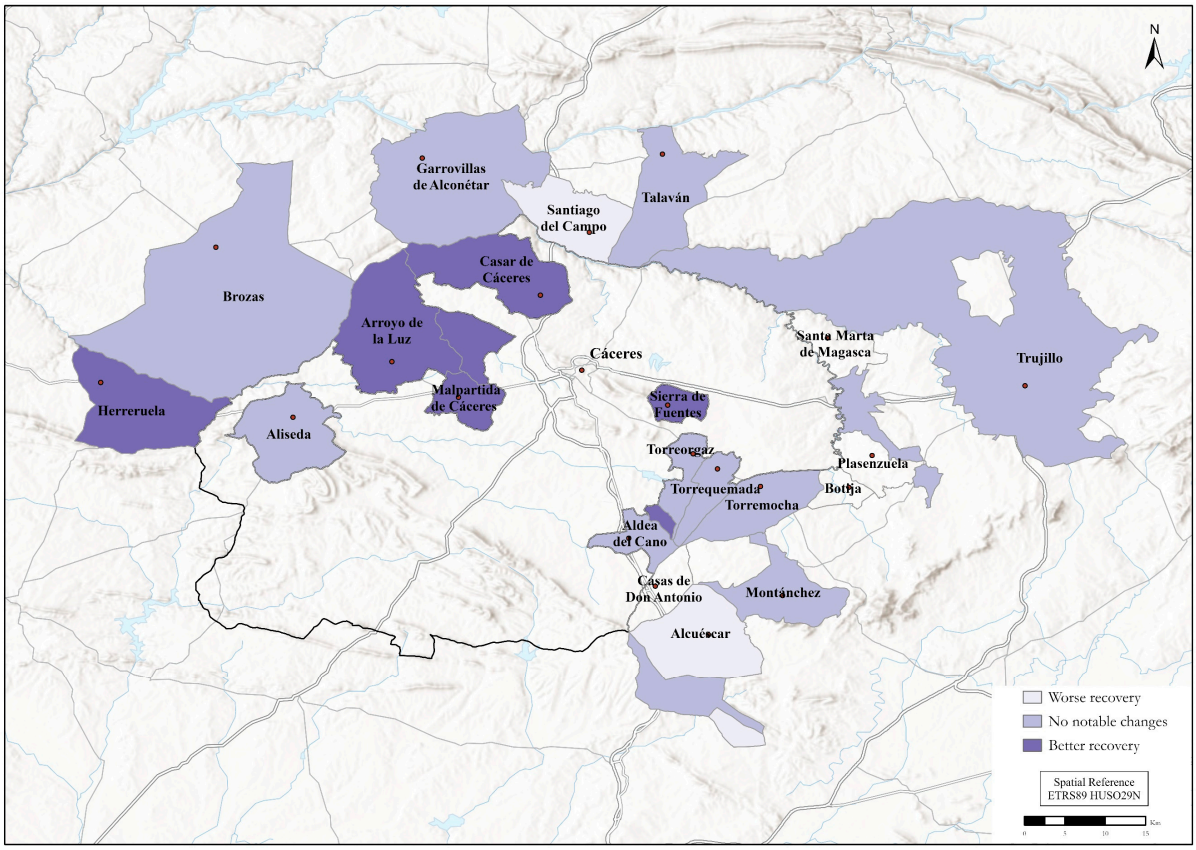


**Figure 10.** Municipalities that recovered worst and best from COVID-19.

The municipalities in the darker shades follow the pattern previously observed, where proximity to the capital, higher populations, and high incomes influence the use of public transport. Their proximity to the capital makes these municipalities opt for public transport to avoid inconveniences such as a lack of parking and high fuel costs, encouraging more sustainable mobility options. In these localities, ticket sales exceeded 80%, evidencing a superior recovery compared to the other municipalities. However, pre-pandemic demand levels have not yet been reached, suggesting that public transport recovery remains a challenge in the post-pandemic context, especially in rural areas. In the lighter shades, for the municipalities with a slower recovery after the pandemic, the de-escalation phases and the post-pandemic period are grouped together. In these localities, the need to commute to the capital has historically been low, limiting the demand for public transport. Instead of heading to the capital, they prefer to satisfy their needs in nearby municipalities. In these areas, ticket sales have not exceeded 50%, remaining at around 45%, a figure significantly lower than that recorded in previous years.

Finally, the municipalities in the intermediate tones present undefined links with the capital, which reduces the frequency of public transport use. These localities tend to benefit from their proximity to other municipalities, reducing their dependence on the capital and the need to travel to it by public transport. Once again, a high bus frequency, combined with a low motorisation rate, has contributed to a better recovery in the municipalities close to the provincial capital two years after the onset of the pandemic. In contrast, the more remote municipalities, which require less travel to the capital, have shown a less effective recovery due to their low public transport frequency and greater reliance on private vehicles.

In addition, supplementary data (the number of tickets sold and the number of travellers who have used the bus) have also been considered in this research. Previously, it was observed how the flow of users declined in 2020 and gradually increased in subsequent years. However, this recovery has been uneven in each year compared to the pre-pandemic

period and varies in each municipality. Figure 11 shows the evolution experienced in each locality of the RMSC.

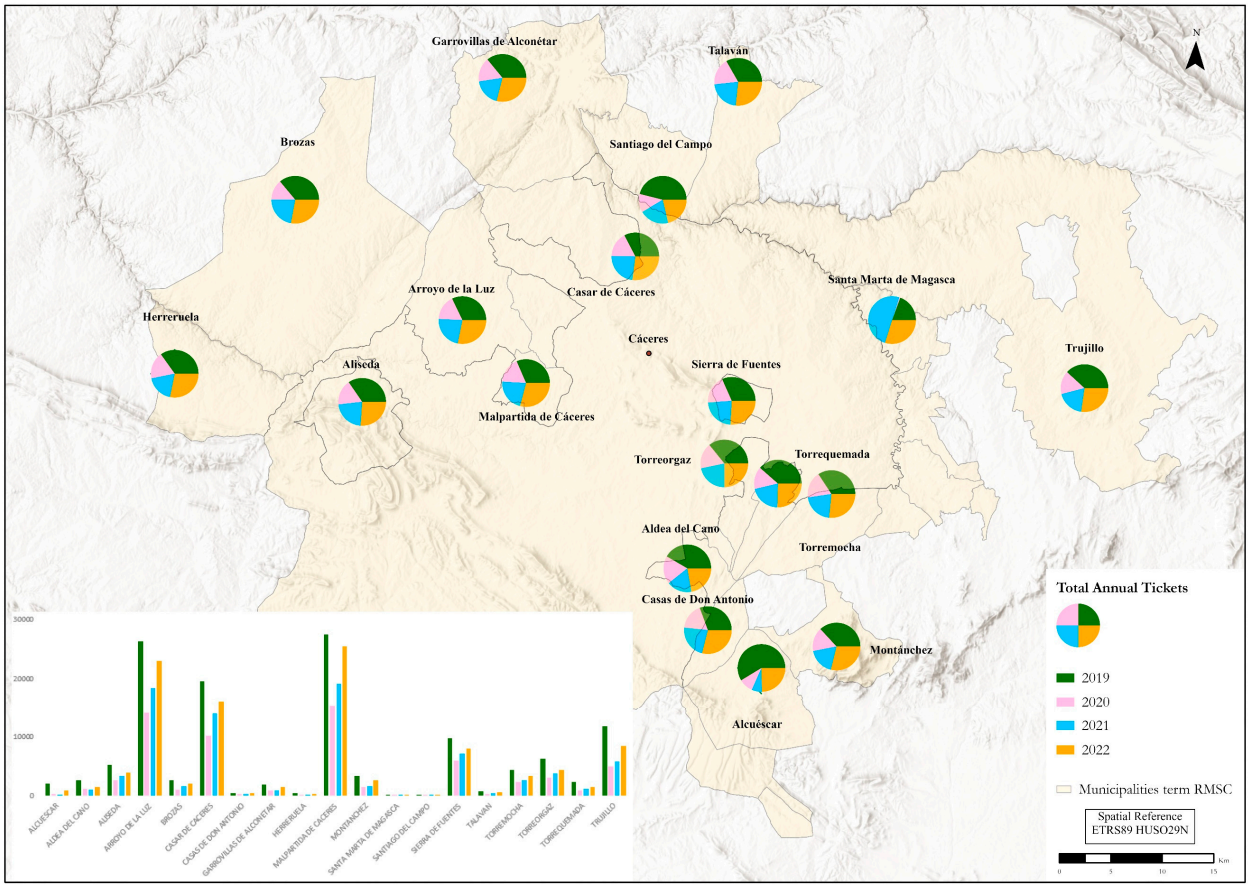


**Figure 11.** Total number of tickets sold per municipality and year.

Taking into account the number of tickets sold, the passengers who have used the bus, and the variables shown in Figure 7, the municipalities closest to the capital stand out, particularly Arroyo de la Luz, Casar de Cáceres, and Malpartida de Cáceres. These localities not only have larger populations but are also located less than 20 km from the capital, which generates a strong need to travel to it. Although Trujillo is more distant, it also stands out for its high demand for transportation and its considerable number of inhabitants, which significantly increases the number of travellers.

In contrast, the municipalities farther away from the capital tend to head for closer destinations, without the need to travel to the capital. These alternative destinations, thanks to their strategic location and the services they offer, act as centres of population attraction, functioning as regional headwaters. These regional poles of attraction make it possible to satisfy local needs without having to travel to the capital.

Although the increase in ridership has been gradual, each locality has experienced this recovery at its own pace. Factors such as perimeter closures and the fear of SARS-CoV-2 contagion in closed and shared spaces influences the fluctuation in the use of public transport, as well as the adoption of more sustainable and healthier means of transport.

In this context, starting from 2019 (the baseline value of ticket sales), a significant drop was observed in 2020, when only 51% were sold compared to the previous year. In 2021, the percentage rose to 64.3%, reflecting a decrease in the fear of contagion in public transport. Finally, in 2022, sales reached 81.7%, consolidating the bus as a key means of mobility in rural areas and reaffirming its importance in the daily lives of their inhabitants.

### *3.2. Bus Route Analysis*

In the second line of work in this research, the route network that connects all the cores of the analysed localities was examined. On a general level, as with the municipalities, 2019 stands out as the best year in terms of activity compared to 2022. Although it was expected that, with the time elapsed since the pandemic, the number of trips would have matched or even exceeded the 2019 figure, the data reveal that no such recovery has been achieved.

The ticket sales in each year clearly reflect this impact. In 2020, ridership declined by 49.6% compared to 2019. In 2021, the figure recovered to 62.2% of previous levels. By 2022, the volume of users reached 80.2% compared to the year before the pandemic. These data highlight the negative effect that the COVID-19 pandemic has had, from total confinement nationwide to perimeter closures and mobility restrictions in the autonomous community of Extremadura, significantly affecting the municipalities studied.

This analysis reveals that the interrelationship between the municipalities varies according to the services and goods that each one offers. This influences the number of travellers using each route, which depends on both the municipality of the destination and the municipality of the origin. In addition, the flow and volume of passengers on each route are conditioned by the localities it crosses so that routes connecting areas with higher population densities register more passengers.

However, despite the fact that 2019 was the reference year with the highest number of mobilisations, not all the routes behaved uniformly during the period studied. This variability is reflected in Figure 12, which compares the total number of tickets sold on each route with the total population of the municipalities, according to the 2019 reference data.

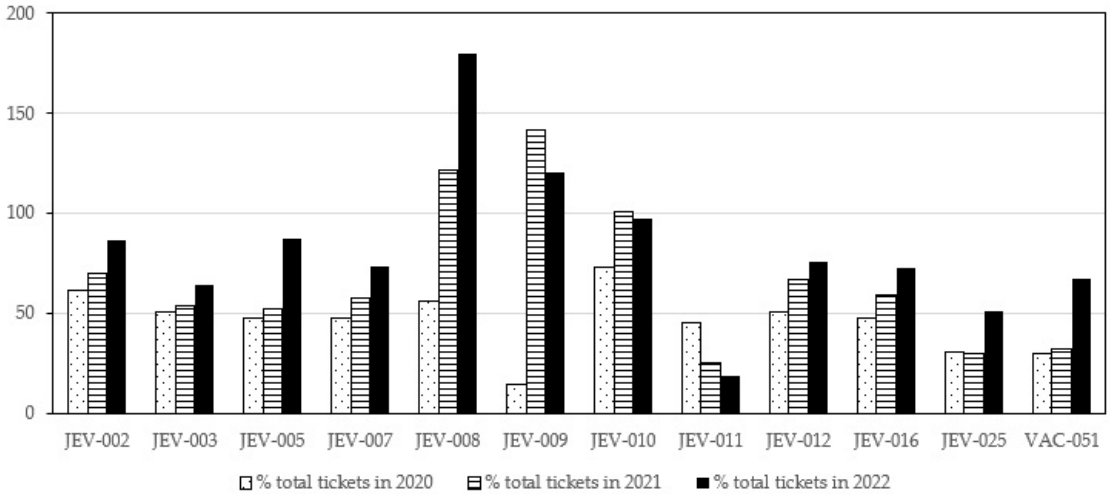


**Figure 12.** Percentage of total tickets sold per year on each route compared to 2019.

Figure 12 shows how the evolution of the bus lines has varied from year to year. In 2020, during the peak of SARS-CoV-2, ticket sales were generally uniform across all the routes, except in some areas with lower sales volumes. In 2021, all the routes exceeded 50% of the tickets sold in 2019, and some even reached levels higher than those prior to the pandemic, especially in the locations where bus use is more frequent. In 2022, the routes stabilised, with most remaining between 70% and 90% of tickets sold in 2019. When analysing the behaviour of the routes after the pandemic, it is observed that the municipalities farthest from the capital have experienced a notable increase in the number of travellers, while those closer to the capital have seen a more modest increase. However, the data show variations according to the analysis approach applied. Two types of analysis were carried out: the first included combining and normalizing the data on the tickets sold on each line with the total annual sales; and the second involved normalizing these data according to the population of the municipalities through which the bus travels. In both

cases, the number of tickets sold on each route shows patterns similar to those observed above, although with differences according to each normalisation methodology used.

To facilitate understanding, figures corresponding to both analysis methodologies are presented, allowing a comparative evaluation of the situations described.

The analysis of Figures 13 and 14 shows a clear differentiation in the ticket sales over the years, with special emphasis on routes that pass through localities close to the capital or with larger populations. Figure 13 shows that the ticket sales remain relatively constant in the four periods analysed, although with some fluctuations on routes in the north (JEV-012), east (JEV-003 and JEV-008), and southeast (JEV-007) zones. In the north zone, an average of 13.8% of the tickets sold during the entire period was recorded, placing it in second position in terms of sales. In the east zone, the two routes combined account for approximately 60% of total sales, ranking first. The southeast zone is in third place, with 11.9% of tickets sold. Both the north and east zones, due to their proximity to the capital, good communication routes, and higher population densities, show a significant volume of sales. On the other hand, the southeast zone experiences an increase in the flow of tickets due to the need of the larger localities to access the capital. Figure 14 reflects a close correlation with the former. This is because, when the tickets sold in each municipality correspond to areas with larger populations, both the municipalities and the associated routes tend to attract more users.

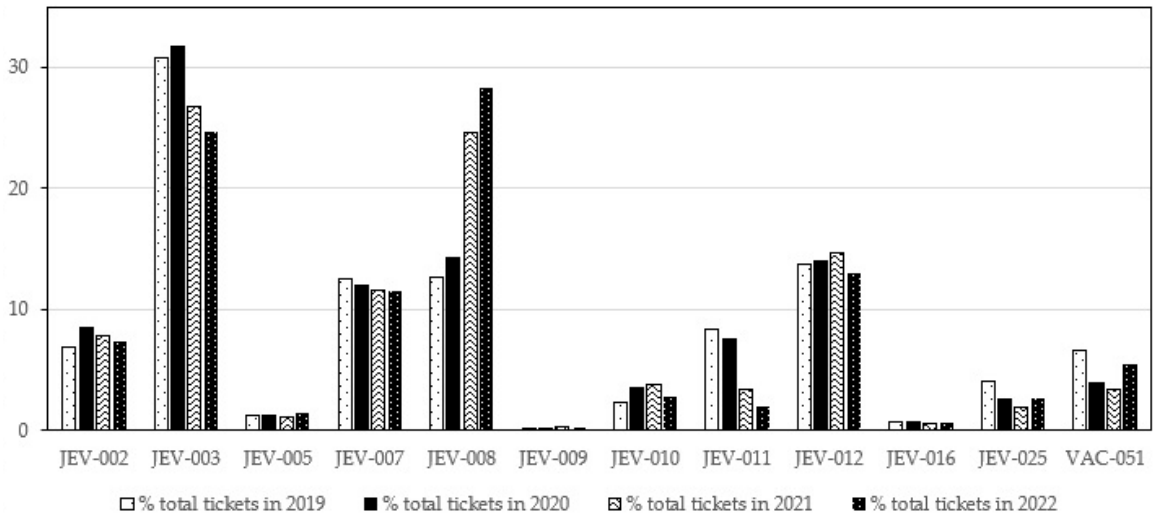


**Figure 13.** Percentage of tickets sold per route each year.

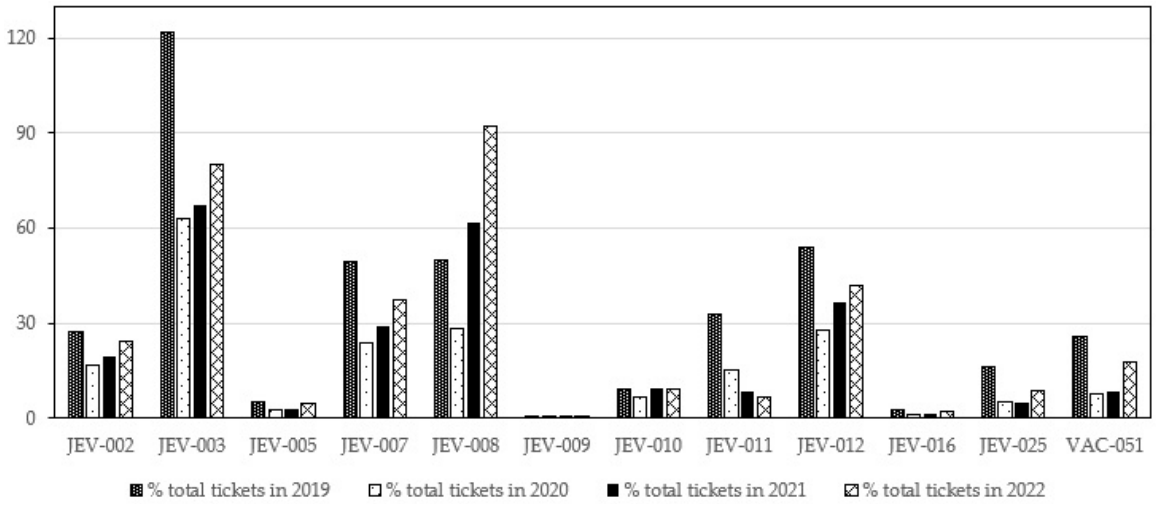


**Figure 14.** Percentage of tickets sold per route considering the population of the municipalities.

## 4. Discusion

This research assessed the impact of the COVID-19 pandemic on the mobility patterns of public bus transport users in the rural and interurban areas of Cáceres. Through a quantitative analysis of mobility data, we sought to determine whether the health crisis caused a decrease in the number of passengers and whether there were significant changes in the routes and schedules of users in a geographical context characterised by a low population density and limited accessibility.

Accessibility in rural areas, as underlined by [58,59], is a crucial factor influencing the mobility patterns of their inhabitants. Rural settlements with better accessibility tend to show increased interrelation and movement towards the city of Cáceres, mainly due to their proximity to the main communication routes. This mobility is driven not only by geographical proximity, but also by the need to access basic services (health, education, employment, and commerce) that are often scarce in rural areas [34,60]. Despite the availability of public transport, the use of private vehicles prevails, a trend supported by multiple studies [61,62]. Several factors, such as the fear of COVID-19 infection in shared spaces [29,63] and deficiencies in public transport supply (frequency and schedules) [64], contribute to this preference for private transport.

The results of this research confirm that the provincial capital is the main destination for journeys originating in the rural municipalities of the area analysed, even exceeding intramunicipal journeys. This trend is particularly marked in municipalities close to the capital. However, as distance increases, there is a reduction in the preference for the capital as a destination, showing an inverse relationship between distance and the choice of the capital as the final destination. These findings corroborate the importance of geographical proximity and transport infrastructure in shaping mobility patterns [65,66].

The COVID-19 pandemic has generated a significant impact on the bus transport sector [67,68]. The social distancing measures imposed to contain the spread of the virus forced a reduction in bus capacity, which, in turn, led to a significant decrease in demand for this service. The research results, obtained from the analysis of the ticket sales data, corroborate this trend, which has been widely documented in the literature [61]. During the state of alarm and the subsequent de-escalation phases, drastic drops in the number of users were recorded in various regions in Spain, with decreases of more than 40% in many cases [34,38,40,42]. In the medium-sized but predominantly rural city under study, a reduction of 49.6% was observed in 2020, partially recovering to 80.2% of pre-pandemic levels in 2022.

The research results confirm the severe dependence of rural municipalities close to the provincial capital on the services offered by the provincial capital. As pointed out in [69], the capital acts as a pole of attraction for these municipalities, which explains the significant reduction of 64.3% in the number of travellers during the pandemic. Although a partial recovery has been observed in the last year, reaching 81.7% of pre-pandemic levels, these data highlight the vulnerability of these municipalities to any disruption in mobility towards the capital, due to their dependence on the capital to meet their basic needs.

Although the analysis of ticketing data has been central to assessing the impact of the pandemic on public transport, other methodologies such as traffic counters, surveillance cameras [35], Bluetooth monitoring [39], and radar systems [43] have provided complementary evidence on the overall reduction in mobility during the confinement. These techniques, although focused on vehicular traffic, have corroborated the drastic decrease in the number of vehicles in circulation and, consequently, in the number of people in motion. On the other hand, surveys [37,38,41,56,57,70,71] have been used to specifically assess the impact on public transport, despite the inherent limitations of this method in terms of representativeness [72].

The results of this research reveal a trend towards a recovery in the use of public transport in the interurban area of Cáceres after the pandemic. Despite the difficulties imposed by health restrictions, an increase in the number of bus users is observed, suggesting that citizens are gradually returning to their previous mobility habits. This phenomenon can be

explained by the need to make essential journeys, which in many cases has led to a combination of public transport and private carpooling [57]. The analysis of an extended time period (2019–2022) has allowed the identification of this recovery trend, complementing studies that have mainly focused on the periods of confinement and de-escalation [35,38,39,41,43]. Our findings are consistent with those of [34,40,42], which have also analysed the long-term evolution of public transport demand.

This research has identified some limitations, such as the lack of open source data from public administrations on user flows, as well as the scarcity of studies on the impact of COVID-19 on public transport in rural areas with low population densities. Nevertheless, the methodology used is considered adequate from the point of view of the implementation of the study variables and the analyses developed (both by municipality and by route), complemented with supplementary data (the number of tickets sold and the number of passengers who have used the bus). Based on the findings of this research, some feasible policy measures are proposed in order to encourage the use of public transport. It is suggested that user development and recovery plans include the following: (a) the promotion of regulated public transport in the main localities, (b) the establishment of on-demand transport in satellite areas, (c) increasing the frequency of services by adapting timetables to the real needs of users, (d) the implementation of specific fares according to sectors of the population, or (e) decreasing the cost of fuel for companies operating in less crowded areas. It could be considered of interest to carry out future research that employs more transportation options in addition to the bus in these interurban areas and that, in addition, allows differentiating users according to their age, gender, etc.

## 5. Conclusions

The aim of this research was to analyse the effect of the COVID-19 pandemic on the mobility habits of public transport users in a rural area of low demographic density in Spain. The findings obtained allow us to identify changes in the mobility patterns and to observe the progressive recovery of the number of users after the initial impact of the pandemic. The pandemic, characterised by the fear of contagion in enclosed spaces and contact with strangers, caused a significant decrease in the use of public transport. During the state of alarm, along with its ensuing extensions, de-escalation phases, and perimeter closures, ticket sales declined by as much as 50%. However, after the easing of the restrictions, the numbers gradually began to recover. By 2022, ridership had returned to near pre-pandemic levels, suggesting a trend towards the normalisation of mobility in the intercity area analysed.

One of the most relevant aspects of this investigation is the interconnection between the rural municipalities and the attractor urban nucleus. As the restrictions decreased, there was an increase in the connections between the municipalities, especially those close to the provincial capital. Medium-sized urban cores and their surrounding rural areas present different mobility needs than areas with larger cores. While the rural areas depended significantly on the services offered by the central urban core, more densely populated areas tended to be more self-sufficient. The provincial capital, due to its concentration of services, continued to be the main destination for commuting from the surrounding rural areas, especially from smaller municipalities with fewer services. The analysis also showed that mobility to the more populated city was crucial for the quality of life of residents in the rural area under study. In many cases, commuting was essential, as was the case of commuters. The capital city was the preferred destination for commuting from the municipalities in the study area, even surpassing trips within the same localities. This pattern was more pronounced in the municipalities close to the capital, while the greater the distance, the preference for that municipality decreased in favour of other larger municipalities within the RMSC. The importance of the large city as a generator of trips was evident in most of the municipalities, although the degree of dependence varied according to the size of the population. The smaller municipalities, with fewer facilities and services, depended more on the city and other larger centres that concentrated schools,

health centres, and public administrations. In contrast, the larger municipalities, with more diversified socio-demographics and economic characteristics, showed less dependence on the provincial capital, which translates into a reduction in trips to that municipality and an increase in trips within the municipalities themselves or to other urban centres.

A remarkable finding of this research was the uneven recovery between the towns closest to the capital and those farther away. The closest localities have recovered more quickly to pre-pandemic mobility levels due to their geographic proximity, larger populations, higher household incomes, and need to access the capital's services. Although these localities also suffered a reduction in the number of users during the health crisis, their recovery has been more effective compared to more distant or less connected areas. Finally, the study showed the impact of COVID-19 on the bus routes connecting these municipalities. Of the twelve routes analysed, all experienced declines in ticket sales, albeit with significant variations. While ridership has shown a gradual recovery, the initial loss was considerable, and normalcy has not yet been fully achieved.

In conclusion, this investigation highlights how the COVID-19 pandemic has altered mobility habits in the rural and peripheral areas of a medium-sized city. Although the recovery has been remarkable, especially in the municipalities closer to the capital, challenges remain related to dependence on urban services and the need to adapt public transport to the new post-pandemic realities. It is crucial to continue research to better understand the dynamics of mobility in these areas and to develop strategies that promote more accessible and efficient transportation for all residents.

**Author Contributions:** M.J.-E. and J.M.V.N. conceived and designed the research. J.G.V. performed the calculations with SIG and edited the maps with ArcGIS. M.J.-E., J.M.V.N., R.G.-E. and J.G.V. wrote and revised the paper. M.J.-E., R.G.-E. and J.G.V. made the formal analysis and supervised the paper. All authors have read and agreed to the published version of the manuscript.

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**Data Availability Statement:** The data presented in this study are available on request from the corresponding author. The data are not publicly available due to ethical restrictions.

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**Conflicts of Interest:** The authors declare no conflicts of interest.

## Appendix A

The following list details the interurban bus transportation lines that run through the different rural localities of the study area. Each route plays a crucial role in intermunicipal connectivity, providing transportation between the localities and improving mobility. A breakdown of the existing routes is presented, including specific details on their length, the towns they pass through, and the companies that operate these services.

- JEV-002 Route Sierra de Fuentes–Cáceres. It connects the municipalities of Sierra de Fuentes and Cáceres with a length of 15.2 km, and it is managed by the company Duran Bus S.L.
- JEV-003 Aliseda–Cáceres. José Ramon Mena Autobuses S.L., known as Mena, is the company in charge of co-connecting the municipalities of Aliseda, Arroyo de la Luz, Malpartida de Cáceres, and Cáceres in a route of 45.4 km.
- JEV-005 Route Garrovillas de Alconétar–Cáceres. It connects the municipalities of Garrovillas de Alconétar and Cáceres and the company Herederos de Juan Gil Hernández, S.L. is in charge of it. This route has a length of 36.4 km.

- JEV-007 Route Montánchez–Cáceres (EX206). It is managed by the local company of the municipality of Montánchez Solís Autocares, S.L. and connects the municipalities of Montánchez, Albalá, Torre de Santa María, Valdefuentes, Torremocha, Torrequemada, Torreorgaz, and Cáceres, with a length of 46.8 km.
- JEV-008 Route Valencia de Alcántara–Cáceres. The route is managed by the company El Gato S.L. and connects the municipalities of Valencia de Alcántara, Membrío, Salorino, Herreruela, Malpartida de Cáceres, and Cáceres in service 1 within this line. The service 2 offered by this line is the one that connects Aliseda with Arroyo de la Luz, Malpartida de Cáceres, and Cáceres, coinciding with the route JEV-003. When this research happened, it was decided by the regional government to suppress the route JEV-003 from the year 2021; however, to carry out our study, we chose to maintain the route JEV-003 as active and to suppress the service 2 of the JEV-008 in order to have a single service within this route that would join the towns of Herreruela, Aliseda, Malpartida de Cáceres, and Cáceres. This service has a length of 49.5 km.
- JEV-009 Route Santa Marta de Magasca–Cáceres. The line is managed by the company Alsa-Mirat and connects the municipalities of Santa Marta de Magasca, Trujillo, and Cáceres. This line is the 36th service within this concession. This line covers a total of 31.9 km.
- JEV-010 Route Alía–Cáceres. It is in the concession of the bus company Alsa-Mirat and runs through 14 towns, starting from Alía and going through Guadalupe, Cañamero, Logrosán, Zorita, Conquista de la Sierra, Herguijuela, Pago de San Clemente, Madroñera, and Trujillo until arriving in Cáceres. This line covers a total of 50 km.
- JEV-011 Route Acehúche–Cáceres. It is managed by the company Autocares Noreste S.L. and departs from Acehúche passing through Ceclavín, Zarza la Mayor, Piedras Albas, Alcántara, Mata de Alcántara, Villa del Rey, Brozas, Navas del Madroño, Arroyo de la Luz, and Malpartida de Cáceres until arriving at Cáceres. This line runs through a total of 12 municipalities, with a length of 49.9 km.
- JEV-012 Route Casar de Cáceres–Cáceres. This route is managed by Autocares Hnos. Fdez. Palomino, S.L. and has two types of services, although both connect in the same way: Casar de Cáceres-Cáceres and vice versa. These combinations are divided by where they circulate, differentiating service 1, which travels by the national road N-630, and service 2, which travels by the conventional road CC-324. The route is 31.9 km in total.
- JEV-016 Ruta Torrejón el Rubio–Cáceres. This line runs along the EX-390 regional road, connecting the municipalities of Torrejón el Rubio, Monroy, Talaván, Hinojal, Santiago del Campo, and Cáceres, and is managed by the company Emiz, S.L. This route has a length of 44.1 km
- JEV-025 Route Oliva de la Frontera–Cáceres. The concession is held by the bus company Autocares de Badajoz S.L., and the route connects the towns of Oliva de la Frontera, Jerez de los Caballeros, Brovales, Burguillos del Cerro, Zafra, Los Santos de Maimona, Villafranca de los Barros, Almendralejo, Torremejía, Mérida, Carrascalejo, Aljucén, Casas de Don Antonio, Aldea del Cano, Valdesalor, and Cáceres. It has a length of 52.4 km, taking into account only the municipalities of the network through which the old route JE-018-C used to run (Montánchez, Alcuéscar, Casas de Don Antonio, and Aldea del Cano), although by a different route. The regional government decided to join both lines and leave a single active service in order to link several municipalities both inside and outside the network.
- VAC-051 Route Madrid–Badajoz–Valencia. This route is the only one that connects two municipalities within the Sustainable Network of Municipalities of Cáceres, which are Trujillo and Cáceres, but the line originates in a town outside the autonomous community of Extremadura.

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