








Article

Accessibility Dynamics and Regional Cross-Border Cooperation (CBC) Perspectives in the Portuguese—Spanish Borderland

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Abstract: Accessibility plays a major role in achieving sustainable transport, and therefore urban and regional sustainability. The urban public transport system promotes mobility and realizes a large part of urban movements. Moreover, improving accessibility in order to promote sustainable transport requires the application of new concepts and indicators as a powerful tool in the process of creating a balanced urban transport system. In this regard, one of the main goals of this research is to present an overview of the relevant accessibility indicators and assessment of accessibility in regional Cross-Border Cooperation (CBC) in order to transcendence challenges and obstacles for sustainable transportation in these regions along of Portuguese-Spanish border. This paper focuses on the accessibility of cross-border cooperation scenarios along the border regions of Alto Alentejo (Portugal) and Badajoz (Spain) where the Case Study Research Method (CSR) made it possible to recognize accessibility as a key factor in territorial success. Also, accessibility analysis can assess improvements as well as regional imbalances. In addition, this methodology can be used to identify missing links, which requires new investments enabling long-term sustainability.

Keywords: accessibility; border regions; cross-border public services; planning; sustainable transportation

1. Introduction

In recent decades, EU policies have been moving towards increasing cross-border cooperation in order to exploit all the potential of border areas [1–5]. Although the Trans-European Transport

Network (TEN-T) has made a tremendous contribution to increasing the provision of transport infrastructure and improving transport services, it often seems that peripheral and border regions are poorly connected and their accessibility is reduced relative to central regions [6–8]. The situation is similar to the international level, which results in many internal borders of the EU becoming its inner periphery [9,10].

Most of the cross-border region, as well as Alto Alentejo (Portugal) and Extremadura-Badajoz (Spanish side of the border) are marked by an overall weak urban network, low-density settlements, continued population losses and fragility in the economic structure, as well as weaker connections between users and services. In fact, many experiences in cross-border public services have not been implemented successfully in these territories, mainly due to the following obstacles: political borders, many administrative obstacles, and effects related to economic discontinuities and natural obstacles [11,12].

A well-planned accessible and public transportation network between cities is pivotal for their sustainable development [13–15]. Accessibility is central to the concept of achieving more sustainable urban transportation and improving the sustainability of cities and regions [16–19]. In fact, many European CBC Projects have demonstrated their success [20–22]. Recent studies and academicians recognize accessibility as one of the most significant factors for territorial development regarding CBC projects in cross border regions [23–30].

Considering the classification criteria of inner periphery presented in [8] these border regions (Alto Alentejo and Extremadura-Badajoz) meet all of them: higher travel time to regional centers is needed, poor access to services-of-general-interest, municipalities having low economic performance, constraining the purchasing power of the population and also the access to services [11,12]. Based on the exposed, this article aims to assess and research the relevance of the accessibility concept in the Spanish-Portuguese border regions of Alto-Alentejo and Extremadura-Badajoz. Besides, this paper aims to propose a theoretical framework which consider the one segment (accessibility) of multidimensionality of the concept of sustainable transportation in borderlands – helping to provide the basis for the regional main-actors and decision makers.

Drawing upon professional, academic and ESPON projects [12,31,32] this article analyses the actual indicators of accessibility, and also assesses the accessibility levels as a factor to achieve more sustainable regional transport in this border territory.

Although significant progress has been made in Spain and Portugal cross-border transportation in the last decades in term of developed TENt networks and many CBC projects, cross border public transport and the provision of public services have received less attention that accessibility in this area makes unsustainable. Therefore, the following hypotheses were formulated: Different accessibility concepts as a territorial aspect of different modes of transport have different dynamics and perspectives in cross-border cooperation at regional and local level. Therefore, the following hypotheses were formulated: Which trends in regional accessibility have been the most relevant? How can we know that accessibility being sustainable and what can we do about it in the border area? Which indicators of accessibility can be a performance metric for sustainable transport? What services are provided in the case study areas? What are negative factors cause the slow development of CPS in the case study areas? What is the development of potential and future needs for CPS in the case study regions?

2. Literature Review

The current patterns and dynamics that are going on in the border regions remains unclear after economic barriers were eliminated [33–37]. “The processes of the European Union (EU) integration and enlargement have produced a new regional socioeconomic map in Europe. Border regions, in particular, have been put in a state of flux” [33]. Peyrony and Denert [35], in their consideration of Cross-Border Planning emphasize how it is important for EU regions to have their own institutional policy for border regions. According to [36] “cross-border integration does not derive from the mere opening of national borders that it supposedly helps at the same time to remove, but stems from the strategic

behavior of actors who actively mobilize borders as resources". Thus, [38] conducted an Internet public consultation (2015–2016) on the border obstacles that showed that EU citizens are considered "legal and administrative" type of barriers (language and transport) major obstacles in their daily movement across the border [33] (Figure 1).

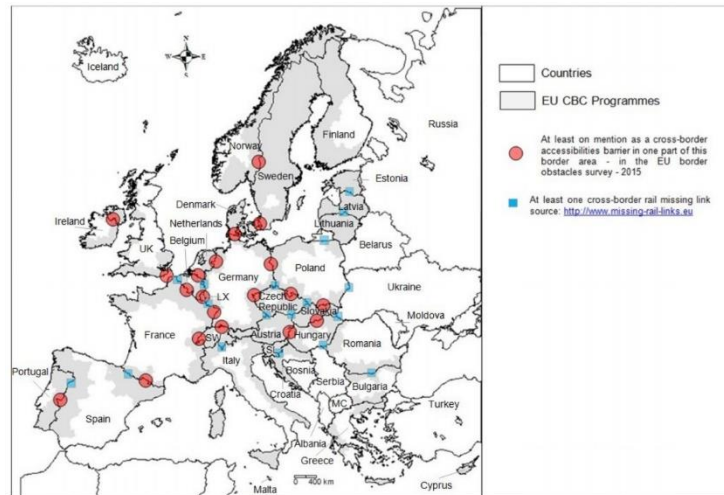


Figure 1. Transport accessibility barriers in Europe, Source: Medeiros [5].

On the other hand, many CBC projects across EU boundaries, have proved to be very successful. [16]. Example of good practice are the Projects b-solutions, where the Association of European Border Regions (AEBR) and The Directorate-General for Regional and Urban Policy [38] strive to be closer to local administrations in border areas with the initiative to collect information with a bottom-up approach in which CBC practitioners can expose what obstacles they encounter when trying to realize projects with the neighboring countries. Starting from such previous experiences, [22] presented a selected sample, incorporating a global analysis sample of best-selected experiences in order to confirm and reinforce previous global views. One of the analyzed active Euroregions is Alentejo-Centro-Extremadura Euroregion (EUROACE).

Based on recent studies and research [1–3,18,38–41], the activation of cross-border spaces depends on many factors that enhance cross-border interaction: cooperation's across modes of transport and operators as well as the accessibility of public transport services with appropriate scheduling for users in both CBC forming areas [19].

The accessibility of the transport system is a prerequisite for social and economic development, as it implies access to basic goods and services. In order to be sustainable, transport must be of high quality, safe, accessible to all, contributing to greater mobility, environmentally and economically sustainable, requiring accessible and environmentally and economically satisfactory transport systems [19].

Basic principles of development (enhancing well-being and equity) and sustainability (preserving natural and human capital) should be imperative for sustainable transport trends and policies [19,42,43], but, we often have a situation of open borders with uncoordinated public transport [44]. Without effective cross border passenger transport the principle of free movement of people within the EU cannot be fully realized: "especially passenger transport is not provided, then those EU citizens who cannot afford personal transport have no chance to enjoy the right of mobility, employment, and the other services in the neighbor country. For CB commuting public transport is of great importance, and in case of the existence of administrative barriers are needed strong economic factors [34,45].

According to [7], border regions are often peripheral and less developed in terms of transport infrastructure than the rest of the country for a number of reasons: sometimes these are the nature of the areas themselves, sometimes the lack of a critical mass that could justify investment in transport, lack cooperation of the authorities, which leads to non-efficiently policies [8]. Maggi et al. [46] and

Lopez et al. [47], emphasize that there is a need for cooperation between states and it would reduce the occurrence of "missing networks and isolated areas in the future" [8]. This is impossible if each country solves its own problems. The relationship between accessibility and development has been exploited especially when it comes to evaluating investments in major infrastructure projects [4]. The most used definition of accessibility is: "accessibility indicators describe the location of an area concerning opportunities, activities or assets existing in other areas and in the area itself, where 'area' may be a region, a city or a corridor" [48].

There is no single approach to measuring accessibility. Accessibility indicators "have generally been used to evaluate the performance of transport networks" and play "a key role in evaluating the competitive advantage of some locations due to the quality of their transport infrastructure" [28]. The classification has been developed by [49]. They suggested four basic perspectives: (1) infrastructure-based measures (focusing on time, congestion and operating speeds in the transport network (road or rail), (2) activity-based measures, (3) person-based measures (opportunities attainable by an individual, i.e., the individual's 'freedom to participate in activities under given constraints') [28]. (4) utility-based measures ('measured at the individual level and assuming that users aim to maximize the benefit of their travel after accounting for the cost' [48–50]. On the other hand, [14,50] consider the subjective perception as a key element for the evaluation of accessibility. Handy and Niemeier [14] argue that there is a need to incorporate 'how residents perceive and evaluate their community' and 'the uses and perceptions of the residents, workers, and visitors of an area' [51].

Furthermore, the population potential indicator or the daily accessibility indicator measure reachable population or activities, while the location indicator or network efficiency indicator use the population of destinations as the weighting of travel cost measures [47,52].

Potential accessibility is one of the most important indicators for measuring accessibility by using different modes of transport [30]. This indicator was developed by ESPON and recalculated in 2006 to retroactively adjust to NUTS3 calculations so that it can be possible to compare results for two years. However, the most of data available in ESPON's public database and most of them are outdated and are available mainly for the 1999 version of NUTS [10,31]. The potential of accessibility indicators not only measures transport networks, but also takes into account travel time (dependency function) and reachable population (activity function), thus giving overall accessibility to each region [28,30].

The concept, pattern and accessibility models have been developed through a large number of studies and projects. The main ones, among many other project and strategies, includes: [32] as an innovative ESPON project (include 18 European CBC areas), has applied results from ESPON with a focus on accessibility and connectivity. In the [53], the analysis of accessibility and infrastructures within EUROACE region in the Spanish-Portuguese border space was also conducted [16,23,29,54–56].

Cross-border public services have become increasingly important by opening up the European internal market [57,58]. Increasing interest in CPS may also be influenced by an observable "come-back" of municipal public service provision in Europe that gives rise to a need for better coordinating service provision across national borders [58]. The ESPON project [12], through one analytical concept of case studies, made it possible to clearly define or delineate the exact nature and scope of cross-border public service delivery activities. The results of the analyzes show that more than five or ten CPSs can be found at the borders of Benelux, France, Germany, Switzerland) and the Nordic countries, with two exceptions along the Czech-German (Elba-Labe region) and Austrian-Germany (Salzburg), which is not the case with other borders. This analysis emphasizes the importance of considering the real status and needs of CPS in terms of overcoming future challenges.

3. Methodology

Considering the aim of the research, a methodological framework based on a case study analysis method [59], as well as other direct and indirect method analysis, have also been applied to the study areas. The indicators for the case study accessibility analyzes are shown in Table 1.

Table 1. Indicators for accessibility and CPS analyses.

Projects	Indicators		
ESPON Project 1.2.1. Transports services and networks: territorial trends and basic supply of infrastructure for territorial cohesion. Update 2006 [31]	Potential accessibility by road, rail, air, multimodal/Absolute level, standardized (ESPON = 100)		
	Geographical scale	Source	Time frame
	NUTS3 *	ESPON Data base	2001;2006
ESPON Project TRACC. Transport Accessibility at regional/local scale and patterns in Europe 2013 [53]	Potential accessibility Travel Indicators TRACC by road, rail, air, multimodal/Absolute level, standardized (ESPON = 100)		
	Geographical scale	Source	Time frame
	NUTS3 *	ESPON Data base	2011
	Daily accessibility (Indicators TRACC by road, rail)		
	Geographical scale	Source	Time frame
	NUTS3 *	ESPON Data base	2011
ESPON project Cross-border public services, Target analyses [12]	Cross-border public-services(key criteria for defining CPS, functional characteristics of provided CPS)		
	Geographical scale	Source	Time frame
	NUTS3 *	ESPON Data base	2018

* NUTS 3 level - according to the Nomenclature of territorial units for statistics, which divides the economic territory of the European Union (EU) into regions at three different levels (NUTS 1, 2 and 3) respectively, moving from larger to smaller territorial units.

This indicator takes into account travel time (dependency function) and reachable population (activity function), thus giving overall accessibility to each region market [31,32]. The accessibility analysis uses data available in the ESPON database [10,13] for different modes of transport (the database was updated in 2006, which allowed us to analyze for two different and comparative years). However, several accessibility indicators used at regional and urban level (which are necessary for further accessibility analyzes at Euro-city level) are not available. Also, daily availability indicators for 2001 and 2006 are not available in the ESPON database [10].

4. Case Study Analyses

Following the method used previously by [16,23,29], and based on a previous study that explores expert attitudes and perceptions towards the identification of a set of critical factors for the success of CBC projects were assessed, described and analyzed, enabling the identification of 14 critical factors to achieve success in development projects based on CBC principles. In that research 20 European CBC case studies (Newry (IE)-Dundalk (UK), Venlo (NL)-Düsseldorf (DE), Aachen (DE)-Liège (BE), Copenhagen (DK)-Malmö (SE), Haparanda (SE)-Tornio (FI), Valga (EE)-Valka (LV), Ruse (BG)-Giurgiu (RO), Oradea (RO)-Debrecen (HU), Frankfurt Oder (DE)-Slubice (PL), Cieszyn (PL)-Cesky Tesín (CZ), Vienna (AT)-Bratislava (SK), Gorizia (IT)-Nova Gorica (SI), Strasburg (FR)-Kehl (DE), Saint Louis (FR)-Basel (CH), Geneva (CH)-Annemasse (FR), Nice (FR)-Monaco (MC), Bayonne (FR)-San Sebastián (SP), Chaves (PT)-Verín (SP), Tuy (SP)-Valença (PT), La Línea (SP)-Gibraltar (GI)) put forward [23].

After identifying critical factors for territorial success on the basis of a case analysis, the acquired critical factors for the Euro city Elvas-Badajoz study area (NUTS3 level: Alto Alentejo - Badajoz) were applied in further analysis.

According to [60], this typology of case study may be considered as within the category Hypothesis-Generating Case Studies, after the method was used in order to “examine one or more cases for the purpose of developing more general theoretical propositions, which can then be tested through other methods” [29].

The methodology was developed through four main phases (Figure 2).

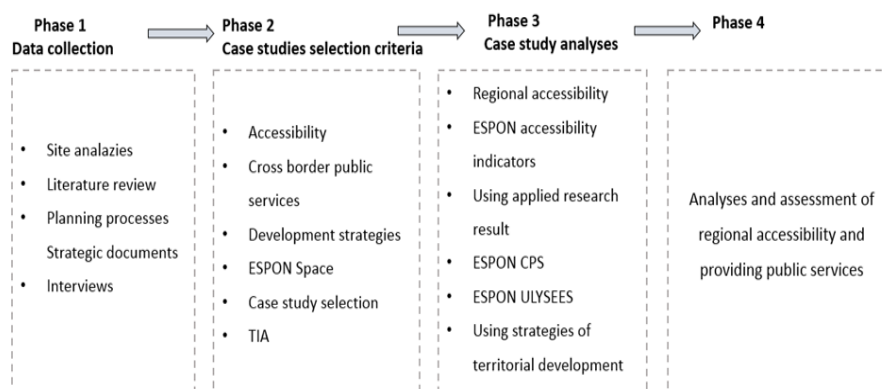


Figure 2. Methodology approach.

The final phase of the methodological framework is the analysis and assessment of regional accessibility and the provision of public services in cross-border cooperation. The phases are: data collection; criteria for selecting case studies; analysis of case studies, which could be schematized as follows.

Besides the aforementioned pre-established criteria, the selected projects were required so as to meet seven specific principles, some of which were adapted from the study developed by [23]:

- Cities must have a record of previous work on CBC.
- The CBC project should consider the integration of environmental, sociocultural, and economic development goals, as part of a singular development strategy.
- Cities should demonstrate relationships with multiple stakeholders organized in a group association created to develop and strengthen aspects inherent to CBC, and development objectives.
- The distance between cities could not be greater than 60 km.
- At least one of the cities should be a medium-sized city.
- There should be considerable connectivity—movement between cities.
- There should be considerable the low formal number of CPS
- Eurocity marketing and advertisements must be previously identified as a critical factor for territorial success.

As mentioned before, the following criteria were used to analyze the Iberian area, after which the results of the case study analysis and the factors of territorial success determined the choice of the Iberian study area, Alto Alentejo-Badajoz (NUTS level 3). These cross-border regions are characterized by low density, poorly developed transport infrastructure and services, lack of critical mass of the population, which hampers the development of mobility when it comes to the realization of public transport [12,61]. Accessibility assessment as a critical factor is further analyzed on NUTS 3 level in the borders regions of Alto Alentejo (Portuguese) and Badajoz (Spain). According to the [31], the potential accessibility is an indicator that relates two functions: the activities and the travel time. As for the travel time between centroids, by different modes of transportation with the population (road, train, and air) was synthesizing values of the potential accessibility for each NUTS 3 of the ESPON space.

Analyses and identification of the current CPS in the region, their topics, governance arrangements and barriers for them to work and further possibilities are based on the ESPON project cross-border public services, and target analyses [12] based on the ESPON CPS 2018 on-line survey. Case study areas Alentejo-Extremadura—Andalusia and their future perspectives have been analysed in-depth. Analyses are done through 11 criteria [12] for defining CPS and field of intervention in some policy area.

4.1. Data Analyses

Potential accessibility indicators for 2001 [31] were obtained according to the Accessibility Model based on Schurman et al. which uses the centroids of the NUTS-3 region as origin and destinations to

calculate minimum paths, i.e., minimum travel times between NUTS-3 region centroids. The value of the potential accessibility indicator for each NUTS-3 region is calculated by summing the population in all other regions. [10,16,17,28,31,53].

The analysis was developed for a case study where several data sources are used to evaluate the actual accessibility situation (summarized in Table 1). These data will also show that accessibility as a critical factor reflects cross-border cooperation projects and sustainable transport.

Research results from ESPON's targeted and applied analysis were used for this analysis. Road, rail, air, daily access and multimodal accessibility indicators are analyzed and summarized. [31,53,62].

We emphasize that the potential accessibility indicators for years 2001 and 2006 in the present ESPON database cannot be directly compared to the potential accessibility indicators for 2011 because these are applied analyses for two different ESPON projects [31,53]. Data for 2011 used because for a later period the data are not readily available in the ESPON database (see Table 1). All indicator values are expressed as an index, i.e., associated with ESPON average [10,16].

Regarding data analyses for cross-border public services there are not many experiences of cross-border services, namely in public services provision, due to the obstacles (Online ESPON CPS Survey 2018) [10]:

- Obstacles associated with political borders linked to legal and administrative questions;
- Effects associated with economic discontinuities and natural obstacles (weak urban network, and low density of population and settlements).

Garrinhas [63] added a third obstacle linked to cultural barriers coming from language differences. In order to assess the development of cross-border public services, in this article we used results of the targeted analysis undertaken by ESPON on this topic is used throughout CPS Target analyses [10,12,53].

4.2. Potential Accessibility Indicators

Concerning travel time and other indicators, the exact methodology is available in the ESPON database metadata. It is also available in the final report of the European Spatial Planning Observation Network (ESPON) project where potential accessibility for all modes of transport was obtained. Values for multimodal accessibility were obtained synthesizes all different modes—a comprehensive indicator. According to ESPON, multimodal accessibility is the accessibility potential “of a log sum that is collected across the road, rail and air” [10,31]. Potential accessibility in the ESPON database has been calculated and displayed for two different years, values were standardized to the ESPON average for 2001 and 2006. Each ESPON average is set to 100, and regional values are transformed accordingly. The change in accessibility index was used, which means that it is possible to see the development of infrastructure in this period. Differences in index values show a change in the position of regions relative to other regions. “Positive values express improvement in the relative quality of localization, while negative values express a loss in relative locational quality” [10].

For this indicator, the 2001 accessibility values are standardized to the ESPON average for that year and from 2006. Each ESPON average is set at 100, and regional values are transformed accordingly. A change in accessibility index was used. Differences in index values show a change in the position of regions relative to other regions. “Positive values express improvement in the relative quality of localization, while negative values express a loss in relative locational quality” [10,53].

In [10,31], “potential accessibility is an indicator linking the activities to be achieved with the travel time required to achieve them.” It functions as follows: ‘ A_i ’ (1) is the availability of area ‘ I ’, ‘ V_j ’ is activity V to be reached in area ‘ j ’, and ‘ c_{ij} ’ is the generalized cost of reaching area ‘ j ’ from area ‘ I ’. “ A_i ” is the total number of activities available on “ j ”, tends to be easy to switch from “ I ” to “ j ”. “The interpretation is that the more attractive destinations in areas ‘ j ’ and the more accessible areas ‘ j ’ than area ‘ I ’, the greater the area ‘ i ’ [10,31].

In the [31], the potential accessibility is an indicator that relates the activities to be reached with the travel time it takes to reach them.

It functions as follows:

- 'Ai'(1)—the accessibility of area 'I'.
- 'Wj'—the activity W to be reached in area 'j'
- 'c ij'—the generalized cost of reaching area 'j' from the area 'I'.

'Ai' is the total of the activities reachable at 'j' weighted by the ease of getting from 'I' to 'j'. "The interpretation is that the greater the number of attractive destinations in areas 'j' is and the more accessible areas 'j' are from the area 'I', the greater is the accessibility of area 'i' [10,31]:

$$A_i = \sum_j W_j^a \exp(-\beta c_{ij}) \quad (1)$$

Destination size is measured by population or economic indicators such as GDP. Potential accessibility is a construct of two functions: the activity function representing the activities or opportunities to be reached and the impedance function representing the effort, time, distance or cost needed to reach them [10,62].

In this accessibility model, the minimum travel time across a network between the NUTS-3 region centroids is calculated. For each NUTS-3 region, the value of the potential accessibility indicator is calculated by summing up the population in all other European regions, including those outside ESPON space, weighted by the travel time to go there [10,16,31].

The values of accessibility indicators, the changes over time, and the absolute level of accessibility and index change of accessibility are presented in Result chapter.

- The absolute level of accessibility (i) / Potential accessibility by road, standardized (ESPON = 100) 2001, 2006 (relative change of accessibility)/(Average relative change of accessibility) * 100/percentage of ESPON average because the accessibility indicators are in non-familiar units. They are standardized to the average accessibility of the European Union i.e., the absolute values are transformed so that the European average is 100. By presenting the absolute values as such indices, it can be seen which regions are in a better or a worse position than the European average [10,16].
- Index change of accessibility (i_ch)/ Potential accessibility by road, change of standardized (stand percentage of ESPON average/(standardized value average = 100 in 2006—standardized value average = 100 in 2001). For this, the accessibility values of 2001 are standardized to the EU27 average of that year and those of 2006 to the average of that year, each EU27 average is set to 100 and the regional values are transformed accordingly [10,31]. A better the relative locational quality is expressed with positive values and loss in relative locational quality is expressed with negative values [10,31].

4.3. Daily Accessibility Indicators

Daily accessibility indicators present the number of people that can be reached within 5 h travel time by fastest mode of road and rail)

4.4. Study Area

For this article, the geographical delimitation of the studied area includes: on the Portuguese side, the Alto Alentejo that corresponds to statistical NUTS 3 Alto Alentejo and on the Spanish side, NUTS3 region Badajoz (Figure 3).

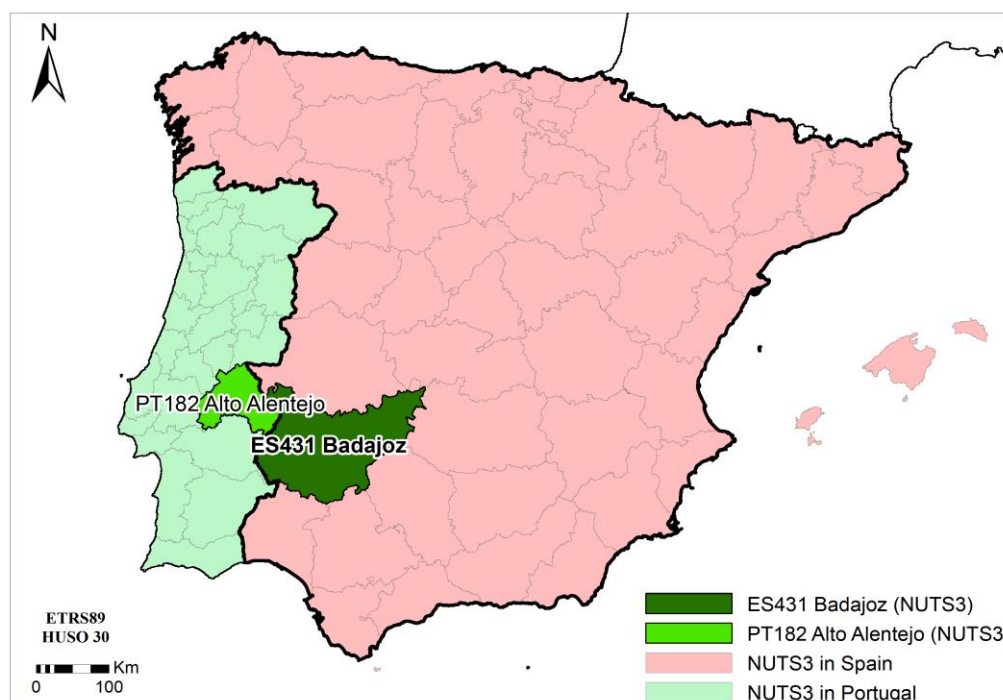


Figure 3. Study area.

According to the ESPON DEMIFER Project (2010), the Alto Alentejo is considered an “ageing challenge region” while Extremadura is considered a “challenge of labour force region” [10,61]. While on the Spanish side we observe an increase in population, and in Portugal a decrease in natural population growth rates, the whole CBA area can be said to be at a level close to stagnation [10,12,61]. Demographic framework is shown in Table 2.

Table 2. Demographic framework.

Country/City	Total Area km ² 2011	Population Number 2011	Population Density Inhabitants/km ² 2011
Spain (Country)	504,645	47,190,493	94
Badajoz (City)	1470	151,565	103
Portugal (Country)	92,090	10,476,021	114
Alto Alentejo (Region)	6230	118,410	19

Historical and cultural factors are the basis of the cooperation between these territories separated by only 20 km. In the last century, until the seventies, the political regimes of both countries limited the formal border crossing of people and goods, so smuggling was the main way to overcome this limitation.

Besides the economic motivations, there were also political ones. But in the last three decades, changes in the political regimes and EU integration have promoted cross-border mobility [12]. The Elvas-Badajoz axis was historically linked to all these historical facts, working as an “entrance-exit door” for Spanish-Portuguese people. “More recently, a new dynamic of flows and cooperation has emerged in these territories, gaining personality in the Euro city arrangement signed in 2013. Currently, Campo Maior has been joined with both cities creating the new Eurocity Badajoz-Elvas-Campo Maior” [12].

The importance of the primary sector in both territories, reinforces the lower human habitation along the border. These specific characteristics, define economic and demographic discontinuities and reinforce the legal and administrative obstacles and the language barriers.

5. Results

5.1. Accessibility

Throughout the analysis of the results of potential accessibility by road, rail, air and multimodal (Table 3), it is possible to identify cross-border differences in this territorial profile.

Table 3. Analyzed accessibility indicators by road, rail, air, and multimodal.

CASE STUDY	Index	Badajoz	Alto Alentejo
		GEOTIME/NUTS3	
		ES/ES431	PT/PT182
Potential accessibility by road	R_i 2001	33.30	31.90
	R_i 2006	35.30	33.80
	R_i 2011	43.50	40.40
Potential accessibility by rail	R_i 2001	20.10	18.20
	R_i 2006	22.10	19.30
	R_i 2011	27.20	22.60
Potential accessibility by air	Air i 2001	45.10	39.90
	Air i 2006	43.70	38.70
	Air i 2011	45.20	39.70
Multimodal accessibility	MM_i2001	43.10	39.10
	MM_i2006	42.10	38.10
	MM_i2011	43.20	38.60

“For each NUTS-3 region, the population in all destination regions is weighted by the travel time required” [10,16] to reach the destination. “The weighted population is summed up to the indicator value for the accessibility potential of the origin region. All indicator values are expressed as an index, i.e., related to the ESPON average” [10,16].

Aiming to summarize the collected data of the case study area, two tables have been developed related to potential indicators by road, rail, air, multimodal accessibility and by analyzing daily indicators, respectively.

Values of Badajoz’s average potential accessibility by all modes of transport is higher than Alto Alentejo’s. However, the values of potential accessibility for Elvas (PT182) and Badajoz (ES431) appear to improve over time [10,16]. Figure 4 presents the absolute value of potential road accessibility in 2006 expressed as the index value. The EU27 average is set at 100 [10]. The clear increase in road potential accessibility related to completed road projects is presented by the accessibility situation in Table 3 and Figure 4.

In terms of potential rail accessibility, ES431 shows a higher rail accessibility potential (index), especially in the 2011 year, while PT182 describes lower values. Regarding the Potential Accessibility Index 2001–2006, there is a slight increase in Badajoz and Elvas. As a result of infrastructure improvements, after the implementation of EU projects, the differences have more than ten points of the index in 2011.

Potential air accessibility gives a different situation from the accessibility by inland modes: both regions have high values, slightly higher in Badajoz than in Elvas. Regarding multimode indicators, the situation is similar due to the fact that their international airports improved their accessibility.

Changes in the index of accessibility show the status of potential accessibility during two different years, reflecting the situation and changes in the infrastructure in that period [10]. Regarding the temporal change during the 2001–2006 period, Badajoz demonstrates slightly higher index-change

for road and rail, while Elvas has the worse position by one index point. Slightly negative values of the standardized index can be found in Elvas and Badajoz for air and multimode. According to [64] positive index values represent the better relative quality of the location, while negative values reduce the quality of the location [64]. Table 4 shows the change of the index values of potential accessibility between 2001 and 2006.

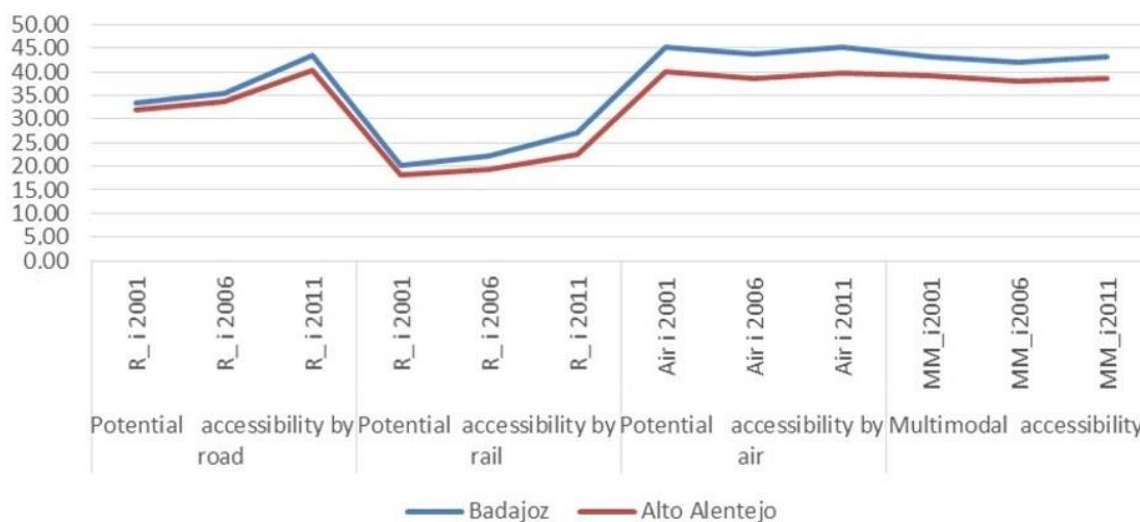


Figure 4. Potential accessibility by road for the year 2006 (absolute value).

Table 4. Index change of accessibility 2001–2006.

CASE STUDY	Index	Badajoz		Alto Alentejo	
		GEOTIME/NUTS3			
		ES/ES431		PT/PT182	
Potential accessibility by road	Ri_ch2001/2006	2.00		1.90	
Potential accessibility by rail	Ri_ch2001/2006	2.00		1.00	
Potential accessibility by air	Air i ch2001/2006	−1.3		−1.20	
Multimodal accessibility	MM_ich2001/2006	−1.00		−1.00	

Through the analysis of daily accessibility indicators (amount of population that can be reached within 5 h travel time by road-rail), Table 5 shows the results which reflect a higher value for daily accessibility by road than rail in 2011.

Table 5. Analysed daily accessibility indicators in 2011.

CASE STUDY	GEOTIME	NUTS3	Daily Road	Daily Rail	Daily Fastest
Badajoz	ES	ES431	6152400	1972900	6152400
Alto Alentejo	PT	PT182	7197900	3661900	7197900

Those differences are higher in Extremadura-Badajoz than in Alto Alentejo-Elvas. The number of population that can be reached within 5 h travel time by fastest mode of the road is 6152400, and only 1972900 by train. These differences are substantial for Elvas but not as high as in Badajoz.

Since 1991 a process of border deactivation has been performed following the instructions of European integration, the development of CBC, and the implementation of programs and Structural Funds, particularly the INTERREG and in line with its condition of the internal community border.

About border deactivation, the minimization of transaction costs is a proven fact, owing to free transit, the elimination of customs, controls, and barriers, and the significant progress made in road infrastructure and cross-border transportation and communication networks. These are determinant factors (and constraints) of the remarkable expansion observed in the traffic of goods, services, and people.

In this process, CBC and its institutions, with their advantages and disadvantages, have played a fundamental role in the territorial channeling of financial resources. Thus, the influence of CBC in the political, administrative, and social landscape of this border area is undeniable. CBC institutions have created a new strand of relations, interactions, and common interests that were previously nonexistent. Thus, they have laid the groundwork for the future and encouraging joint ventures [65].

When it comes to external accessibility, many TENT projects have greatly contributed to the integration of the Iberian Peninsula with the central parts of the EU. They are an important contribution to the ongoing efforts to improve connectivity between the EU center and its peripheral regions and to strengthen the position of the Iberian Peninsula as a Western European gate, this refers to external accessibility. Also until 2004, much of the TENT budget was invested in cross-border sections, this is shown by changing the results of regional accessibility indicators in the 2001–2011 table. The high-speed rail link from the Sines seaport to Madrid passing through the CBA will also have positive effects on the whole region [10,66].

On the other hand, there is internal accessibility in low density territory characterized by low accessibility values due to lack of infrastructure and services [10]. In that case, one could consider the improvement low-density accessibility program based on taking advantage of capacities that are already there, new “multimodal intelligent and flexible transportation”+1 networks, and “alternative forms of service provision” [10].

Cross-border co-operation development policies need to address this issue in terms of promoting a sustainable economy and the attractiveness of these regions through increased accessibility based on a join approach about the transport accessibility [10,16].

5.2. Cross-border Public Services

Mobility patterns and cross border public transportation connection in the region need to be analyzed (this could mean analyzing commuting flow and their intensity, or possibilities for common ticket prices or timetables) [10,12] (Table 6).

Table 6. Provided CPS Source: ESPON CPS, 2018 [12].

CPS Name in the Policy Area	Border	Key Selection Criteria
EURES-Cross-border Information Service (in field Labor market and employment)	SP-PT	Service provision in a labor market with a relatively low number of cross-border commuters. Aiming more at promoting cross-border working in a large geographical area along the border. The CPS has been established recently in 2017.
EUROBEC: Building the Eurocity Badajoz-Elvas-Campo Maior/Construyendo la Eurociudad Badajoz-Elvas-Campo Maior	SP-PT	Possibilities for improving the institutional capacity and better public administration
Cross-border early warning networks in environmental protection systems in civil protection	SP-PT	Prevention of risks and improvement of the management of natural resources and promote adaptation to climate change in all sectors

Three CPS were chosen by the regional entity in the Alentejo region to illustrate the future CPS in the region:

- Invasive species management system, of climate change, and environmental protection;
- Cross-border multimodal freight transport platform, in the field of transport and mobility;
- Cross-border mobility observatory, in the field of transport and mobility.

Transport is one of the identified areas by the Regional Commission of Alentejo (CCDR Alentejo, Interview 2017) and by the regions as having great potential to remove cross-border cooperation hurdles. Harmonization and coordination of technical and legal standards and achieving inter-operability in the transport sector as well as the provision of multimodal travel information are high priorities [10,12].

The promotion of networking and flow initiatives and public transport, through the introduction of joint solutions that can be boosted by the use of ICT, is also a priority. Regarding cross-border multimodal freight transport platform priorities, the opportunity to have more rapid access to the sea, through the port of Sines, is of major importance to the border territory and that is dependent on the improvement of the Sines-Badajoz multimodal transport corridor [12,67].

Regarding [9] Eurocity Elvas Badajoz is a solution for overcoming the need to get critical mass for the CPS and the EUROBEC emerges as a project that contributes to Eurocity consolidation and acts through the creation of a solid governance structure open to citizens, with multilevel action. During the previous years of cooperation between Badajoz and Elvas, a large number of projects and actions in the cultural, sports, social, employment, mobility, and infrastructures fields, have been developed. As previously pointed out, the border territory of Alentejo and Extremadura is characterized by demographic and economic activity scarcity. "The recent addition of Campo Maior is a positive aspect of Eurocity enrollment because the capacity for providing services in this border territory is higher and that provides more critical mass to carry out concrete cooperation activities, giving more equilibrium to population distribution and possible demand" [12,67].

An important key feature of this CPS cooperation EUROBEC project is the need to consolidate the structures of governance to formulate the best way to integrate other institutions which operating in this project and improving institutional capacity and efficiency of public administration through CBC [12].

In strategic terms, in addition to passenger transport, the high-speed rail link from Lisbon to Madrid also includes freight services from the port of Sines to Madrid, passing through the CBA directly affecting the greater logistical importance of the Elvas-Badajoz transit axis [10]. In terms of internal accessibility, it is necessary to invest in the development of an integrated low-density accessibility program and in that way also take advantage of existing transportation infrastructure capacity [10].

CBC and its institutions, with their advantages and disadvantages, have played a fundamental role in the financial resources allocation. Thus, the influence of CBC in the political, administrative, and social landscape of the Spain –Portugal borderland is undeniable. CBC institutions have created a new strand of relations, interactions, and common interests that were previously nonexistent. Thus, they have laid the groundwork for the future and encouraging joint ventures [65]. Therefore, in the future, national governments should invest not only in national projects, but their priorities should also be cross-border links outside their national borders.

Moreover, transport infrastructure projects could have a substantial impact on the potential accessibility of cross-border regions. The improved use of opportunities provided by the existing INTERREG in this area can play an important coordination role and help solve cross-border accessibility challenges. From a methodological aspect, attention should be given when looking at changes over time.

According that, the relation between sustainable transport, key issues, and particular performance of accessibility indicators are summarized in the following Table 7 and contains overviews of performance accessibility indicators, on the regional level in CBC areas as well as the possible

future challenges facing transport policymakers which contribute to achieving more sustainable transport of passengers.

Table 7. Accessibility as one of the pillars of sustainable transport (general and specific performance indicators for regional level). Adapted from [18].

Regional Accessibility	
Indicators	<ul style="list-style-type: none"> • Potential accessibility by road, rail, air, multimodal [53]. • Daily accessibility indicators by rail, road [31].
Sustainable targets	<ul style="list-style-type: none"> • Efficient financing of infrastructure and public transport services; • Development of a harmonized methodology for transport infrastructure planning; • Infrastructure density linked to social development performance; • Strategic international links which could lead to a more direct link between this region and Central Europe; • Related rail accessibility improvement, the better implementation of a stable long-term planning for ‘small-scale’ cross-border railway projects.
Future challenge	<ul style="list-style-type: none"> • Improvement of the capacity of the trans boundary transport routes; • Better global harmonization of transport competitiveness; • Better use of opportunities provided by the existing INTERREG in this area which can play an important coordination role and help to solve cross-border accessibility challenges.

Therefore, planning sustainable accessibility is both a challenge and an opportunity. It is a challenge because there are still many prejudices and practical obstacles that usually cannot be solved at the regional level, and have no priority at the national level. It is an opportunity because it is a basic building block of sustainable transport and it should be further facilitated.

6. Discussion and Conclusions

This research allows for the analysis of accessibility factors between cities, which in the case studies of European cross-border cooperation projects are considered critical for achieving territorial success [18,23,24,68]. This factor identified in the Eurocity Elvas-Badajoz case study [16,17] through the assessment of the many levels of CBA for accessibility showed the importance of accessibility analysis in cross-border cooperation areas and their change and trends at the Portuguese-Spanish border.

If we look at the quality of the interaction between different modes of transport, through the applied transport policies between 2001 and 2006, we can say that significant improvements are evident, but that there are still inequalities in accessibility values by region and by modes of transport.

Regarding the temporal change during the 2001–2006 period, Badajoz demonstrates a slightly higher index-change for road and rail, while Elvas has the worse position by one index point. A somewhat negative standardized index is found in Elvas and Badajoz for air and multimode. We can conclude that differences have more than a ten-point index in 2011, as a consequence of investing in infrastructure through EU infrastructure projects.

Regarding public transport and regional sustainability, the problem is low quality of public transport and low level of connectivity with TEN-T corridors and transport nodes. Also, there is a difference in the development of mobility systems, some regions have neither the knowledge nor the capacity to plan these systems.

According to the Transport Sustainable Development Principles (2015) [19]: “Transport system improvements should aim to ensure equal access to citizens to reach desired destinations (services, health, recreation) and access (employment, education), regardless of individual wealth, age, gender or possible health conditions resulting in impaired mobility’, which has not been confirmed in the CBA cross-border region of Alto Alentejo – Extremadura-Badajoz.

The results of previous studies [16,17], where public transport/ urban movement, political commitment and cooperation between cities and health have been assessed as issues that have not been adequately addressed, question the creating the project of Eurocity. Including the results obtained during this research, we can conclude that sustainable transport in this cross-border area is a serious problem, which requires the implementation of sustainable solutions in the future.

In strategic terms, the high-speed rail link from Lisbon to Madrid would diminish the remote location of the region, i.e., it would increase external accessibility, also including freight services from the Port of Sines to Madrid, passing through the CBA directly affecting the greater logistical importance of the Elvas-Badajoz transit axis [10]. In terms of internal accessibility, it is necessary to invest in development of public transport and implementing an integrated low-density accessibility program and in that way also take advantage of existing transportation infrastructure capacity) [10].

Similar results were obtained in later published studies regarding the Portuguese-Spanish border area [5,44,69–72]. Major differences have been identified between the two sides of the border: Spanish citizens have higher values of accessibility, which lead to higher standards than the Portuguese border population. This unbalance within this borderland, results in a deviation from the desired territorial sustainability. Disparities of accessibility by road, rail, air and multimodal still exist in this area. Despite efforts to increase the infrastructural endowment and thus change the low value of accessibility in recent decades, the periphery of these regions has done its part, as peripheral regions will remain peripheral from the point of view expressed throughout Europe [10]. The Spanish Portugal border area defining as an area where “Potential Accessibility is high at international level and low at the national level”) [8] (Figure 5).

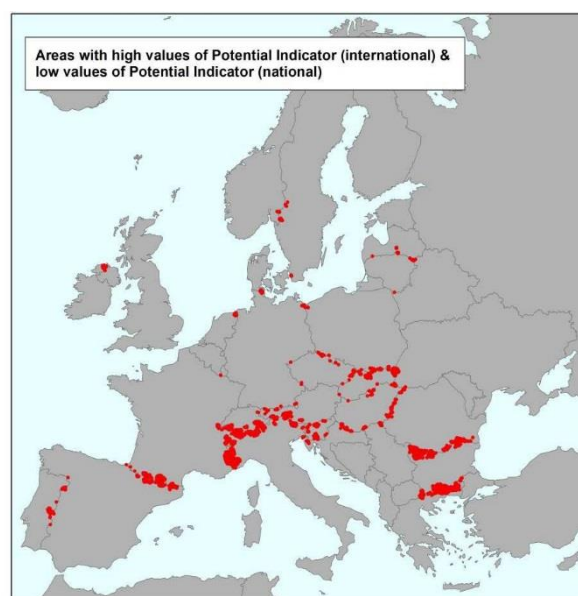


Figure 5. Potential Accessibility is high at international level and low at national level. **Source:** EC-Cross-border transport infrastructure in the EU (2018) [8].

In this border area, the problem is also asymmetric decision level on the cross-border cooperation between a regional entity in Spain, and a central entity in Portugal what present the common difficulty in the provision of a CPS [12]. Regarding ESPON CPS project, the development of the multimodal

platform is on the way and its importance could be empowered by the construction of a new rail segment and the requalification of the previous rail line on the Portuguese side, connecting the Badajoz platform to the port of Sines, but also being able to serve the ports of Lisbon and Setúbal. “The requalification of the rail line on the Spanish side, connecting Badajoz to Mérida and Navamorale, could contribute to extending the area of service of this platform and could contribute to a desirable modal transfer from road to rail freight transport. In any case, the schedule of those future infrastructural investments will not make the development of this CPS impossible. Despite the asymmetry in the level of the public entities that participate in this CPS organization, the conjugation of the national objectives and regional ones have made it easier to start it” [12].

The implementation of the mobility observatory has the objective is to inform mobility flows and policies in the border area, in particular in the Eurocity territorial scope. However, it will require “some technical capacities and its effectiveness will depend on the capacity to set up the best strategic option to develop sustainable mobility in the border area”. Thus, the regional entity for transports and mobility of Extremadura (SP) and the *Instituto da Mobilidade e Transporte* (PT) should agree on a legal framework for passenger transport as a cross-border public service. In the CB area, the existence of public transport has the effect of increasing mobility and only strong economic interests can influence to overcome the administrative obstacles for the realization of this mode of transportation [5,45].

Increased accessibility in the CB area can be significantly influenced by transport projects, as well as the benefits and possibilities of INTERREG implementation, and when it comes to the methodological aspect it should be observed how things will go over time [10,66].

The effective passenger transport supply in Elvas-Campo Maior-Badajoz Eurocity is strongly constrained by the passenger transport legislation framework because what could be understood as an urban passenger transport service, is considered as an international passenger transport with all the limitations and impositions to operators and to operate [73–76]. This is not only a Spain–Portugal borderland problem, but some European actions should also be taken in order to overcome the limitations that this CPS work highlights.

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