CISMOB - Cooperative information platform for low carbon and sustainable mobility

Baseline Assessment Report

CISMOB

Cooperative information platform

for low carbon and sustainable mobility

Baseline Assessment Report

Project Summary

CISMOB main vision is to promote innovative ways to reduce carbon footprint and increase the sustainability of urban areas by improving the efficiency in the use of urban transport infrastructure through ICT.

In a context of increasing availability of sensor technology to monitor and record large amounts of data, a common challenge to policy makers is to identify the best practices to take advantage of these new sources of data and use them to prioritize intervention areas, to manage efficiently current road networks, to inform citizens and motivate them to choose more sustainable mobility options.

CISMOB will focus on improving the implementation of regional policies and local mobility programmers by having a thorough understanding about the different transport-related impacts and the main vulnerabilities associated to different zones of the territory. CISMOB partners consider that policy and local mobility programs should not be focused in minimizing a particular parameter (ex. Levels of congestion), but rather to promote holistic approaches capable of responding to the questions: what (to minimize)? why? when? where? and how? Regional and Policy instruments should also provide a framework of indicators to assess and inform the costs and benefits of environmentally effectiveness of different mobility solutions.

CISMOB integrates a set of cities and regions of heterogenic characteristics, which are represented by institutions with complementary profiles. All partners will cooperate together in order to learn best practices of sustainable management of urban transport taking advantage of ICT. Workshops, staff exchange-programs and dissemination actions will be carried out with the aim of exchanging local experiences, learning best practices and enhancing the citizen's participation.

Executive Summary

The present baseline assessment report (BAR) examines and evaluates the status of ICT implementation in the transport sector in the CISMOB partner regions and provides the foundation for the subsequent activities and outputs.

Specifically, the BAR evaluates how ICT and sensing technology is being used in the transportation system and how carbon footprint and sustainability indicators are being considered in the three regions represented by CISMOB partners. BAR will contain a SWOT analysis of partner regions' positions, in this field. The assessment will be based on questionnaires and historic data. A designated working group of CISMOB partners will describe the regional status in 6 key topics:

1. Online traffic monitoring capacity

2. ICT penetration in multimodal mobility

3. Environmental and urban activity patterns monitoring

4. Available IT and ITS tools to promote low-carbon and sustainable mobility

5. Policy frameworks, socio-political awareness and readiness

6. Financial instruments and institutional capacity.

The information will allow scoring the regions advances and to critically assess their own status for future progress.

The specific objectives of the present baseline assessment are to:

- Provide an overview of the current state of CISMOB areas in terms of sustainable mobility development, implementation of measures and application of ICT to the transport sector as a mean of reducing energy consumption and the carbon footprint, as well as currently available policy instruments that CISMOB project will address, and also evaluating its impact and contribution to drive policy change;
- Identify good practices across the CISMOB partnership and classify them;
- Offer inputs and guidance in terms of good practices, particularly in which extent they can be transferred to other cities and regions with different scales and specificities.

Table of Contents

List of Abbreviations

CISMOB – Cooperative Information Platform for Low Carbon and Sustainable Mobility

GDP – Gross Domestic Product

PT – Portugal

ES – Spain

SE – Sweden

RO – Romania

NMS – New Member States

EU – European Union

NUTS – Nomenclature of Territorial Units for Statistics

PPS – Purchasing Power Standards

GVA – Gross Value Added

EC – European Commission

INE – Instituto Nacional de Estatística

ICT – Information and Communication Technologies

IT – Information Technologies

ITS – Intelligent Transport Systems

ATIS – Advanced Traveler Information System

APTMS – Advanced Public Transportation System

ATMS – Advanced Traffic Management System

EMC – Emergency Management System

EFC – Electronic Fee Collection

GNSS – Global Navigation Satellite System

IVIS – In-vehicle Information Systems

EU – European Union

AVL – Automatic Vehicle Location

SPIN – Street Parking Information Network

AID – Automatic Incident Detection

C-ITS – Cooperative Intelligent Transport Systems

VMS – Variable Message Signs

TMC – Traffic Management Centres

CO – Carbon Monoxide

SOx – Sulfur Oxides

NOx – Nitrogen Oxides

NO_2 – Nitrogen Dioxides

PM10 – Particular Matter 10 micrometers or less in diameter

PM2.5 – Particular Matter 2.5 micrometers or less in diameter

EEA – European Environmental Agency

ISA – Intelligent Speed Assistance

NVDB – Swedish National Road Database

NTS – National Traffic Management System

GCP – General Communication Platform

API – Application Programming Interface

SMHI – the Swedish Meteorological and Hydrological Institute

SL – Storstockholms Lokaltrafik

SLB analysis – Stockholm Air and Noise Analysis

EPA – Environmental Protection Agency

SCB – Official Statistics of Sweden

SLU – Swedish University of Agricultural Sciences

UNFCCC – UN Climate Change

FORES – Forum for reforms and entrepreneurship

AQS – Air Quality Station

SMTUC – Municipal Urban Transport of Coimbra

RATB – Regia Autonoma de Transport Bucuresti

CCDRC – Regional Development Committee of Centro Region

DGT - General Directorate of Traffic

1 CISMOB Regions Characterization

CISMOB partners form a diverse grouping of cities and regions from four different countries: Águeda (Portugal), Bucharest (Romania), Centro Region (Portugal), Extremadura (Spain), Romania and Stockholm (Sweden). The areas bear heterogeneous characteristics and differ in terms of size, population and Gross Domestic Product (GDP) per capita. This chapter presents fundamental information and general description on the CISMOB regions: location, area, population, density, GDP, economic structure, digital scoreboard, modal share, road fleet composition, climate and environmental vulnerability and externalities valuation. Regarding the particular cases of Bucharest and Stockholm, data referred to region areas.

1.1 Location

The regions of CISMOB project cover four different countries: Portugal (PT), Romania (RO), Spain (ES) and Sweden (SE). Centro Region (PT), Extremadura (ES) and Stockholm (SE) are from the EU-15 group[1], while Romania is from the European Union (EU) new member states (NMS)[2] (Figure 1-1).
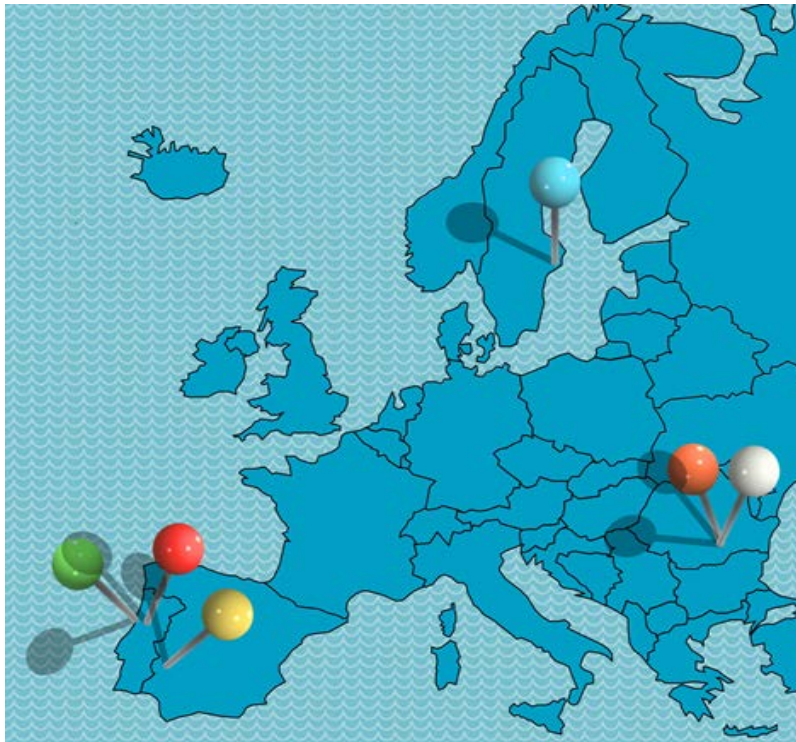
Figure 1-1 Location of the CISMOB project partners' headquarters

---

[1] It was the number of member countries in the European Union prior to the accession of ten candidate countries on 1 May 2004.
[2] Countries that joined EU after 2004.

1.2 Area

The cities and regions are quite different in area (Figure 1-2). The largest examined area is the country of Romania, with 238,390.7 km^2, while Águeda's surface area is only 335.3 km^2. To enable comparison, the data used are from Eurostat Database – Total and Land Area by NUTS 2 region[3], where the information provided are based on the regional structure and the Nomenclature of Territorial Units for Statistics (NUTS) classification, which has been used for regional statistics for many decades. The information about the municipality of Águeda was retrieved from national data (DGTerritório, 2016).

	Romania	Extremadura	Centro Region	Stockholm	Bucharest	Agueda
Area (km2)	238.390,70	41.611,00	28.199,00	6.779,00	1.821,20	335,28

■ Area (km2)
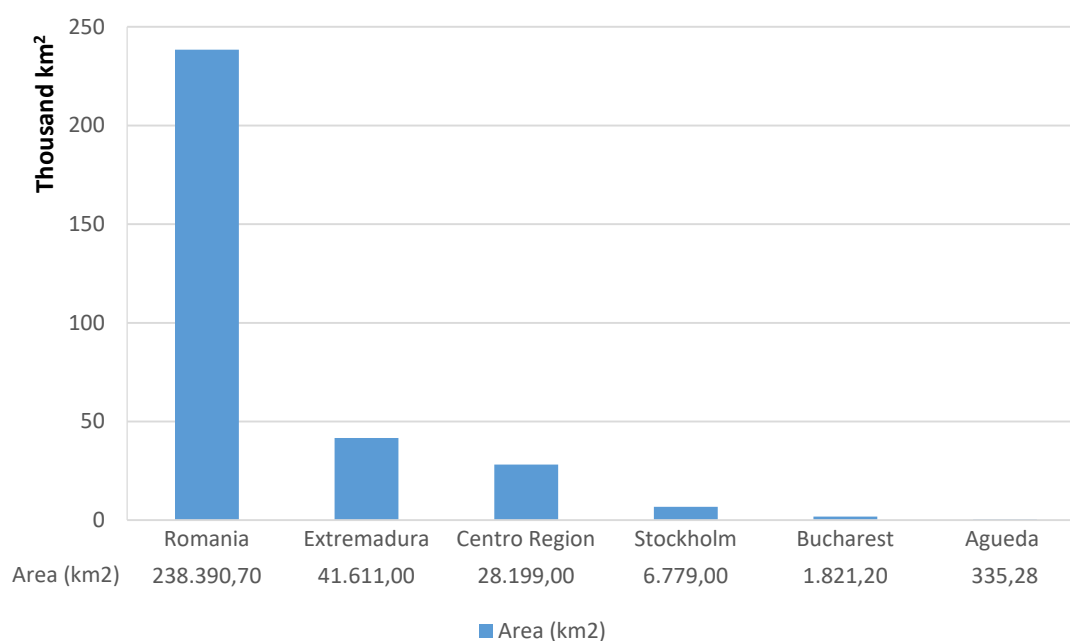
Figure 1-2 Surface area of CISMOB project areas (2014) (Eurostat, 2016g)

1.3 Population

Within the studied areas, population also presents significant differences (Figure 1-3). Most populous area is Romania with 19,947,311 inhabitants, while Águeda's population (2011) is only 47,729 inhabitants (INE, 2012). Centro Region and Bucharest have the same level of population as Stockholm.

---

[3] The data used are total area.
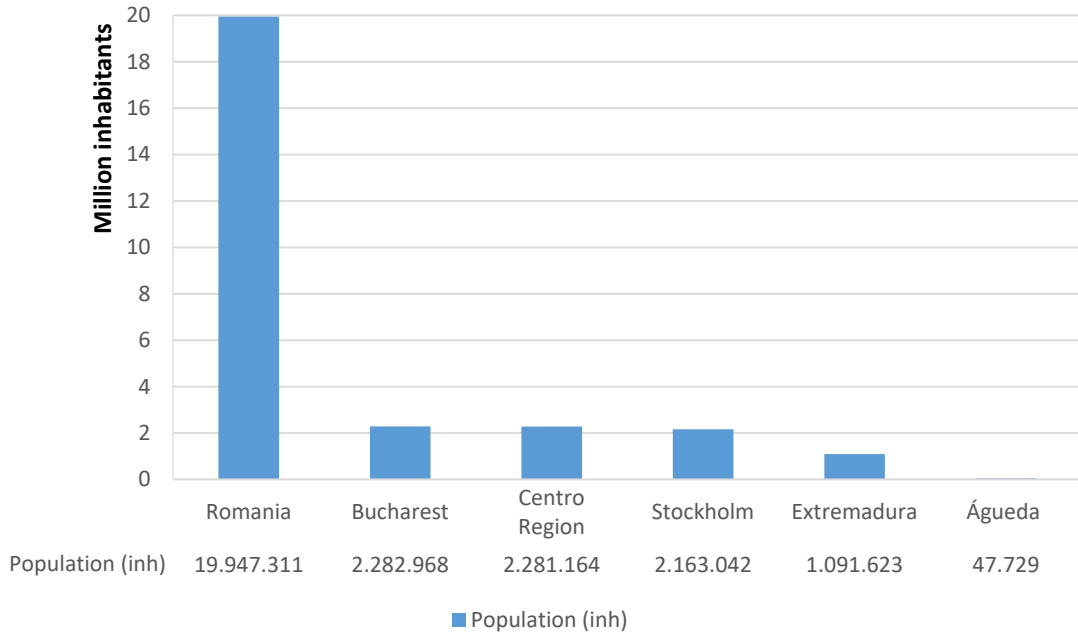
Figure 1-3 Population of CISMOB project areas (2014) (Eurostat, 2016e)

1.4 Density

Regarding the density of each area, the metropolitan area of Bucharest clearly stands out as the most densely populated area with 1,296.8 inh/km^2, while the region of Extremadura is the least densely populated area with 26.8 inh/km^2 (Figure 1-4).
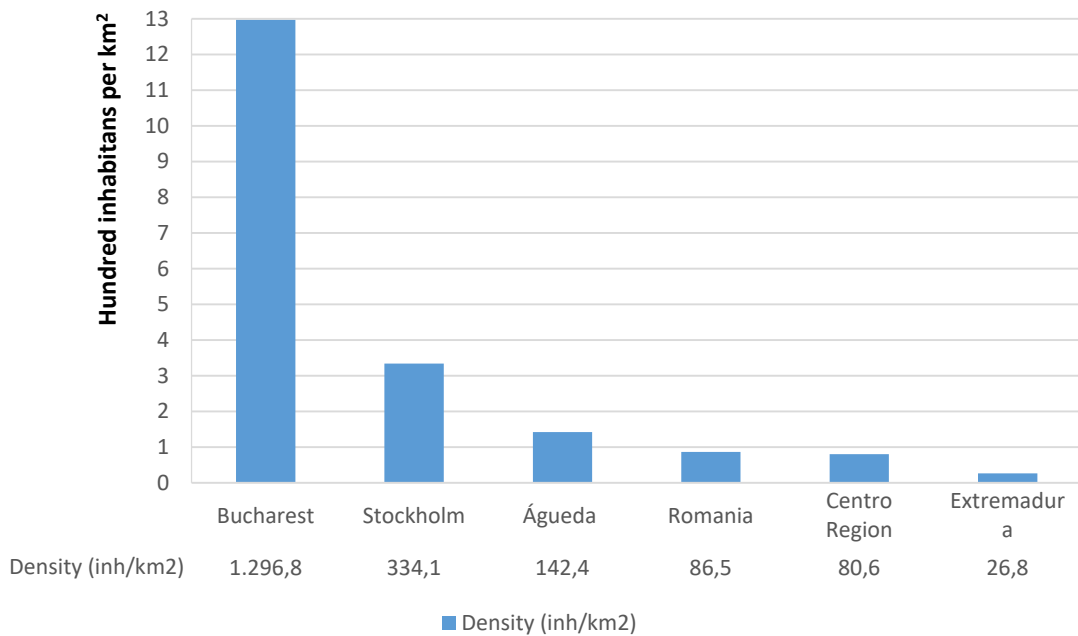
Figure 1-4 Density of CISMOB project areas (2014) (Eurostat, 2016b)

1.5 Gross Domestic Product

Gross Domestic Product is the most common indicator for the overall size of the economy of a country or a region. It shows the total value of all goods and services produced less the value of goods and services used for intermediate consumption in their production. GDP per capita is widely used for a comparison of living standards, or to monitor the process of convergence across the EU. Expressing GDP per capita in Purchasing Power Standards (PPS)[4] in relation to the EU-28 enables cross-country comparisons and is the key variable for determining the eligibility of NUTS 2 regions in the framework of the EU's structural policy (Eurostat, 2016f).

GDP per capita in PPS in CISMOB areas ranges from €15,200 to €47,200 for 2014. The richest CISMOB region is Stockholm, where the GDP per capita in PPS in relation to the EU-28 average was 172% in 2014, while the poorest area is the country of Romania, where the GDP was only 55%. On the contrary, the GDP per capita in PPS in the region of Bucharest is significantly higher, since almost one third of the National Romanian GDP is generated there. Finally, in PPS terms, the GDP per capita in PPS in Centro Region and Extremadura and in the city of Águeda are very similar (Table 1.1).

Table 1.1 GDP of CISMOB project areas (2014)

CISMOB Area	GDP (PPS per capita)	GDP (million Euro)	% of the EU (28) average (PPS per capita)	% of national GDP generated in region
Stockholm	47,200	135,631	172	31.4
Bucharest	35,600	40,453	129	26.9
Centro Region	18,500	32,708	67	18,9
Águeda[5]	17,819	-	67	-
Extremadura	17,300	16,907	63	1,6
Romania	15,200[6]	150,230	55	100

Source: Regional Economic Accounts – ESA 2010 (Eurostat, 2016f) and own calculations for % of national GDP generated in region.

1.6 Climate Change and Energy Vulnerability

Climate change vulnerability index was developed in order to assess the extent to which regions will be affected by the consequences of climate change (e.g., flooding, coastal erosion, land degradation and desertification and potential drought hazard). Regions under threat of these underlying processes are already facing social, environmental and economic issues. According to the Commission Staff Working Document "REGIONS 2020: an Assessment of Future Challenges for EU Regions (EU, 2008), regions subject to the highest pressure are generally located in the South and East of Europe, where CISMOB regions are

---

[4] If the index of a country is higher than 100, this country's level of GDP per head is higher than the EU average and vice versa.
[5] Data was available until year 2013 (Pordata, 2016).
[6] Provisional.

located. The pressures from climate change would be greater in regions with low GDP per capita, which thus have a lower capacity for adaptation to climate change.

Energy vulnerability index combines three main elements: i) energy import dependency; ii) energy consumption by households and industry, and finally, iii) carbon emissions (EU, 2008). According to the Commission's document, peripheral regions located mainly in Eastern and Southern Member States appear particularly vulnerable, while regions generally located in Northern and Western Europe show a greater capacity to adapt (for instance, Sweden).

Climate change and energy vulnerability in the CISMOB regions are diverse, as it can be verified through the index scores reported in Table 1.2 demonstrate. Scores for each index range between 0 and 100, with zero representing the least vulnerable and 100 the most vulnerable. On one hand, Centro Region and Extremadura show the highest climate vulnerability, while Stockholm presents the lowest. On the other hand, Centro Region has the highest energy vulnerability, while Stockholm has the lowest.

Table 1.2 Climate Change and Energy Vulnerability Index of CISMOB project areas (2008)

CISMOB Area	Climate Change Vulnerability Index (0-100)	Energy Vulnerability Index (0-100)
Stockholm	25.76 – 30.33	< 15
Bucharest	37.11 - 52.35	37 - 45
Centro Region	>= 52.35	47 - 52
Águeda	-	-
Extremadura	>= 52.35	37 - 45
Romania	-	-

Source: Regions 2020. An Assessment of Future Challenges for EU Regions (EU, 2008).

1.7 Transport Externalities

Externalities are costs or benefits of an activity experienced by those who have not generated them. Transport externalities are primarily negative (external costs) and the most important in this context is the road transport sector, because it is responsible for the majority of these external costs. In the area of internalizing external costs, considerable research has been carried out over the past few decades, especially about the transport sector and the significant knowledge which has been produced so far could provide major contributions to the formulation of policies. Policy intervention should aim at making external costs part of the decision-making process of transport planners and users, and lead to a more efficient use of road infrastructure (Korzhenevych et al., 2014). This section provides information on the most important transport costs and gives an overview of the current situation in CISMOB areas.

1.7.1 Accident Costs

Each Member State is required to carry out the calculation of its average social accident costs. Its calculation is generally easier compared to marginal accident costs, because it is

based on data availability and collection. Table 1.3 presents the average social accidents costs of the countries that are represented from CISMOB's areas at €-2010 market prices.

Table 1.3 Average social accident costs, at market prices (PPP) in €-2010

Country	Number of Deaths	Fatality	Severe Injury	Slight Injury
Portugal	937	1,505,000	201,000	13,800
Romania	2,377	1,048,000	136,200	10,400
Spain	2,479	1,913,000	237,800	17,900
Sweden	266	2,224,000	328,700	23,500

Source: EU transport in figures 2012 (EC, 2011a) *and Update of the Handbook on External Costs of Transport (Korzhenevych et al., 2014).*

The European Union has been working hard to improve road safety and reduce the number of people killed in road accidents in each Member State. Despite the significant improvement, the target to halve fatalities between 2001 and 2010 that was set in the European Road Safety Action Programme 2001–2010, was not met. According to European Commission, a road injury accident is considered an accident that involving at least one road vehicle in motion on a public road or private road to which the public has right of access, resulting in at least one injured or killed person. The collection and analysis of data on accidents and physical injuries is an integral and critical part in order to evaluate road safety problems, to identify the priority fields of action, to define the necessary measures and to monitor their effects (EC, 2003).

Table 1.4 provides an insight into the trends in fatalities of road transport and covers the total social cost of road fatalities in each CISMOB region. The indicator is the number of persons killed each year in road accidents expressed both as absolute totals and per million of population. It demonstrates the relative road safety and the need for improvement of safety measures as well as infrastructure. The safest CISMOB area, and one of the safest in EU, is Stockholm with approximately 16 deaths per million inhabitants by 2010. On the opposite, the city of Águeda has the highest rate of persons killed in road accidents per million inhabitants among CISMOB areas. Regarding total social cost of road fatalities, the most compelling figure of the table is the estimation of their cost in Centro Region compared to the other areas, highlighting the need for immediate measures and actions.

Table 1.4 Total social cost of road fatalities at market prices (PPP) in €-2010 by CISMOB project areas

CISMOB Area	Number of Deaths	Number of Deaths (per million inhabitants) (EU-27 = 62)	Cost
Stockholm	33	16.34	73,393,000
Bucharest	212	93.74	222,176,000
Centro Region	296	90.68	445,480,000
Águeda(Eurostat, 2016h)	9	188.57[7]	13,545,000
Extremadura	85	77.30	162,605,000
Romania	2,377	117.12	2,491,096,000

Source: Victims in road accidents by NUTS 2 regions (Korzhenevych et al., 2014) *and Update of the Handbook on External Costs of Transport* (Litman & Doherty, 2009; Wardman & Chintakayala, 2012) *and own calculations for Cost.*

---

[7] The number is based on Águeda's population in 2011.

1.7.2 Travel Time Costs

Travel time and related costs are major factors contributing to travel decisions. Travel time is one of the most significant costs of transportation and their evaluation is a very important concept in transport research and policy. Traffic congestion wastes time (increases travel time), energy and causes pollution, decreases productivity and imposes costs on society. According to the recently updated TomTom 2016 Traffic Congestion Statistics[8], Bucharest is the first European city in the Top 5 of the cities with largest congested level. In particular, Bucharest, in Romania, had a level congestion of 50%, while the city of Coimbra, a medium-sized city of Centro Region in Portugal, presented a congestion level of 17%. Regarding the situation in Stockholm, in Sweden, this city had a congestion level of 28%, and statistics showed a decrease around 1% when compared to the year 2015.
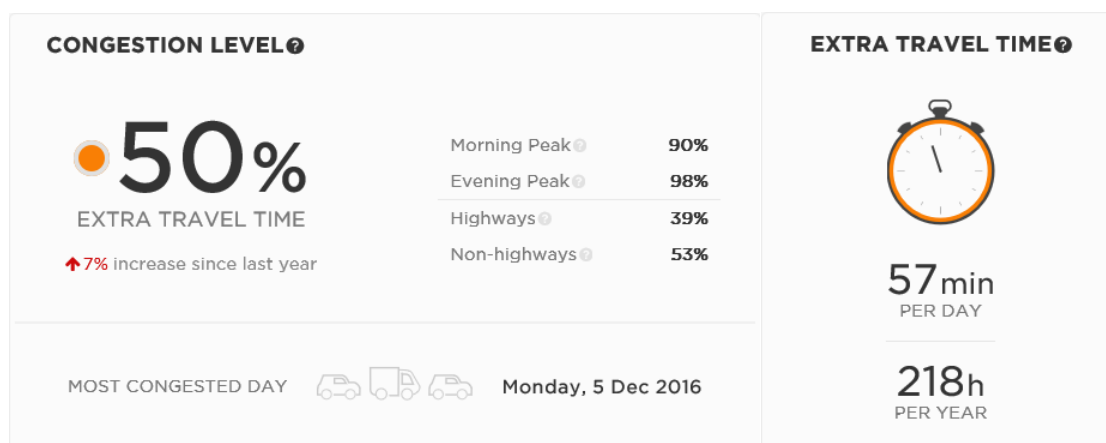
Figure 1-5 Traffic congestion statistics for Bucharest based on TomTom's historical database for 2016.
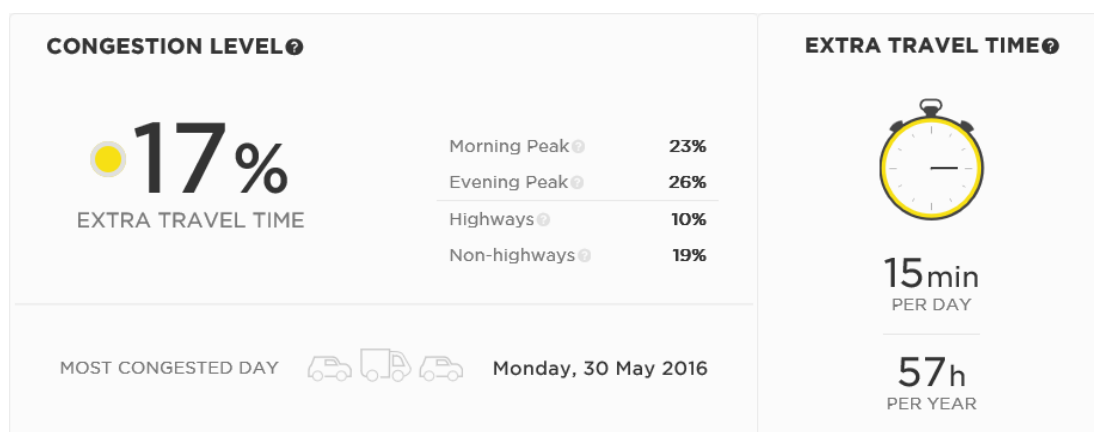
Figure 1-6 Traffic congestion statistics for Coimbra based on TomTom's historical database for 2016.

---

[8] TomTom Traffic Index – Measuring Congestion Worldwide https://www.tomtom.com/en_gb/trafficindex/
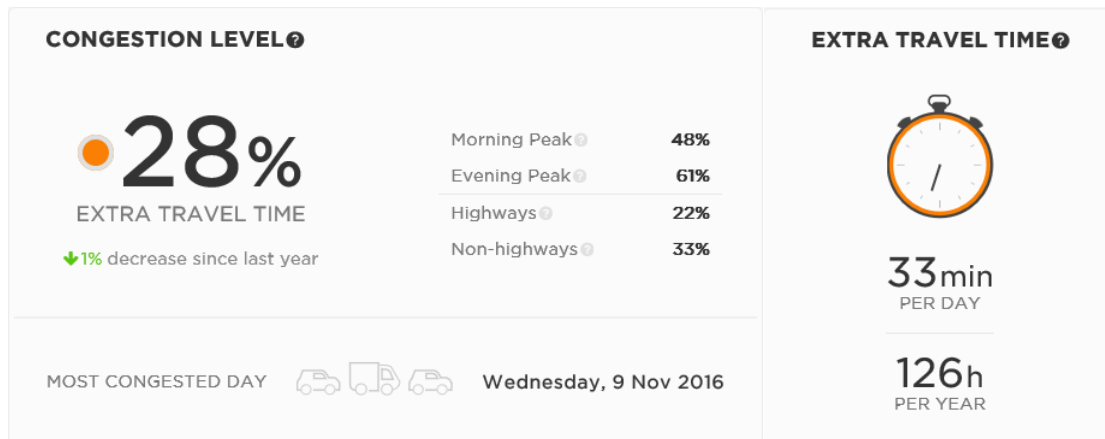
Figure 1-7 Traffic congestion statistics for Stockholm based on TomTom's historical database for 2016.

The value of travel time depends on the type of trip and travel conditions and it is referred to the cost of time spent on travelling. Total travel time cost is the product of time spent travelling and unit costs, and it is usually expressed in euros per hour (Litman & Doherty, 2009). Various studies and organizations have developed estimates of travel time values, although World Bank economist Kenneth Gwilliam, after an extensive review of international studies, recommends that work travel time should be 133% of wage rate per hour, and that a default value for adult personal travel (including commuting) time should be 30% of household income per hour, unless better local data are available (Eurostat, 2016d). Table 1.5 provides indicative values of personal travel time costs for CISMOB's areas based on the aforementioned values.

Table 1.5 Travel Time Values of CISMOB project areas (€-2010/h)

CISMOB Area	Household income per inhabitant	Travel Time Value (personal travel)
Stockholm	3.16	0.95
Extremadura	1.20	0.36
Centro Region	1.09	0.33
Bucharest	0.98	0.29
Romania	0.39	0.12
Águeda	-	-

Source: Income of households by NUTS 2 regions (OECD, 2014) and own calculations for Travel Time Value.

1.7.3 Air Pollution Costs

Air pollution is one of the most important environmental issues of our time. It is a leading cause of many health problems and kills more than 3 million people across the world every year (Korzhenevych et al., 2014). It costs countries many billions per year in diseases and deaths and constrains economic development. Dealing with air pollution and improving air quality has become a top priority for policy makers and environmental agencies.

1.7.3.1 National Air Pollutant Indicators - Contribution of Transport Sector to Air pollution in CISMOB Countries

The following table shows the contribution of transport sector to key air pollutant emissions in the countries of CISMOB partners, namely, NO_X, NMVOCs, SO_2, NH_3, PM2.5, CO, and CH_4. From Table 1.6, it can be observed NO_X is the air pollutant whose transport sector has higher contributions for national emissions in all countries. CO emissions from road transport have also a considerable impact in Portugal and Sweden representing 28 and 29% respectively of total air pollutant emissions. Regarding PM2.5, the impact of transport is more notorious in Spain and Sweden representing more than 20% of total emissions.

Table 1.6 Contribution of the transport sector to key air pollutant emissions in the countries of CISMOB partners

Country	NO_X	NMVOCs	SO_2	NH_3	PM2.5	CO	CH_4
Portugal	42%	9%	0%	2%	7%	28%	0%
Romania	39%	6%	0%	1%	3%	14%	0%
Spain	34%	5%	0%	1%	20%	11%	0%
Sweden	42%	14%	0%	5%	24%	29%	2%

Regarding population exposed to air pollutant concentrations, Table 1.7 shows the minimum and maximum percentage of urban population exposed above the EU air quality objectives in the triennium before 2014 (2011-2013).

Table 1.7 Urban population exposed to air pollutant concentrations above the EU air quality objectives - minimum and maximum range (EEA, 2014)

Country	PM10 day (50µg/m3)	O_3 8-hour (120 µg/m3)	NO_2 year (40 µg/m3)
Portugal	12.4% - 30.3%	0%	1.3% - 1.7%
Romania	57.5% - 95.5%	0% -7.6%	0.2% - 10.2%
Spain	1.4% - 6.0%	7.2% - 20.8%	9.1% - 22.8%
Sweden	0.6% - 1.5%	0%	0.3% - 1.2%

Romania was clearly the country of the CISMOB consortium presenting worse levels of urban air quality. At least 57% (in the year with better air quality levels) of urban population exposed to air pollutant concentrations (PM10) were above the EU air quality objectives in the triennium 2011-2013. Portugal and Spain also recorded poor air quality levels in terms of PM10 and NO_2, respectively, with values raising up to 30% and 23% of urban populations in the years with the highest pollutions levels. In Sweden, urban population exposed to poor air quality is marginal.

1.7.3.2 Air Quality in CISMOB Regions

This section describes average concentrations of atmospheric pollutants where transport sector is directly (NO_2 and PM) and indirectly (Ozone) a main contributor. The type of monitoring technology, sensors and data processing is distinct among the various regions of the consortium. As far as possible, this section attempts to provide a general picture of the air quality indices of the CISMOB regions.

Table 1.8 Exceedance of air quality limit values in CISMOB Regions (2014)

Pollutant	Concentration (Averaging period)	Permitted exceedances each year / threshold alert	Romania	Centro Region	Extremadura	Sweden
NO$_2$	200 $\mu g\ m^{-3}$ (1hour)	200 $\mu g\ m^{-3}$ not to be exceeded 18 hours per year	0	0	0	0
	40 $\mu g\ m^{-3}$ (1 year)	Not to exceed an annual average of 40 $\mu g\ m^{-3}$	0	0	0	0
	400 $\mu g\ m^{-3}$ (3 hours)	Alert threshold	0	0	0	0
	30 $\mu g\ m^{-3}$ (1 year)	Annual critical level for vegetation protection	0	0	0	.
PM10	50 $\mu g\ m^{-3}$ (1 day)	50 $\mu g\ m^{-3}$ not to be exceeded 35 days per year	1 AQS 48 days	1 AQS 41 days	0	6
	40 $\mu g\ m^{-3}$ (1 year)	Not to exceed an annual average of 40 $\mu g\ m^{-3}$	0	0	0	0
O$_3$	120 $\mu g\ m^{-3}$ (8 hour)	Maximum daily 8-hour mean of 120 $\mu g\ m^{-3}$ not to be exceeded 25 days averaged over 3 years	0	1 AQS 27 days	-	1.5
	180 $\mu g\ m^{-3}$ (1 hour)	Information threshold	3	0	-	0
	240 $\mu g\ m^{-3}$ (1hour)	Alert threshold	0	0	-	0

Source: (ANPM, 2014; Lameiras, 2015; REPICA, 2017)

This table permits to conclude that during 2014, Romania and Centro Region (Portugal) exceeded for more than 40 days the limits of air quality w.r.t. PM10. Additionally, Centro Region exceeded the legal limits w.r.t. O$_3$ for almost 30 days in that year.

1.7.3.3   Monetization of road traffic-related air pollution emissions

Damage costs associated to pollutant emissions reflect the total estimated amount of economic losses produced by the impact of the road traffic-related air pollution. Table 1.9 provides the damage cost values from the most common air pollutants in the corresponding countries to CISMOB areas, while Table 1.11 gives information about estimated costs related to pollutant emissions in each country. Table 1.10 presents the results in terms of pollutant emissions for each country.

Table 1.9 Damage costs of main pollutants from transport, in €-2010 per tonne

Country	PM2.5			NOx	NMVOC
	Rural Area	Suburban Area	Urban Area		
Portugal	18,371	49,095	196,335	1,957	1,048
Romania	56,405	84,380	231,620	22,893	1,796
Spain	14,429	48,012	195,252	4,964	1,135
Sweden	14,578	50,210	197,450	5,247	974

Source: Update of the Handbook on External Costs of Transport (Korzhenevych et al., 2014)

Note: Urban - population density of 1500 inhabitants/km2; suburban - population density of 300 inhabitants/km2; rural - population density below 150 inhabitants/km2

Table 1.10 Air pollutants from transport sector in tonnes (2014)

Country	PM2.5	NOx	NMVOC
Portugal	3,914.24	67,456.50	15,417.81
Romania	3,573.83	81,315.65	30,451.74
Spain	18,412.49	390,487.05	118,558.34
Sweden	2,856,06	60,651.02	15,913.39

Source: Own calculations

Table 1.11 Damage costs of main pollutants from transport in CISMOB Project areas, in €-2010 per tonne

CISMOB Area	PM2.5	NOx	NMVOC
Stockholm	63,046,133.44	60,781,747.76	2,744,415.91
Bucharest	145,988,022.10	452,092,933.30	13,282,170.16
Centro Region	73,849,400.11	24,474,984.16	3,942,277.92
Águeda	1,722,973.89	479,963.82	99,494.64
Extremadura	49,176,732.86	48,669,978.18	2,238,032.16
Romania	601,127,064.20	1,861,559.16	54,691,319.68

Source: Own calculations

Figure 1-8 gives an overview of the differences among CISMOB Project areas in terms of emission costs per kilometre in Euros (€), based on recent official data from 2014. Vertical axis on left refers to costs of NMVOC, while the right one refers to costs of PM2.5 and NOx.
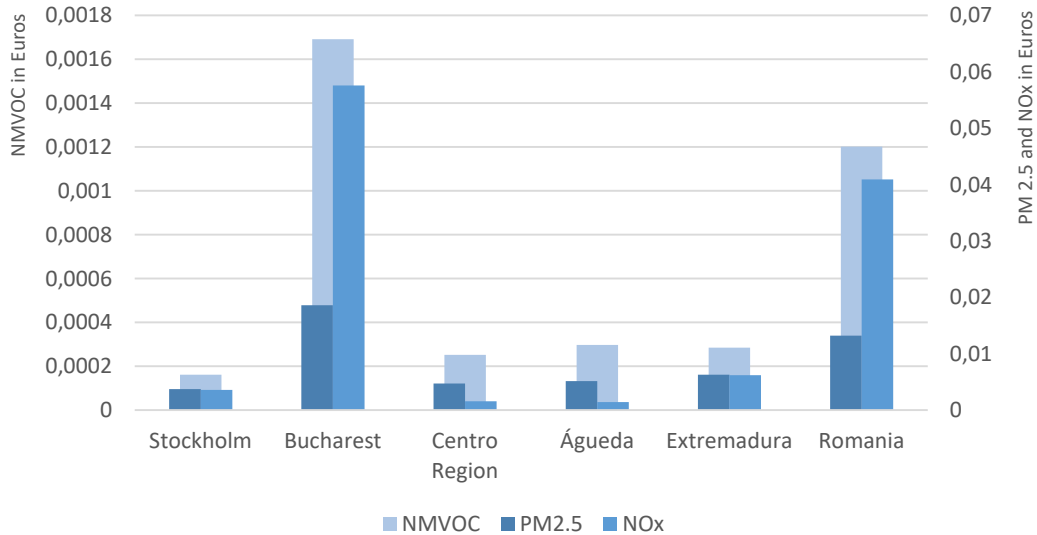
Figure 1-8 Estimates of emission costs per kilometre in Euros (€), in CISMOB Project areas

It is clear Bucharest presents the highest costs per kilometre for all these pollutants. A closer look shows the lowest costs for NMVOC and PM2.5 are verified in Stockholm, while for NO_X is in Águeda. In terms of NMVOC costs, Águeda and Extremadura values are quite similar.

1.7.4 Noise Costs

Transport sector is the major source of noise, while traffic noise is one of the main local environmental problems in Europe, with around 80 million EU-citizens suffer from unacceptable noise levels (Korzhenevych et al., 2014). It is important that the impacts on noise are fully considered in decision making for any policy, programme or project as noise emissions can affect people's health, wellbeing, productivity, and the natural environment.

The Handbook on External Costs of Transport (EEA, 2015b) provides the updated values for different levels of noise (Table 1.12), while based on Noise Observation and Information Service for Europe data (Korzhenevych et al., 2014)(Table 1.13), we estimated the noise costs in major cities of CISMOB areas (Table 1.14). Regarding Centro Region and the city of Águeda, there were not available data about the number of people in agglomerations exposed to noise from roads.

Table 1.12 Cost factors (central values) for noise exposure (€-2010, factor costs, per year per person exposed)

Country	Lden[9], dB(A)					
	=51	=55	=60	=65	=70	=75
Portugal	6	29	56	84	113	187
Romania	3	15	29	44	58	97
Spain	8	39	78	117	156	259
Sweden	13	67	133	199	256	411

Source: Update of the Handbook on External Costs of Transport (EEA, 2015b).

---

[9] Lden is the common EU indicator that corresponds to the average noise level throughout the day, evening and night, to which a citizen is exposed over the period of a year.

Table 1.13 Number of people in agglomerations exposed to noise from roads (Lden) (2012)

City	Number of people in agglomerations exposed to noise from roads (Lden)				
	55-59	60-64	65-69	70-74	>75
Badajoz	11900	47500	23000	12700	1000
Stockholm	150000	60100	20200	3600	200
Bucharest[10]	469500	660900	366500	116100	17900

Source: NOISE_Database | ETC Spatial Information and Analysis (Korzhenevych et al., 2014)

Table 1.14 Noise costs in major cities of CISMOB areas (€)

City	Cost for noise exposure				
	55-59	60-64	65-69	70-74	Total
Badajoz	464,100	3,705,000	2,691,000	1,981,200	8,841,300
Stockholm	10,050,000	7,993,300	4,019,800	921,600	15,790,730
Bucharest	7,042,500	19,166,100	16,126,000	6,733,800	49,068,400

Source: Own calculations

1.7.5 Climate Change Costs

The valuation of climate change costs, i.e., the evaluation of the cost of GHG emissions, according to The Handbook on External Costs of Transport (Eurostat, 2016c) is connected with extremely high uncertainty due to complex global pathways of various effects and long-time horizons involved. However, for the purpose of this report the calculation of the cost of GHG emissions based on the estimates of CO_2 costs[11] that is provided from the Handbook enables the cross-regional comparison. Table 1.15 provides information about the greenhouse gas emissions from transport[12] in the year 2010 for the countries that represented in CISMOB project, while in Table 1.16 results on estimation values of climate change costs in CISMOB Project areas are presented.

Table 1.15 Greenhouse gas emissions from transport (2010)

Country	Greenhouse gas emissions from transport (tonnes of CO_2 equivalent)	
	Total	Per capita
Portugal	18,504,770	1.75
Romania	14,229,860	0.70
Spain	91,989,060	1.98
Sweden	20,383860	2.18

Source: Greenhouse gas emissions from transport (EC, 2016b) and own calculations

---

[10] Data referred to 2007 results.
[11] The mean of CO2 damage cost (€/tonne) for a statistical distribution based on 232 published estimates is 49.
[12] Including road, rail, inland navigation and domestic aviation.

Table 1.16 Climate change costs in CISMOB Project areas (2010)

CISMOB Area	Greenhouse gas emissions from transport (tonnes of CO_2 equivalent)	Climate Change Costs (€)
Stockholm	4,401,816.76	216,689,021.20
Bucharest	1,583,188.60	77,576,241.40
Centro Region	4,091,127.25	200,465,235.30
Águeda[13]	83,251.00	4,079,299.00
Extremadura	2,177,227.80	106,684,162.20
Romania	14,229,860	697,263,140.00

Source: Own calculations

1.8 Digital Agenda Scoreboard

The Digital Scoreboard measures progress of each country towards the European digital economy. The Digital Economy and Society Index (DESI) is a composite index that summarises relevant indicators on EU member's digital performance and tracks their evolution in digital competitiveness. The DESI is structured around five principal dimensions: i) the Connectivity dimension that measures the deployment of broadband infrastructure and its quality, ii) the Human Capital dimension which measures the skills needed to take advantage of the possibilities offered by a digital society, iii) the Use of Internet dimension that accounts for the variety of activities performed by citizens already online, iv) the Integration of Digital Technology dimension measuring the digitisation of businesses and their exploitation of the online sales channel, and finally, v) the Digital Public Services dimension which measures the digitisation of public services, focusing on eGovernment (EC, 2016b).

Figures 1-9 – 1-12 provide information about the digital performance of the countries that represented from CISMOB Project regions and cities. In total, the top performing country is Sweden (0.672), while the bottom performing country is Romania (0.35). Finally, the country that have improved the most from 2015 to 2016 is Portugal (from 0.49 to 0.53) (EC, 2016c).

---

[13] Based on Agueda's population in 2011.
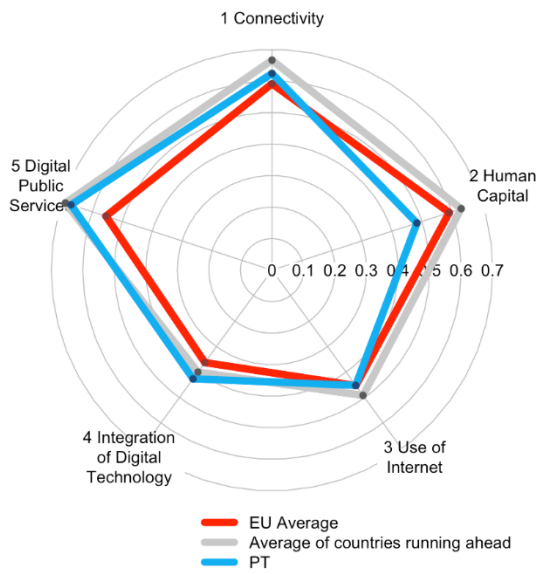
Figure 1-9 Portugal's DESI 2016 (EC, 2016c)
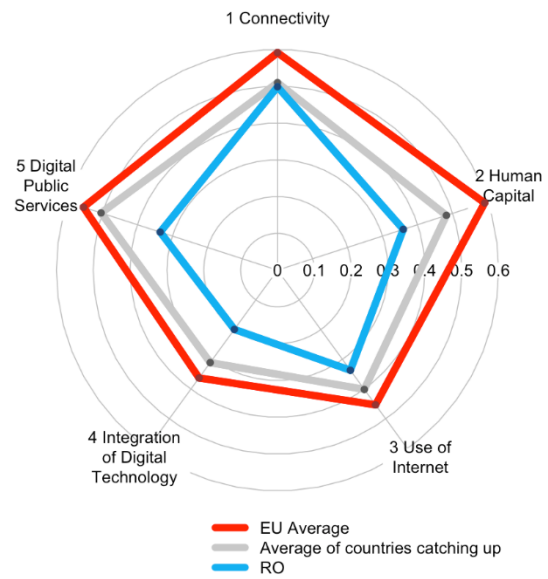
Figure 1-10 Romania's DESI 2016 (EC, 2016d)
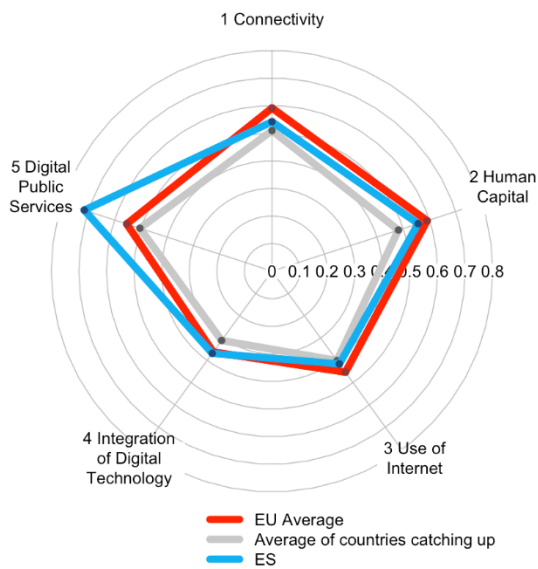
Figure 1-11 Spain's DESI 2016 (EC, 2016e)
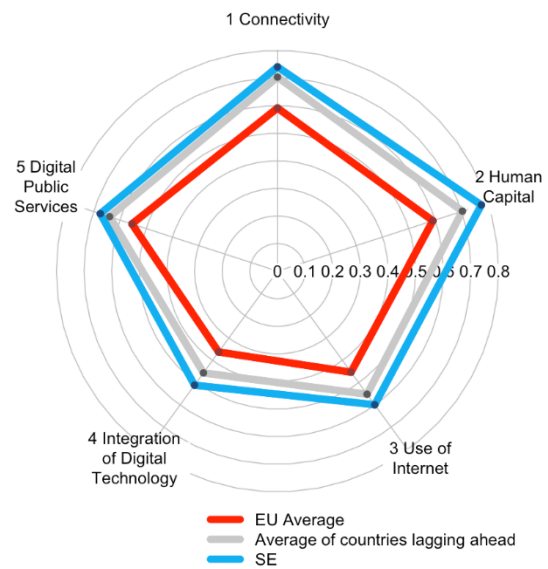
Figure 1-12 Sweden's DESI 2016 (EC, 2016f)

1.9 Summary of Current Baseline Situation of CISMOB Project Areas

Figure 1-13 describes the current baseline situation for the regions involved in the CISMOB project regarding their GDP, safety, digital performance and air pollution. This type of plot is very important to the baseline analysis, since it permits not only to understand current state, but also future needs.

CISMOB REGIONS RELATIVE COMPARISON
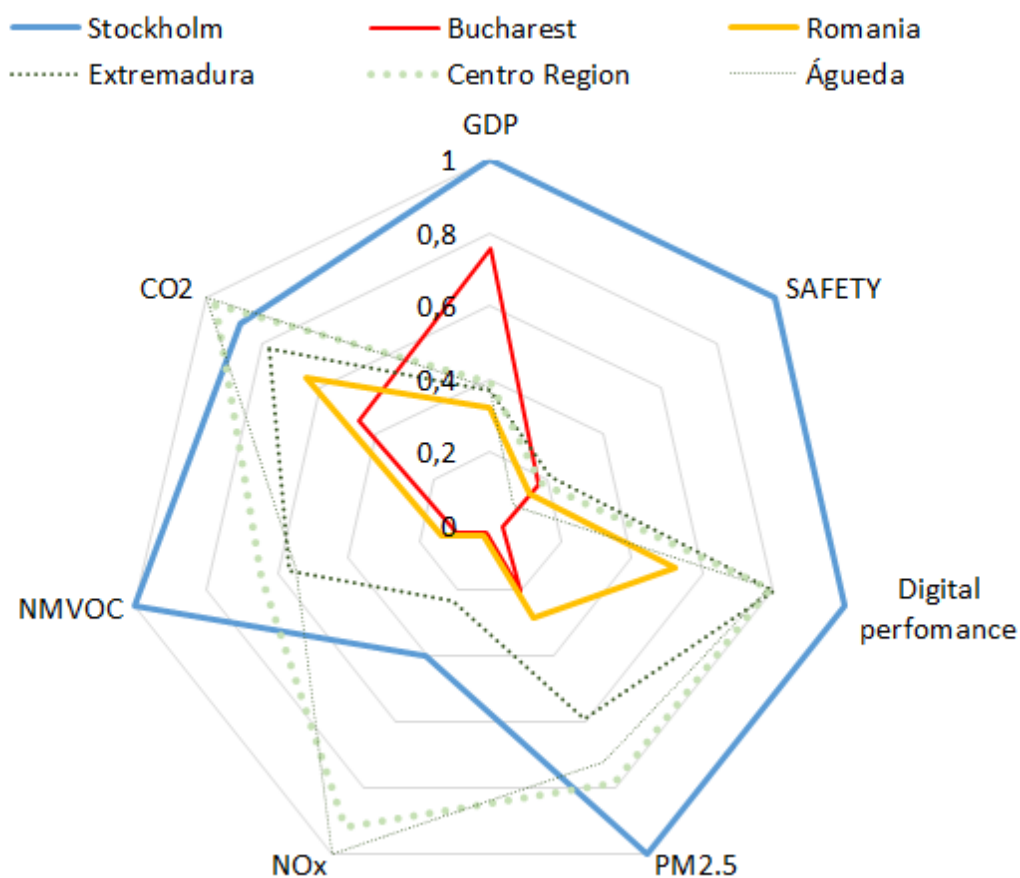
Figure 1-13 Relative comparison between CISMOB Project areas

Stockholm's baseline scenario stands out as the best among the studied regions in all parameters, except in terms of CO_2 and NO_X emissions, where Águeda and Centro Region, in Portugal, perform best. Águeda and Centro Region overall analysis permits to conclude there are some major issues related to safety, especially in Águeda which presents the worst index compared to all CISMOB regions. In fact, it can be observed that all regions, with exception of Stockholm, present serious issues in terms of safety, being Centro Region and Bucharest at the same level. Concerning digital performance, Bucharest has the worst index, while Extremadura, Águeda and Centro Region present quite higher indices, followed by Stockholm. Regarding emissions, Bucharest and Romania present the worst possible scenario w.r.t. NO_X, and Stockholm presents low index values, when compared to its overall picture. In fact, Bucharest and Romania present the worst values for all traffic-related pollutants. Besides all efforts Extremadura has made in order to reduce carbon footprint, the truth is that NO_X emissions continue to be a problem which requires attention.

2 Available ITS Tools to Promote Low-carbon and Sustainable Mobility

Intelligent Transport Systems (ITS) mean applying Information and Communication Technologies to transport sector (EC, 2011b). The use of IT tools in transport has brought significant improvement in transport systems performance and is a key element in reducing carbon footprint and increasing the sustainability on an urban scale. The increasing road transport volumes in the EU are the primary cause of growing congestion and rising energy consumption, as well as a source of environmental and social problems (Urban ITS Expert Group, 2013). According to EC, ITS can contribute to the main transport policy objectives by reducing environmental impacts and save energy through better demand management. Therefore, the primary goals for urban transport should be the promotion of cleaner cars and fuels and the reduction of road accidents and traffic congestion. ITS tools can have a significant role to a cleaner, safer and more efficient transport system. EC with the ITS Directive (2010/40/EU) gave the necessary legal framework to their member states to accelerate the implementation of smart technologies in transport sector, giving the freedom to each country to decide their priorities (Yen & Lyoen, 2012).

Available ITS tools vary in technologies applied, from basic management systems such as car navigation and traffic signal control systems to more advanced applications that enables the use of real-time data and involve various technologies, such as: software and sensor technologies, wireless communications, computing technologies; floating car data/floating cellular data and sensing technologies (Singh & Gupta, 2015). A wide range of communication technologies, such as internet, cellular phones, radio, etc. are implemented in ATIS to assist road users in decision making regarding travel mode and transit route choice (Tempier & Rapp, 2011).

2.1 Multimodal Journey Planners

A Multimodal Journey Planner is a software application usually accessible on computers and smartphones that provides pre-trip travel plan information to users allowing them to use multiple modes of public and private transport (Urban ITS Expert Group, 2013). Over the past few years, many real-time trip planners were developed to overcome the possibility of inaccurate travel plans by taking into account delays caused of accidents, traffic congestion etc. Multimodal Journey Planners, in order to promote sustainable mobility and the use of public transport, provide door-to-door routing with visual maps, information on how to change between modes and allow commuters to easily book and pay for their journey (e.g. with the use of the application or by providing integrated tickets).

Multimodal journey planning systems and services are usually operated by transport authorities or city regions in a small scale (cities) or in a bigger scale (countries). There is also

an alternative approach, where city authorities, governments, transport service providers and network and fleet operators provide their own data under a standardised data exchange format and allow private companies to use it in order to develop applications for journey planning like in Trafiklab, Stockholm (Sweden).

Well known examples of journey planners are:

- Destineo (France),
- FromAtoB (Europe),
- Google Transit (with varying coverage around the planet),
- MOTUS (Milan, Italy, a real-time information system for public transport in case of delays and service disruptions),
- Onlymoov (Lyon, France),
- Rome2rio (international),
- Trafiken (for specific cities in Sweden),
- Transport for London (London, United Kingdom),
- Wisetrip (international).

2.2 In-Vehicle Information Systems

Due to the increasing problems of traffic congestion in urban areas, information and communication systems are increasingly present in road vehicles. In-vehicle Information Systems (IVIS) include navigational and traffic information systems, warning and emergency help systems and can provide drivers with information such as road and traffic conditions, navigation information, emergency road conditions etc.

Real-time traffic information and navigational systems could promote fuel-efficient driving and reduce travel times. Drives base their route choices on real-time and accurate information about traffic conditions and road incidents that could cause delays. Real traffic information on road hazards ahead could reduce accidents, as it could provide type and location of incidents, inform about dangerous road conditions, and suggest alternative safer routes. Recent initiatives focus on developing a new approach called "eco-routing" that provides information about routes that require least amount of fuel and/or produces the least amount of emissions (e.g., MyFord Touch, Garmin, etc.). The aforementioned systems are usually provided form the carmakers and data is collected from road sensors, transport authorities, etc.

2.3 Smart Ticketing

Smart ticketing systems are recently gaining attention as new technologies that can improve overall efficiency, level of service and attractiveness of public transport. Nowadays electronic ticketing schemes can easily be used through smart cards of mobile phones, although they are limited geographically inside a metropolitan area. The implementation of smart ticketing systems across Europe can contribute to the overall improvement of public

transport and to the political goal of developing a sustainable transport policy (AECOM, 2011). It has the potential to achieve a significant modal shift from private cars and resulting in reducing congestion, noise pollution and vehicle emissions and in a lower carbon footprint (EY, 2014). In London, the introduction of the Oyster Card in 2003 has contributed to the increase of the distances travelled on public transport by 45% between 2000 and 2010 (Urban ITS Expert Group, 2013).

However, the overall vision of the development of smart ticketing schemes should be the possibility of users to combine trips and services, enabling interoperability between different transport modes with the same ticket or with different tickets on the same smart support system (Urban ITS Expert Group, 2013). The integration of smart ticketing into Multimodal Journey Planners could promote the use of public transport even more. The use of internet tools and information services for providing real-time information to commuters could support the vision of smart ticketing by improving the travel experience. The aim of I integrating ticketing is to encourage people to use public transport by allowing them to change transport modes easily and by increasing the efficiency of the services.

Furthermore, cities in order to enhance the use of smart ticketing, should offer an attractive and simple system, combined with reasonable prices and easily accessible with sales points distributed throughout the city or through internet and mobile phones (TNS Opinion & Social, 2014). Best practises in the area of smart ticketing are listed below:

- BOB Card (Bremen, Germany), aims at non-frequent public transport passengers and allows users easy access to public transport without the need for prepaid tickets or cash. The card is free and users get billed automatically every month based on their trips. It is smart as it provides the commuters the most economical tickets based on the built-in best-price function;
- E-ticket (Riga, Latvia), the use of the card combines travel and social services, such as entrance to schools, school catering services, the provision of free meals by the Welfare department of Riga City Council etc.;
- Octopus Card (Hong-Kong), is also used for paying goods and other services;
- OV-Chipkaart (Nederlands), is a contactless smart card system used for all public transport in the Netherlands, offering the final users the possibility to acquire different tickets that will permit them to use a combination of trips and services. The card gradually replaces the traditional ticketing systems;
- Mobility card (Netherlands), it is smart card providing access to several business travel options, like public transport, taxis and shared cars. This smart card is provided by a commercial organisation;
- Oyster Card (London, United Kingdom), is a smart card used on public transport in Greater London which can hold pay as you go credit;
- Mobib-pass (Brussels, Belgium), is a smart card that can be used to access public transport and hire bicycles;
- Navigo (Paris, France), is a multimodal smart card to use in public transports in Paris;
- MITT (Trentino, Italy), is a smart card that can be used to access public transport and interchange parks;

- T:card (Trondheim, Norway), it is a smart card that can be used to access buses, trams and regional coaches;
- Coimbra conVida (Coimbra, Portugal), is a multimodal smart card for travellers to have access to buses and car & park facilities. The scheme may be extended in the future to rail transport and bike/car sharing schemes;
- SL Access Card (Stockholm, Sweden), is a smart card that is used for electronic ticketing in the Stockholm county;
- Resplus (Sweden), it is a smart ticketing system that includes combined tickets for all long-distance train traffic, regional and local trains, trams and the underground as well as a broad selection of both commercial bus and boat transport. Resplus even includes taxis reserved in advance in sparsely populated areas as well as museum railways.

2.4 Real-Time Passenger Information

Travel information is a key aspect of ITS deployment in public transport. As already mentioned, the real-time passenger information systems are a common application of AVL tools. These systems can provide information about arrivals and departures times of public transport vehicles base on AVL data, through visual, voice or touchable media on street displays or available online. Even more, they could inform travellers about delays, alternative route or mode choices, the available capacity of vehicles etc. Real time information about all the available transport modes and services allows users to manage efficiently their journey by taking into account their own preferences (e.g. choosing modes with greater capacity or faster routes etc.)

Transit authorities by providing real time information to commuters about their services enhance their reliability and encourage greater use of public transport. The need for high quality and up-to-date information is essential to maintain the competitive position of public transport relative to private vehicle. IT role is to increase the availability and quality of the required data and contributes in that way to the creation of a more integrated transport system that will promote sustainable mobility.

2.5 Automatic Vehicle Location

ITS have an important role to play in modal shift, as frequent services (27%), better coverage (26%) and cheaper or seasonal ticket options (25%) are the main reasons that could affect travellers to leave their cars and use public transport (Peng, Yu, & Beimborn, 2002). Automatic Vehicle Location (AVL) is one of the emerging applications in the field of public transport that could contribute in the overall improvement of its services. They have been increasingly used during the last years by public transport authorities in fleet management and in passenger information systems as a means of tracking the locations of vehicles in real-time (Predic, Rancic, & Milosavljevic, 2010).

Tracking vehicle location is the most common function of AVL systems, giving to public transit authorities the possibility of real-time monitoring of their fleet and allow them to quickly respond to emergency situations in the field. The provision of accurate and reliable travel time and location information can also assist commuters in their travel decisions. By having knowledge of the expected arrival and departure times of vehicles, as well as on-route information can help them in gaining time savings and also result in making public transport services more attractive (Persad, Walton, & Hussain, 2006). Moreover, AVL systems have the potential to increase operational performance, reduce cost of running services and fuel demand, improve the fleet management, minimize traveling and waiting times and increase reliability by providing real-time information.

Notable examples of AVL systems in public transport services are:

- ATI - Saluzzo (Cuneo, Italy), a comprehensive public transport system combining electronic ticketing system with AVL system, managing effectively over 400 buses,
- Malmö, Sweden, city buses and some regional buses were equipped with AVL units providing its exact position and time on bus stop signs informing commuters about the exact time of their arrival,
- Park for Truro (Truro, United Kingdom), a dedicated park and ride service for people who visit city centre. Bus are equipped with AVL systems providing passengers the exact time of their arrival,
- Sabimos (Almelo, Nederlands), travel information system using AVL technologies with traffic intersection priority system, providing real-time information about trains, regional and city buses to travellers and transport companies.

2.6 Electronic Fee Collection

Urban toll schemes were developed as a measure to decongest downtown areas, while the use of Electronic Fee Collection (EFC) systems and video recognition technologies was a revolutionary step toward that target. EFC systems offer the possibility of charging road vehicles in congested urban areas in a flexible way by electronically debits the accounts of the passing vehicles owners, aiming at eliminating the delay on toll roads.

The implementation of EFC systems could contribute in improving the speed and efficiency of traffic flows, travel time savings and reducing congestion and air pollution (EC, 2008). Moreover, they could play an essential role in the greening of transport as a way to influence traffic demand (Evenepoel, Van Ooteghem, Verbrugge, Colle, & Pickavet, 2014). The main technologies used in EFC today across Europe today are the dedicated short range communications (wireless communication channels specifically designed for automotive use) and the video-based charging, which recognise the plate number of the vehicle automatically. Types of EFC are the Open Road Tolling, which allows the toll collection without the use of toll booths and the GNSS (Global Navigation Satellite System) Tolling with the use of sensors inside vehicles allowing tolling by distance. Examples of European EFC are:

- AutoPass (Norway), uses electronic radio transmitters, allowing road tolls collection automatically from cars,
- Congestion Charge (London, United Kingdom), launched in 2003 and combined with the introduction of 300 extra buses,
- Milano Area C (Milan, Italy), a combined Low Emission Zone and urban road charging scheme, where vehicles entering the Area are detected by a system of 43 electronic gates equipped with Automatic Number Plate Recognition) technology,
- Stockholm Congestion Charge (Stockholm, Sweden), payment is allowed by direct debit triggered by the recognition of the on-board electronic tag that is loaned to drivers,
- Via Verde (Portugal), the first EFC system that was applied in a whole country.

2.7 Smart Parking

Smart parking Systems can improve the traffic flow, reduce congestion and fuel emissions, and contribute to the more efficient parking space management by helping to locate available on street parking places. Drivers searching for a vacant parking spot is an important factor to traffic congestion (up to 30%), while vehicles stuck in traffic result in air pollution and greenhouse gas emissions (ITS America, 2013). The more efficient approach in the management of street parking can minimize the need for investments in infrastructure and improve the use of the existing transport systems. Current transportation infrastructure and car parking facilities are unable to deal with number of vehicles on the streets and the extensive deployment of smart parking systems could be a key tool to reduce carbon footprint and improve sustainable mobility in urban areas, as they reduce parking's environmental footprint (Evenepoel et al., 2014). With the use of smart parking applications drivers could easily be guided to empty slots saving time and fuel, through a mobile app.

Sensors technologies are currently widely applied in smart parking systems as is entirely placed underground and do not interfere with road users or suffer from vandalism or extreme weather conditions. The sensors are able to detect the presence of vehicles and to inform the driver about the nearest available parking space. Although, the use of these systems are highly employed because of their high performance among operators of off-street parking lots, city wide monitoring of on-street parking space however is not as common (Ranjini & Manivannan, 2013) as they consume a significant amount of power to transfer the information (Busher, Doody, Webb, & Aoun, 2014) and require higher deployment costs. Below are listed some notable examples:

- SPIN (Street Parking Information Network) is an on-street smart parking solution from VehicleSence for parking management systems. SPIN provides both real-time and historical information on parking occupancy, turnover, and other information that allows parking operators to better manage their systems.
- Another approach in infrastructure-based sensor system is the Siemens Integrated Smart Parking Solution. Siemens developed an integrated smart parking system that can support multiple applications such as traffic and light management. The system

also allows you to have a clear picture of the available parking places and for how long each space has been occupied for.

- Parker is one of the various mobile applications developed by Streetline, a smart parking company. The application helps the user to find vacant parking spaces with real time information and also provide directions to return back to your vehicle.
- SFpark (San Francisco, United States) is another initiative of smart parking that takes advantage of sensor and wireless communication technologies to collect and share real time information about the number and location of available parking spots. It uses innovative technology and advanced pricing strategies to reduce circling and double-parking in congested areas. SFpark has significant impact in dealing with phenomena of overcrowding or low occupancy blocks. (Hanfried et al., 2013).

2.8 Traffic Signal Control

Traffic Signal Control Systems were one of the first traffic management solutions used in urban areas. They function were based on fixed cycle times with their initial role inevitably limited in separating conflicting movements at individual junctions. The introduction of advanced technologies enables the development of features such as the use of traffic data to optimise traffic flow, public transport prioritization and the control and management of a wider network area.

Traffic Signal Control Systems can contribute in improving vehicle journey times, reducing congestion, and promote the use of public transport, while the use of floating vehicle data and cellular data could minimize the need for road infrastructure (e.g. detectors) (Hanfried et al., 2013). The most two common traffic management strategies are the dynamic control and the adaptive traffic control. In the first occasion, based on data from the detectors, traffic control centres can change the signal timing and phasing within the time limits of the programme giving priority to the lanes that are experienced heavy traffic. On the latter occasion, traffic signal timing is continuously adjusting based on real traffic demand, changing also the green time to each approach from cycle to cycle.

2.9 Pollution Monitors

The last few years a new approach in traffic management is employed aiming at optimizing traffic flow and minimizing air pollution. This innovative solution deploys air quality monitoring systems to measure air pollution and provide traffic management authorities with real-time data about vehicles emissions. The use of pollution monitors contributes in developing strategies to alleviate congested urban areas by redirecting traffic away from those areas (Edwards & Evans, 2010).

The data collected from pollution monitors except of assisting transport authorities in deploying informed traffic strategies, can also influence transport policies, governments priorities and helping local authorities meeting their policy targets (Edwards & Evans, 2010). Notable examples of using pollution monitors for traffic management are: i) the Swansea

Project (Swansea, United Kingdom) aimed to develop a working traffic emissions forecast model (Nowcaster) that would have the ability to estimate air quality conditions in advance, contributing in a more efficient traffic management control and (Edwards & Evans, 2010), ii) Leicester Area Traffic Control Centre (Leicester, United Kingdom) which deploys 13 pollution monitors as traffic management tool (Andersen & Muhammed, 2013).

2.10 Automatic Incident Detection

Automatic Incident Detection (AID) technologies have the ability to provide accurate and real time information about road incidents using radar systems or electromagnetic loops and dedicated algorithms, which deploy video cameras or image analysis. The use of AID systems in transport systems can enhance road safety and improve traffic flow by tracking vehicles position immediately and informing transport authorities to deal with the situation and ensuring the emergency services would arrive on time.

Highway incidents can cause injuries, fatalities, increase traffic congestion and environmental pollution. The deployment of AID in highway management systems permits to improve operators' response times and save millions in terms of delay and damage. The deployment of AID system in the Limfjordstunnel in Aalborg (Denmark) improved the traffic flow and reduced travel time by detecting immediately stopped or slow driving vehicles inside the tunnel and larger objects on the pavement (Andersen & Muhammed, 2013), while the Video-based Automatic Incident Detection System in the Clem Jones Tunnel (Brisbane, Australia) as a part of the CLEM7 project (a 6.8 km toll way) contributed to reduce travel times by up to 30 percent (Gelencser, Hopkin, Tindall, & Francsics, 2010).

2.11 Cooperative Vehicle Systems

Cooperative Vehicle Systems are currently the main direction towards the future of ITS. Cooperative Intelligent Transport Systems (C-ITS) enable the direct interaction between vehicles, road infrastructure and transport authorities, allowing them to share data and information. This cooperation is empowered by mobile communication networks and aims at improving road safety, transport system efficiency, increasing sustainability and reducing air emissions.

The development of cooperative vehicle systems is also essential to increase the safety regarding the full integration of automated vehicles into transport systems, while major areas of ITS such eco-driving and dynamic passengers information could take advantage of the new capabilities (EC, 2016a). The possibilities that will arise of their instalment, except the introduction of new innovative technologies, include also the more effective use of existing ITS. Cooperative vehicle systems can deploy various services such as hazardous location notifications, signage applications, navigation systems, traffic and parking information etc. (Anderson et al., 2016). Examples of cooperative vehicle systems are the truck platooning, emergency braking, optimal speed advice, etc.

A few years ago, an innovative C-ITS was implemented in Verona (Italy), aiming at improving traffic management and contributing to less congestion and air emissions. A traffic light assistant application was developed, which can be easily downloaded in a smartphone or installed into the on-board unit of any vehicle. The application by communicating with the infrastructure could provide the drivers with information regarding the time-to-green and speed advice to avoid stop and start at traffic lights.

2.12 Automated Vehicles

In recent years, research focus on the development of vehicles that would take full advantage of the capabilities that are offered from the available ITS tools. Automated vehicles deploy a wide range of technologies and services as their function based on informed decision after exchanging data with other vehicles, infrastructure, or traffic centres. These technologies are able to guide the vehicles with minimal or no driver effort providing increased safety and mobility and environmental benefits, as the driving would be more secure, efficient and environmentally friendly. Among the anticipated benefits of automated cars would also be the reduction of road accidents and traffic congestion, the increase of traffic flow, the lower fuel consumption, the travel time savings, etc. (García-Palomares, Gutiérrez, & Latorre, 2012).

Automated vehicles have the potential to change drastically transport systems. These technologies are also find application in public transport. For instance, CityMobil2 was a research project co-funded by the European Commission, designed to support current public transport systems. The project has conducted pilot programs of their driverless electric shuttles in urban areas, offering rides to travellers to bus stations, in order to continue their journey.

2.13 Bicycle Sharing Schemes

In recent years, transport planners and policy makers in order to achieve a modal shift from motorized transport to more environmentally friendly ways have set the promotion of cycling as a top priority (Heinen, van Wee, & Maat, 2010). Bicycles could be an alternative transport choice for daily commuters and a low-cost measure to alleviate transport issues, as their use contribute in reducing motor traffic volumes, less traffic noise and pollution, fewer traffic jams etc. However, only a small proportion of people choose to use a bike to cover their daily mobility needs due to their many disadvantages e.g. riding a bicycle is extremely dangerous and inconvenient especially during rush hour traffic and is not recommended in adverse weather conditions. Moreover, cycling requires a great physical effort and is slower than a private car or public transport, while the distance that a rider can travel depends greatly on these two factors (Olson, Hodges, & Bouget, 2015).

Over the last few years, many cities have launched bike sharing programs in almost every region of the world, although until now they failed to fulfil their primary goal which was to establish cycling as a daily transportation mode. On the other hand, electric bicycles are a

promising measure, as they could deal with various factors that limit traditional share systems such as the distance that can be covered, steep terrain, dispersed land use patterns, potential users' fitness and comfort levels or the level of effort that needs to be expended in making a trip (INE, 2014). A bike sharing scheme usually includes a series of ITS applications such as smart card access, automatic docks and stations, real time information about number of bicycles in use, capability of stations, etc. Below are listed some notable bike sharing programs:

- Vélib (Paris, France) is a smart bike-sharing system with over 23,600 bikes and almost 1,800 stations. The system is easily accessible as bike stations are found every 300 metres and you can buy tickets online or at any station. The system is self-service, available 24 hours a day, with on-screen instructions and the possibility to return the bicycle in any station making it very attractive to commuters.
- Bicing (Barcelona, Spain) is a highly accessible bike sharing service and an important part of the public transport system in the city of Barcelona with around 6,000 bikes, 400 stations every 300 m and the possibility of using also electric bikes. The system provides real-time information on bike availability on the internet and gives you the flexibility to return your bike in every station.
- OV-Fiets (Nederland) is a bike rental scheme running by the Dutch national train company and the users' card can be combined with public transport card. The service gives you the possibility of using bicycle to reach or leave stations. There are more than 300 rental locations, at many train stations, bus or tram stops and in several cities.
- Styr & Ställ (Gothenburg, Sweden) is a bike sharing service, which is a complement to the public transportation of Gothenburg city. The system is very easy to use, as they are on screen instructions in every station and to return the bike the user has just to use the nearest terminal in his destination.
- Velo'v (Lyon, France) is a self-service bike system with 4,000 rental bikes found at 348 stations in Lyon and Villeurbanne. The service is available 24/7, 365 days a year and each station has a terminal with a touch screen with instructions. The system is using smart technology in order to limit incidents of theft and vandalism, the service is available also through a smartphone application and the user can optimize his route with real time information.

3 ITS Penetration in CISMOB Regions

In this chapter, we examined the ITS (Intelligent Transport Systems) penetration in CISMOB Regions. ITS applications are possible to be subdivided in four main branches based on their implementation in different aspects of transportation management: i) Advanced Traveller Information System (ATIS), ii) Advanced Public Transportation System (APTMS), iii) Advanced Traffic Management System (ATMS) and iv) Emergency Management System (EMC).

3.1 Advanced Traffic Management Systems (ATMS)

Advanced Traffic Management Systems (ATMS) include traffic and congestion monitoring and integrate technologies and tools as cameras, sensors, internet-connected portable devices, GPS-enabled systems, etc. that allow real-time traffic data exchange between infrastructure and transport management centers improving their effectiveness. Transport authorities require accurate and reliable information, while the road users need timely traffic information in order to plan their trips. The use of ATMS can significantly relieve transport externalities by improving safety, reducing fuel consumption and congestion. The most common systems for traffic management are:

- automated warning systems,
- dynamic message sign monitoring and control,
- incident monitoring,
- real-time traffic monitoring,
- traffic camera monitoring and control,
- traffic signal monitoring and control,
- in-vehicle information systems,
- web-based tools (e.g. Google Traffic) etc.

3.1.1 Centro Region

In Centro Region, some road sections have a traffic monitoring system through video cameras. One of them is A25 located in the north area of Centro Region, while most of video cameras are implemented in the southwest area, especially in the complementary itineraries IC8 and IC9, and highways A17 and A19. Considering the information reported on the following table (whose content was retrieved from official sites (estradas.pt, Brisa.pt)), it permits to identify 87 traffic monitoring video cameras which corresponds to a ratio of 1,3 cameras per 100 km of national roads.

Table 3.1 Number and location of traffic monitoring cameras in Centro Region

Road	EN242	IC9	N1	A19	A8	COL	VPL	IC8	A17	A1	A25
Cameras	1	14	1	9	5	3	1	19	11	23	Unknown

In addition to information related to incidents, the website estradas.pt provides real-time video images of approximately 60 cameras installed on several Portuguese roads, as well as information in the existing variable message panels on occurrences, accidents, road works and fuel prices. In this portal, it is also possible to plan a trip, calculating routes and tolls.
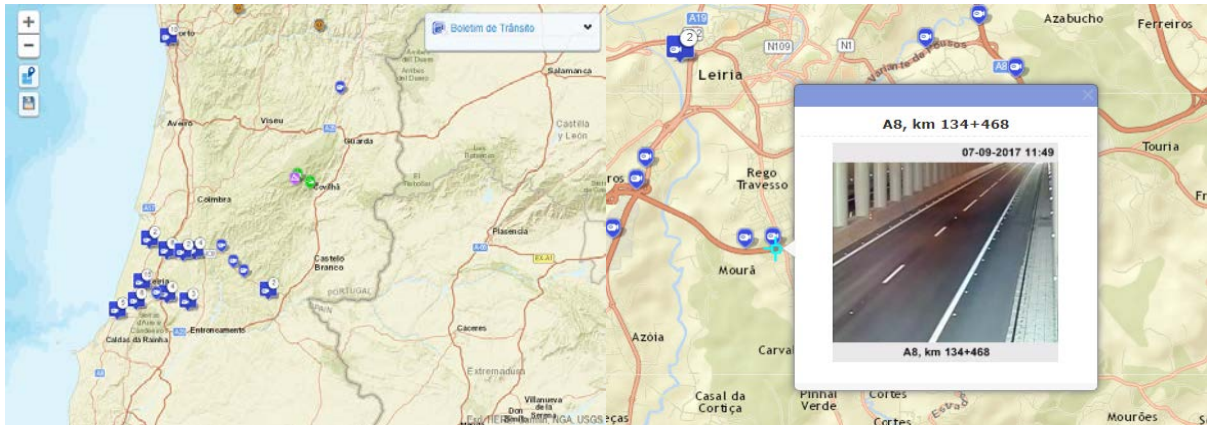
Figure 3-1 Left: Localization of traffic monitoring cameras in Centro Region and Right: snapshot of video camera image in A8 Leiria (estradas.pt)
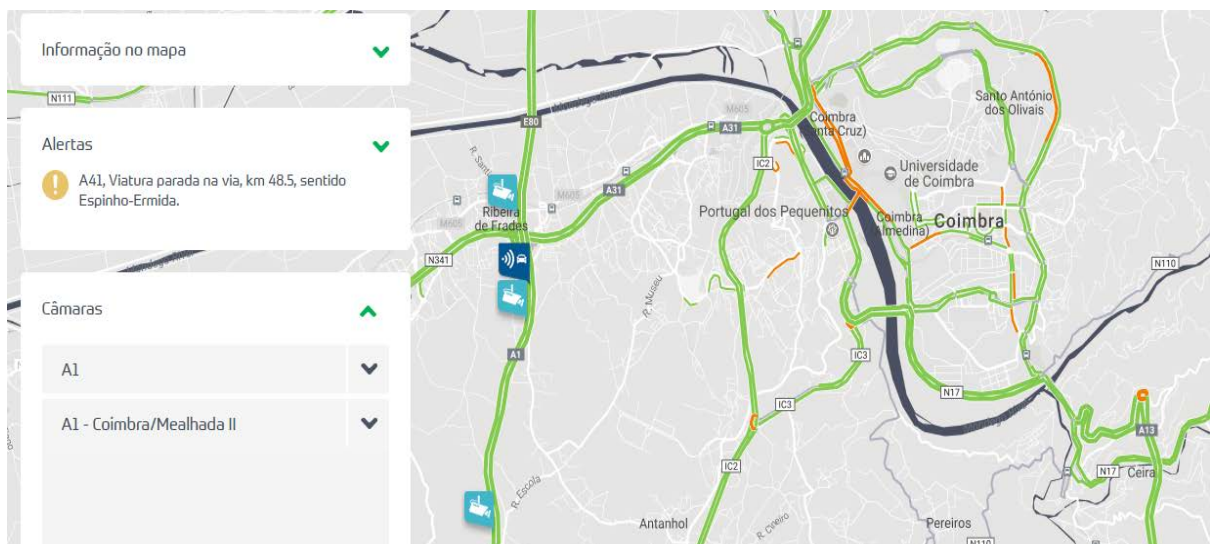
Figure 3-2 Real-time traffic information retrieved from the website (viaverde.pt)

The website via verde.pt also provides free access to traffic monitoring video cameras of A1 and A19 motorways crossing the Centro Region.

3.1.2 Águeda

The city of Águeda has a Pilot of real-time monitoring, called URBAN PROBE (Figure 3-3). This embedded system is a sensor prototype based on computer vision, capable of monitoring large areas. It permits to count people, monitor parking spaces, identify wrong-way driving vehicles and vehicle parking in forbidden zone. In particular, it provides a set of applications involving:

- Monitoring large areas both indoors and outdoors,
- Analysis of the flow of people and vehicles,
- Managing trajectory and identity of objects along different sensors,
- Detection, counting and tracking of people and vehicles,
- Extraction of information regarding the behaviour of people and vehicles (e.g., in which zones they stop, how much time they spend, paths travelled),
- Quantify the number of vacant or busy parking spaces,
- Definition of occurrence-based alarms (e.g., entity in interdict zone),
- "Heat" maps - people flow maps.

Figure 3-3 Image of the URBAN PROBE (ccg.pt)

3.1.3 Extremadura

The General Directorate of Traffic (DGT) is an autonomous body under the Ministry of the Interior from Spanish Government that is responsible for the implementation of traffic policy.

DGT has been promoting innovative systems, applications and services that citizens and professionals use on their travels for several decades, with clear objectives: to provide

security; decrease delays by increasing accuracy in predicting travel times; and improve the quality of road transport and the comfort of citizens who move through them.

Some data that describe the impact of the actions of the DGT: In 2013, 364,827,666 long-distance movements were monitored in 12,196 km of the Spanish road network; 790,600 messages were displayed in the variable message panels (in large part each message was sent to users through several panels); the DGT web traffic mapping information system received 169,160,918 visits. Today, the installed equipment consists of more than 1,500 cameras, more than 2,100 variable message panels and around 2,000 detectors, all over the country.

Some applications of traffic monitoring are described as follow:

- Flow monitoring through electromagnetic whorl and EVA's (Artificial Vision Stations). Traffic intensity and speed, percentage of heavy vehicles, distance between vehicles, occupation, etc. can be measured.
- Meteorological monitoring via Atmospheric Variables on the Road (SEVAC's):
  - Atmospheric variables: air temperature, relative humidity, atmospheric pressure, global radiation, dew-temperature, speed, direction and type of wind, etc.;
  - Precipitation variables: Visibility, intensity, quantity and type of precipitation;
  - Roadway variables: Water film height, snow layer, surface condition, surface temperature, freezing temperature, salinity, etc..
- Monitoring via TV cameras:
  - Continuous Vision on many major road sections;
  - Access to large cities;
  - Conflicting places: tunnels, bridges.
- Monitoring and control of the speed by velocity radars.

In Extremadura there are TV cameras focusing on the road, data collection stations and meteorological stations located in the roads that support the most interurban traffic in Extremadura. Apart from that, information panels have been installed, designed to inform both the traffic conditions on the roads and the weather conditions. These panels give alarm messages, speed limits, danger messages and general information. They will be the basis of a closed signal circuit that take the images in real time to the screens of the Traffic Management Center of Madrid. The traffic management system includes data collection stations, which collect information on issues such as average speed, occupancy, traffic intensity or the presence of vehicles stopped. Likewise, license plates reading systems is installed, which are responsible for capturing, recognizing and sending the registration information of the vehicles for further processing. They are mainly used to control the accesses and to manage the traffic, and for their use in statistical studies, travel times, informative calculation of the speed of section, management of lists. In various municipalities in the region (mainly big cities such as Badajoz, Cáceres, Plasencia, etc), cameras have been installed in order to control vehicle access to restrict places such as old town, pedestrian streets, etc. On the other hand, in the city of Badajoz, cameras and sensors have been installed on traffic lights in order to punish traffic law violations.

Table 3.2 Number and location of traffic monitoring cameras in Extremadura

Area/Road	A1	A5	A66
Badajoz	-	14	7
Caceres	7	13	-

3.1.4 Romania

In Romania, ATMS are implemented on motorways and in several cities. The motorway sections equipped with ATMS are:

- A1 from Nadlac-Arad-Timisoara-Deva-Orastie-Sibiu (300km),
- A1 from Bucharest to Pitesti (110km),
- A2 from Cernavoda to Constanta (50km).

while such tools are also implemented in the following Romanian cities: Bucharest, Timisoara, Cluj Napoca, Craiova and Iasi.

The systems on the motorways are similar in terms of technologies used and functions they provide. They support traffic management and also provide information to travellers using Variable Message Signs (VMS) installed in different locations. Other technologies deployed are: inductive loops, closed-circuit television cameras for surveillance and incident detection, weather sensors and stations, weight in motion devices and fibre optics communication infrastructure.

For the A1 from Nadlac-Arad-Timisoara-Deva-Orastie-Sibiu there is on average 1 camera/direction for incident detection and 1 PTZ surveillance camera at every 3 Km.

The A1 from Bucharest to Pitesti and A2 from Cernavoda to Constanta are each equipped with approx. 10 traffic monitoring cameras.

The data from the systems is collected and processed in four different Traffic Management Centres – TMCs, each assigned to a specific part of the monitored motorways. ITS functions implemented in the TMCs are:

- Traffic Monitoring,
- Traffic Information,
- Automatic Incident Detection,
- Incident Management,
- Weather Information, and
- Traffic Flow Management.

Figure 3-4 Example of a VMS on A2 motorway

In 2016, the implementation of a new, integrated, traffic management system was finalised in Timisoara. The main components of the system are:

- Traffic Control Centre Integration Platform (OMNIA),
- Detection Subsystem (inductive loops and video cameras as virtual loops),
- Traffic Light Subsystem Centralised Traffic Management and Control Subsystem (UTOPIA),
- Public Transport Prioritization Subsystem (FLASH),
- Video Surveillance Subsystem (CCTV),
- Communication Subsystem (fibre optics backbone), and
- Red Light and Speed Enforcement Subsystem VMS Info-Mobility Subsystem (Compass).
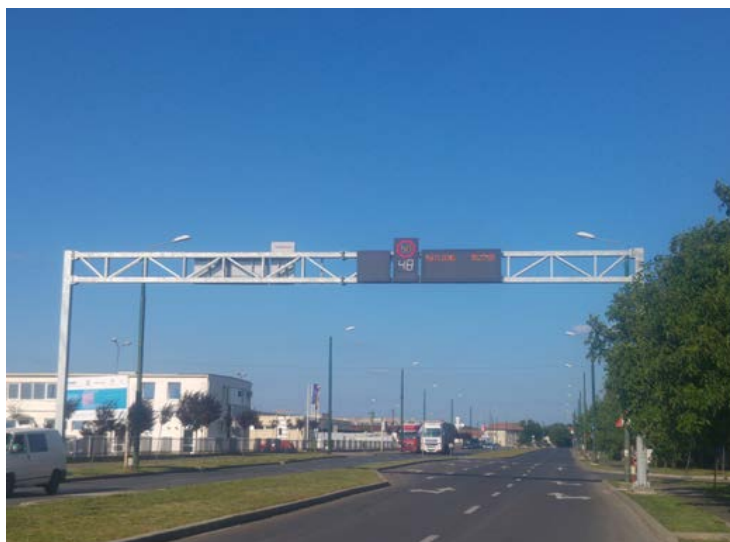
Figure 3-5 Example of a VMS in Timisoara (SWARCO Romania, 2017)

The system in Timisoara integrates all 134 signalized intersections in the city and 260 public transport vehicles that are monitored by the FLASH subsystem. All the information is collected and processed in the Traffic Control Centre.

Figure 3-6 Videowall in Timisoara Traffic Control Centre (Trafik Stockholm, 2017)

Between 2009 and 2013 the city of Cluj Napoca implemented an integrated traffic management system. The system covers 41 intersections and the main components are:

- Traffic Control Centre,
- Integration platform (OMNIA),
- Detection Subsystem (inductive loops and video cameras as virtual loops),
- Traffic Light Subsystem,
- Centralised Traffic Management and Control Subsystem (UTOPIA),
- Public Transport Prioritization Subsystem (FLASH),
- Video Surveillance Subsystem (CCTV),
- Communication Subsystem (fibre optics backbone) and,
- VMS passenger information system.

Craiova is another Romanian city which implemented a traffic management system. Its main components are:

- Traffic Control Centre,
- Detection Subsystem (inductive loops),
- Traffic Light Subsystem,
- Video Surveillance Subsystem (CCTV),
- VMS information system,
- Communication Subsystem (fibre optics backbone) and,
- Speed Enforcement Subsystem.

The city of Iasi has a traffic management system that covers 90 out of approximate 200 total intersections. Its main components are:

- Traffic Control Centre,
- Detection Subsystem (inductive loops),
- Traffic Light Subsystem,
- Video Surveillance Subsystem (CCTV),
- Communication Subsystem (fibre optics backbone) and,
- Speed Enforcement Subsystem.

3.1.5 Bucharest – Ilfov

The implementation of the traffic management system in Bucharest began in 2007. The total length of the Bucharest road network is about 1,800 Km on about 5,340 streets. At the present, an intelligent urban traffic management and control system, crucial for the purpose of easing traffic, reducing travel times, traffic jams, traffic events, and fuel consumption is covering Bucharest.

The project represents a unified and integrated implementation of three open systems:

- Adaptive Urban Traffic Control System,
- Emergency intervention vehicle management,
- Fibre optic communication network,
- Public Transport Management System and,
- Closed Circuit Surveillance System for Traffic Management (280 cameras).

The system was installed between 2007 and 2009. The monitoring equipment was installed in 240 traffic intersections. At present 140 intersections and 300 public transport vehicles have been modernized and integrated. The system relies on a fibre optics communication backbone that connects all equipment with the TMC. Inductive loops are used for traffic detection. The Municipality is planning to gradually expand the system in order to cover all approximate 400 intersections in Bucharest in the near future.

Figure 3-7 Videowall in Bucharest Traffic Management Centre (SWARCO Romania, 2017)

3.1.6 Stockholm County

In the region of Stockholm, Trafik Stockholm is one of the Swedish Transport Administration's four traffic management centres (Gävle, Gothenburg and Malmö) which run jointly by the City of Stockholm. It collects, processes and provides traffic information around the clock, all year round in the county of Stockholm (Gotland too). The centre is responsible for the delivery of information about the current traffic situation to the general public and other interested parties via radio, internet and mobile services. Moreover, the centre also handles calls reporting anything amiss on Stockholm's city streets, public squares and parks.

The aim of the operation is to deliver safer and more effective navigability on the roads and to reduce the environmental impact. Through different channels the traffic management centre gives information about, for example, stationary cars, traffic queues, accidents and objects on the traffic lanes. However, the traffic management system in Stockholm County remains subordinated to human decisions. A host of technical systems assist the Traffic Management Centre to monitor the traffic, but a traffic manager makes an initial analysis of the situation before the decision regarding action is taken. With the system's assistance, the traffic manager can even steer traffic by, for example, reducing the speed, closing traffic lanes, anti-skid measures or giving information about obstacles on the road via the variable message signs.

Trafik Stockholm dependent on good collaboration with their internal and external partners as well as their technical system for the collation of information regarding the traffic situation:

- SOS Alarm, police and the emergency services;
- Road and traffic reporters and road users who via telephone report disruptions in traffic;
- Technical equipment along the roads, e.g., cameras, sensors and detectors;
- Road maintenance contractors;
- The Swedish Road Administration's road weather stations which register the weather situation along the roads.

An advanced system facilitates traffic routes. In order to assist in the monitoring and management of traffic and to give information pertaining to the traffic situation Trafik Stockholm uses the National Traffic Management System (NTS), an advanced comprehensive operational support system. Monitoring of the region's traffic equipment is executed with the aid of this system.

The system facilitates the management of:

- Information for and cooperation with authorities, media and the public;
- Management and monitoring of traffic equipment such as barriers, signs and cameras;
- Management and control of Road Assistance;

- Receiving of alarms from technical equipment and management of the service group;
- Functional support for operators.

Alongside the roads there is a multitude of technical equipment which delivers information to Trafik Stockholm, for example cameras, queue warning systems and road weather stations which among other things register the temperature of the lanes. The information is sent to the General Communication Platform (GCP), which is the Swedish Transport Administration's own broadband network for data, image and sound communication.

Figure 3-8 Trafik Stockholm Road Traffic Management Centre (Halvorsen, 2011)

The City of Stockholm's Operations Centre which is located in the premises of Trafik Stockholm handle calls relating to:

- street lighting,
- refuse collection,
- snow clearance,
- traffic signals and traffic markings damage to streets and roads, including cycle paths and paths,
- public toilets,
- graffiti,
- taking care of injured animals,
- damaged trees and planting,
- parking metres,
- lifts and escalators,
- flooding, and
- parking permit applications.

The total road network in Sweden amounts to over 220,000km of roads, where total length of network in Stockholm is around 7,630km. In terms of number of number of surveillance cameras, in Stockholm there is a total of 1500 cameras (including tunnel system), but Trafikverket is currently adding more. Regarding number of speed radars in Stockholm, there are 161 speed radars, and during 2017-2018 there will be another more 135 speed radars installed (source: https://mitti.se/nyheter/trafik/karta-ska-fartkameror/).

The Swedish National Road Database (NVDB) is a result of an assignment the Swedish Road Administration got from the government in 1996. NVDB is a national road and vehicle database, containing up-to-date information about, for example, road-coordinates, functional road class, speed limit, number of lanes and road width. A parallel database includes measured traffic volumes on state-owned roads, while traffic volumes on municipal roads have been simulated with a traffic demand model. NVDB results from a collaboration between the Swedish Transport Administration, the Swedish Transport Agency, The Swedish Association of Local Authorities and Regions, forestry and Lantmäteriet.

NVDB has an ICT-Transport program called Intelligent Speed Assistance – ISA, which is an in-vehicle system that supports drivers' compliance with the speed limit, using information on the position of the vehicle in a network in relation to the speed limit in force at that particular. This program is based on the principle of ITS which is seeking contributing to a cleaner, safer and more efficient transport system, according to Plan – Action area 1: Optimal use of road, traffic and travel data. In Figure 3-6 the NVDB dataflow transport information is presented, while in Figure 3-7 are shown the services that are available.
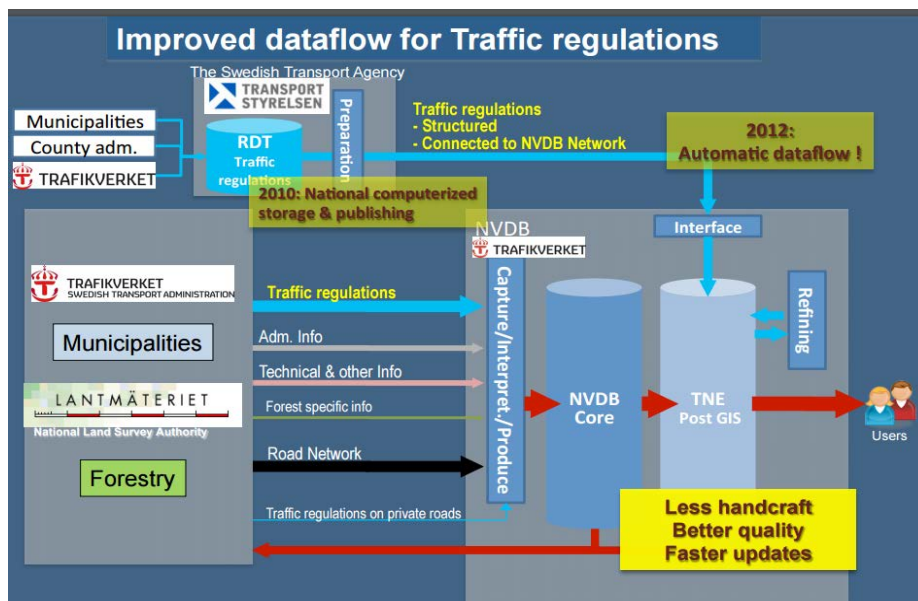
Figure 3-9 NVDB dataflow transport information (Halvorsen, 2011)
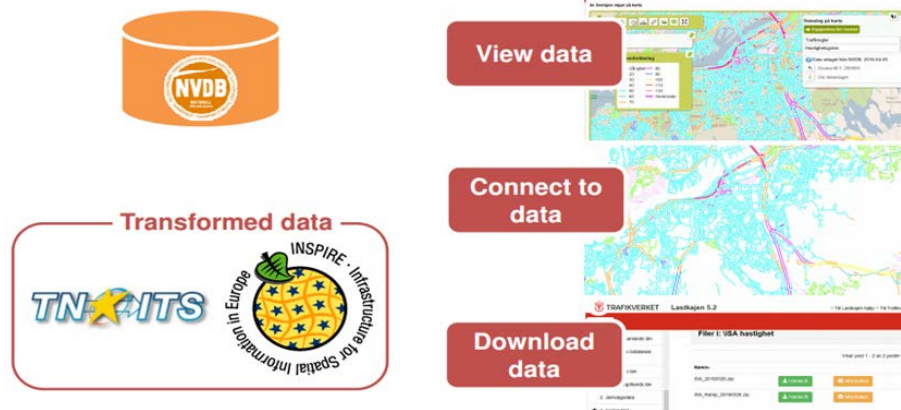
Figure 3-10 NVDB Interface (EEA, 2015a)

3.2 Advanced Traveller Information System (ATIS)

ATIS main aim is to provide real-time information to the commuters to improve their travel experience Trip information helps travellers and drivers in making better decision and contributes in travel time savings, mitigating congestion, reducing CO_2 emissions and relieving urban environments (e.g., Multimodal Journey Planners, Real-time Passenger Information, etc.).

3.2.1 Centro Region

In Centro Region, there are traveller information systems using VMS, but almost exclusively installed on motorways. There are also VMS located in the mountain "Serra da Estrela" providing information about road conditions, especially due to snow conditions.

The journey planners offering the most relevant information for Centro Region travellers are Google Maps, HERE maps, WAZE, bing maps and viamichelin. These route planners provide information on traffic conditions and toll costs, but limited information about public transport which is mostly focused on trains (such as on google maps). Multimodal route planners, such as rome2rio.com, provide information about car sharing opportunities and regional intercity coach routes. However, these platforms do not provide information about last mile travel solutions, such as connections with local public transport.

There is also routing platforms focused on soft modes such as cycling. In bikemap.com website, cycling routes can be created by users on online maps according to their own criteria, imported as GPS files or recorded with the mobile app. In July 2017, more than 2000 bike routes in Centro Region have already been registered on bikemap.

3.2.2 Águeda

In Águeda, there are available two main categories of ATIS:

- single mode or multimodal journey planners and;
- public transport passenger information systems according to each private company (train or bus).

Google Maps has public transport information for several Portuguese cities and it offers multimodal (train and public transport) journey planning between cities.

Given the heterogeneity and geographical dispersion, as well as the profile of the population, the Municipal Authority of Águeda faces bottlenecks with regard to the use of public transport instead of private motorised transport, motivated by the fact that transport network is structured according to school and services timetables, concentrated in the city. The issue is compounded by existence of a single bus operator - TRANSDEV, SA, and a train operator - Caminhos de Ferro Portugueses (CP) - which operates the railway line that connects Aveiro to Espinho (Vouga Valley Railway Line) offering 20 daily connections (10 in each direction).

3.2.3 Extremadura

In the region of Extremadura, information panels have been installed, designed to inform both the traffic conditions on the roads and the weather conditions. These panels give alarm messages, speed limits, danger messages and general information.

3.2.4 Romania

In Romania, there are available three main categories of ATIS:

- traveller information systems using VMS on motorways and city roads,
- single mode or multimodal journey planners and,
- public transport passenger information in vehicles and/or stops.

The journey planners that offer the most relevant information for Romanian travellers are Google Maps, HERE maps and transporturban.ro. Google Maps (maps.google.ro) has public transport information for several Romanian cities and it offers multimodal (train and public transport) journey planning between these cities. HERE maps (wego.here.com) does not have public transport information in cities therefore it only offers journey planning by train or car between different cities. The local private application transporturban.ro offers public transport journey planning for 12 Romanian cities, including Bucharest. Public transport passenger information systems in vehicles and/or stops are implemented in Timisoara, Cluj Napoca and Brasov.

3.2.5 Bucharest – Ilfov

In the region of Bucharest – Ilfov the main public transport options are trams, trolleybuses, buses and metro.

The metro is operator by the company Metrorex and its network is only within the city of Bucharest. Trams, trolleybuses and busses are operated by the company RATB. Most of their network is within the city of Bucharest but there are some bus lines that extend towards Ilfov county (map in Romanian available here http://ratb.ro/maps1/PREORASENESTI.pdf).

Travellers can use the services of Google maps and HERE maps which have good information about the (static) timetables and routes of both surface transport (tram, trolleybus and bus) and metro. The application transporturban.ro can also be used to plan journeys based on routes and static timetables of surface transport and metro.

On the Metrorex website there are available static timetables here http://www.metrorex.ro/program_skedule_in_working_days_p1379-2 and on the same page also a route calculator is available.

The timetables for the surface transport operator RATB can be found on their website like for example here http://ratb.ro/eng/v_tramvai_eng.php.

3.2.6 Stockholm County

In the county of Stockholm, to improve journey planning for road users, variable message signs are placed above the carriageways that can be used to advise drivers to reduce their speed or change lanes. Other digital signs give information pertaining to road work or closed roads. Trafik Stockholm updates the information with messages relating to imminent events.

Journeys can be planned with the help of current traffic information. Trafik Stockholm conveys traffic information to road users and partners through various channels; mobile services and websites, Swedish Radio and via several commercial radio stations, text TV and navigation systems with a built-in TMC receiver. Thanks to modern technology inhabitants can plan an efficient journey and obtain free of charge road and traffic information via the above-mentioned sources. It is even possible to subscribe to this information via mobile services. During the journey users are kept up-to-date with the traffic situation via radio, mobile phone, palm computers, GPS with RDS/TMC-receiver and variable message signs.

Trafik Stockholm closely collaborates with several radio stations who inform the motorists about the situation on the conurbation's network of roads. Moreover, TV4 Stockholm sends traffic report directly from Trafik Stockholm every weekday morning. Trafik Stockholm even conveys traffic information to a total of seventy service providers (companies who convey traffic information services under their own name) who publish over the internet or through mobile services.

Trafiken.nu is a web and mobile service run and developed by the regions of the Swedish Transport Administration together with the municipalities and public transport companies. There is possible to see a nationwide summary of the traffic situation with maps, text reports and photos as well as skid forecasts during October-March. Additional information is obtained from the CCTV-cameras, lay-bys and weather stations and from the travel planners for county traffic and flights. In the website, there is even a travel planner where travellers

can compare different travel alternatives in order to find the quickest means of travel, as well as the most environmentally-friendly means of travel. The service currently exists for Skåne, Göteborg and Stockholm.

Regarding Stockholm County, the service gives an overall, accessible and current picture of the traffic situation. Users can make more intelligent choices and enjoy more comfortable journeys - regardless of whether they travel by car, bicycle, public transport or a combination of transport modes. Much of the information on Trafiken.nu is based on open data, digital information that is freely available to everyone. In the service, road users will find information about:

- Current traffic speeds on different roads and highways;
- Any disruptions in public transport services;
- Road works;
- Where traffic accidents have occurred and how this affects the rest of the traffic;
- Road and weather conditions;
- Cycle routes and maps;
- Parking facilities.

In Trafikverket website (Transport Administration), road users can through APIs (Application Programming Interface) retrieve dynamic information about road and rail traffic. Trafikverket has data that users may find useful, because they operate and manage databases where digital information of roads, railways and ferries are collected and develop apps, and other services. Trafikverket offer both open data and master data that users can use to develop new services. Open data is free to use while the basic data required agreements and licenses. The goal is to collect all the data in one place and make them available and searchable. They want to support the development of market information in the transport sector by making it easier for those who want to download their data and documents. For example, it is possible to develop new services by compiling, processing and making that information searchable. This in turn can result in positive economic effects.

Lastkajen is an application where you can order and download the road and rail network related data. Road data contains both a model of the road network, and information which describes properties of the road network. The same for train data. The information can be used in many fields. This can include route planning, transportation planning, traffic safety, environment, operation, and maintenance or to analyze transportation facilities. Data is retrieved from the Swedish Transport Administration systems Lastkajen. There is no charge to download the data from Lastkajen and you can either choose to download the complete package or self-compose own files.

From Stockholm's city open data portal (http://dataportalen.stockholm.se/dataportalen), users can download many different types of open data sets with associated metadata and access descriptions that are provided since 2011 related to:

- cultural and archive data,
- population data,

- traffic and parking data,
- environmental data, activities and satisfaction surveys and finally,
- geodata.

The traffic data includes road and traffic related geodata City of Stockholm gathers for traffic planning, maintenance and engineering. The types of information are:

- Traffic and road data (WMS / WFS): http://openstreetgs.stockholm.se/Home/Gs
- Traffic and road data (SOAP): http://openstreetws.stockholm.se/Home/Ws
- Parking Data: http://openparking.stockholm.se/Home/Parking.

Trafiklab is a community for open traffic. A place that developers can share data and APIs for public transport in Sweden and easily get the information users need to develop sharp services. Trafiklab also want to make it easier for users to show off what they have done and to get inspiration from what others have already created. Trafiklab built in cooperation with Samtrafiken, Stockholm Transport and Victoria ICT (by research ISET). They interconnect the Swedish public transport companies through services ResRobot and Resplus. Through their APIs, they offer access to all of Sweden's public data.

SMHI, the Swedish Meteorological and Hydrological Institute, is an expert agency under the Ministry of the Environment and Energy. Through unique expertise in meteorology, hydrology, oceanography and climatology, SMHI contributes towards greater public welfare, increased safety and a sustainable society. They also have a specific service for Roads and traffic. SMHI's winter road maintenance package will ensure to drivers are prepared for icy conditions and help them make plans so that they can take the right action at the right time. To prepare for snow and icy conditions on the roads, SMHI is able to assist drivers with relevant forecasts and maps several days in advance and through consultation with our experienced meteorologists. SMHI can provide radar information every 15 minutes relating to areas of precipitation. SMHI's forecasts are available 24 hours per day, 365 days per year.

3.3 Advanced Public Transportation System (APTMS)

Advanced Public Transportation System is concerned with managing and controlling traffic by using real-time information to optimize the vehicles flow and is usually used by traffic police department and traffic regulation authorities. These systems seek to manage congested traffic situations by improving the efficiency of utilization of existing infrastructures (e.g., Automatic Vehicle location, Fleet Control Management, Smart ticketing).

3.3.1 Centro Region

The provision of real-time information on the service and real-time public transport timetables through monitors is mainly found in the train stations (Northern Line - CP) and at inter-city bus stations. As far as urban transport is concerned, this information is practically non-existent in almost all the territory of the Centro Region, with the exception of some cases such as the Municipal Urban Transport of Coimbra (SMTUC).

Figure 3-11 Left: Real-time transit information in Train Station Cacia and Right: Coimbra Urban Bus Stop with real-time information (SMTUC.pt, 2017)

According to Civitas 2020 "Coimbra developed a new GPS software that improved real-time travel information available to public transport users and also provided information through mobile phones and other devices. The new system is able to update information displays on bus stops within less than a minute. It also allows more than four items on arrival times of public transport vehicles at bus stops. The new system also has greater capacity to monitor a higher number of vehicles in real-time. It has the capability to provide real-time travel information via SMS. Coimbra also has prepared the system for a future integration with a new traffic light regulation system which gives priority to public transport. Especially relevant is the purchase of 5 new e-panels for interiors with real time information about the bus transit time at the bus stops adjacent to the main hospital of Coimbra (as one of the actions included in the mobility plan SanusMobilis for the health cluster – CIVITAS MODERN measure 04.05)

The demonstration of the measure achieved positive impacts over (passenger numbers and therefore in) the average operating revenues, operating costs, the percentage of trips lost due to traffic problems, the average network speed, and the awareness level of the PT users in a relatively short period of time. More precisely, the e-panels have a refresh frequency rate lower than 1 minute and the SMTUC commercial speed was increased by 2,4%. The results obtained in relation to the Cost Benefits Analysis (CBA) suggest that the measure is both effective and efficient in achieving positive results in terms of cumulated costs not only in lifetime of the measure (11,7M € in 10 years) but since the year of its implementation. Also, more than half of the investment will be covered in 10 years only with the decrease of the costs. In the framework of the OP CENTRO 2020 PI 4.5, 477 00 EUR of funding have been approved to support the implementation of the second generation of SMTUC BUS system information in real time.

The new ticketing system constitutes a technological innovation, which will allow for the creation of a transportation pass for the citizens of Coimbra and the surrounding municipalities to use SMTUC lines without extra charge. Significant energy savings due to the assessed reduction of the energy consumption per passenger (-0,24 MJ/pkm). The system generates a positive impact on CO_2, NO_x, and PM emissions with a decrease of 17,081 g/pkm, -0,698 g/pkm, and 0,03 g/pkm, respectively (civitas.eu).

Finally, in the city of Aveiro, Urban BUS lines deploy a system that provides information to passengers about vehicle location in real-time.

3.3.2 Águeda

The Transdev - Collective Passenger Transport, which operates in the municipality of Águeda have a recent app called "myTransdev" available in the Play Store and Appstore for Android and iOS smartphones.

In this app, users can easily and quickly check the times of the lines operated by Transdev in Portugal. They can also search for times by selecting the origin and destination stops and the date of the trip, know next vehicle to stop at and the course of the various lines.

All the information is organized by CIC (Customer Information Centers), and Águeda belongs to the Aveiro CIC.

Transdev is one of the largest public transport operators in Europe with a reputation for delivering high quality local public transportation.

3.3.3 Extremadura

The city of Cáceres already has a free mobile application called Cáceres Bus that allows passengers to have all the information of bus public transport. This is an easy-to-use, agile and intuitive app with information on bus stops, bus travel time, bus time to the stop and information of any incidence that may occur. Also, SuBús app can have information about which stops are closest to you. In addition, one of the most comfortable features offered by the app is based on an alarm system that can be configured not to miss the bus. In addition, the map is integrated with Google Places, which will provide information on activities in the area. From the billboard of the cinemas to monuments, government buildings, fashionable places and much more. The app also includes a QR code reader, which will enable to read the ones that are ready at the stops and get all this information quickly. In addition, the app calculates how much CO_2 is being saved to the Environment with the decision to move around the city by bus. Other cities have similar services like Badajoz city.

3.3.4 Romania

In Romania, APTMS systems are implemented in Bucharest, Timisoara, Cluj Napoca and Brasov. Several LED passenger information displays in airports, railway stations, bus and tram terminals. Concretely, the tools display flight, platform, tram and bus route numbers with destination and arrival/departure information in real-time.

For instance, in the city of Ploiesti, Romania, the public transportation company RATPP provides connections throughout the city for a daily average of 300,000 passengers. It operates approximately, 62 trams, 193 buses and 10 trolleybuses. Real-time passenger information tools have been seen as a way of improving the quality of public transportation, boosting public confidence in the system and increasing passenger numbers. In Romania, more than 28 LED panels of VMS have been installed at the busiest interchanges. The

system was integrated with a new information management system, a new ticketing system and the acquisition of GPS equipment (169 units, entirely equipping the city's 35 routes).

3.3.5 Bucharest – Ilfov

In Bucharest, Regia Autonoma de Transport Bucuresti (RATB) company provides public transport services all over the city by trams, trolleybuses and buses. It has an inventory fleet of 1930 vehicles, which run on a network of 471 km double way, from 20 depots and garages for RATB's trams, trolleys and buses. Through the last years, RATB have implemented passenger information system (utilizing LED panels) in order to augment the quality for passengers. Most vehicles are equipped with LCD panels for providing information for the passengers and surveillance system. Information offered to the passengers on the LCD screen inside the vehicle includes the real-time position of the vehicle on a map; the estimated time to the next stop and to the terminus; the name of the next stop and the terminus; the names of the streets forming the junction.

3.3.6 Stockholm County

SL (Storstockholms lokaltrafik), the company Stockholm Transport, is responsible to make extensive, accessible and reliable public transport using bus, subway, commuter trains, trams and certain ferry lines in Stockholm county. It is the Stockholm County Council, which is responsible for procuring public transport in Stockholm.

The following points are some examples of the penetration of ICT's in the public transport in Stockholm County:

- Planning tool online: The easiest way to plan a journey in the public transport in Stockholm county is using the planning tools on the homepage, where users can choose between real time departures if you are on the go now, or scheduled departures if they want to plan ahead. This is possible for the different modes of transport;
- Transport accessibility: There are digital information displays on all buses, in recent model Metro carriages, on Nockebybanan, Tvärbanan and City trams, and in the new commuter trains, showing line information and the name of the approaching station; There are digital information displays and automatic service announcements in bus terminals and at frequently used bus stops;
- Tickets for journeys with SL: In order to travel with the SL services user will of course need a ticket. There are tickets and travel cards for short and longer periods of time. Nearly all tickets are loaded on an SL Access card, which is an electronic smart card. Users need to pay a fee of 20 SEK for the card itself, but they can re-use their card at future visits to Stockholm. There are single use travel cards with tickets valid 75 minutes, 24 or 72 hours. User must place their travel card or SL Access card on the card reader at the automatic barriers in the Metro and at the commuter train stations, the blue card readers on board the buses or the blue card-readers on poles placed on tram and light railway stops as well as at some commuter boat jetties. It is possible to buy tickets via a smart phone app or as a text message from mobile

phone (but users must to register for this service). User must to download the app from App Store or Google Play, it's called "SL-biljetter". The app is free of charge;

- Refund for delays and disruptions: If users run a risk of being delayed by 20 minutes or more, they are entitled to a refund for a taxi journey of a value of up to 1110 Swedish kronor. They can also receive a refund for tickets with another transport service provider, if there is another service for the route they are taking. This is a clear example of the performance management system of the public transport fleet in Stockholm County, according to the demand of passengers and the rush hours during the day. Therefore, SL provide information about disruptions in Swedish in the whole transport public system;

- Research and innovation in public transport: Traffic management interact with the research community to conduct research and innovation in areas that are important for developing the future of public transport. Traffic management cooperation in research and innovation priorities based on six focus areas. These are traffic, infrastructure, business, sustainable development, communication, and customer service;

- Sustainable development in public transport: Sustainable development is a priority in public transport vision and goals. Ecologically, socially and economically. Attractive, accessible and efficient travel sets the framework for the development of public transport.

The key sustainability issues in which the county council's traffic management focused are:

- Attractive travel: The more people travel with SL-transport instead of by car, the less local environmental impact, noise and congestion;
- Emissions: SL rail driven 100 percent by electricity from renewable resources such as water and wind driven bus and to over 99 percent of renewable fuels. Traffic management's goal is to stop using fossil fuels by 2030;
- Noise: Traffic management is working systematically to prevent and reduce noise in rail and bus traffic, as well as the track work, expansions and custody operations. In the procurement of new vehicles are also requirements for noise emissions;
- Energy-intensive operations: The County Council uses large amounts of energy to operate public transport. It is important to conserve energy because it means both lower costs and reduced environmental impact. Traffic management can make a big difference by demanding and environmentally sound vehicles and vessels operating in public transport.

3.4 Emergency Management System (EMC)

Emergency Management Systems are valuable tools to deal with emergency situations in roads, as its main focus is to develop a safer transport system. The use of EMS applications can result in improved management of the emergency, as it provides the ability to transport authorities and health services to communicate and coordinate operations and resources in real-time (e.g. Automatic Vehicle location (AVL), Automatic Incident Detection (AID), ITS

road safety and security applications, etc.). Automatic incident detection systems are especially used for road safety since they permit the real-time detection of anomalous situations, which is a decisive contribution to the activation of emergency procedures and prevention of accidents, avoiding potentially dangerous situations. These systems are effective in detecting:

• Congested traffic,

• Vehicles moving in opposite direction,

• Standing vehicles,

• Drop load,

• Improper circulation of people.

Automatic vehicle location systems are tools conceived to provide position information with relatively high accuracy, which is commonly achieved using GPS technology. Many AVL systems are employed to track and manage fleets such as buses, taxis, and delivery vehicles.

3.4.1 Centro Region

Many Centro Region highways are equipped with AID systems installed in specific locations where incident are more likely to occur (ascendi.pt). The Automatic Vehicle Location is implemented in medical emergency vehicles (INEM – Instituto Nacional de Emergência Médica | National Institute of Medical Emergency), Portuguese Firefighters and in some public and private vehicles used by entities. INEM has equipped all ambulances, including those located in fire stations, with an information and geo-referencing system, which includes GPS, to improve the access time of relief to the citizen. In what concerns the Portuguese Firefighters the SIRESP GL system allows the use of communication radio voice used by firefighters to communicate the position on the ground, allowing real-time monitoring of the vehicles and teams location.

Figure 3-12 Image of the SIRESP GL system|Castelo Branco (Reconquista, Semanário Regionalista da Beira Baixa, 2016)

3.4.2 Águeda

In Águeda, all the e-bikes have a GPS system and are monitored, the number of kilometers and the travel circuit are registered, and the availability of each bike is known and available on the project website (beÁgueda).

3.4.3 Romania

In Romania, traffic management systems implemented on the motorways include an Emergency Managements Sub-system. Also, at national level, Romania is an eCall ready country. This means that the national 112 system is capable of receiving and processing eCall messages. The 112 system is managed by the Special Telecommunications Service in a national Control Centre. This centre would receive the eCall message and then direct the responsible authorities to intervene.

3.4.4 Bucharest – Ilfov

The national 112 system dispatches the police, ambulance and other rescue services that operate in the administrative area of Bucharest – Ilfov in any emergency, including traffic incidents/accidents. Also, when the eCall system will be introduced, it will also operate within the area of Bucharest – Ilfov.

The city of Bucharest also has a CCTV monitoring system integrated in the Traffic Management Centre. Together with the operators there are also police officers who would trigger an intervention in case an incident is observed.

3.4.5 Stockholm Country

In the region of Stockholm, the NTS makes it possible for Trafik Stockholm to monitor traffic around the clock, 365 days a year. Surveillance of tunnels and traffic routes in Stockholm is carried out with the aid of cameras, sensors and detectors through filming and registering the traffic flow. With the help of cameras, the traffic controller can zoom in on objects or accidents obstructing the traffic lanes in order to be able to dispatch the relevant emergency service: call Road Assistance, ambulance service, the police, close traffic lanes, reduce speed limits etc.

Moreover, all technical safety equipment such as electrical, cable, control or ventilation installations in the road network is monitored. In the event of the slightest defect in the system, for example, inaccurate values or malfunctioning technical installations, a call is made to Trafik Stockholm and the problem is rectified. The tunnels currently being monitored are Södra Länken, Norrortsleden, Eugenia tunnel, Muskö tunnel and Klara tunnel.

The operational engineers handle the operational surveillance of road tunnels and other technical installations within the area of the roads such as electrical, telecom, cable, ventilation and control as well as pump stations. They handle incoming alarms, analyse the seriousness of the incident, and forward calls reporting faults to the relevant contractor to ensure that the fault is rectified as quickly as possible. To maximise safety, Trafik Stockholm has its own power station in order to keep the technology operating even in the event of a

power cut. In addition, the operational engineers control and coordinate Together with the traffic controllers to make decisions regarding the closing/opening of tunnels. The engineers even participate in the planning and construction of new tunnels to increase safety for road users.

All tunnels in Stockholm County have a host of built-in systems pertaining to, for example, control, security, telecom and traffic. All systems in tunnels are communicated with each other as well as with Trafik Stockholm via GCP. In the event of operational malfunctions or disruptions the local monitoring system automatically sends an alarm to Trafik Stockholm which ensures that the problem is rectified. Along the main traffic routes, for example Essingeleden and Södra Länken, there are stationary and mobile cameras. The stationary cameras are supported by a sophisticated technology that continuously reads and analyses the images, sounding an alarm at any disruption in normal traffic pattern, for example a stationary vehicle. These cameras fulfil an important function for the extensive surveillance of tunnels. The mobile cameras are Trafik Stockholm's instrument for the confirmation of different traffic incidents, for example an automobile accident.

On the portals above the carriageways, primarily in the tunnels and on the trafficked routes, there are automatic traffic queue warning systems, activated by sensors that register the speed at which traffic is moving as well as where the queues start and end. The technology is connected to variable signs which are controlled either automatically or manually from Trafik Stockholm. Through the signs drivers are advised to slow down and/or change lanes in the event of, for example, heavy traffic or an accident. In certain cases barriers are used to control the traffic.

Trafik Stockholm has a surveillance system for traffic signals. If they are out of order a call is sent to the Traffic Management Centre so that action can be taken with the aid of a contracted technician. The Swedish Road Administration or the Traffic Office of the City of Stockholm is primarily responsible for repairs and maintenance.

Several weather stations have been installed in and around Stockholm to measure the air and road surface temperature, wind velocity and atmospheric humidity. A camera is used to monitor any changes in the road conditions. This system, combined with information obtained from SMHI (Swedish Meteorological and Hydrological Institute) enables Trafik Stockholm to provide highly accurate information on how and when different weather situations will affect the road conditions, and thereby traffic. The information even forms the basis for the planning of road preparations.

In Stockholm, there are a number of Road Assistance cars working with the prompt and effective removal of traffic hazards and disruptions. The assistance vehicles are fully equipped to be able to offer rapid assistance at minor breakdowns, provide fuel for empty tanks and remove traffic hazards. The assistance is free of charge and the benefits for society are huge. Vehicles are always on hand in the vicinity of Södra Länken in order to ensure good safety in the tunnel system. Road Assistance is directed by Trafik Stockholm.

4 Environmental and Urban Activities Patterns Monitoring

In this section, information concerning environmental and urban activities patterns of CISMOB regions is provided.

4.1 Urban Activity

Monitoring and understanding human mobility and activity patterns is a key factor of transport policy and planning. Information and data on travel activities can be used to estimate transport demand and traffic related-impacts. The deployment of Information and Communication Technologies (ICTs) in transport sector creates a wide range of new spatio-temporal data sources that is possible to be acquired from cell phone traces or from applications like Google Maps (Popular Times), Foursquare or Twitter and become a valuable input for researchers and policy makers.

In Romania Google Maps (Popular Times) is available for a number of shops and restaurants in several cities. There are no other similar implementations.

In Sweden, there is a Strategic Innovation Program launched by the Swedish government, called Drive Sweden, that gather information in the transport sector, specifically automated transport systems, that use ICT's to monitor the activity patterns of urban transport, as a means to improve road safety, adaptation of infrastructure and legislation that needs updating. They work for new, smart solutions, also to enable flexible goods deliveries in cities. Large areas that are currently used for parking will become available for activities that contribute to increased quality of life. In parallel, the transportation sector will change its focus from products to services. This will open up for new business models and diminish differences between people. The Drive Sweden innovation program started in the spring of 2015. It is funded by the Swedish Energy Agency, the Swedish Research Council Formas and Sweden's innovation agency VINNOVA. Lindholmen Science Park is the host for the program.

Lastkajen, allows the users to create their own services (app), which can be share with other users in a retrieve dynamic information process. The main source of information is the database of Trafikverket. Here, it is possible to develop location-based check-in services where the users can share their activity-related choices in the transport system of Stockholm, and analyse the data collected to make optimal choices according their location and planning travel.

4.2 Air Quality

According to "Air quality in Europe – 2015 report" (EEA, 2015a), transport is among the major contributor to Europe's air pollution. Despite the significant reduction in terms of Carbon Monoxide (CO) or Sulfur Oxides (SOx) emissions, Nitrogen Oxides (NOx) and Nitrogen Dioxides (NO$_2$) emissions decrease did not reach air quality standards in many circumstances. transport sector is the largest contributor to NOx emissions, accounting for 46% of total EU-28 emissions in 2013 while it also contributed to 13% and 15% of the total PM10 and PM2.5 (Particular Matter) primary emissions, respectively.

In this section, information and data about air quality and air pollutant concentrations in CISMOB Regions are provided. Available air quality index or other forms of sources are presented in detail. The countries that are represented from CISMOB Regions as members of the European Union are required to transpose EU regulations into national law.

4.2.1 Centro Region

The coordination and Regional Development Committee of Centro Region (CCDRC) has in its area of jurisdiction of 9 air quality monitoring stations belonging to the national Air Quality Measurement Network. In view of the need to assess air quality throughout the Territory, in order to comply with Decree-Law no. 102/2010, of 23 September, were delimited in the Centro Region three and two agglomerations (Coimbra and Aveiro/Ílhavo). Figure 1 shows the delimitation of the zones and agglomerations of the Centro Region, as well as the monitoring stations installed.
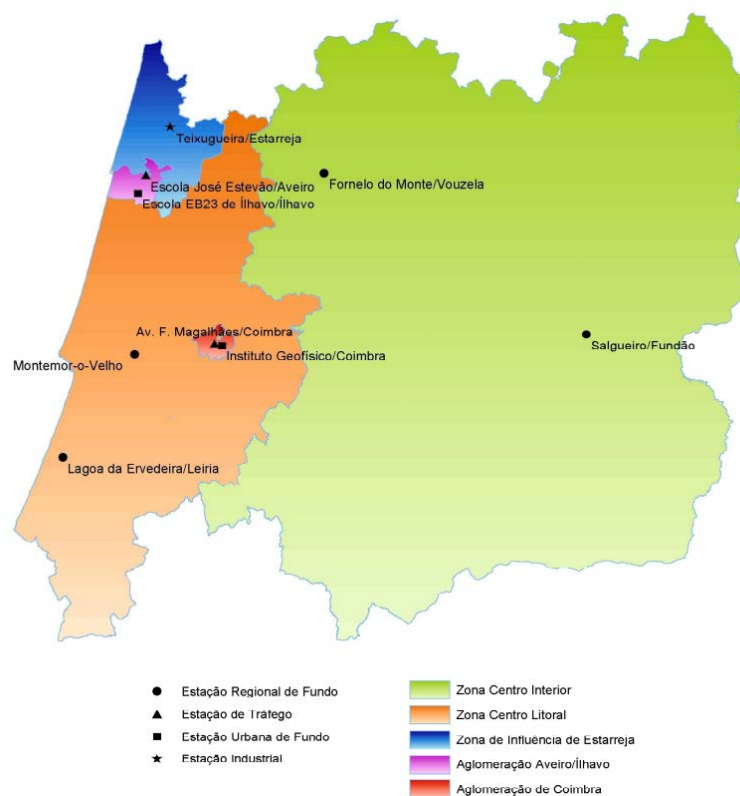
Figure 4-1 Position of the air quality monitoring station in Centro Region (ccdrc.pt)

4.2.2 Águeda

The municipality of Águeda carried out a campaign to monitor several gases and suspended dust in an environment for 7 consecutive days, along with housing located in the Northwest and Southeast of the Casarão Business Park. In 2016, three sensors were installed in the city of Águeda to monitor various parameters of air quality (NO; NO_2; CO; O_3; PM2.5; PM10; CO_2 e SO_2). The Municipality continues to install a sensor network to measure various parameters of air quality throughout the county, covering rural, urban and industrial areas, and areas where there is a large road flow. In particular, the three sensors have the following features:

Sensor 1 Location: 1º de Maio Square	Measurements: Temperature, Humidity, Atmospheric pressure, NO, NO_2, CO, O_3, PM1, PM2.5, PM10. Measuring frequency: every 15 min
Sensor 2 Location: Conde Sucena Garden	Measurements: Temperature, Humidity, Atmospheric pressure, CO_2 and SO_2. Measuring frequency: every 15 min
Sensor 3 Location: Conde Sucena Garden	Measurements: Volatile Organic Compounds Measuring frequency: every 15 min

Figure 4-2 Location of the sensors in Águeda (Google Maps).

This sensors network will consist of 11 sensors and aims to monitor air quality throughout the county and provide information to the public on air quality, as well as issue alerts when air pollution values exceed the limits.

4.2.3 Extremadura

REPICA (Red Extremeña de Protección e Investigación de la Calidad del Aire) is an instrument for the protection of the population and the natural environment of Extremadura against possible phenomena of air pollution that could threaten the quality of the air and to inform the citizens. It is designed and managed by the Extremadura Regional Government (Directorate General for the Environment from the Regional Ministry of Environment and Rural Affairs, Agrarian Policies and Territory) with the collaboration of the University of Extremadura.

The objectives of REPICA are:

- Evaluate the air quality based on physical-chemical and meteorological parameters;
- Inform the population about the state of air quality;
- Maintain an alert system for potential episodes of air pollution;
- Preventing negative developments in air quality;
- Promote research and knowledge in relation to air quality.

This Network is created to comply with the European Directive 2008/50.

The most prominent items of the project were:

- Six remote stations located in Badajoz, Cáceres, Mérida, Zafra, Plasencia and Monfragüe National Park, with:
- Two mobile stations (with the same equipment of previous stations), allowing air monitoring in other towns or rural areas of the region over periodic campaigns;
- Eight weather stations;
- Three Information panels located in Badajoz, Cáceres and Mérida;
- Two laboratories;
- Two Control Centers located in SICE offices in Badajoz, and Extremadura Government Offices in Mérida.

The following website show data of the air quality in the different stations http://xtr.gobex.es/repica/Informes/datos.html# . All the information on the different

contaminants is registered such as pollution levels, legislation, as well as the explanation of each pollutant and its effects.
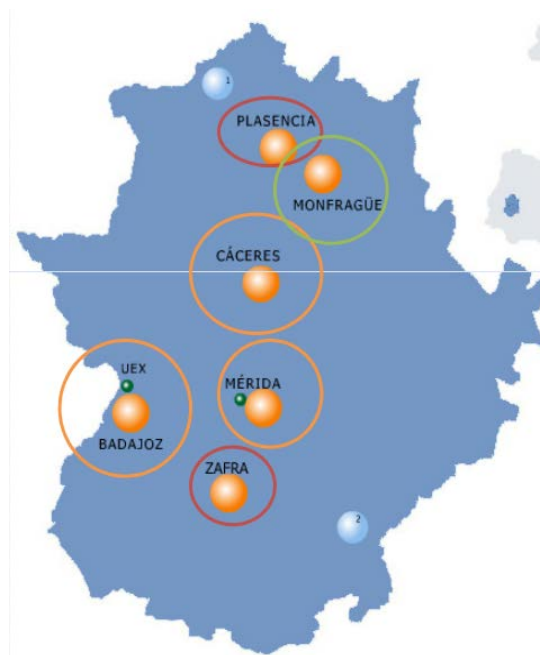
Figure 4-4 Position of the air quality monitoring stations in Extremadura (REPICA, 2017)

4.2.4 Romania

One of the main national targets of Romania is the improvement of the environmental quality of the country as high air pollutant concentrations in urban areas considered one of the major challenges of national environmental policy. The country has almost reached its targets regarding SO_2, while has also made a great improvement in terms of PM during the last decade (EC, 2017). However, air quality in Romania continues to cause concern. For 2013, the EEA estimated that about 25,330 premature deaths were attributable to concentrations of fine particulate matter, 430 to ozone concentrations and 1,900 to nitrogen dioxide concentrations (Manoiu, Gheorghe, & Craciun, 2016).

In Romania, the main legislative framework regarding air pollution is:

- Law 104/2011 transposing Directive 2008/50/EC into national legislation and setting the context under air quality assessment is performed.
- Ministerial Order 1095/2007 of the Minister for Environment, which defines the methodology for calculating air quality indices.
- Governmental Decision 275/2015, which defines the methodology for developing air quality plans, short term plans and plans for maintaining air quality.

Romania has a National Air Quality Monitoring Network, which consists of over 100 stations across the country. Measured values and computed indices based on real-time information are available to the public online in Romanian in http://calitateaer.ro .

4.2.5 Bucharest - Ilfov

The air in the capital of Romania, Bucharest, is one of the most polluted in Europe and the most polluted in the country with road transport being the main source of air pollution in the city (SLB, 2017). The municipality uses a mobile lab to measure periodically the pollutant levels of various emissions pollutants in 24 different locations and publishes the values and the calculated indices online in the below web addresses http://pmb.ro/institutii/primaria/directii/directia_mediu/date_de_calitate_aer.php and in http://pmb.ro/institutii/primaria/directii/directia_mediu/locatii_valori_mediu/locatii_valori_mediu.php (in Romanian).

4.2.6 Stockholm County

SLB-analys (Stockholm Air and Noise Analysis) is a department at the Environment in Stockholm responsible for monitoring air environment of the city. SLB-analys also operates a regional system for air surveillance on behalf of East Sweden Air Pollution Control Association. In addition to these activities are carried out consultancy in air quality and weather comfort. SLB-analys measures both the air pollution and meteorological parameters at a plurality of stations in Stockholm and outside (see the map below). The measured air pollution levels are caused in part by local emission sources: mainly road but also industries, energy and shipping. The levels are also affected by regional emission sources and the inward transport of polluted air outside the region and from other countries. Various meteorological conditions will determine how air pollution spread.

SLB measurements of air pollutants occur mainly in places that represent the general air quality (light air) or on particularly sensitive areas (e.g., trafficked street canyons).

The information is used among other things to:

- compare with environmental quality standards and environmental quality,
- get information about trends and content variations,
- verify model calculations and,
- monitoring impact of measures taken to reduce the health and environmental impact.

SLB-analys continuously measures the outdoor air in the city of Stockholm, but also in other municipalities in eastern Sweden Air Pollution Control Association. Measurements are also made on behalf outside the Air Pollution Control Association, and in different research and action projects. Below is a map of SLB-analys ongoing measurements.
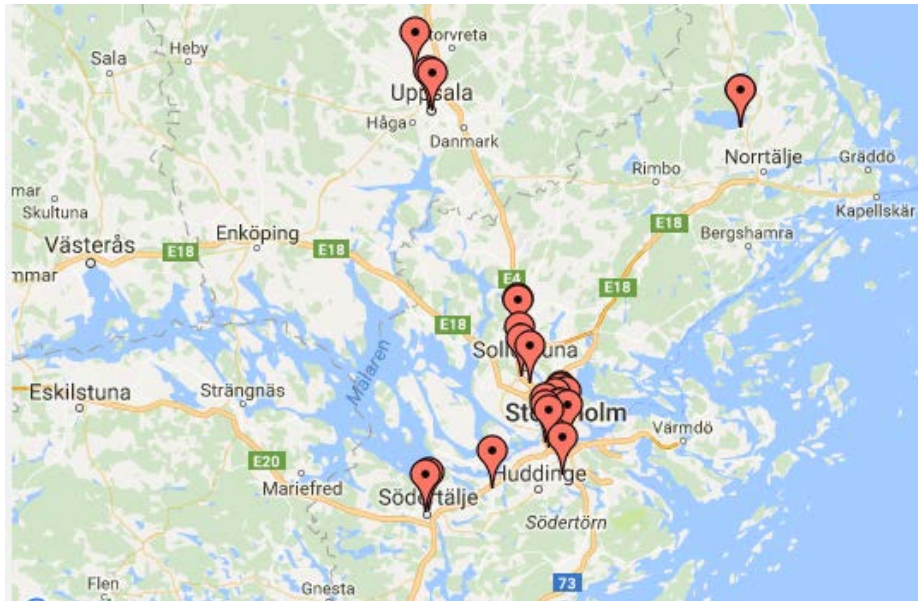
Figure 4-5 Map of the Location of SLB' Fixed Stations (SMHI, 2017)

Finally, SLB-analys use dispersion models to calculate the levels of some air pollutants at a particular place or a region. These models are: i) the Operational Street Pollution Model – OSPM, a street space model, ii) the three-dimensional flow models (CFD), and, iii) the Airviro gauss model from the SMHI. The last one, SMHI Airviro Gaussian dispersion model, is used to calculate the geographic distribution of air pollution levels two meters above the open ground. In areas with dense urban represents calculations levels two meters above the roof level. It is possible to see the information about environmental quality compared with standard values for the protection of human health (SFS 2010: 477). Each normalized value of the most difficult to cope with terms of daily averages and refers to short-term exposure at high levels. The graphics show the number of days with concentrations of PM10 and NO_2 over respective standard value. For NO_2 are also recognized in the number of hours over the standard value for the hourly average. As well as, the number of exceedances, summarized per year, for the previous two years, as a comparison.

SIMAIR-road is an Internet based system that helps municipalities, air control associations and other regional operators to quickly and cost efficiently assess the levels of regulated air pollutants in the surrounding areas around roads. SIMAIR-road use a coupled model system of different models for the local, urban and regional geographical scales, using the best available emission data, but presented in a very simplified way, as we can see in the next graphic.
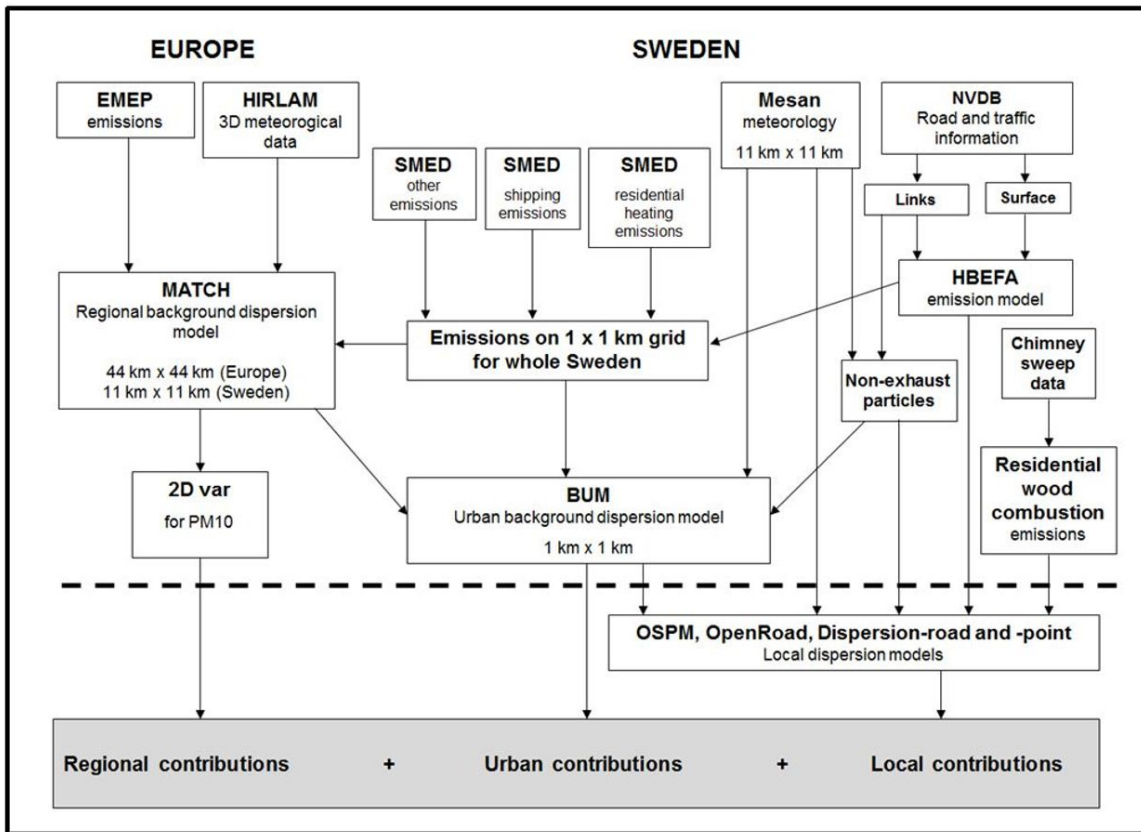
Figure 4-6 Simair - Model Description (Korzhenevych et al., 2014)

SIMAIR-road is used in the air quality control in municipalities and cities. The Internet based system works as a cost-efficient complement to measurements and as a tool in the physical planning. It is appropriate to use for evaluations of air quality in streets and near open roads.

SIMAIR-road shows a map of your municipality or city. All necessary information about meteorology, dispersion, concentrations from long range transport of air pollutants and urban background are already stored in the system. You can easily add data, if you have own measurements from the city. For each road link, information is stored regarding the amount of traffic, type of vehicles, width of the road, speed limit etc. from the Swedish Transport Administration's national road database. The user can modify the information for more precise model results.

The databases in SIMAIR-road are updated with data one year at a time. Scenarios for the year 2020 are available in the system. SIMAIR-road does not require an installation, you simply log in via your regular Internet browser. The results can be exported as images, shape, pdf, and Excel files.

The Swedish Environmental Protection Agency has data, databases and applications containing environmental data. The data is available in various formats depending on the subject area and is free to use. The Swedish Pollutant Release and Transfer Register, contains data on the quantities of certain chemical substances that large facilities emit

annually. This register is part of the Swedish Environmental Protection Agency's (hereafter the Swedish EPA) work of meeting the public's right to information about national emissions of pollutants. Reports on some 70 substances are included in the Swedish Pollutant and Transfer Register. The selection is based on international requirements for reporting on these pollutants.

The companies listed in the register require environmental permits under the Ordinance (1998:899) concerning Environmentally Hazardous Activities and Protection of Public Health and the Ordinance (2013:251) concerning Environmental Permitting. These companies' emissions of chemical substances are thus reviewed by a permitting authority, which issues individual permits stating the preconditions for emissions from the companies concerned. The Swedish Pollutant Release and Transfer Register of the Swedish EPA are available online at http://utslappisiffror.naturvardsverket.se/en/Emissions-to-Air/ with the last update dated in 2015. In that site, information regarding air emissions of a particular substance is publicly available. The presentation covers emissions both from diffuse sources, such as road traffic, and from point sources such as an industrial manufacturing facility. The emissions are shown by county or municipality. They are classified according to a grid in which every square measures 1x1 km.

The Swedish Environmental Emissions Data is the name of the consortium, in which the four organizations IVL Swedish Environmental Research Institute, SCB (Statistics Sweden), SLU (Swedish University of Agricultural Sciences), and SMHI (Swedish Meteorological and Hydrological Institute) collaborates. Since 2001, SMITH Air worked at the Environmental Protection Agency to develop, calculate and compile all data for both Swedish climate reporting to the UN Climate Change (UNFCCC) and the European Commission, as well as Sweden's reporting to the UN Convention on transboundary air pollution - UNECE CLRTAP. The latter also includes reporting to the EU directive on national emission ceilings for certain atmospheric pollutants (NO_X, SO_2, NMVOC and NH_3) - the so-called "Emission Ceilings Directive".

RUS is a link between regional, central and local environmental work. They show statistics about emissions of greenhouse gases and air pollution by county, municipality and the grid in Sweden reported on the Environmental Objectives Portal (data developed by SMED basis of national emission statistics on behalf of the RUS and the Environmental Protection Agency). RUS is responsible for the county government joint information and coordination between various stakeholders in the environmental system, including national authorities and municipalities. This means data across environmental mission, as well as follow-up goals and action work. This site is primarily for those who work with the coordination and monitoring of the environmental objectives of the county administrative boards and the National Board of Forestry. Other national and regional authorities and municipalities can find valuable information on the page. The site is also home to some data/statistics, especially for air/climate, which has a broader audience. RUS does not store data and statistics. However, it should be a support for the counties in the development of indicators, data flows, monitoring and coordination of this.

The Sweden's official emission data for air pollutants as well as forecasts up to 2030 are available in https://cdr.eionet.europa.eu (choice Sweden).

Finally, in Sweden the main legislative frameworks regarding air pollution are:

- the Swedish Code of Statutes: Air quality Ordinance and,
- the Swedish Environmental Protection Agency Code of Statutes.

4.3 Noise

Noise is one of the main road transport externalities. The gradually increase in road traffic volumes is one of the main reason that noise emissions has become an important environmental issue in urban areas (EC, 2017). In this chapter information regarding noise in CISMOB Regions is provided.

4.3.1 Centro Region

The new legal framework on ambient noise in Portugal consists of: Decree-Law no. 9/2007, of 17 January, which approves the General Regulation of Noise (RGR), rectified by Statement of Rectification no. 18/2007, of 16 of March, and amended by Decree-Law no. 278/2007 of 1 August, Decree-Law no. 146/2006 of 31 July, transposing Directive no. 2002/49 / EC, of the European Parliament and of the Council of 25 June on the assessment and management of environmental noise, rectified by Statement of Rectification No 57/2006 of 31 August.

4.3.2 Águeda

The legal framework for environmental noise consists of Decree-Law No. 9/2007 of 17 January approving the General Noise Regulation (RGR) and Decree-Law No. 146/2006 of 31 July , which transposes Directive 2002/49 / EC of the European Parliament and of the Council of 25 June on the assessment and management of environmental noise.

Decree-Law no. 9/2007 of 17 January was rectified by Decree-Law no. 18/2007 of 16 March and amended by Decree-Law no. 278/2007 of 1 August.

Decree-Law no. 146/2006, of 31 July was rectified by Statement of Rectification no. 57/2006, of 31 August.

A noise map is a global vision instrument for territorial management in the area of noise that allows to diagnose areas of potential negative impact on the population, as well as to outline possible intervention strategies to be taken into account in the implementation of the Municipal Master Plan. The main objectives of Águeda Municipal Noise Map were established as: identification of dominant noise sources, visualization of the influence area of each noise source and identification of priority intervention zones. In addition to these objectives, the APA (Agência Portuguesa do Ambiente | Portuguese Environment Agency) further provides that a noise map facilitates the preservation of sensitive and mixed areas with sound levels, corrects areas with non-regulatory levels and creates areas with compatible noise levels.

The noise map is an integral part of Água's Master Plan (PDM) review and has been elaborated simultaneously to the other elements and pieces that constitutes the Plan and characterizes the territory, being a precious tool for the integration of all aspects for the design of the territory and also for the definition of strategies.
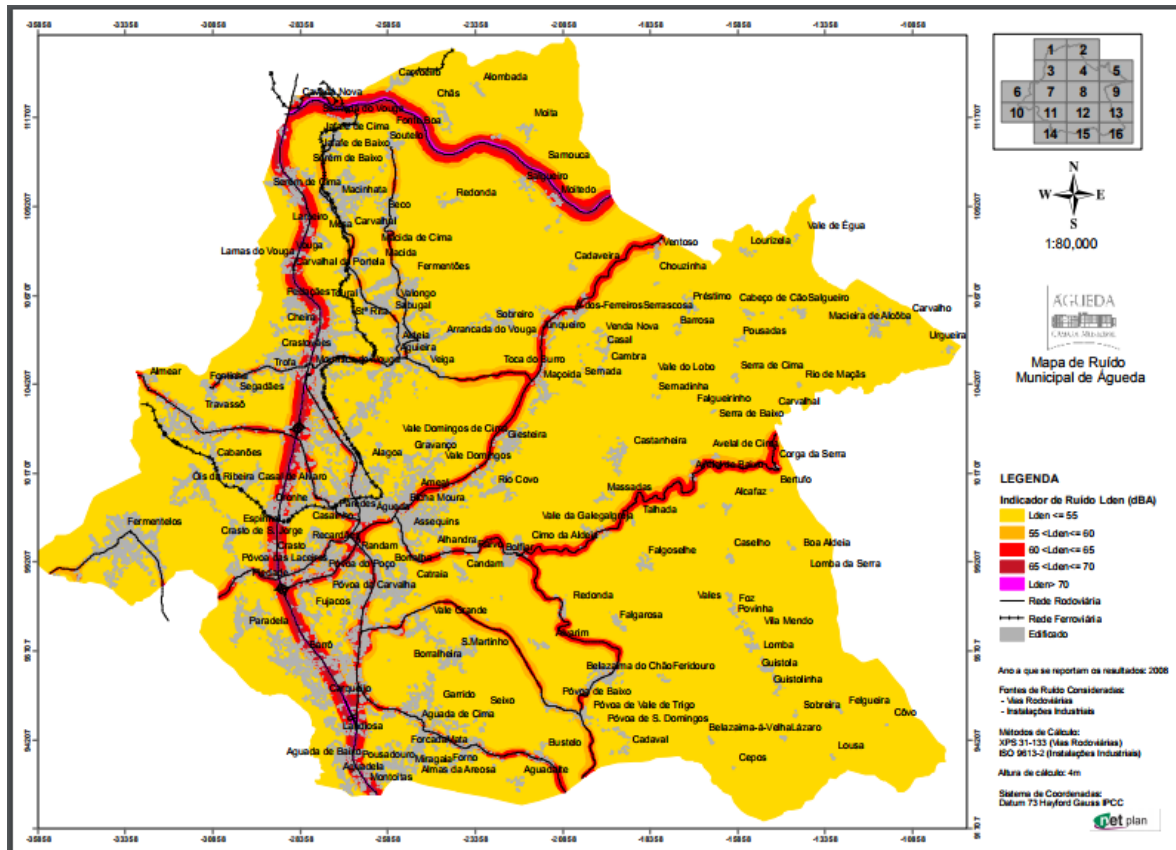
Figure 4-7 Image of Água's noise map (2006) – Lden noise indicator from: https://www.cm-agueda.pt/pages/688?folders_list_54_folder_id=196#.WXCzzYTyvIU

All maps and descriptions from the noise map is available at:

https://www.cm-agueda.pt/pages/688?folders_list_54_folder_id=196#.WXCzzYTyvIU

There was no increase in traffic over than 20%. There was no change of the typologies of the sites, neither was significant growth of the urban and / or industrial zones (nevertheless in the past year the industrial municipal park of Casarão, has an increasing rate of investments and new traffic movements started to increase towards this area.

In Água, the quality of the sound environment is translated in Água's Noise Map, integral element of the Revision of the Municipal Master Plan of Água. It is possible, through the visualization of the noise map, to identify which zones have the highest and lowest noise levels in the study area. The analysis of the noise maps of the Municipality of Água allows to conclude that the road traffic is the dominant source of noise, prevailing over any other source of noise.

More information: https://www.cm-agueda.pt/pages/523#.WSQ15rhH4Vh

4.3.3 Extremadura

Spain's implementation of the Noise Directive which requires its Member States to prepare and publish, every 5 years, noise maps and noise management action plans for agglomerations with more than 100,000 inhabitants, and for major roads, railways and airports, is quite delayed.

4.3.4 Romania

In Romania, the main legislative framework regarding noise levels consist of:

- the Governmental Decision 1260/2012 transposing Directive 2002/49/EC and,
- the Governmental Decision 321/2005 which defines the methodology for assessing and managing ambient noise.

According to EC's report regarding the environmental implementation review, Romania is delayed. The noise mapping for the reference year 2011, is mostly complete while action plans for noise management in the current period have been adopted for 53% of agglomerations and only 3.7% of major roads (EC, 2008).

Romania has a National Air Quality Monitoring Network which consists of 100 stations (Figure 4.5) across the country. Measured values and computed indices are available in Romanian here http://calitateaer.ro/index.php.
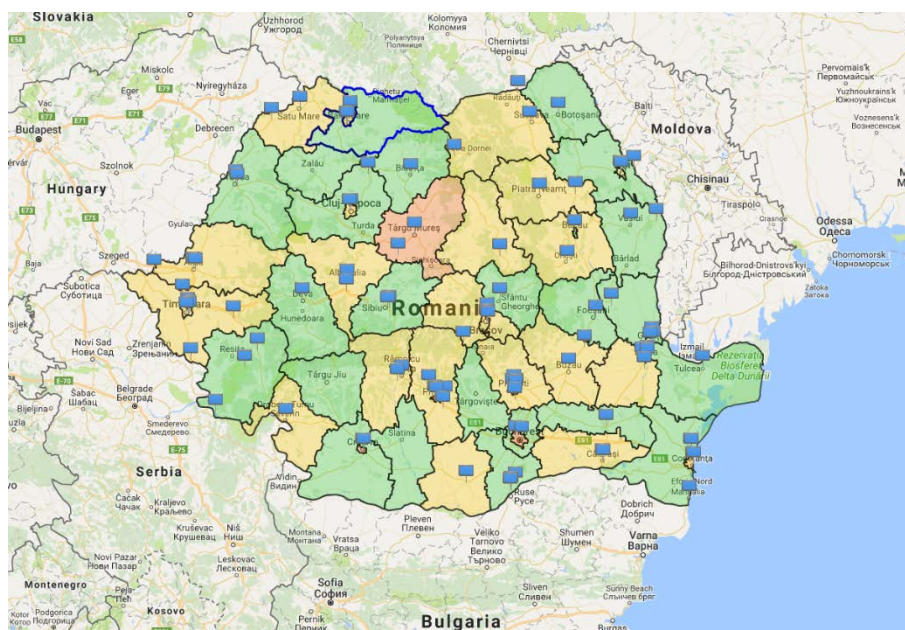
Figure 4-8 Position of the air quality monitoring stations in Romania (calitateaer.ro)

4.3.5 Bucharest - Ilfov

In the city of Bucharest, the Municipality deploys an urban noise monitoring system consisting of 15 fixed monitoring stations. The daily measurements, with raw values and also comparative charts, are published in Romanian only in the following link:

http://pmb.ro/institutii/primaria/directii/directia_mediu/zgomot/statii.php

4.3.6 Stockholm County

In Sweden, there are current environmental quality standards for Noise (SFS 2004:675), where the Swedish Transport Administration must, every five years, mapped railway rail traffic noise with a traffic density of more than 30 000 trains per year and developed strategic noise maps showing the noise situation during the previous calendar year. Regulation (2012: 51).

Municipal authorities and the Swedish Transport Administration must report their data to the Swedish Environmental Protection Agency. Among other things, the strategic mapping will show the number of people and homes exposed to noise in different noise bands (from traffic on such road, rail or airport), the exposed areas and maps showing the noise situation.

The noise mapping includes municipalities with more than 100,000 inhabitants (Stockholm, Gothenburg, Malmö, Uppsala, Linköping, Norrköping, Jönköping, Helsingborg, Lund, Örebro, Västerås, Umeå and Borås). Roads carrying more than three million vehicles per year, railways with more than 30,000 trains per year and airports with more than 50,000 flights per year were also included. In addition to this, the Swedish Transport Administration mapped around 4,000 km of roads, approximately 1,400 km of railway and noise levels at Arlanda, Landvetter and Bromma airports.

In order to achieve a good environmental quality outside existing homes, noise levels should normally be below the following levels ('free field values') according to the Government bill on infrastructure 1996/97:53 and associated documents from central government agencies.

The Stockholm county webpage has a e-service traffic service, where people can search based on street addresses to see the noise information of its area. The information is available at: https://iservice.stockholm.se/open/Trafikbuller/Pages/Trafikbuller.aspx

Furthermore, in the next link, traffic noise data of Stockholm County Map is provided: http://www.stockholm.se/TrafikStadsplanering/Trafik-och-resor-/Trafik-och-iljo/Trafikbuller/Bullerkartor/

4.4 Overview of the Environmental Capacity in CISMOB Project Areas

Monitoring air quality is essential for local and national authorities to understand and prevent air pollution and assess emission sources. A comprehensive air quality monitoring network could contribute in a more effective and efficient way to preserve health and contribute to the fight against the greenhouse effect. In Table 4.1, the number and density of air quality stations in CISMOB Project areas is presented.

Table 4.1 Number and density of air quality stations in CISMOB Project areas

Road	Centro Region	Agueda	Extremadura	Romania	Bucharest - Ilfov	Stockholm County
Number of Air Quality Stations	9	2	8	100	4	5
Density of Air Quality Stations	1:3,133.2	1:167.6	1:5,201.4	1:2,383.9	1:455.3	1:1,355.8

5 Policy Framework, Socio-political Awareness and Readiness

In chapter 5, information about the priority given to the promotion of smart mobility on regional political agenda, political actions on climate change, overall awareness of policy makers on reducing carbon footprint through improving transport system efficiency and the overall awareness of local communities on reducing carbon footprint in CISMOB regions are provided.

5.1 Centro Region

In Portugal, there has been an increasing attention and interest in supporting the reduction of the carbon footprint and transport related externalities. Portugal policy instruments are strongly aligned with the Europe 2020 Strategy. It is important to emphasize the importance of transport as regards, on the one hand, the consumption of fossil fuels and, on the other hand, the emission of carbon. Centro Region has a trajectory (and a model) that does not deviate from the trajectory of the country and is based on favoring road transport in terms of passenger and freight transport. There are various relevant policy instruments of possible support in Centro Region. Besides, there are also Sustainable Urban Mobility Plans of different Centro Region communities focusing on specific regional areas and whose objectives include:

- Promotion of sustainable mobility;
- Integration of territorial planning and transport policies;
- Promotion of inter-modality, taking into account physical, price, operational and institutional dimensions;
- Promoting quality of environment, public health and safety;
- Implementation of measures of mobility management;
- Restructuring of public transportation networks;
- Optimization and expansion of the pedestrian and cycling networks;
- Promotion of using electric vehicles;
- Promotion of actions to change behaviours towards sustainable mobility.

The Portuguese Operational Program for Centro Region (PO CENTRO2020) is a regional development strategy which is built upon the strong mobilization of each one of the Centro Region members. This Program will prioritize for instance, the support on enhancing value creation and knowledge transference, structuring a polycentric network of medium-sized cities, move towards sustainability of existing infrastructures and consolidate institutional capacity building. Concretely, it is structured on nine priority axes, and mobilizes nine thematic objectives and twenty-seven investment priorities. Among them, the thematic objective 4 is very important in the context of the CISMOB project.

The thematic objective 4 supports the transition to a low-carbon economy in all sectors, under the investment priority 4e - Promotion of low-carbon strategies for all types of territories, namely urban areas, including the promotion of sustainable multimodal urban mobility and adoption measures relevant to mitigation of emissions, which will support sustainable urban mobility and decarbonization of territories.

This priority investment will be mobilized to support initiatives related to urban centres complementary of the regional urban area, focusing on the mobility using environmentally friendly means of transport, and allow the centers to interact with their surrounding spaces with other centers, through the sharing of means of locomotion, creation and management of routes, with articulation of different means of locomotion (inter-modality). In particular, the idea is to support initiatives aimed at reducing emissions of CO2 and other pollutants such as PM, NO2 and ozone, and to promote decarbonisation of the economy and society by supporting the development of models and integrated transport systems (inter-modality), specially conceived to work on integrated mobility and interventions in the area of sustainable multimodal urban mobility.

The Program is an important instrument for the implementation of the Smart Specialization Strategy defined in Centro Region (RIS3), which will act as a rationalization of the investments to be supported, whether in the achievement of competitiveness priorities (research, development and innovation), or in three transversal objectives, namely, territorial cohesion, city politics and sustainability and efficient use of resources. From the innovation platforms identified in the smart specialization RIS3, two of them have as priorities the promotion of technologies for quality of life and the territorial innovation, which is basically the promotion of overcoming the green economy and low-carbon challenges and the challenges of territorial cohesion.

The Portuguese Operational Program for Sustainability and Efficiency in the Use of Resources (PO SEUR) is related to the Environment and aims to contribute to consolidation of the Europe Strategy 2020, especially in the sustainable growth priority, in order to overcome the challenges arising from the transition to a low-carbon economy based on a more efficient use of resources. The strategy behind PO SEUR sustains in a multidimensional perspective of sustainability, which mobilizes the following thematic objectives, structured operationally into three priority axes:

1. Support the transition to a low-carbon economy in all sectors, including promotion of energy efficiency in the transport sector, support for the implementation of energy efficiency measures and the rationalization of consumption in public passenger transport, which projects should encompass a set of specific measures such as campaigns raising awareness of eco-mobility and adoption of good practices; promotion of eco-driving; use of transport and energy-efficient mobility solutions; campaigns encouraging use of public passenger transport; support for the promotion of the use of green transport and sustainable mobility, with several actions which can be supported, namely: technological upgrading of public electric charging points, expand public charging points network and launching measures and actions promoting electric mobility.

2. Promotion of energy efficiency in transport sector, businesses and residential buildings; adaptation to climate change and risk management and prevention, which identified some priorities as municipal, inter-municipal and regional plans for adaptation to climate change, actions to promote green infrastructures, in addition to actions to implement these infrastructures in the Regional Ops, production of information and knowledge (e.g., studies, analyses) and development of decision-support tools, including information systems and modelling.

3. Environment protection and promotion of efficiency of resources, especially focusing in the operationalization of measures for the waste and water sectors.

The Portuguese National Territorial Planning Policy (PNPOT) is a strategic instrument for territorial development. It establishes the great options relevant to the organization of the national territory. This is a reference framework to be considered in the elaboration of the other territorial management instruments and it is an instrument of cooperation with the other member states for the organization of the territory of the European Union. The PNPOT is applied to the entire national territory, covering also archipelagos of Azores and Madeira, as well as territorial waters defined by law, without prejudice to the competences of the Autonomous Regions. This Program is a major tool for the definition and organization of a Territorial Development Strategy for the application of the Community and national funds, in a perspective of integration and territorialization of public policies, constituting the strategic and institutional support for the implementation of the new integrated approaches of Territorial Development foreseen in the Portugal 2020. The PNPOT was approved by Law no. 58/2007, of 4 September, rectified by Correction Statements no. 80-A / 2007, of September 7 and no. 103-A / 2007, of November, and consists of a Report and a Program of Action. Information about the priority given to the promotion of smart mobility on regional political agenda, political actions on climate change, overall awareness of policy makers on reducing carbon footprint through improving transport system efficiency and the overall awareness of local communities on reducing carbon footprint.

Regional Territorial Planning Plans (PROT) are instruments of territorial development, strategic nature, of regional scope. The main challenge of PROT-CENTRO is to ensure a framework for interventions likely to be different scales, modes of transport and entities and agents, policies, plans and programs. It supports for instance, initiatives for development of transport infrastructures and services that should contribute to the progressive optimization of the various parameters of the transport system, favouring solutions that combine high levels of efficiency and effectiveness with respect to environmental, energy and safety objectives; road transport solutions focusing on solution of congestion problems that should be based on active demand management.

The sustainable urban development of Portugal depends on the promotion of competitive solutions and smart cities. The Sustainable Cities Strategy 2020 results from the recognition that sustainable, integrated and harmonious development of the Portuguese territory depends crucially on the ability of their cities assert themselves as key players, catalysts of environmental, social and economic development leaders in promoting equity, social cohesion and the safeguarding and strengthening of territorial resources. It focuses on city

planning, seeking to promote its regeneration and the improvement of the quality of life. It is a referencing framework for all municipalities and inter-municipal entities. Sustainable Cities Strategy 2020 integrates a set of operational and evaluation tools, such as the Cities Forum, which is an instrument to support governance in the form of a platform of cooperation and coordination, especially focused in the sustainable urban development, and the Barometer of Urban Sustainability, which is aimed to provide information regarding sustainability.

PEDU stands for Strategic Plan for Urban development. PEDU covers the entire municipal territory of each of the Municipalities. It focuses in the context of sustainable urban mobility, urban regeneration and physical, economic and social regeneration, that is, the PEDU of each Municipality should support sustainable urban mobility and reduce dependence on the car by creating a network of cycle and pedestrian circuits linked to interfaces and public transport services, enhancing quality of mobility by for instance, the adoption of real-time user information systems; implement specific corridors in urban corridors of high demand, by prioritizing access to public transport and soft modes; or prioritizing investments in equipment of intelligent road traffic control systems.

Portuguese Action Plan for Sustainable Urban Mobility (PAMUS) should be based on a low-carbon strategy focused on promoting multimodal and sustainable urban mobility. Among the overall objectives of the plan is the need to reduce CO_2 emissions and other atmospheric pollutants, contributing to decarbonisation of the economy and to the use of public transport through inter-modality and improved access to the transport system. Specific objectives of PAMUS contribution are to improve efficiency of transporting people and goods, to convert to cleaner and more efficient modes of transport, to ensure a transport system and inclusive accessibility, to reduce negative impacts of the transport system on health and safety, the reduction of air pollution, noise and greenhouse gas emissions, as well as energy consumption.

5.2 Águeda

The territory defined by the Municipality of Águeda is characterized by the heterogeneity of its terrain, causing severe constraints on mobility and sociability between the Historical Centre and the Upper Areas of the city.

Framed by the sustainability strategy of the Municipality of Águeda for the adoption of better environmentally friendly and energy efficient means of transportation, associated with a local culture of the two-wheeler industry, metallurgy and lighting, the municipality issued a challenge to companies inside the Municipality of Águeda to develop a pilot project for Electric Bike (BeÁgueda). With this project, the municipality combines tradition and innovation, giving new emphasis to the sector of two wheels, inseparable from its history and its economic development, enabling its residents and visitors to take routes in an innovative and sustainable way. It must also be noted that the dimension of sustainability

goes beyond the concept of mobility, because power is partly provided by a photovoltaic panel (a solution that fully meets the needs of the park is under study).

It is in this economic, social and environmental context that the Municipality of Águeda, together with the Águeda companies (Miralago and Órbita), developed a pilot project to make electric bicycles available for public use: the beÁgueda. Along with the different aspects presented above, it is intended that the electric bicycles are potential elements of intermodality (bus - bike, train - bike, car - bike), promoting quality of life of the inhabitants of Águeda and all those who visit Águeda. In this context, one must systematize that beÁgueda aims at:

- Integrate a wide sustainability strategy;
- Minimize consumption of resources and increase the effectiveness of those being used;
- Involve a change in lifestyles;
- Promote knowledge, technological progress and strengthening of the local economic fabric;
- Improve the environmental quality of all citizens (think global, act local).

Accepting the challenges posed by the United Nations and the European Union, the Municipality of Águeda has sought to implement a set of initiatives and actions, based on objectives, policies and strategies aimed at sustainable development of the territory, thus promoting economic growth consistent with environmental protection and a better quality of life for all and involving everyone.

The Municipality of Águeda accepted the challenge launched by the University of Aveiro, through the Technological Platform of the Bike and Soft Mobility, and signed the Commitment for the Bicycle, in the April 26th, 2016. Águeda signed a set of goals and challenges in order to encourage the citizen to use the bicycle in everyday life, thus taking another step towards gaining a valuable brand image: Águeda - Bike Capital. In a municipality with a strong tradition in the use of both wheels, the Municipality intends to reinforce the importance that the bicycle has in the sustainable development of the county, fomenting the change of habits in the citizens towards behaviors more responsible and healthy, while promoting a better quality of life. Águeda is a territory in which the use of the bicycle should be promoted by excellence, and it is also a way to re-design this important sector of the County. The Municipality of Águeda have recent signed the new Covenant of Mayors for Climate and Energy, and voluntarily committed to implementing EU climate and energy objectives on their territory. Águeda now pledge to reduce CO2 emissions by at least 40% by 2030 and to adopt an integrated approach to tackling mitigation and adaptation to climate change. The new signatories also endorse a shared vision for 2050: accelerating the decarbonisation of their territories, strengthening their capacity to adapt to unavoidable climate change impact, and allowing their citizens to access secure, sustainable and affordable energy. In the Municipality of Águeda, in addition to the TRACE project (Walking

and Cycling Tracking Services) under the Horizon2020 programme of the European Commission and CISMOB project (Cooperative information platform for low carbon and sustainable mobility) under the Interreg Europe Programme, through which we have secured funds related to the promotion of sustainable mobility and consequent reduction of the carbon footprint. Águeda also have the PEDU (Plano Estratégico de Desenvolvimento Urbano | Urban Development Strategic Plan), where funds are also secured for the construction of cycle tracks and for the introduction of a parking management system. The Municipality of Águeda have also created a Fund for Energy and Water Efficiency (FEWE), and its regulation which aims to establish a set of rules and procedures defining the constitution, management, strengthening and regulation of the FEWE, created with the purpose of financing investments to increase energy and water efficiency of the municipal facilities by reducing the consumption of electric energy, gas and water, and measures to contribute to the fulfilment of the Municipality objectives and sustainability commitments. The FEWE may only be used for the following situations:

- Investments that is eligible for the promotion of energy and water efficiency;
- Maintenance and preservation of such investments.

It is in this context, with an important socio-cultural legacy related to bicycles, which pilot project beÁgueda - the electric bike of Águeda appears, as part of a wider strategy for sustainable mobility.

Thus, within these projects, and resulting from a dialogue between the municipality and hundreds of organizations and citizens, the 10 major Commitments of Águeda towards Sustainability were set and the main lines of action to be taken. Of these, it is important to detail the 3rd Commitment of Águeda towards Sustainability - *to improve mobility*, and two of its four lines of action: *Focus on use of bicycles and / or pedestrian mobility*; *Invest in cleaner vehicles* (Águeda 21, 2011), in which the pilot project beÁgueda fits in, as well as the Strategy for Sustainable Mobility in Águeda. The pilot project beÁgueda will also contribute to meet the commitment set to *stimulate sustainable and locally-based economic activities*, because the production of bicycles, which are made by a company from Águeda, will also strengthen and boost the local economy, based on innovation and compatibility of activities with environmental protection and in order to reduce energy dependence and carbon emissions (2nd commitment).

The Municipality of Águeda joined the Covenant of Mayors on 12 November 2008, having already made the Sustainable Energy Action Plan (SEAP), formally approved on July 7, 2011, and submitted the first monitoring report in 2015. On October 1, 2014, the Municipality joined the "Mayors Adapt" initiative - on adaptation to climate change, and the commitment was made to contribute to the overall objective of Adapting the European Union by developing a comprehensive local adaptation strategy or integrating adaptation to climate change into existing and more relevant plans.

The new Integrated Covenant of Mayors for Climate and Energy was launched by the European Commission on 15 October 2015. In this context, and in view of the projects, studies and initiatives that the Municipality of Águeda has been developing in combating and adapting to climate change, and in the use of sustainable energy, decide to join the new Covenant of Mayors for Climate and Energy, by extending its commitment to the Covenant of Mayors up to 2030, and thus to benefit from technical assistance, under the responsibility of the European Commission, in assessing the vulnerabilities of the territory and in the implementation of action plans. The Municipality will be further integrated into the Covenant of Mayors and Mayors Adapt networks, which will allow the exchange of good practices among the participating local and regional governments, while also giving Águeda increased visibility in this commitment to fight against climate change.

The main responsibilities of the Municipality upon becoming a signatory are as follows:

- Reducing CO2 (and possibly other greenhouse gas) emissions on the territory of our municipalities by at least 40% by 2030, namely through improved energy efficiency and the greater use of renewable energy sources

- Increasing their resilience by adapting to the impacts of climate change;

- Sharing each vision, results, experience and know-how with fellow local and regional authorities within the EU and beyond through direct cooperation and peer-to-peer exchange, namely in the context of the Global Covenant of Mayors

- Prepare an Emission Reference Inventory and an Impact Assessment and Vulnerability in Climate Change;

- Submitting a Sustainable Energy and Climate Action Plan (SECAP) and mainstreaming mitigation and adaptation* considerations into relevant policies, strategies and plans within two years following the municipal council decision.

The Municipality had already committed to reduce CO2 emissions by 33% by 2020, and is implementing energy efficiency actions that are expected to contribute to exceeding this goal. Moreover, in adapting to climate change, various adaptation actions are being implemented, while others are planned for the short, medium and long term. Likewise, updating of climate projections and scenarios, as well as emissions, is underway in the framework of the Climate Change Adaptation Plan. The Municipality of Águeda have acquired 12 vehicles 100% electric, in an investment of around 150 thousand euros, which will contribute to save more than 16 thousand euros per year in fuel, thanks to the replacement of diesel cars by electric cars, and 19 tons of CO_2. The vehicles are destined to transport the municipal technicians, as well as the School

Groups of the county, who will receive a vehicle (model Twizy) to support administrative tasks. According the Mayor Gil Nadais, this measure is part of "a strategy to reduce CO_2 emissions, in accordance with the commitment made in 2009, with the signing of the Covenant of Mayors where the Municipality of Águeda focused on less carbonic mobility and more sustainable!"

Figure 5-1 Image of the Municipality of Águeda new electric car fleet

5.3 Extremadura

Currently, Extremadura region is developing the "Extremadura 2030: Marco Regional de Impulso a la Economía Verde y la Economía Circular en Extremadura" [Extremadura 2030: Regional Framework for Impulse to Green Economy and Circular Economy]. This framework aims to link the most of material and human resources from Extremadura into the search of economy and society more green and circular. Here, the natural resources will be a permanent source of opportunities for the Extremadura population. The Regional Framework has been showed as a model of citizen participation, where both projects to making and the activities will be in permanent evolution with the contributions from the society.

Extremadura 2030 resulted from a commitment of coordination of the different public policies and government areas (education, culture, employment, health, economy, industry, agriculture). The Framework has been structured in 5 programs, 30 guide projects and more than 300 are expected. The guide project number 21 is named "Elaboration and development of a new model of sustainable mobility in Extremadura"

5.4 Romania

In Romania, the general policy framework is supporting the reduction of the carbon footprint and environmental impact not only in the transport field but also in other economic sectors. As an example, there are national programmes financing green measures as a financial incentive scheme for buying electric cars and there are also incentives for building eco-friendly houses. The most relevant policy documents are:

- The National Strategy for Climate Change 2013–2020 implementing the national strategy on climate change and economic growth based on low-carbon economy for the period 2013–2020;
- The National Transport Masterplan of Romania, a high-level roadmap setting the major objectives of its national transport system in the long term;
- The National Strategy for Sustainable Development: This National Strategy aiming to connect Romania to a new philosophy of development, adopted by the EU and widely shared globally — that of sustainable development;
- The Strategy for the territorial development of Romania, a strategic document conceived by the Ministry for Regional Development and Tourism in 2008, as part of the reforming process of the Romanian planning system initiated in 2005. The document is an integrated multiscale approach of the national development policy, correlated with the main European strategic planning documents and latest researches;
- Sustainable Urban Mobility Plans of different cities.

5.5 Bucharest – Ilfov

There is nothing specific to mention about Bucharest – Ilfov. The SUMP for the city of Bucharest has been developed and at present efforts are being made to implement the selected measures.

5.6 Stockholm County

The main contribution to climate change in Sweden, as in many other developed nations, is transport. For this reason, this part has a very important role to state the basis of the Stockholm County BAR.

Today, "the Stockholm county has more than two million people and the number is expected to increase by a further 440 000 until 2030. With more than 780.000 of passengers every day in public transport, the Stockholm County Council has the overall responsibility to ensure that everyone, living in or visiting the county, will have access to extensive, accessible and reliable public transport"[14].

Therefore, for the Stockholm County BAR, it is important to understand the planning transport system of Sweden, which works together with other two sectors, environment and ICT.

---

[14] http://www.sll.se/framtid/
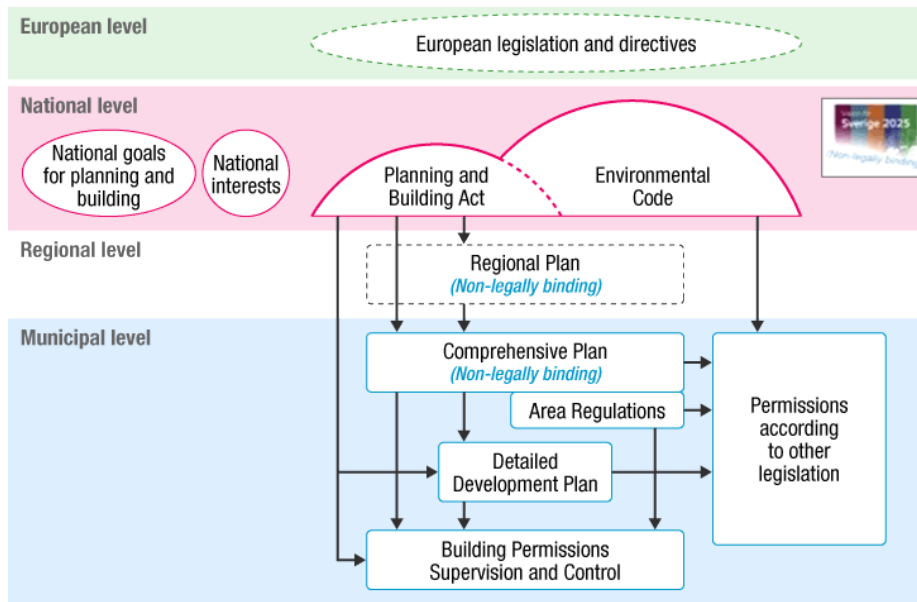
Figure 5-2 Planning System of Sweden (Government Offices of Sweden, 2017b)

Regarding the Legal and Regulatory Framework of the Penetration of ICT's in a Sustainable Transport Sector, the main instruments about the environmental sector are:

i) The Swedish Environmental Code, entered into force in 1999. This legislative framework aims to promote sustainable development that will assure a healthy and sound environment for present and future generations. To achieve this, the code shall be applied so that:

- the human health and the environment are protected against damage and detriment, whether caused by pollutants or other impacts,
- valuable natural and cultural environments are protected and preserved,
- the biological diversity is preserved,
- the use of land, water and the physical environment in general is managed well in the long term in regard to ecological, social, cultural and economic values and finally,
- re-use and recycling, as well as other management of materials, raw materials and energy, are encouraged so that natural cycles are established and maintained.

The Swedish Environmental Code also requires that an environmental impact assessment be carried out before permission can be given for an environmentally hazardous activity. This assessment takes into account the impact on people, animals, soil, water, air, the landscape and the cultural environment.

ii) The Environmental quality standards that are a type of legally binding policy instrument introduced by the Swedish Environmental Code of 1999 (details in Chapter 5 of the Code). These standards were imposed to remedy the environmental impact of diffuse emission sources, such as road traffic.

The current environmental quality standards exist in the following areas that are related to CISMOB aim: Ambient air (SFS 2010:477), Regulations on air quality assessment (NFS2013:11) and Noise (SFS 2004:675).

The Ordinance SFS 2010:477 on Ambient Air Quality derive from the Swedish Environmental Code and it is based on: 1) the Air Quality Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe; and 2) Directive on Metals and PAHs in Ambient Air: Directive 2004/107/EC of the European Parliament and of the Council of 15 December 2004 relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air, as amended by European Parliament and Council Regulation (EC) No 219/2009.

The Regulation on Air Quality Assessment NFS 2013:11 apply to the measurement, modelling, objective estimation, provision of information and reporting of results for the assessment of environmental quality standards in ambient air for which the municipalities are responsible for implementing under Section 26 of the Air Quality Ordinance (SFS 2010:477). The Regulations also apply to the procedures for reporting of an action programme under Section 33 of the Air Quality Ordinance (SFS 2010:477).

iii) And finally, the Sweden's environmental objectives which are intended to guide the sum total of Swedish efforts to safeguard the environment. They have been adopted by the Riksdag (the Swedish Parliament). Swedish environmental policy overall aim is to hand over, by 2020. They are of three different types. "One is the generational goal, which defines the overall direction of environmental efforts. To facilitate those efforts, and to make the generational goal more tangible, there are also 16 environmental quality objectives and a number of milestone targets".

In reference to the CISMOB aim, it should be highlighted three of them. Specifically, Reduced Climate Impact, Clean Air (for both the responsible authority is The Swedish Environmental Protection Agency) and Good Built Environment (The National Board of Housing, Building and Planning is the government's expert authority and responsible of this objective).

The implementation of Stockholm's climate initiatives is a decision taken by the City Council. Overall responsibility for ensuring proper follow-up of the Council's decisions, including the supervision of climate initiatives implementation and the evaluation of results, rests with the City Executive Board. The latter, assisted by the Executive Office, is also in charge of financial administration and ensures the sustainability of climate plans.

The Environment and Health Administration, responsible for environmental monitoring, and the City Planning Administration, in charge of land-use planning and of issuing of building permits, are the main city departments involved in the day-to-day operations related with the implementation of the climate initiatives.

The City of Stockholm has strategically chosen to collaborate with other public authorities and agencies, as well as with the private sector and the general public, in order to achieve its climate and energy goals, and maximise the impact of its initiatives. More precisely, measures aiming at the reduction of the city's own energy consumption and operational costs are implemented through the Stockholm Energy Centre, which is the city's internal energy advisory service. Public transport issues are managed together with Stockholm Public Transport (SL), a county agency responsible for the provision of public transport

services. Issues related to the traffic congestion tax (e.g. assessment of impact on traffic, public transport, traffic safety, business and environment), are managed by the Stockholm City Traffic Administration, with the support of the Swedish Transport Administration.

In addition, the contribution of the private sector has been strongly encouraged by the city authorities. More than 125 companies are involved in the implementation of the city's plan through the 'Climate Pact', an initiative launched in September 2007 with a view to engaging business in local climate action (Stockholm City, 2010). The Climate Pact is being used by the city and businesses as a platform for inspiration, sharing of good practices and annual reporting on environmental work. Participating companies commit to the same goals as with the City of Stockholm and are free to choose their own actions towards fulfilling their commitments.

Among the key stakeholders of the initiatives are also the citizens themselves; their involvement facilitates the implementation of measures beyond the City of Stockholm's direct mandate. The city authorities facilitate the direct involvement of individuals and families living in Stockholm in several ways, but notably through the Climate Account, a web-based application assisting users to monitor their emissions and take actions to reduce their carbon footprint.

Regarding the planning responsibilities for Transport Infrastructure in Sweden:

- Major roads and railways is a national responsibility;
- County councils are responsible for public transport;
- Municipalities are responsible for local roads.

On 1 January 2012, a new Public Transport Act came into force. New regional public transport authorities are formed to be responsible for developing the public transport system in each region. Strategic decisions on public transport will be made by these authorities, which will mean greater insight and better co-ordination with other forms of social planning.

The public transport authorities will decide on regional transport provision programmes which specify the long-term goals for regional public transport. They will also decide on their public service obligations, which mean the transport for which they intend to be responsible and which, as an undertaking to their citizens, they guarantee to maintain.

The new Act also means that commercial companies are free to set up public transport services anywhere in the country. All types of transport operators, including the commercial players, will have to submit information on the range of services they offer to be fed into a common system for passenger information.

From 2012 onwards, new regional public transport authorities will be responsible for political decisions and strategic development plans as well as for the scope of the public transport offered in the various regions in Sweden. The transition to the new scheme will take place successively and in step with the expiry of current public transport contracts.

One important aspect of the strategies followed by the public transport authorities will concern what is required in order to achieve important social goals, for example the possibilities to commute to work and to places of education.

The overall transport policy objective is to ensure that citizens and the business sector in all parts of the country are provided with transport that is efficient in terms of the economy as a whole and sustainable in the long term. Transport policy is a linchpin of the EU's internal market. The EU regulations are primarily concerned with market access, transport safety and increasing the efficiency of the transport system in order to counter its detrimental impact on the environment and health.

The Government's objective is that Sweden will have the lowest unemployment in the EU by 2020. The Government's objective is also for Sweden to become one of the world's first fossil-free welfare nations. All policy areas must contribute to tackling the major challenges. The transport system is a basic condition for access to jobs and housing throughout the country.

The environmental impacts and emissions of the transport sector must decrease significantly if Sweden is to meet its environmental and climate objectives and live up to the international commitments under the Paris Agreement.

The main goals of the Swedish Transport Policy related to CISMOB aim are:

- Safety, environment and health: "The design, function and utilisation of the transport system are to be adapted in such a way that no one is killed or seriously injured in traffic. The design of the transport system is also to help to achieve the overarching generational goal for the environment and the environmental quality objectives, and to contribute to improved health".
- Increase the reliability of the transport system: "… The effective operation of the road and rail networks is an important prerequisite for being able to make optimal use of available capacity. This involves preventing disruptions by optimising traffic management and traffic information and minimising the impact of unplanned disruptions using traffic management, traffic planning and traffic information. In order to facilitate effective governance and monitoring".
- The transport system and the EU's internal market: The Government sees increased collaboration within the EU as a prerequisite for being able to address the problems of poor working conditions and illegal traffic that exist in the road haulage sector. Poor terms of employment in the airline industry also require increased collaboration within the EU.
- Reducing the transport sector's environmental impact: The environmental impact of the transport sector is to be reduced. The Government intends to introduce what is known as a bonus-malus system, whereby environmentally adapted vehicles with relatively low carbon dioxide emissions are awarded a bonus at the time of purchase and vehicles with relatively high carbon dioxide emissions are imposed with a higher tax (malus).

The Government's ambition is also to design the economic instruments for biofuels in a way that provides good long-term conditions for sustainable biofuels. For example, the Government intends to investigate the possibility of introducing a compulsory quota system for biofuels.

The ICT Policy concerns to utilising and promoting the opportunities offered by digitalisation and includes regulation of IT and electronic communications, network and information security, frequency policy and issues concerning broadband access and IT infrastructure. This policy area also covers eGovernment issues, i.e., using IT to make the activities of government agencies more efficient and simplify the general public's contacts with them – for example through electronic identification, electronic signatures and open data.

The goal of ICT policy is for Sweden to be the best in the world at utilising the opportunities of digitalisation. Sweden is to have world-class broadband. All households and businesses should have good opportunities to use electronic public services via broadband. This has been adopted in accordance with the bill Accessible Electronic Communications (Govt. Bill 2009/10:193). In the first instance, electronic communications are to be provided through an effective market, but the State is also to have a responsibility in areas where needs cannot be met by the market alone.

Digitalisation is also a key tool to enable modern society to reduce its impact on the climate. Sweden is already prominent in the digital field, but continued efforts are needed to maintain Sweden's leading position. Sweden works for a digitally interoperable government administration, called eGovernment where the administration should be innovative, interoperable, legally certain and efficient, and should offer a high degree of quality, service and accessibility, so as to contribute to the continued development of Sweden and efficient EU-related activities.

6 Financial Instruments, and Institutional Capacity

In this chapter it is briefly summarized the information regarding the financial and institutional instruments available in each CISMOB Region especially designed to promote sustainable mobility and reduce carbon footprint is presented in this chapter.

6.1 Portugal/Centro Region/Águeda

In Portugal, the principal instrument in the context of CISMOB is the Portugal 2020, a partnership agreement adopted between Portugal and the European Commission, which brings together the five European Structural and Investment Funds - ERDF, Cohesion Fund, ESF, EAFRD and FEAMP – in which are define the programming principles consecrate the economic, social and territorial development policy to promote, in Portugal, between 2014 and 2020. The programming and implementation of Portugal 2020 are organized in four thematic areas:

- Competitiveness and Internationalization;
- Social inclusion and employment; - Human capital;
- Sustainability and Efficiency in the Use of Resources

The Operational Programme of the Centro Region (Centro2020), which is an integral part of Portugal 2020, and in which Águeda is located is a regional development strategy built on a strong mobilization of all regional partners. With application of the Community funds registered in the Operational Program, Centro Region aims to become Innovation Follower, to represent 20% of National GDP and to converge to national productivity levels, to reduce territorial asymmetries by 10%, to have 40% of the young population with higher education and have an unemployment rate below 70% of the national average. Centro Region will therefore prioritize, by 2020, sustain and enhance value creation and knowledge transfer, promote a responsible, industrialized and exporting economic fabric, capture and retain qualified and innovative talent, strengthen territorial cohesion, a polycentric network of medium-sized cities, to give life and sustainability to existing infrastructures and to consolidate institutional capacity building. For the period 2014-2020, the Operational Program for the Centro Region will be allocated 2,155 million EUR, of which EUR 1,751 million from the European Regional Development Fund (ERDF) and EUR 404 million from the European Social Fund (ESF). This figure corresponds to a value of 925 EUR per inhabitant of the Centro Region.

The Centro 2020 Programme has so far approved 115 urban regeneration projects, involving a municipal public investment of 60 million euros, with support from European funds of

around 46 million euros. In the context of the cities policy, Portugal 2020 provides support to the larger urban centers through the PEDU - Strategic Urban Development Plans and to the complementary urban centers through the PARU - Urban Rehabilitation Action Plans. In 2016, the Centro 2020 Programme has committed around 262 million euros to the municipalities of the region for its urban regeneration strategies. These include projects to promote sustainable urban mobility (e.g., management systems promoting the interoperability of public transport systems), urban regeneration in historical centers, riverine areas and industrial degraded areas, and physical interventions in disadvantaged communities (as social neighbourhoods). European funding currently contracted for concrete projects (€ 46 million) represents around 17.5% of the Centro 2020 commitment to the region's PEDU / PARU strategies (€ 262 million).

6.2 Extremadura

As it was mentioned, previously, in point 5.3, Extremadura Regional Government is developing "Extremadura 2030: Regional Framework to Promote the Green Economy and the Circular Economy in Extremadura" [Extremadura 2030: Regional Framework for the Impulse to the Green Economy and the Economy Circular]. This Framework has already designed several guidelines related to sustainable mobility.

In parallel and according to the Statute of Autonomy of Extremadura region, the regional public authorities pursue a model of Sustainable Development. Because of that, the Regional Government defines policies that contribute to the objectives established in the international agreements on the fight against climate change.

Following these criteria, the Social and Political Pact on Reforms for Extremadura was created in 2011. This is a commitment of the society of Extremadura for a model of long-term development that faces the challenges of a globalized and sustainable economy.

Through the Pact, a commitment was made to develop a total of 21 concrete actions, including the elaboration of a Strategy for the Sustainable Development of Extremadura (Directorate General for Environmental Evaluation and Quality, 2011). This Strategy has been a basic element of coordination of all the actions that make up the Pact, integrating the environmental, economic and social dimensions of sustainability.

Included within the Strategy for the Sustainable Development of Extremadura is placed the strategic line of Climate Change.

Another key sector for the economic and environmental development of Extremadura is the energy sector. This sector arises from the sustainable point of view in the Agreement for the Sustainable Energy Development of Extremadura, where the energy saving and efficiency in the region is clearly promoted.

The Extremadura Observatory for Climate Change, an organization created and directed by the Directorate General for Environmental Evaluation and Quality have the aim to promote a climate action policy that integrates, in coordinated way, all the sectors of the society of Extremadura in the actions of fight against Climate Change.

Within the Extremadura Climate Change Strategy 2013-2020, the key objectives to promote transport and sustainable mobility are:

- OBJECTIVE 05. Promote of Energy Efficiency in Mobility;
- OBJECTIVE 06. Improve urban transport habits;
- OBJECTIVE 07. Improve the habits of the interurban displacement;
- OBJECTIVE 08. Improvement of infrastructure relating to environmentally friendly means of transport;
- OBJECTIVE 09. Encourage the introduction of vehicles with zero or reduced emissions in the Extremadura mobile fleet;
- OBJECTIVE 10. Dissemination of information on sustainable mobility.

It has been planned that all these Plans, Strategies and Pacts will be included and updated in the "Extremadura 2030: Regional Framework to Promote the Green Economy and the Circular Economy in Extremadura".

Within the lines of action in European Projects of AGENEX are:

Project URBANSOL: Where the implementation of a series of plans Ación for Smart and Sustainable Interurban Development in EUROACE area is promoted to improve the sharing of resources and services, implementing a low-carbon economy and achieve energy self-sufficiency.

Among the actions of the project, apart from the CISMOB project, are:

- Transfrontier Platform URBANSOI that will design Action Plans Interurban Sustainable Development and intelligent throughout the Spanish-Portuguese border.
- RED URBANSOI that will promote the development of cross-border inter-urban infrastructures, by ensuring integrated cross-border planning and efficient use of resources.

6.3 Romania/Bucharest

In Romania, the most important instrument in the context of CISMOB is the National Operational Programme for Regional Development. The program makes available financing for measures in terms of reducing carbon footprint not only in the Priority Axis 4, which is targeted by the project, but it also in the Priority Axis 3 called "Supporting transition to a low carbon economy". Both axes will finance only projects than can prove their impact on reducing the increase of CO_2 emissions. . The projects have to be developed and managed by local municipalities and they have to be the result of a strategic document, for example a SUMP.

Under Priority Axis 3 there are allocated 1.19 billion EUR for projects related to sustainable mobility and reducing carbon footprint. Examples of projects eligible for funding are:

- buying electric public transport vehicles
- rehabilitation of electric public transport vehicles

- modernization/extension of public transport routes served by electric vehicles
- development of park and ride facilities
- e-ticketing or any other ITC/ITS systems than can be proven to reduce carbon footprint
- development of urban forest areas with high capacity of CO2 absorption

Under Priority Axis 4 there are allocated 1.12 billion EUR for projects related to sustainable mobility and reducing carbon footprint. Examples of projects eligible for funding are:

- buying electric public transport vehicles;
- building of dedicated lanes/road infrastructure for public transport infrastructure;
- building of bicycle lanes and connected services/infrastructure: bike parking, bike sharing systems etc.;
- development of pedestrian ares;
- ITC/ITS systems than can be proven to reduce carbon footprint;
- development of urban forest areas with high capacity of CO2 absorption.

The National Environmental Protection Agency is also an important institution regarding environment and mobility. The Agency has coordinated the development of Local Environmental Action Plans which are now available for 42 Romanian Municipalities. These planes are correlated and harmonized with the other local strategies, including the ones for sustainable mobility, reducing pollution and carbon footprint.

In terms of sustainable urban mobility, the Bucharest Environmental Action Plan has identified the following main measures:

- development of electric urban transport systems and infrastructures;
- development of systems, services and infrastructures to encourage and support cycling;
- traffic restriction zones and ITS systems for traffic management;
- better integration of surface and underground transport, of urban and inter-urban/train networks and services.

Another financial instrument that can be used is the Large Infrastructure National Operational Programme. It finances investments in transport infrastructure for sustainable mobility, including ITS as intelligent infrastructure and also projects related to renewable energy, climate change, energy efficiency, waste water management and air quality monitoring.

6.4 Sweden/Stockholm

In Sweden, the Institutional Framework for the Environment and Transport Sector is divided to:

- Government: The Swedish Government bears overall responsibility for the environmental quality objectives. Once a year, the Government reports to the

Riksdag on Sweden's progress towards the objectives. Every four years, the Environmental Protection Agency submits an in-depth evaluation to the Government. This is intended to provide a factual basis for deciding whether the environmental quality objectives or policy instruments, including legislation, need to be revised. The evaluation is part of the basis for the Government's Environmental Bill. Within the Swedish Government, it is the Ministry of the Environment that bears overall responsibility for environmental issues.

- Riksdag: Sweden's Parliament (the Riksdag), the supreme political decision-making body in the country, has adopted environmental quality objectives and interim targets for sustainable development. In April 1999, the Riksdag adopted 15 national environmental quality objectives. On a number of subsequent occasions, it passed resolutions introducing a total of 71 interim targets. In November 2005, a 16th environmental quality objective was adopted by the Riksdag. At the same time, some interim targets were withdrawn and others set or revised. In June 2009, an additional target was introduced under the objective Reduced Climate Impact, bringing the number of interim targets to 73. On 22 June 2010, the Riksdag established a new goal structure for environmental efforts, a new organisational framework, and a new basis for assessing progress towards the environmental quality objectives.

- All Party Committee on Environmental Objectives: has been set up to secure broad political consensus on environmental issues. Its role is to advise the Government on how the generational goal and the environmental quality objectives can be achieved in a way that is cost-effective in economic terms.

- The Environmental Objectives Council: is a platform for the heads of government agencies that are strategically important to achieving the environmental objectives. Each year, the Environmental Objectives Council presents measures which the government agencies undertake to implement in order to lift the pace of efforts to achieve the environmental objectives.

- Swedish Environmental Protection Agency (Swedish EPA): coordinates follow-up, provision of information and the use of economic impact assessments within the environmental objectives system. In addition, it is responsible for some of the individual environmental quality objectives. Every year, the Swedish EPA presents an overall assessment of the prospects of meeting the environmental quality objectives and the milestone targets. At least once every parliamentary term, it presents an in-depth evaluation of the prospects of achieving the environmental quality objectives. The Swedish EPA collects the basic data needed to follow up progress in safeguarding and improving the environment. It does so, on the one hand, by regularly monitoring the state of the environment and, on the other, by obtaining data from agencies with responsibilities within the environmental objectives system and from official statistics, international reporting and research. The Swedish EPA supports the stakeholders involved in the environmental objectives system in their efforts to develop the provision of information and ensure that it is effective.

- Central government agencies: Eight national agencies have been assigned one or more of the environmental quality objectives, which it is their job to follow up and

evaluate. Other agencies work within their respective sectors to promote progress towards the objectives.

- Trafikverket, The Swedish Transport Administration, is the main authority regarding the transportation. Trafikverket is responsible for long-term planning of the transport system for all types of traffic, as well as for building, operating and maintaining public roads and railways. It cooperates with LFV (the LFV Group - Swedish Airports and Air Navigation Services), the Swedish Maritime Administration and the Swedish Transport Agency in order to simplify everyday travel by sea, road, air and rail.
- Transportstyrelsen: The Swedish Transport Agency stipulates rules and monitors how they are followed, grants permission (driver's licenses and certificates) registers change of ownership and manages congestion and vehicle taxation.
- Trafikanalys: The Transport Analysis is a government agency charged with providing decision-makers in the sphere of transport policy with sound and relevant policy advice. Their work is based on the objectives of economic efficiency and the sustainable provision of transport services for people and business throughout the country. They participate in developing transport policy by reviewing, analysing, following up and evaluating proposed and implemented measures at the request of the Government. They analyse the business environment and future prospects within transport policy. Our business environment analyses place special emphasis on the development of the transport system within the context of the European Union. Transport Analysis is also responsible for the production of official statistics in the transport and communication sectors, including travel surveys and commodity flow surveys. Their aim is to disseminate knowledge, experiences and results of activities to other authorities and stakeholders, for example, regional actors and organisations. The information that we can find in this site is about: i) road traffic (vehicle statistics, Swedish road goods transport, international road goods transport, road traffic injuries, persons hospitalized due to road traffic accidents, vehicles kilometres on Swedish roads and driving distances with Swedish registered vehicles), ii) public transport (local and regional public transport, special transport services, regularly scheduled road transport and regularly scheduled waterborne transport), iii) travel survey (expand rail traffic, rail traffic, railway transport, rail traffic accidents and train performance).
- LFV is responsible for civilian and military air traffic control in Sweden, as well as for safety and development of Swedish air space.
- Sjöfartsverket, The Swedish Maritime Administration is responsible for safety and navigability at sea, as well as for building, operating and maintaining navigation infrastructure.
- The former Rikstrafiken, The National Public Transport Agency, works to achieve basic accessibility of interregional public transport via procurement, for example. It is part of Trafikverket since 1 January 2011.

Further institutional capacity, includes institutional arrangements and coalitions between: Institutes, Foundations, Departments and NGO's as:

- SMHI, the Swedish Meteorological and Hydrological Institute, is an expert agency under the Ministry of the Environment and Energy. Through unique expertise in meteorology, hydrology, oceanography and climatology, SMHI contributes towards greater public welfare, increased safety and a sustainable society.
- Platform for Sustainable Cities. Cooperation is necessary to promote sustainable development. The Swedish Government has therefore assigned five authorities to create a platform for sustainable urban development. The Swedish National Board of Housing, Building and Planning is coordinating the assignment which is being conducted together with the Swedish Energy Agency, the Swedish Environmental Protection Agency, the Swedish Agency for Economic and Regional Growth as well as the Swedish Transport Administration. Issues related to urban development are becoming more important, both within Sweden and internationally. The EU Commission prioritises urban development issues during the programme period of 2014-2020 which has now been initiated, but in the past funds for urban development in specific programmes have also been allocated. In February 2014 the Government assigned the Swedish National Board of Housing, Building and Planning, the Swedish Energy Agency, the Swedish Environmental Protection Agency, the Swedish Agency for Economic and Regional Growth and the Swedish Transport Administration to develop and administer a platform for issues on sustainable urban development. The Platform builds further on the special investment the Government made between 2014 and 2020 to promote sustainable development of cities, urban areas and residential areas – the Delegation for Sustainable Cities. The aim of the Platform is greater collaboration, coordination, knowledge development, dissemination of knowledge and exchange of experience within the context of sustainable urban development. The authorities included in the Platform will collaborate on a number of key issues which are important for developing the work on sustainable urban development. Some challenges which are currently known include, for example, inadequate coordination within and between sectors and political levels, insufficient investments in research and knowledge development as well as a gap between sustainability rhetoric and practical action. The State has an important role in strengthening the cooperation between sectors and levels. The Platform comprises an important link between practice and politics at a local, regional and national level. Through the platform, discussions and activities can be coordinated locally, regionally and nationally, while a continuous dialogue is held with the Government Offices of Sweden. The Platform can also be a meeting place for local and regional initiatives.
- FORES (Forum for reforms and entrepreneurship): is the green and liberal think tank which wants to renew the debate in Sweden with belief in entrepreneurship, the people's ability to shape their lives and on market solutions to society's challenges. They have four program areas: climate and environment, migration and integration, entrepreneurship and economic reforms and the digital society. Each program has a council with great academic rigor and business is managed overall by a Board with broad community involvement.

- The Swedish 2030-secretariat: is a coalition to reach a fossil independent transport sector by 2030. It was founded in 2013, the same day as the government report on fossil fuel independence was presented. The target is to be understood as an 80 per cent reduction in the usage of fossil fuels in the transport sector 2010-2030, which will translate into about a 60% reduction in CO2 emissions from the transport sector. A public report risks to land between ministers and ministries, so the directors (Mattias Goldmann and Jakob Lagercrantz), formed the 2030-secretariat to keep the pressure up. They approached more than 50 Swedish partners from industry, municipalities, trade organizations, NGOs and academia, which have agreed on the proposals: more efficient vehicles, fuel switch and behavioural changes in society. All three areas are necessary to reach the 2030. They are working to present as soon as possible a proposal for six policy measures that need to be introduced by 2020 if Sweden wants to reach the 2030 target. The proposed policies will range from bonus-malus for cars and trucks, bonus-malus on fuels, an obligation/reduction quota similar to what Germany have, and some kind of road taxation with a CO2 component. The Swedish 2030-secretariat has introduced 30 indicators that follow the developments towards the target, 10 for each activity area, that evaluate developments. More specifically, 80% reduced dependency on fossil fuels in the transport sector, corresponding to:
  - about 60% reduced CO2e emissions from the transport sector,
  - improved local air quality (NOx, SOx, PM), linked to
  - health improvements; less emissions and more active transport modes,
  - job creation and better trade balance when substituting imported oil (petrol, diesel, natural gas) for partially locally produced renewable energy sources,
  - Sweden's state as role model strengthened; substantial international attention for the target has already been achieved.

The work is focusing on four pillars:
1. Best practice example: By collecting and spreading best practice-examples from municipalities' procurement, energy companies' production, etc., large and cost-effective gains can be made.
2. Policy advocacy: Seven of the eight parties represented in the Swedish parliament form a 2030-reference group, where they are helped to develop their policy proposals, both within their party groups and at parliamentary level. The policy advocacy is also done at the EU/European level, including our Nordic think tank collaboration and a wider network of think tanks all over Europe.
3. Working groups: for specific issues are formed, based on identified needs and decisions from the partners. Some of them are long-term, some ad hoc and short term. Among the current groups Behavioral Change, Biofuel Taxation, Vehicle Taxes and EV infrastructure are the most active.
4. Outreach. The 2030-secretariat is currently the most visible actor in Swedish media on climate issues, which combined with more specific focuses on target groups, means that they have a substantial outreach capacity about fossil independent transports, and how to make the target relevant for all.

Regarding the financial Instruments in Sweden are:

- The Government's Infrastructure Bill: The Government has adopted the infrastructure bill 'Infrastructure for the future – innovative solutions for strengthened competitiveness and sustainable development' (Govt Bill 2016/17:21). The financial framework is proposed to amount to SEK 622.5 billion, which is just over SEK 100 billion more than the current plan. This means that the Government is making a major investment in operation and maintenance, but also that new investments will be possible. The bill contains the direction and financial frameworks for investments in transport infrastructure for the planning period 2018–2029. The proposals in the bill will enable us to achieve the goals of a transition to a fossil-free welfare state, a Sweden that stands together, an increase in housing construction and improved conditions for business. "New ideas are needed with regard to the technology and infrastructure that can contribute to a more sustainable transport system. Increased use of new technologies, for example digitisation and automation, can contribute to the more intelligent use of existing infrastructure and decrease the burden on the transport system. In addition, investments are needed in renewable energy to replace fossil fuels", said Minister for Infrastructure Anna Johansson.

Table 6.1 Framework levels in the applicable plan for 2014–2025 and proposals for the planning period 2018–2029 (Government Offices of Sweden, 2017a)

Framework levels in the applicable plan for 2014–2025 and proposals for the planning period 2018–2029				
SEK billion, 2017 prices	Development	Maintenance Railways	Maintenance Roads	Total framework
According to the current plan 2014–2025	277	85	153	515
Proposed new framework for 2018–2029	333,5	125	164	622,5

- Innovations for Sustainable Cities: Grants for Leading-Edge Technologies and New System Solutions. The Swedish EPA announces in 2017 grants for leading-edge technologies and advanced system solutions for innovations in urban environments. Demographic and economic growth in the world's cities demand innovations for sustainable solutions in areas such as waste, water, air, construction, noise, energy and transport. Such solutions are needed when cities are built, renovated and managed. To meet these needs, a new generation of advanced environmental technologies must be developed.
- Congestion Tax. The congestion charge was reintroduced in the city of Stockholm in 2007. The scheme was tested in 2006, in an attempt to reduce congestion, improve traffic flow and create a healthier environment. Analysis of the results show that traffic volumes has decreased by an average of over 20 percent. The Swedish Transport Agency is in charge of the congestion tax. In Sweden there is a system of

congestion taxes in Stockholm and Gothenburg. The tax applies to vehicles registered in Sweden and outside Sweden. The payment system is completely automatic. When you drive past a control point, this is registered and a payment slip is sent to the owner of the vehicle. If the vehicle is registered abroad, the Swedish Transport Agency has entrusted a notification partner to identify the owner of the vehicle, send out invoices to and obtain payments from the owner of the vehicle via EPASS24. Changes to the congestion tax in Stockholm. In Sweden infrastructure charges can only be charged for a newly built bridge, tunnel or mountain pass, for example, in order to cover the construction costs. If the bridge, tunnel or mountain pass has already been built using public money, under Swedish law no charges may be introduced at a later date. Infrastructure charges are justified by the fact that the people who use the infrastructure are paying for it. If the aim is to reduce congestion in Sweden's city areas, a congestion tax is used instead. Congestion taxes are justified by the fact that the people who are contributing towards congestion and environmental problems are paying for the costs to society this causes.

- Sustainable Järva. The project Sustainable Järva is part of the City of Stockholm's initiative to give its Million Homes Programme-areas a new environmental profile. Using innovative energetics technology, investments in sustainable transportation, and a high degree of resident participation, the project is to promote a positive social, ecological and economic development in Järva. The project is coordinated by the Stockholm Environment and Health Administration together with housing companies, other city administrative departments, and the Royal Institute of Technology.

7 SWOT Analysis

A SWOT analysis for each region to identify situational strengths and weaknesses, as well as opportunities and threats. The analysis would help to explore possibilities or solutions, determine possible changes and reveal priorities about the current situation.

7.1 Centro Region

The Centro Region, in Portugal, is characterized by different rural and urban areas, involving also mountain areas, and is facing challenges concerning mobility issues, namely regarding congestion, air pollution, and safety in urban areas, and cost-efficiency and accessibility in rural and mountain areas.

Regarding the strengths, there have been identified five main strengths in the Centro Region. First, current road and rail infrastructures are still adequate, so no major costly improvements are needed, i.e., the region is served with fairly good quality of roadways, highways and railways. Highways are equipped with cameras and variable message signalization, which is useful for traffic and safety management. Current public transport services are a starting point for the design of strategies to improve daily mobility. The denser areas are served by public transport, namely buses and trains, having adequate public transport networks. Over the years, there can be verified an increasing interest and effort of local entities in addressing rural and mountain mobility issues. At the scientific level there is a significant set of multidisciplinary research units working in the area of transport, new communication technologies, connected communities and soft mobility. At the industrial level there is a strong exporter in the field of soft mobility specifically linked to the bicycle sector.

In terms of weaknesses, there have been identified seven weaknesses. It remains a strong dependence of private cars, despite its higher costs. Lack of public transport, direct connections, low frequencies and inadequate bus stops, specially, due to the low population density and dispersed settlement in rural and mountain areas, where transport operations become difficult, costly and time consuming yielding unprofitability of public transport and inaccessibility for a large part of population of the Centro Region. In general, there are inadequate multimodal transport facilities, specially there is a lack of dedicated and support infrastructures nearby industrial and business centres. There is some lack of information, coordination and cooperation between municipalities and authorities in charge of transport. There can also be pointed out some issues regarding safety, in particular, where safe pedestrian crossings and signage and also citizen safety measures on public transport are still lacking. The lack of alignment between best-practice solutions and the traveller behaviour can be considered as a weakness.

Seven major threats for the Centro Region to move towards sustainable mobility can be stated as follows. In terms of demographic trends, it can be verified population ageing in several areas, which can compromise introduction of new routines, measures, or technologies. It is evident that the commodity and comfort of a trip in a private car is attractive and is associated to the idea of saving travel time, costs, and that is safer than public transports. Motorization rate has shown an increasing trend in recent years. The limited financial funding (at regional and local levels) to expand or improve public facilities and implement new measures and technologies can be a drawback regarding sustainability. Lack of policy will to address rural mobility issues namely regarding the accessibility of public transport services of fairly quality. Growing costs of energy will affect mobility costs, not only for car-drivers, but also for public transport systems. A traveller behaviour change is also challenging and can be considered as a threat.

There have been identified five major opportunities to take advantage of to ensuring a safe, reliable and comfortable, and more sustainable mobility. Availability of new emerging technologies, connected and automated mobility makes possible real-time transport-related information, suitable not only for travellers, but also for traffic planners and policy-makers. It is important to learn from (inter)national experience in other cities, since it allows to bring valuable insights in terms of possible applicability of specific measures or technologies, and can be considered references to build a sustainable transportation system. In the last few years, electric mobility has gained huge attention as an alternative to conventional, so there is a favourable climate to invest in facilities for electric mobility. There can be also referred that the growing environmental concerns and consciousness for sustainable mobility can be regarded as an opportunity. Another opportunity is to invest in existing transport systems to improve or establish new or expand networks, since the Centro Region is already served by a good network system.

Despite many behavioural and technological solutions had already been implemented in several areas of Centro Region, such as:

- promotion of cycling with construction of cycle lanes;
- bike sharing systems;
- creation of electric vehicle charging network;
- implementation of specific charging systems in highways, that can be regarded as car usage deterrent measures,

The truth is that there is much more that can be done on Centro Region regarding sustainable mobility. It is important to strengthen the role of public transportation in mobility, as well as ensure accessibility and affordability and also an intermodal integration. It is also important to implement specific measures contributing to the reduction of emissions, noise, congestion and delays.

Table 7.1 SWOT grid analysis of the mobility situation in Centro Region and possible actions

External Level	Threats	Opportunities
	Challenging demographic trends (population ageing in several areas)	Availability of new emerging technologies
	Comfort of private cars	Learn from (inter)national experience in other cities
	Increasing trend of motorization vehicles	Favourable climate to invest in facilities for electric mobility
	Limited financial funding	Rising consciousness for sustainable mobility
	Lack of policy will to address rural mobility issue	Investing in existing transport systems to improve or establish new or expand networks
	Growing costs of energy will affect mobility costs	
Internal Level	Behaviour change challenges	
Strengths	**Strengths-Threats Strategies Use strengths to avoid threats (Actively confront)**	**Strengths- Opportunities Strategies Use the strengths to take advantage of opportunities (Maximize potential)**
Quality of roadway, highway and railway infrastructures are adequate	Develop strategic plan with emphasis on improving public transport services	Invest in intelligent traffic control systems
Cameras and variable message signs already exist along some sections of highways	Design schemes of cooperation between local and regional entities	Implement integrated real-time travel information regarding mode and route choices and associated costs and environmental impacts.
Competitive rail rates in urban lines.	Study of spatial, technical, organizational and applicability issues for improving both quality of life and environmental effects	Reorganize bus routes and implement more flexible (electric) (mini)bus services
Provision of public transport services	Develop a long-term strategy to support sustainable forms of transport	Increase the public transport proximity offer
Interest and effort of local entities in addressing rural and mountain mobility issues		Create free parking facilities near train stations and reformulate urban parking policies
High quality of research units on transport, environmental, IT, urban studies.		Provide intermodal passenger information on bus and train stations
Air quality is not critical in the majority of territory		Demand synchronization schedules among different public transports
		Create the necessary support schemes to overcome social exclusion and transport disadvantage
		Implement video surveillance to improve safety on public transports
		Improve comfort and quality of public transport facilities and services
		Implement online reservation systems and smart ticketing

Weaknesses	Weaknesses-Threats Strategies Minimize weaknesses and avoid threats (Avoid exposure)	Weaknesses- Opportunities Strategies Overcome weaknesses by taking advantage of opportunities (Improve to meet potential)
		Implement carpooling for employees of local entities and carpooling incentive programs
		Implement congestion charging systems for most of the vehicles, with exception for hybrid and electric cars, and public transport (first, an experience as a trial, then, permanently, if benefits are achieved)
Strong dependence of private cars	Restrict car use in urban centres	Review processes and coordinate efforts to address mobility, environmental and safety issues
Low population density and dispersed settlement specially, in rural and mountain areas (transport operations become difficult, costly and time consuming)	Prioritize improvement of public transport and soft modes	Expand the network of stationary and mobile cameras for traffic and safety management
Lack of direct connections, low frequencies	Improve and expand cycling and walking network	Consider planning transport systems based on regional co-operation and integration
Lack of coordination between municipalities	Disseminate negative impacts of the use of private car and promote multimodal mobility	Consider public transport information on vehicle, stops, mobile applications
Inadequate multimodal transport facilities	Improve the quality of the buses stop stations	Consider development of mobile services to improve multimodal regional journey planning
Safety issues regarding public transports, specially buses	Encourage carpooling and car sharing	Evaluate integrated parking policies
Lack of alignment between best-practice solutions and the traveller behaviour	Promote online survey in order to seek citizens' opinion regarding some specific measures	Evaluate incentives to privilege the use of public transport instead of private
NOx and PM concentrations during some periods		Consider incentives for new hybrid or electric cars
Unawareness of the ability of infrastructures to receive CAVs		Evaluate implementation of congestion charging systems

7.2 Águeda

Águeda presents a population and employment dimension, as well as a set of equipment and services with importance in regional terms that allows to be configured as a reference point within the Aveiro Region. The population and employment dimension also give the municipality a critical mass for the development of collective transport solutions, both for inter-municipal and intra-municipal connections, so as to reduce the dependence on the car.

There is a strong contrast between the East and West of the County, which is reflected in several dimensions - Orography; Population, Demography; Employment; Poles of Attraction

and Generation of trips, etc. The different territorial characteristics require different approaches adapted to their specificities.

Mobility in the municipality of Águeda is clearly marked by a strong propensity to use the car - only 13% of the surveyed households do not own a car, with 44% of households with 2 or more cars available.

The modal split is strongly favorable to individual transport (81%) with pedestrian journeys in second place with 13%. Collective transport (CT) appears as a residual option - only 3%. This modal split does not show any great variation with the alteration of the travel motives, and only the trip to school presents some weight of trips in CT (18%).

There is a strong dynamism in the qualification and consolidation of integrated pedestrian and cycling networks, both in an urban and leisure context.

In the urban context - daily mobility - plans for the Promotion of Accessibilities and Urban Regeneration Projects are underway aimed to improving pedestrian conditions and qualification of the public space. There is also a proposal for the cycling network, which encompasses the city and its environs, of which the first phase is already built and an electric bicycles loan service is implemented, integrated into the BeÁgueda project.

The bicycle parking network in the city is almost fully structured, there will be parking spaces for bicycles next to the main collective equipments (near the City Hall, Schools, Municipal Library and Tourism Office).

There is a high potential for Individual Transport to soft modes, as 18% of IT travel is less than 1km and 52% less than 4km.

Table 7.2 SWOT grid analysis of the mobility situation in Águeda and possible actions

Strengths	Weaknesses
High number of internal trips to the county performed by residents, which makes it possible to infer that this is self-sufficient for a very significant set of activities	High rate of motorization and high dependence on car
There is a strong and structured offer of pedestrian and cycling network of tourist and leisure scope	17% of residents have at least one type of expenditure with vehicle paid by the company, which makes it difficult to transfer to other modes of transport
Águeda is one of the counties in which cycling has greater expression and dynamism although not in a context of daily mobility	The share of the "walking" mode is relatively low and is conditioned by the orographic characteristics
Electric Bicycle Loan Service provided by the pilot project of shared use of bicycles "BeÁgueda"; cycling network and high levels of bicycle ownership	Almost residual importance of collective transport on daily commutes, as well as on the bicycle
Reasonable coverage of the territory by the road transport network during the school period	Despite the investments already made, the use of soft modes for daily trips is low, especially in the case of bicycle
Coexistence by road and rail	There are problems of improper occupation of cycle tracks and pedestrian zones which jeopardize the comfort and safety of journeys, also contributing to the deterioration of the public space

An important part of the collective transport (CT) careers is operated by the same operator, which can facilitate the negotiation process of the restructuring of careers and an easier acceptance of the introduction of innovative CT measures	In some areas the orography may be a deterrent to the use of soft modes and there are problems associated with the flows and profile of the road network, especially in agglomerations crossed by national roads
	Low CT service frequency
	Strong dependence on the demand associated to the segment "students", with a significant reduction of the collective road transport supply in the non-school periods
Opportunities	**Threats**
Most of the trips have short extensions, compatible with the adoption of smooth modes of travel	The county has an orography and physical barriers that may be adverse to the implementation of pedestrian and cycling networks
Bet on the development of a pedestrian and cycling network, contributing to the effective transfer of travel in IT to the soft modes	Inability to mobilize the younger population to use soft modes on their trips to school, combined with the concentration of schools at larger poles
Existence of some potential to improve and adapt the TC network to the needs of residents	The Vouga Railway Line is on the list of lines to be closed in the Strategic Transport Plan (PET), and as such, if it does not have the capacity to recover part of the demand, it is to be admitted that this will happen
There is a favorable environment for promoting the use of soft modes, either through increased awareness of the population about environmental problems, or through fuel prices and collective transports tariffs	
There is a concerted strategy at the regional level to promote soft modes	
High fuel prices and the economic crisis may favor a greater transfer to the CT, if conditions are created for this	
Alteration of the regulatory framework for passenger transport, imposing the need to contract public transport services and giving more power to municipalities in the organization and management of the transport system	
Legal opening for the emergence of flexible transport services logics that improve accessibility in lower density areas of demand	

7.3 Extremadura

Extremadura, in Spain, is sparsely populated and has serious mobility issues in terms of circulation, congestion, parking, air pollution, and noise in urban areas, since there are important daily flows of entrance in urban centres, mostly due to the massive private vehicle use and the confluence of a large volume of users in specific areas and specific hours of the day. These affect negatively both population's quality of life and historical heritage of city centres in Extremadura. Various measures have been implemented in order to promote sustainable mobility development, having in mind the need of prioritizing the reduction of private transport in favour of public or promoting the use of soft modes of transport.

Table 7.3 SWOT grid analysis of the mobility situation in Extremadura

Strengths	Weaknesses
Good network of public roads	Low population density and large territory
Extremadura is one of the most large territory of union with Portugal and especially with Lisbon	Interurban public transport with low quality in terms of connections number and commodity
Extremadura is a convergence objective of first priority for European Funds	Low development of sustainable transport infrastructure
	Low impact of ICTs in the transport sector
Threats	**Opportunities**
User's mentality focused on individual and inefficient transport	Great potential for growth in the use of public transport
Low offer of sustainable transport in the regional market	Beneficial orography for the creation of transport networks
Small investment capacity	Extremadura is an exporter of electrical energy whose production is low in CO_2 emissions

7.4 Romania

Romania is characterized by different rural and urban areas, involving a wide range of geographic zones from flat planes to high mountains. It is also a large territory so a mix of transport modes from road to air is necessary to cover the mobility needs. Romania is facing challenges concerning mobility issues, mostly regarding congestion, safety and air pollution for road transport and a rail transport network affected by low investments in maintenance over the last 10 years.

Regarding the strengths, there have been identified four main strengths in Romania. First, rail infrastructure is very extended so it covers a major part of the territory. Relatively small investments for rehabilitation of the most degraded links could ensure efficient services as a real alternative for road transport. The economic environment, business opportunities and the skilled workforce in Romania are contributing to the development of important manufacturing, research and development industrial poles. These drive and support local and national authorities to develop transport infrastructure and mobility solutions for their workforce and also for the transport logistics related to the manufacturing process. At the scientific level there is a significant set of multidisciplinary research institutes and universities working in the area of transport, new communication technologies, connected communities and soft mobility. At the industrial level there are several strong and mature companies (some local and others subsidiaries of major international companies) in the fields of ITS, IT and Communications.

In terms of weaknesses, there have been identified five weaknesses. It remains a strong dependence of private cars, despite its higher costs. Lack of good quality and reliable train services determines people to use private cars or mini-bus and coach transport services. Many national roads are in a poor condition and not built for the current traffic volumes. Also, the motorway network is underdeveloped therefore it is difficult to ensure the mobility of people and goods. In general, there are inadequate multimodal transport facilities, specifically there is a lack of multimodal transport hubs in and around major cities. There is some lack of information, coordination and cooperation between municipalities and National Motorway Company in charge of national roads and motorways.

Three major threats for Romania to move towards sustainable mobility can be mentioned. In terms of investment, bureaucracy is quite high and there is a lack of knowledge and expertise to attract especially European funding. Bureaucracy and sometimes bad management leads to long implementation times for major infrastructure projects. Motorization rate has shown a sharp increasing trend in recent years. The commodity and comfort of a trip in a private car is attractive and is associated to the idea of saving travel time, costs, and with a certain increased social statute.

There have been identified four major opportunities for more sustainable mobility in Romania. ITS services and systems for road transport are in an emerging stage in Romania. This is an opportunity to implement the latest technologies integrated and correlated at national level. The young and mature (up to 45 years old) age groups are very open to new technologies and readily adopt new mobility services like car sharing, ride sharing, traveller information apps etc. This is an opportunity to reduce the usage of private cars and to increase the share of public transport systems supported by ITS technologies. In the last few years, electric mobility has gained huge attention as an alternative to conventional, so there is a favourable climate to invest in facilities for electric mobility. On one hand people buying electric or hybrid cars receive financial incentives. On the other hand, a national legislative framework is in place for the development of charging infrastructures in cities and on national roads. There are also private developments of charging stations in a few cities. Another opportunity is that national investment programmes, leveraging on European funds, are becoming mature and national beneficiaries are starting to have the necessary expertise to develop and manage the projects.

Table 7.4 SWOT grid analysis of the mobility situation in Romania and possible actions

	Threats	Opportunities
	Lack of knowledge and expertise to attract especially European funding	Emerging ITS implementation
	Long implementation times for major infrastructure projects	The young and mature (up to 45 years old) age groups are very open to new technologies
	Increased motorization rate	Favourable climate for electric mobility
		More mature national investment programmes
Strengths	**Strengths-Threats Strategies Use strengths to avoid threats (Actively confront)**	**Strengths- Opportunities Strategies Use the strengths to take advantage of opportunities (Maximize potential)**
Good national coverage of railway infrastructure	Develop strategic plan for railway transport development	Invest in railway infrastructure
Active industrial poles	Design schemes of cooperation between private and public entities	Implement ITS systems for traffic management and open data for logistics. Implement carpooling for employees of local entities and carpooling incentive programs
High quality of research institutes and universities on transport, environmental, IT, urban studies.	Support and encourage knowledge transfer between academia, industry and policy makers	Develop innovative solution for electric and sustainable mobility
Strong and mature ITS, IT and Communication local industry	Develop a long-term strategy to support sustainable forms of transport	Increase the investments in ITS and smart city solutions
Weaknesses	**Weaknesses-Threats Strategies Minimize weaknesses and avoid threats (Avoid exposure)**	**Weaknesses- Opportunities Strategies Overcome weaknesses by taking advantage of opportunities (Improve to meet potential)**
Strong dependence of private cars	Prioritize improvement of railway transport	Review processes and coordinate efforts to address mobility, environmental and safety issues
National roads are in a poor condition and not built for the current traffic volumes		
Motorway network is underdeveloped		
Lack of multimodal transport hubs in and around major cities	Disseminate negative impacts of the use of private car and promote multimodal mobility	
Lack of information, coordination and cooperation between municipalities and National Motorway Company	Consider revising the legal framework to better support the cooperation and coordination	Consider development of mobile services to improve multimodal regional journey planning

7.5 Bucharest

Bucharest is the capital of Romania and its biggest city. It is currently facing challenges concerning mobility issues, mostly regarding congestion, safety and air pollution as a result of a sharp increase in motorization and a fast urban growth over the last years.

Regarding the strengths, there have been identified three main strengths in Bucharest. First, as capital city, in is very attractive for businesses which provide important revenues for the local budget. Bucharest has a good tram network complemented by several electric trolleybuses. This provides a good option for a clean, electric public transport network. The metro system is another efficient and clean public transport solution.

In terms of weaknesses, there have been identified six weaknesses. It remains a strong dependence of private cars, despite its higher costs. Lack of reliable and integrated public transport services determines people to use private cars. The majority of the street network was not designed to cope with the current traffic volumes. Also, some urban developments were done without planning and building the necessary transport infrastructure for people and goods. Moreover, the lack of a complete, high-capacity ring road brings most of the transit traffic thru the city centre. There is a lack of proper multimodal transport hubs in major nodes like the main railway station or the airport. In terms of ITS, systems for traffic management, public transport management and traveller information are not very well developed. Further investments and implementations are needed.

Four major threats for Bucharest to move towards sustainable mobility can be mentioned. In terms of investment, bureaucracy and sometimes bad management leads to long implementation times for major infrastructure projects. Motorization rate has shown a sharp increasing trend in recent years. The commodity and comfort of a trip in a private car is attractive and is associated to the idea of saving travel time, costs, and with a certain increased social statute. This in turn has led to congestion, pollution and noise. Especially for surface public transport, investments in maintenance of fleet and infrastructure have been insufficient over the last years. This contributed to the decrease of the quality and capacity of the service.

There have been identified four major opportunities for more sustainable mobility in Bucharest. There is an increased awareness of the need to implement ITS systems so the investments in this area are starting to increase. The young and mature (up to 45 years old) age groups are very open to new technologies and readily adopt new mobility services like car sharing, ride sharing, traveller information apps etc. This is an opportunity to reduce the usage of private cars and to increase the share of public transport systems supported by ITS technologies. In the last few years, electric mobility has gained huge attention as an alternative to conventional, so there is a favourable climate to invest in facilities for electric mobility. On one hand people buying electric or hybrid cars receive financial incentives. On the other hand, a national legislative framework is in place for the development of charging infrastructures in cities and on national roads. In Bucharest there are already private developments of charging stations. Another opportunity is the increased awareness and

willingness to use non-motorized transport modes like cycling. Three private bike-sharing services are already operating in Bucharest.

Table 7.5 SWOT grid analysis of the mobility situation in Bucharest and possible actions

	Threats	Opportunities
	Congestion, pollution and noise	Increased awareness of the need to implement ITS systems
	Long implementation times for major infrastructure projects	The young and mature (up to 45 years old) age groups are very open to new technologies
	Increased motorization rate	Favourable climate for electric mobility
	Investments in maintenance of public transport fleet and infrastructure have been insufficient over the last years	Increased awareness and willingness to use non-motorized transport modes like cycling
Strengths	**Strengths-Threats Strategies Use strengths to avoid threats (Actively confront)**	**Strengths- Opportunities Strategies Use the strengths to take advantage of opportunities (Maximize potential)**
Very attractive for businesses which provide important revenues for the local budget	Develop strategies and mechanisms to cooperate with private sector and benefit from private investments	Invest in ITS infrastructure
Good tram network complemented by several electric trolleybuses	Develop strategies for the integrated planning of tram, trolleybus and bus network	Reorganize bus routes and implement electric/hybrid/alternative fuels bus services
Efficient metro system	Develop strategies for the integrated planning of surface and underground transport	Implement integrated real-time travel information systems
Weaknesses	**Weaknesses-Threats Strategies Minimize weaknesses and avoid threats (Avoid exposure)**	**Weaknesses- Opportunities Strategies Overcome weaknesses by taking advantage of opportunities (Improve to meet potential)**
Strong dependence of private cars	Restrict car use in urban centres	Review processes and coordinate efforts to address mobility, environmental and safety issues
The majority of the street network was not designed to cope with the current traffic volumes	Prioritize improvement of public transport	Evaluate incentives to privilege the use of public transport instead of private
Some urban developments were done without planning and building the necessary transport infrastructure for people and goods	Improve urban planning strategies	Encourage initiatives like carpooling, car sharing and ride sharing
Lack of proper multimodal transport hubs in major nodes	Disseminate negative impacts of the use of private car and promote multimodal mobility	
Lack of a complete, high-capacity ring road		
Low deployment rate of ITS		

8 References

AECOM. (2011). *Study on Public Transport Smartcards – Final Report*.

Andersen, C. L., & Muhammed, R. (2013). Automatic Incident Detection in Denmark and Hard Shoulder Running on the Hillerød Motorway.

Anderson, J., Kalra, N., Stanley, K., Sorensen, P., Samaras, C., & Oluwatola, O. (2016). *Autonomous Vehicle Technology: A Guide for Policymakers*. RAND Corporation. https://doi.org/10.7249/RR443-2

ANPM. (2014). *CALITATEA AERULUI ÎN ROMÂNIA ÎN ANUL 2014*. Retrieved from http://www.anpm.ro/documents/12220/2723600/Raport+calitatea+aerului+2014.pdf/8b9e87da-c03e-4815-8723-cdfe52e1e563

Busher, V., Doody, L., Webb, M., & Aoun, C. (2014). Urban mobility in the smart city age. *Smart Cities Cornerstone Series*.

calitateaer.ro. (n.d.). Calitate Aer | Acasă. Retrieved October 3, 2017, from http://calitateaer.ro/public/home-page/?__locale=ro

ccdrc.pt. (n.d.). Regional Development Committee of Centro Region (CCDRC). Retrieved October 3, 2017, from http://www.ccdrc.pt/

civitas.eu. (n.d.). CivitasInitiative | Clean and Better Transport in Cities. Retrieved October 2, 2017, from http://civitas.eu/

DGTerritório. (2016). DGTerritório - CAOP 2016. Retrieved August 30, 2016, from http://www.dgterritorio.pt/cartografia_e_geodesia/cartografia/carta_administrativa_oficial_de_portugal__caop_/caop_em_vigor/

EC. (2003). Communication from the Commission-European Road Safety Action Programme. Halving the Number of Road Accident Victims in the EU by 2010, 40. https://doi.org/COM/2003/0311

EC. (2008). *Action Plan for the Deployment of Intelligent Transport Systems in Europe*. COM (Vol. 1612). Brussels .

EC. (2011a). *EU transport in figures 2012. Luxembourg: Publications Office of the European Union*. *Luxembourg: Publications Office of the European Union*. https://doi.org/10.2832/52252

EC. (2011b). White Paper - Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system. *Comission Staff Working Paper*, *COM(2011)*(144 final), 170. https://doi.org/http://ec.europa.eu/transport/strategies/doc/2011_white_paper/white_paper_2011_ia_full_en.pdf

EC. (2016a). *A European strategy on Cooperative Intelligent Transport Systems, a milestone towards cooperative, connected and automated mobility*. COM (Vol. 30). Brussels.

EC. (2016b). Digital Scoreboard | Digital Single Market. Retrieved December 11, 2016, from https://ec.europa.eu/digital-single-market/en/scoreboard

EC. (2016c). Portugal | Digital Single Market. Retrieved December 11, 2016, from https://ec.europa.eu/digital-single-market/en/scoreboard/portugal

EC. (2016d). Romania | Digital Single Market. Retrieved December 11, 2016, from https://ec.europa.eu/digital-single-market/en/scoreboard/romania

EC. (2016e). Spain | Digital Single Market. Retrieved December 11, 2016, from https://ec.europa.eu/digital-single-market/en/scoreboard/spain

EC. (2016f). Sweden | Digital Single Market. Retrieved December 11, 2016, from https://ec.europa.eu/digital-

single-market/en/scoreboard/sweden

EC. (2017). The EU Environmental Implementation Review Country Report -ROMANIA. Retrieved from http://ec.europa.eu/environment/eir/pdf/report_ro_en.pdf

Edwards, S., & Evans, G. (2010). *GUIDELINES FOR IMPLEMENTERS OF Using Environmental Pollution Data in Traffi c Management Centres*.

EEA. (2014). Air pollution country fact sheets (2014) — European Environment Agency. Retrieved October 2, 2017, from https://www.eea.europa.eu/themes/air/air-pollution-country-fact-sheets-2014/air-pollution-country-fact-sheets-2014

EEA. (2015a). *Air quality in Europe — 2015 report*.

EEA. (2015b). NOISE_Database | ETC Spatial Information and Analysis. Retrieved August 12, 2016, from http://forum.eionet.europa.eu/etc-sia-consortium/library/noise_database/

estradas.pt. (n.d.). Portal de Estradas. Retrieved October 2, 2017, from http://www.estradas.pt/index

EU. (2008). Regions 2020. An Assessment of Future Challenges for EU Regions. *Communities*, (November).

European Environment Agency. (2013). *Air pollution by ozone across Europe during summer 2012 : Overview of exceedances of EC ozone threshold values for April-September 2012.* Publications Office of the European Union.

Eurostat. (2016a). Eurostat - Population density by NUTS 2 region. Retrieved August 31, 2016, from http://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=tgs00024&plugin=1

Eurostat. (2016b). Greenhouse gas emissions from transport. Retrieved September 12, 2016, from http://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=tsdtr410&plugin=1

Eurostat. (2016c). Income of households by NUTS 2 regions. Retrieved November 30, 2016, from http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nama_10r_2hhinc&lang=en

Eurostat. (2016d). Population on 1 January by NUTS 2 region - Eurostat. Retrieved August 30, 2016, from http://ec.europa.eu/eurostat/web/products-datasets/-/tgs00096

Eurostat. (2016e). Regional Economic Accounts -ESA 2010. Retrieved August 31, 2016, from http://ec.europa.eu/eurostat/web/regions/data/database

Eurostat. (2016f). Total and land area by NUTS 2 region - Eurostat. Retrieved August 30, 2016, from http://ec.europa.eu/eurostat/web/products-datasets/-/tgs00002

Eurostat. (2016g). Victims in road accidents by NUTS 2 regions. Retrieved November 21, 2016, from http://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do

Evenepoel, S., Van Ooteghem, J., Verbrugge, S., Colle, D., & Pickavet, M. (2014). On-street smart parking networks at a fraction of their cost: performance analysis of a sampling approach. *Transactions on Emerging Telecommunications Technologies*, *25*(1), 136–149. https://doi.org/10.1002/ett.2776

EY. (2014). *Smart ticketing on transport*.

FLIR. (n.d.). Video-based Automatic Incident Detection and Traffic Statistics in the Clem Jones Tunnel – Brisbane (Australia). Retrieved January 27, 2017, from http://www.flir.co.uk/traffic/display/?id=61010

García-Palomares, J. C., Gutiérrez, J., & Latorre, M. (2012). Optimizing the location of stations in bike-sharing programs: A GIS approach. *Applied Geography*, *35*(1–2), 235–246. https://doi.org/10.1016/j.apgeog.2012.07.002

Gelencser, A., Hopkin, J., Tindall, D., & Francsics, J. (2010). *Cooperative vehicle highway systems – implications for the Highways Agency*.

Government Offices of Sweden. (2017a). Ministry of Enterprise and Innovation. Retrieved October 1, 2017, from http://www.government.se/

Government Offices of Sweden. (2017b). Swedish National Board of Housing, Building and Planning. Retrieved September 29, 2017, from http://www.government.se/

Govier, P. (n.d.). *Traffic Management Systems with Air Quality Monitoring Feedback*.

Halvorsen, I. (2011). National Road Database in Sweden, NVDB Head of section Development Road and Railway Data Department. Retrieved from https://ec.europa.eu/transport/sites/transport/files/themes/its/events/doc/2011_03_29/2011_03_29-43-swedish-solution.pdf

Hanfried, A., BEASLEY Simon, D., Gino, F., HASELBERGER Rainer, S. I., HEDIN Johan Hybris Konsult IZDEBSKI Piotr ZTM Warsaw PL JENSEN Helge, A. S., & KEARNS Steve, N. (2013). *Guidilines for ITS Deployment in Urban Areas - Traffic Management*.

Heinen, E., van Wee, B., & Maat, K. (2010). Commuting by Bicycle: An Overview of the Literature. *Transport Reviews*, *30*(1), 59–96. https://doi.org/10.1080/01441640903187001

INE. (2012). Instituto Nacional de Estatística, Censos 2011. Retrieved September 1, 2016, from http://censos.ine.pt/xportal/xmain?xpid=CENSOS&xpgid=censos_quadros_populacao

INE. (2014). Statistics Portugal. Retrieved September 1, 2016, from https://www.ine.pt/xportal/xmain?xpid=INE&xpgid=ine_destaques&DESTAQUESdest_boui=211523163&DESTAQUESmodo=2

Institute for Transport Studies, University of Natural Resources and Applied Life Sciences, & (BOKU). (2010). *Innovative ticketing systems for public transport*. Vienna.

ITS America. (2013). Smart parking key to sustainable urban mobility. Retrieved January 23, 2017, from http://www.itsinternational.com/categories/parking-access-control/features/smart-parking-key-to-sustainable-urban-mobility/

Korzhenevych, A., Dehnen, N., Bröcker, J., Holtkamp, M., Meier, H., Gibson, G., … Cox, V. (2014). Update of the Handbook on External Costs of Transport. *Final Report*, (1), 139. https://doi.org/Ref: ED 57769 - Issue Number 1

Lameiras, H. (2015). Relatório da Qualidade do Ar na Região Centro 2014. Retrieved from http://www.ccdrc.pt

Litman, T. A., & Doherty, E. (2009). Travel Time. *Transportation Cost and Benefit Analysis*, (August), 1–24.

Manoiu, V.-M., Gheorghe, S., & Craciun, A.-I. (2016). THE SYNOPTIC CONDITIONS AND THE CRITICAL LEVELS OF POLLUTION FOR SPECIFIC SITUATIONS IN BUCHAREST. Retrieved from http://search.proquest.com/openview/87d031d55b66537817204ed56fa12643/1?pq-origsite=gscholar&cbl=2026591

OECD. (2014). *The Cost of Air Pollution*. OECD Publishing. https://doi.org/10.1787/9789264210448-en

Olson, J., Hodges, C., & Bouget, J. (2015). *Electric Bicycle Share Feasibility Study*. New York.

Peng, Z.-R., Yu, D., & Beimborn, E. (2002). Transit User Perceptions of the Benefits of Automatic Vehicle Location. *Transportation Research Record: Journal of the Transportation Research Board*, *1791*, 127–133. https://doi.org/10.3141/1791-19

Persad, K., Walton, M. C., & Hussain, S. (2006). *Toll Collection Technology and Best Practices*. Austin, Texas.

Pordata. (2016). PORDATA - Search Environment. Retrieved November 15, 2016, from http://www.pordata.pt/en/DB/Municipalities/Search+Environment/Table

Predic, B., Rancic, D., & Milosavljevic, A. (2010). Impacts of Applying Automated Vehicle Location Systems to Public Bus Transport Management. *Journal of Research and Practice in Information Technology*, *42*(2).

Ranjini, R., & Manivannan, D. (2013). A Comparative Review on Car Parking Technologies. *International Journal of Engineering and Technology*, *5*(2), 1763–1767.

Reconquista, Semanário Regional da Beira Baixa (2016). Retrieved October 30, 2017, from

http://www.reconquista.pt/articles/bombeiros-sistema-de-comunicacao-por-gps-arranca-em-castelo-branco

REPICA. (2017). Red Extremeña de Protección e Investigación de la Calidad del Aire. Retrieved October 2, 2017, from http://xtr.gobex.es/repica/Informes/historico.html

Singh, B., & Gupta, A. (2015). Recent trends in intelligent transportation systems: a review. *Journal of Transport Literature*, *9*(2), 30–34. https://doi.org/10.1590/2238-1031.jtl.v9n2a6

SLB. (2017). SLB-analys. Retrieved September 18, 2017, from http://slb.nu/slbanalys/

SMHI. (2017). SIMAIR - model tool for Air Quality | SMHI. Retrieved September 25, 2017, from https://www.smhi.se/en/research/research-departments/air-quality/simair-model-tool-for-air-quality-1.6830

SMTUC Serviços Municipalizados de Transportes Urbanos de Coimbra (2017). Retrieved September 30, 3017, from http://smtuc.pt/avisos/main.php?id=882

SWARCO Romania. (2017). SWARCO Romania. Retrieved May 11, 2017, from https://www.swarco.com/romania-en

Tempier, R., & Rapp, P. (2011). *ITS ACTION PLAN Study "Towards a European Multi-Modal Journey Planner"* Brussels.

TNS Opinion & Social. (2014). *Special Eurobarometer 422a "Quality of Transport."* https://doi.org/10.2832/783021

Trafik Stockholm. (2017). Swedish Transport Administration traffic management centre. Retrieved September 12, 2017, from http://www.trafikstockholm.com/docs/en/index_en.html

Urban ITS Expert Group. (2013). *Guidelines for ITS Deployment in Urban Areas*.

viaverde.pt. (n.d.). Via Verde: Anda consigo. Retrieved October 2, 2017, from https://www.viaverde.pt/

Wardman, M., & Chintakayala, P. (2012). European wide meta-analysis of values of travel time. *Final Report*, (May). Retrieved from http://www.significance.nl/papers/2012-European wide meta-analysis of values of travel time.pdf

www.ccg.pt. (n.d.). Urban Probe - Urban spaces monitoring system based on computer vision. Retrieved October 2, 2017, from http://www.ccg.pt/en/projetos/urbanprobe/

Yen, R., & Lyoen, C. (2012). ITS ACTION PLAN D6 – Final Report of the Study regarding liability aspects of ITS applications and services EUROPEAN COMMISSION Directorate-General for Mobility and Transport.