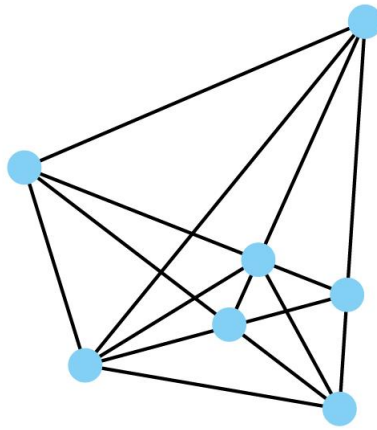




STARDUST

Smart City level in lighthouse cities

D1.2: Smart City level in lighthouse and follower cities
WP 1, T1.3

Terttu Vainio (VTT); Kaj Mäntylä (VTT); Sergio Diaz de Garayo(CEN); Gabriele Zacco (FBK); Alyona Zubaryeva, Adriano Bisello (EUR)



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1. Technical references

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- * PU = Public
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3. Introduction

3.1. Smart City

EU defines a smart city as ‘a place where traditional networks and services are made more efficient with the use of digital and telecommunication technologies, for the benefit of its inhabitants and businesses’. Smart cities are innovative, making traditional networks and services more efficient by using digital technologies, creating more inclusive, sustainable and connected cities for the benefit of inhabitants, public administrations and businesses. Smart cities have the potential to improve the quality of life, while ensuring the needs of present and future generations with respect to economic, social and environmental challenges.

The concept of smart cities covers a broad range of areas - the economy, the environment, mobility, or governance. Some practical applications include efficient ways to light and heat buildings, or the introduction of wireless sensors for waste disposal facilities to optimise collection schedules. Smart urban transport networks can reduce congestion: for example, a city that operates as an integrated system would be able to reconfigure its activity if a traffic incident occurs, temporarily rerouting emergency services to avoid congestion, or sending additional public transport services to affected parts of the city. These technological advances can also enhance the understanding of how cities function and provide the potential for considerable efficiency savings, which may in turn help reach the Europe 2020 targets.

3.2. Content of report

This report introduces the three lighthouse cities and their smart city baseline. While all three are medium size cities at European level, their baselines have adopted from Ranking of European medium-sized cities¹. The medium-sized cities meet following criteria:

- Urban population between 100,000 and 500,000 (to obtain medium-sized cities)
- At least 1 University (to exclude cities with weak knowledge basis)
- Catchment area less than 1.500,000 inhabitants (excl. cities dominated by a bigger city).

¹ <http://www.smart-cities.org/>



3.3. Smart City assessment - method and benchmarking

The model developed by TU-Wien considers in its fourth version 90 indicators within six keyfields of urban development – smart economy, smart mobility, smart environment, smart people, smart living and smart governance (Figure 3.1). Each of the key fields consists of domains grouping one or more indicators. Assessment indicators are partly city specific, partly national (Annex 1). The aggregation sums standardised values of indicators within the different domains. The standardisation process uses the z-transform method:

$$z_i = (x_i - \bar{x}) / s.$$

This way all indicators transfers into values with average 0 and standard deviation 1. The aggregation considers the coverage rate of each indicator. The sum of values divides by the number of them. Benchmarking performed by using a system diagram visualising the six key fields with usually three cities. A ranking of cities is possible by selecting one of the rankings within the key fields or a result thereof. A final ranking over the six domains is available, however the method could not be identified from the available sources.

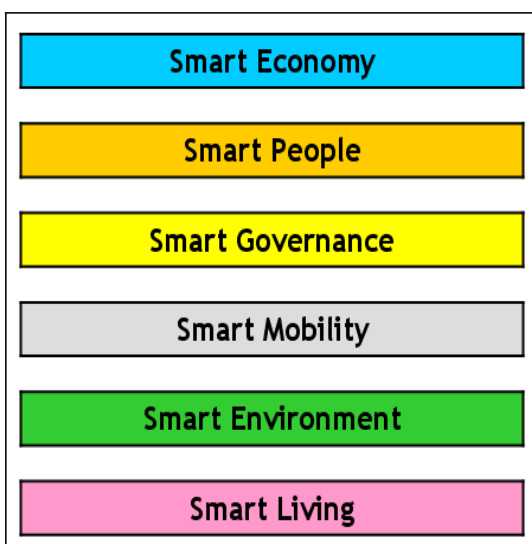


Figure 3.1. Characteristics of a smart city.



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Table 2 illustrates the assigned factors for the six characteristics. Smart Economy includes factors all around economic competitiveness as innovation, entrepreneurship, trademarks, productivity and flexibility of the labour market as well as the integration in the (inter-)national market.



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Table 2. Characteristics and factors of a smart city

SMART ECONOMY (Competitiveness) • Innovative spirit • Entrepreneurship • Economic image & trademarks • Productivity • Flexibility of labour market • International embeddedness • <i>Ability to transform</i>	SMART PEOPLE (Social and Human Capital) • Level of qualification • Affinity to life long learning • Social and ethnic plurality • Flexibility • Creativity • Cosmopolitanism/Open-mindedness • Participation in public life
SMART GOVERNANCE (Participation) • Participation in decision-making • Public and social services • Transparent governance • <i>Political strategies & perspectives</i>	SMART MOBILITY (Transport and ICT) • Local accessibility • (Inter-)national accessibility • Availability of ICT-infrastructure • Sustainable, innovative and safe transport systems
SMART ENVIRONMENT (Natural resources) • Attractivity of natural conditions • Pollution • Environmental protection • Sustainable resource management	SMART LIVING (Quality of life) • Cultural facilities • Health conditions • Individual safety • Housing quality • Education facilities • Touristic attractiveness • Social cohesion

Smart People describes besides by the level of qualification or education of the citizens but also by the quality of social interactions regarding integration and public life and the openness towards the “outer” world. Smart Governance comprises aspects of political participation, services for citizens as well as the functioning of the administration.

Local and international accessibility are important aspects of Smart Mobility as well as the availability of information and communication technologies and modern and sustainable transport systems.



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Smart Environment is described by attractive natural conditions (climate, green space etc.), pollution and resource management and also by efforts towards environmental protection. Finally, Smart Living comprises various aspects of quality of life as culture, health, safety, housing, tourism etc.

Figure 3.2 summaries benchmarking of the three Stardust lighthouse cities and average of all assessed 77 medium-sized cities. Among assessed 77 (2014) and 70 (2007) cities, ranking of Stardust cities have been: Pamplona 38. (2014) and 42. (2007); Tampere 9. (2014) and 6. (2007); Trento 52. (2014) and 45. (2007).

The best medium-sized cities in year 2014 by characteristics were Luxembourg (Smart Economy), Eskilstuna (Smart People), Jyväskylä (Smart Governance), Eindhoven (Smart Mobility), Umeå (Smart Environment) and Salzburg (Smart Living).

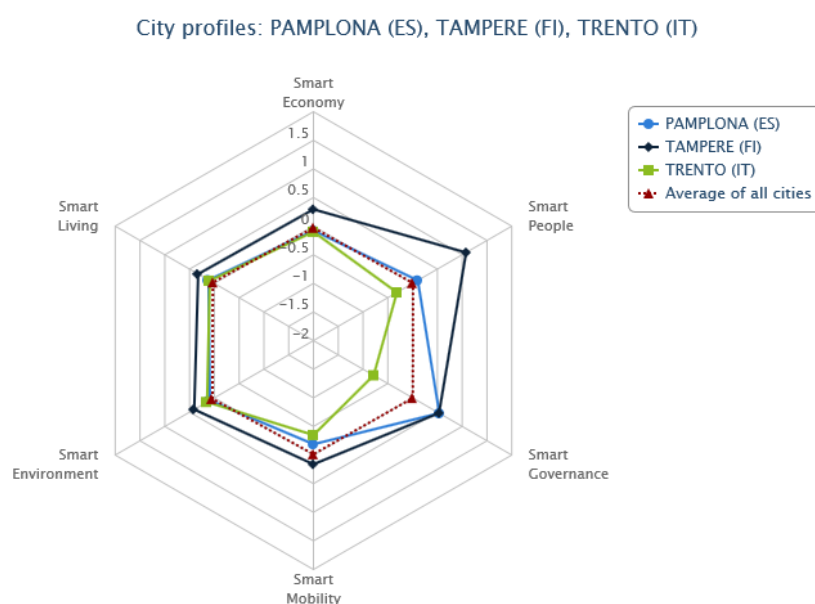


Figure 3.2. Benchmarking of Stardust lighthouse cities (2014).

The best rate + 2 and the worst - 2. While full scale is used, the rate 0 means average level.

Benchmarking and ranking of cities has a purpose in that it encourages dialog and debate about what constitutes a smart city and how should we measure progress. However, the selection of indicators and the proper concept of smart cities are always under discussion. Citizens, who should have concern of all urban development, use the technologies.

STARDUST will propose in Deliverable 1.5 a tool developed by ISC (Institute of Smart Cities). This tool not only score the smartness, but also advice how new technologies could affect urban development. This methodology has already applied as a pilot project to analyze the existent Smart City Strategy of Pamplona (see sub-chapter 4.4).



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4. Pamplona

4.1. Chartered Community of Navarra

The Chartered Community of Navarra has a land area of 10,421 km² and 640,647 inhabitants, which represents 1.4% of the total population of Spain. The capital, the main commercial and services centre of Navarra is Pamplona (Figure 4.1).



Figure 4.1. Navarra situates in the north of Spain, at the western end of the Pyrenees.

Over the last 50 years, Navarra has undergone a deep socio-economic change. The region has shifted from an agriculture-based economy to a balanced economy. Navarra has a gross domestic product (GDP) of €19,018m. This corresponds to a GDP per capita of €29,807, which is far above the national average (24,100) and the EU 28 average (29,121).

In 2016, Navarra's unemployment rate was 10.0% (the lowest since 2011), whilst Spain's unemployment rate was at 18.6% (INE, 2016) and EU 28 average was at 8.2% (Eurostat). Navarra is part of the core-group of Spanish regions registering the highest indicators of social wellbeing.

During the 21st century, the renewable energy sector in Navarra has increased in a continuous way reaching values close to the automotive industry in terms of Gross Added Value. There are more than a hundred companies of this sector employing more than 5,000 people. The main players are Gamesa Innovation and Technology, Acciona and Ingeteam. The renewable energy sector gets support from the technological and innovation policies of Navarra and it is currently the sector with the highest level of R&D expenditure.

4.2. Basic information from Pamplona

Location: Pamplona (Iruña) founded in the year 74 BC and it is situated 446 m over the sea level (Latitude: 42° 46' 37" N - Longitude: 1° 39' 0" W). Pamplona and its region are located in a mountainous belt with an altitude of around 1,000 meters.



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Population: In 2016, the city of Pamplona had 201 300 inhabitants, and the metro-area of Pamplona 356 600 inhabitants. Population growth has been the effect of an intense immigration process during the 1960s and 1970s from the Navarrese countryside and from other less developed regions of Spain. Since the 1990s the immigration is coming mainly from abroad. The density of the city of Pamplona was 8300 persons per km².

The urban expansion of Pamplona exceeded the administrative limits of the city. In recent years, single-family house-predominant neighborhoods have grown in the metropolitan area. The urbanization of Pamplona is not constrained by the grid plan. The apartment buildings are taller: never less than five floors and many taller than ten floors. Industry, which previously coexisted with housing, moved to industrial parks.

According to the latest ranking conducted by the Spanish Organization of Consumers and Users (OCU) in 2011, Pamplona is the city with the highest quality of life in Spain motivated primarily by education, healthcare system, security, green areas, accessibility, etc. Despite its small size, Pamplona has three universities with over 24,000 students.

Economy: Pamplona has shifted in a few decades from a little administrative and even rural town to a medium-size city of industry and services. The most important industry sector is automobile industry (Volkswagen) and its auxiliaries. Other remarkable industries are building materials, metalworking and food processing. Renewable energy technologies are also an increasing economic sector (wind turbines manufacturing and generation).

Transport: Public transport system consists urban, provincial and national bus lines as well as air and train lines.

Pamplona is linked by motorways with neighboring cities (Zaragoza, San Sebastian, Vitoria, Logroño). Railway links connect Pamplona with Madrid, Zaragoza and northern Spain and airport to Madrid and Barcelona.

Climate: Pamplona is located in the middle of Navarre in a rounded valley, known as the Basin of Pamplona. It links the mountainous North with the Ebro (river) valley. The city lies on both sides of the river Arga, which is a tributary of the Ebro. The climate and landscape of the basin is a transition between those two main Navarrese geographical regions.

The climate of Pamplona is normally classified as temperate oceanic climate (Cfb in the Köppen classification), with influences of a semi-continental Mediterranean climate. Precipitation patterns do not vary much over the course of the year as is typical of marine climates, but both classifications are possible due to the Mediterranean patterns of somewhat drier summer months. Sunshine hours are more similar to the oceanic coastal climate in nearby Basque locations than typical Spanish Mediterranean areas are (Figure 4.2).



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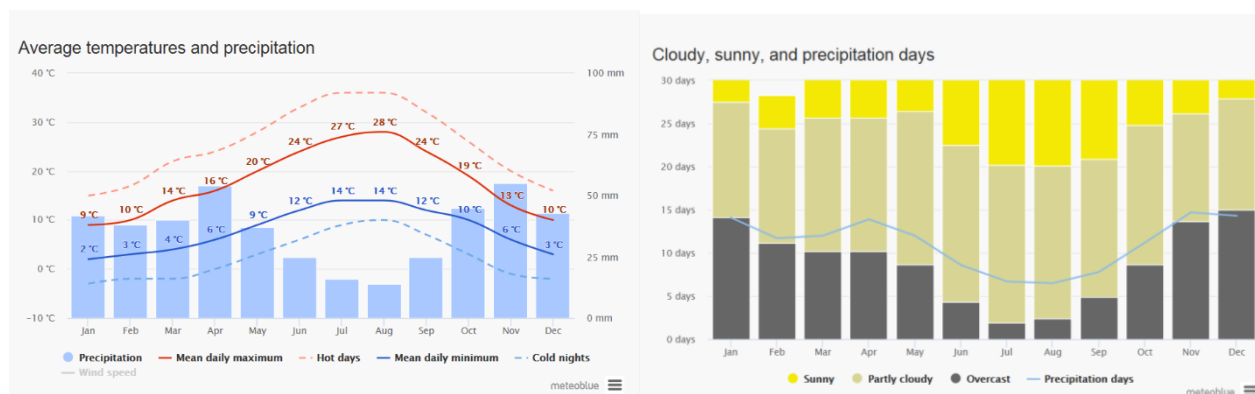


Figure 4.2. Average temperatures, precipitation, cloudy and sunny days in Tampere (Source: Meteoblue).

4.3. Smart City assessment (medium-sized EU cities)

Following figures introduces factors by characteristic of Pamplona. Factors have get their values from statistics and comparison of 77 medium-sized EU cities².

Smart Economy in Pamplona (Figure 4.3) scores neutral, similar to the average of the benchmarking. However, if we look at the factors, we may find out that the entrepreneurship is remarkable, while the city trademark and the international embeddedness are under the average. STARDUST project will help strongly to improve this situation.

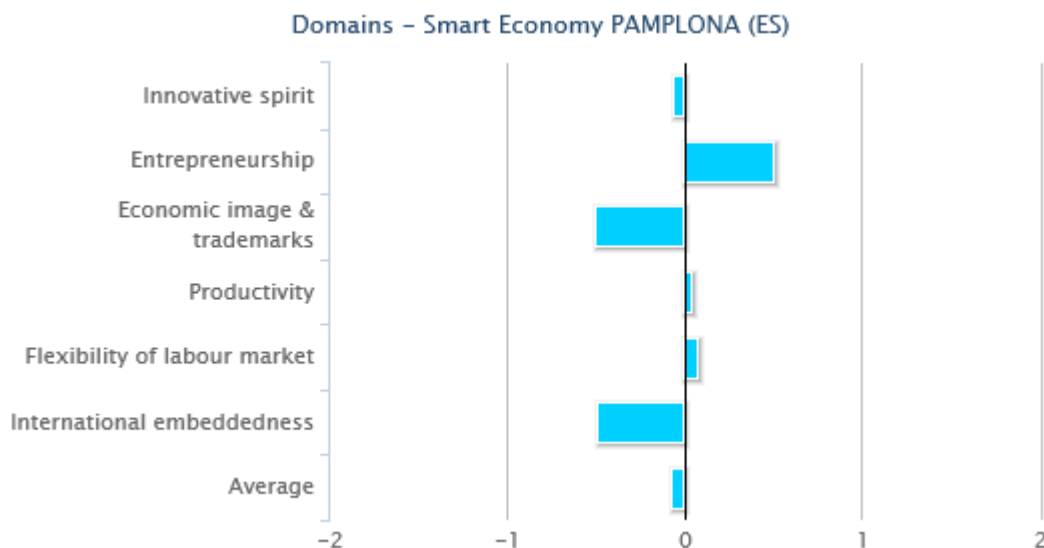


Figure 4.3. Smart Economy factors in Pamplona

² www.smart-cities.org / Pamplona cityprofile



The score for “Smart People” is slightly positive (Figure 4.4), which is in line with the high quality of life in Pamplona, with high level of qualification, as result of a wide variety of educational facilities.

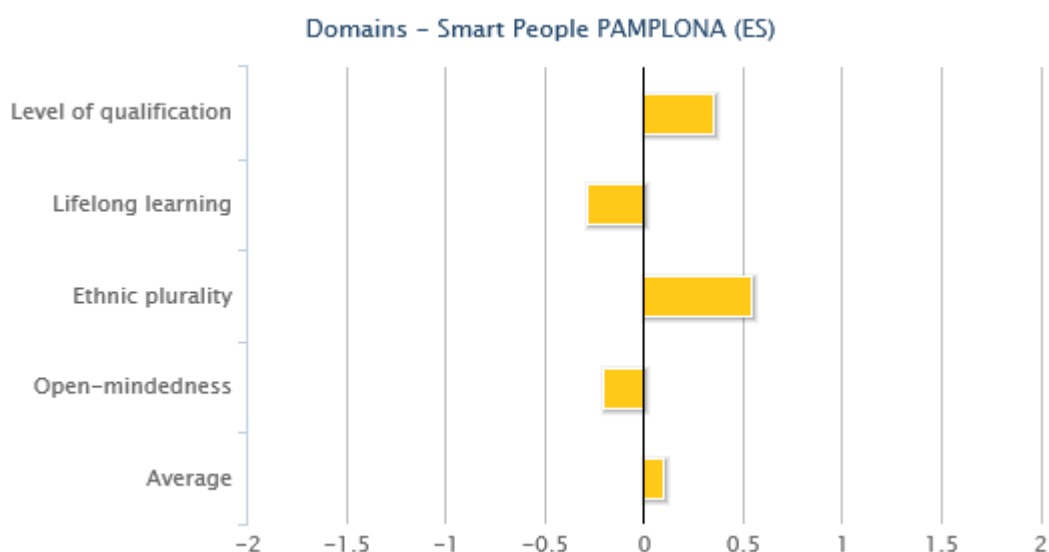


Figure 4.4. Smart People factors in Pamplona.

Smart Governance (Figure 4.5) is the most remarkable characteristic of Pamplona, according to this benchmarking. This is mainly due to public and social services. The study shows, however, a slightly negative score in transparent governance. Actually, this factor has experimented a retrogression, compared with 2012.

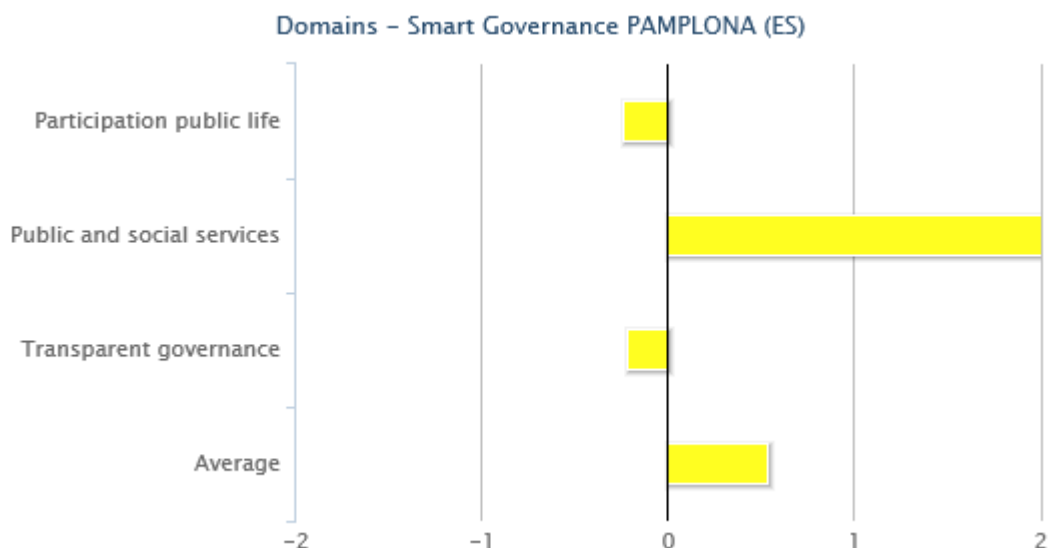


Figure 4.5. Smart Governance factors in Pamplona.



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In terms of Smart Mobility (Figure 4.6), the City has made several effort to improve the mobility in Pamplona, by signing a Local Agreement with stakeholders, promoting the electro mobility (project ICT 4 EVEU to deploy a public e-charging system compatible with the Vitoria, a neighboring city 100Km away) and integrating TICs to promote public transport among citizens. Despite these efforts, electro mobility is only 1% of the overall volum of urban travels.

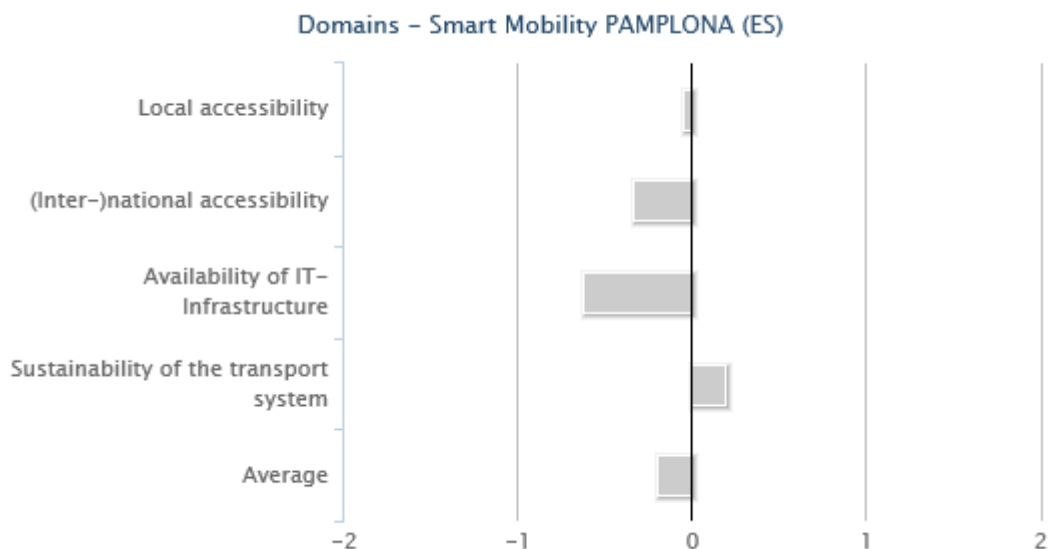


Figure 4.6. Smart Mobility factors in Pamplona.

The european study carried out by the University of Viena, scores very positively the air quality in the city. Environmental issues have been dealt detailed in sub-chapter 4.4.

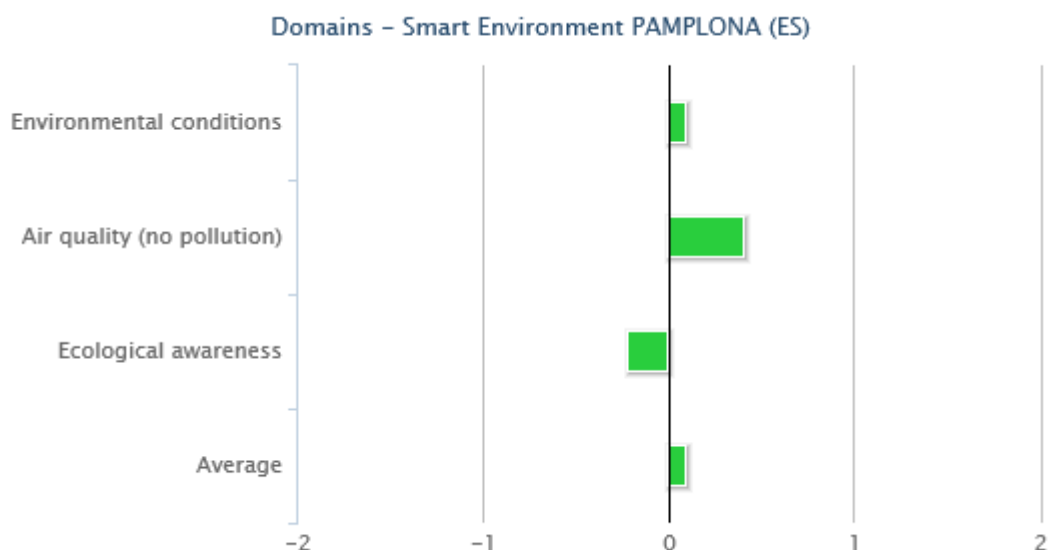


Figure 4.7. Smart Environment factors in Pamplona.



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Finally, Smart Living in Pamplona is well valued (Figure 4.8), highlighting the security and the health conditions.

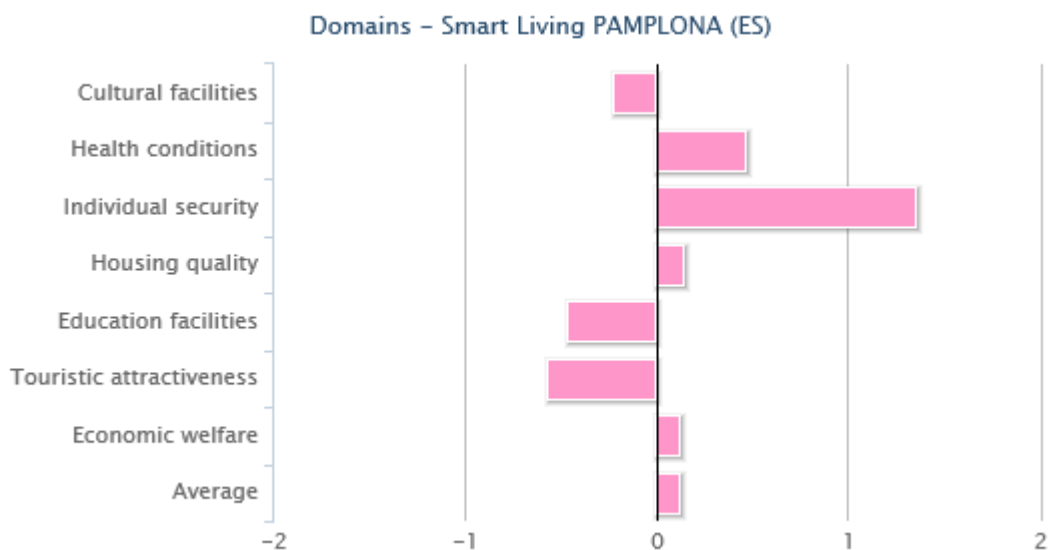


Figure 4.8. Smart Living factors in Pamplona.

The next picture (Figure 4.9) shows a summary of the overall score obtained by Pamplona, with the average on each of the key fields that have analyzed.

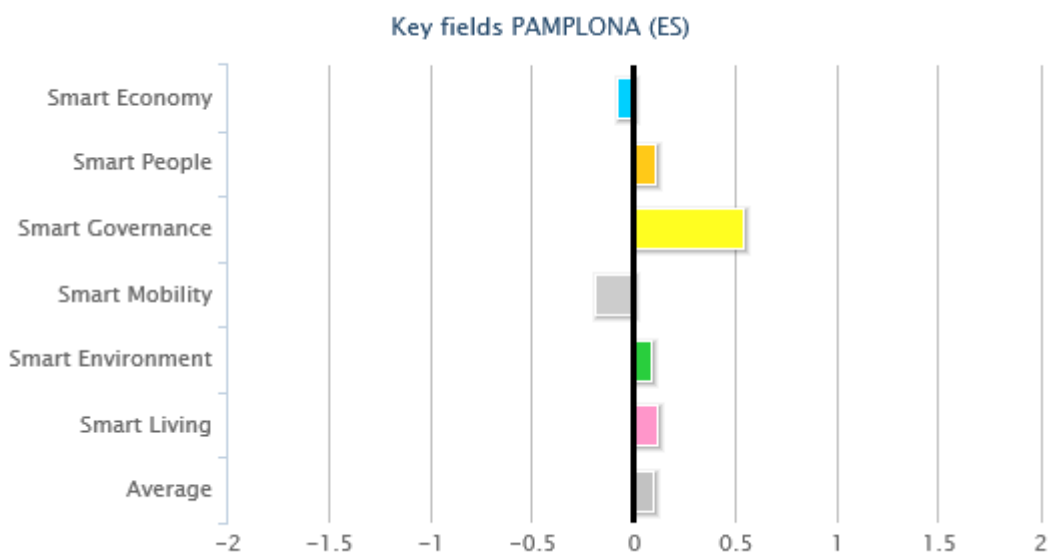


Figure 4.9. Smart City indicators (characteristic averages) in Pamplona.



4.4. National assessment of Pamplona

Figure 4.10 shows the Spanish Cities IDC ranking 2012. IDC evaluates cities on a range of topics with 94 indicators, classified in 5 building blocks: Smart Government; Smart Buildings; Smart Mobility; Smart Energy & Environment and Smart Services. The ranking shows a list of runners: Valladolid, Zaragoza, Vitoria, Donostia and Pamplona, behind the top five: Barcelona, Santander, Madrid, Malaga and Bilbao.

In Smart City comparison inside Spanish cities, Pamplona situates as the 10. To reach the top cities, Pamplona City Council will invest to the process efficiency, public service, citizens and quality of life.

Despite their worsening economy in the last years, cities in Spain have been continuing to move ahead with long-term investments in smart city innovation.

España: Ranking de Ciudades Inteligentes de IDC en 2012



Figure 4.10. Spanish Cities IDC ranking 2012.

In 2013 the City Council designed the "Pamplona Smart City Strategy" with the aim of increasing the use of TICs in Pamplona. The strategy is the joint work of the different municipal areas, other public councils, qualified representatives of the private sector and the field of knowledge work. The program addresses specific actions with measures to monitor and measure the achievements obtained in the different fields: social development, sustainability, economic growth and improvement in R + D + i.

Next picture shows the summary diagram (in spanish) of the strategy designed by the City to integrate different actions in different areas that will increase the level of smartness of Pamplona.



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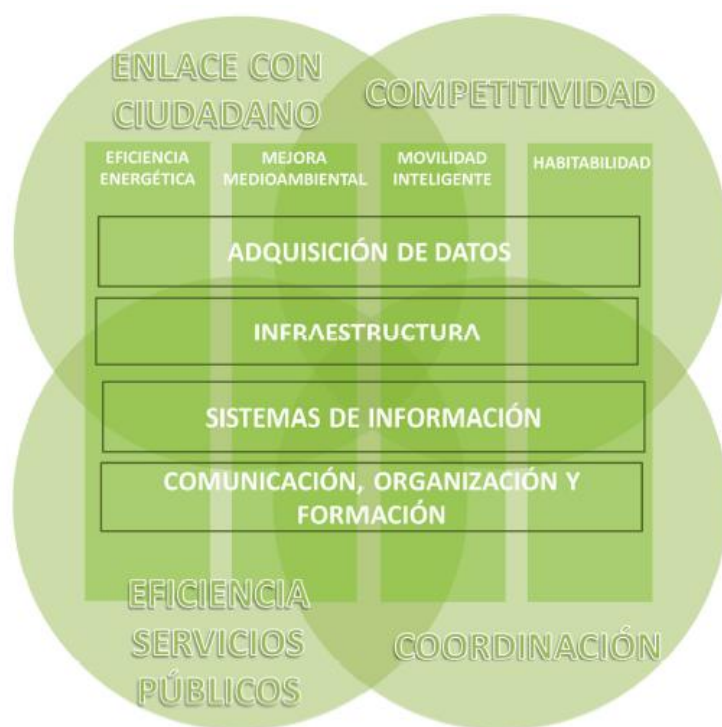


Figure 4.11. Pamplona Smart City Strategy summary diagram].

The Transparency Indexes prepared and published by Transparency International Spain measures the level of transparency of public institutions, through evaluation of data and information they make available on their website regarding the indicators and areas of transparency of each index.

In 2012 Pamplona was at the top of the benchmarking, while the negative tendency in the last 6 years puts it the 86th position among the 110 analyzed municipalities. This aspect needs to be significantly improved during STARDUST.

According to the study “25 sustainable Spanish cities” carried out in 2012 by Siemens, in which aspects such as: CO₂ emissions, air quality, energy use, water use, generation and waste management, mobility and construction were evaluated in order to assess the degree of sustainability, Pamplona was placed in fifth position, highlighting the water management.



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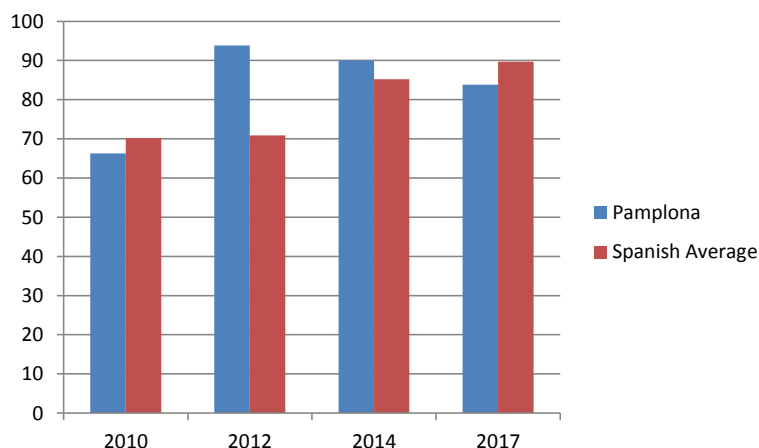


Figure 4.12. Transparency Index of Pamplona in comparison with the Spanish average. Source: CENER, based on transparency index of Spain³.

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Figure 4.13. Spanish benchmarking in sustainability. Source: Siemens, 25 sustainable Spanish cities⁴.

³ <https://transparencia.org.es/indice-de-los-ayuntamientos-ita/>

⁴ <https://ciudadesdefuturo.es/las-25-ciudades-espanolas-mas-sostenibles.php>



5. Tampere

5.1. Tampere region

The Tampere region (in Finnish Pirkanmaa) has a land area of 14,613 km² and 512,379 inhabitants, which represents 9% of the total population of Finland. The capital, the main commercial and services centre of Tampere Region is Tampere (Figure 4.1).

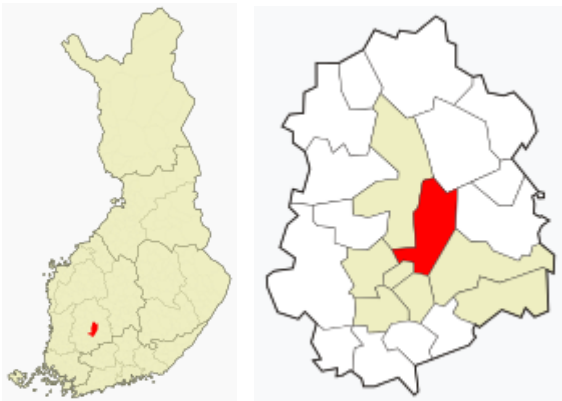


Figure 5.1. Tampere is a city in Pirkanmaa, southern Finland.

Over the last 50 years, Tampere region has undergone restructuring from industry to post-industry society where service sector is strong. Tampere has a gross domestic product (GDP) of €17,400m. This corresponds to a GDP per capita of €34,550, which is 90 % from the national average (38,400) and above the EU 28 average (29,121). In 2017, regions unemployment rate was 10% (2018), whilst Finland's unemployment rate was at 9% and EU 28 average was at 7.3%.

Tampere Region's business ecosystem bases to the strong co-operation with companies, universities and research. The strong fields are mechanical engineering and automation, information and communication technologies, and health and biotechnology, as well as pulp and paper industry education. Tampere Region puts an exceptionally large amount of effort into research and development, approximately 7 % of the regional GDP. Tampere Region is also a home to hot Finnish tech-startups and growth companies.

5.2. Basic information from Tampere

Location: Tampere's city centre surrounds by lakes. Tammerkoski (rapid) run through the city from Lake Näsijärvi (95 m above the sea level) to Lake Pyhä (77 m). Location coordinates of city are Latitude: 61° 29' 54" N - Longitude: 23° 45' 53" E. Total Tampere area is 690 km² (land 525 km² and water 165 km²), the urban area is only 266 km².

Population: The population at the end of 2017 was 231 853, so population density is 442 persons per square kilometres (the land area) or 336 persons per square kilometres (the whole Tampere area). Year after year Tampere is the most desired place to move to in Finland, most wanted city to study in and the most popular travel destination in



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Finland. The average population growth has been more than 2 000 annually. According estimates, Tampere city centre have 23% more inhabitants by 2030 than today.

Economy: The City of Tampere wants to be an early enabler for new business models and innovation. In practice, this means that the city opens its challenges and plans to the companies and enhances co-operation, business ecosystems and creates innovation and testing platforms. The aim is to co-create smart city services that can scaled to other cities globally. Smart Tampere initiative have seven dimensions: Smart Mobility, Smart Health, Smart Industry, Smart Government & Citizen, Smart Buildings, Smart Infrastructure and Smart Education.

Transport: Public local transport (bus lines) in Tampere region is organized jointly between eight municipalities (Tampere, Pirkkala, Nokia, Kangasala, Lempäälä, Ylöjärvi, Vesilahti, Orivesi). Tampere is investing in long-term forward-looking sustainable solutions, such as the city tramlines. The planned tramlines will connect major residential areas and work places, educational establishments, the railway station and the University Hospital and retail districts. As a long distance ground traffic hub, Tampere is a crossing point for both road and railway traffic routes. Own airport has limited amount flight routes, the most important ones to Helsinki, Stockholm and Riga hubs.

Climate: Tampere situates on the borderline of two climate zones: the humid continental climate and the subarctic climate (Köppen "Dfb" and "Dfc"). The climate is mainly continental, but large lakes also bring marine influences. Due the Gulf Stream, climate is slightly warmer than in other parts of the world with corresponding latitudes.

Winters are cold and the average temperature from November to March is below 0 °C. The snow season lasts 4–5 months from late November to early April. Ice covering Lake Näsijärvi for an average of 140 days. Summers are mild. July is the warmest month, with an average temperature of about 16.0 °C. The wind blows predominantly from the south and the south. The average rainfall is 7-8 days a month, otherwise 10-11 days a month. Monthly rainfall in February is 29 mm, but July to August over 70 mm. On average, 1,661 hours of sunshine accumulates annually, and the growing season is 137 days. (Figure 5.2)

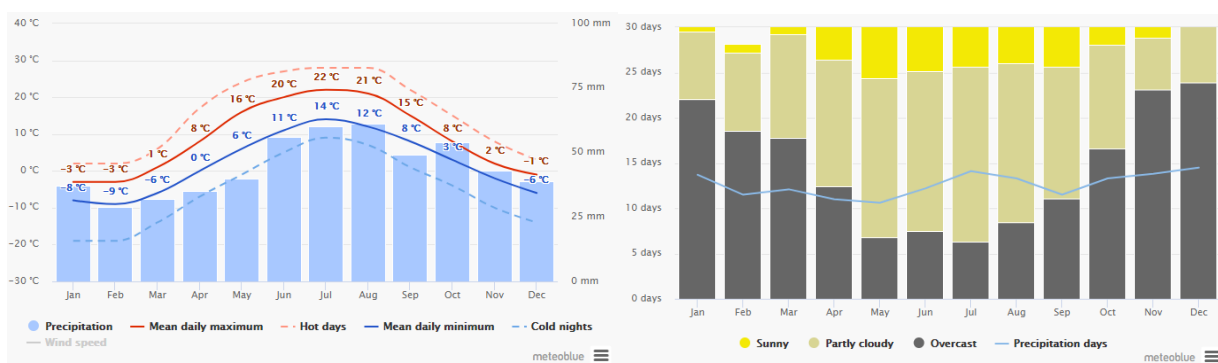


Figure 5.2. Average temperatures, precipitation, cloudy and sunny days in Tampere (Source: Meteoblue)



This project has received funding from the European Union's Horizon 2020 research and innovation programme under agreement N° 774094.



5.3. Smart-City assessment (medium-sized EU cities)

Following figures introduces factors by characteristic of Tampere. Factors have got their values from statistics and comparison of 77 medium-sized cities⁵.

From the point of view of innovation, the Tampere can especially thank the close cooperation between companies, higher education and research institutes. When a giant employer (Nokia) left Tampere, a large number of start-up companies are growing to its place. This development was only at the starting point in Figure 5.3 numbers.

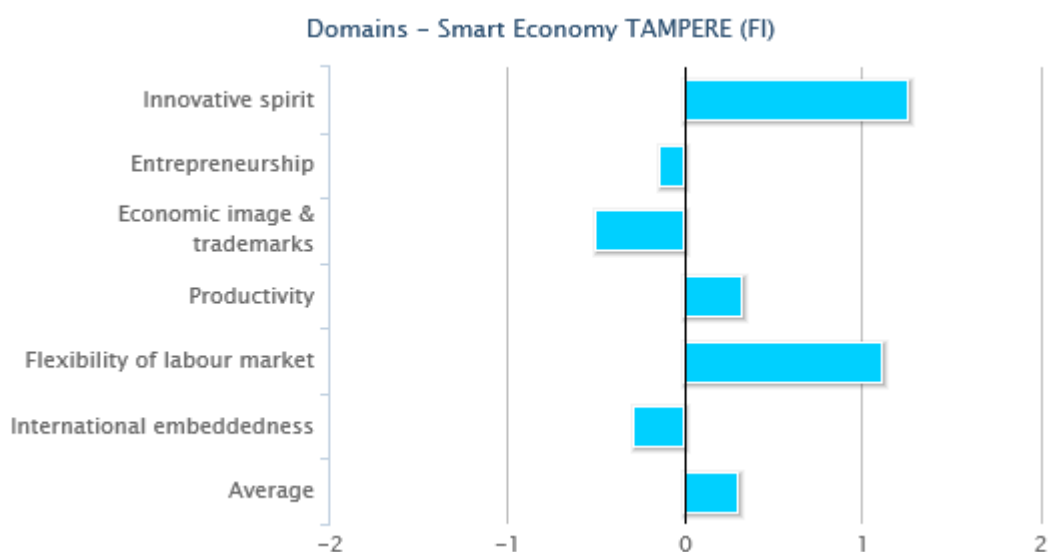


Figure 5.3. Smart Economy factors in Tampere.

⁵ www.smart-cities.org / Tampere cityprofile



Behind Smart People numbers (Figure 5.4) is the Finnish education system, which guarantees free education to the highest level. 73 % of population aged 15 years have degree after elementary school, over 30 % have academic degree.

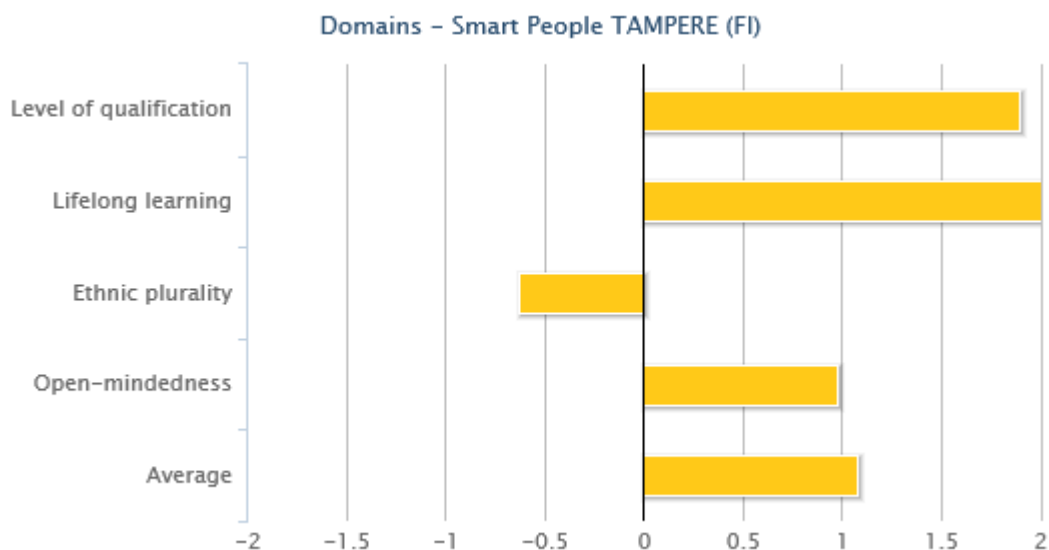


Figure 5.4. Smart People factors in Tampere.

Open governance is an embedded in Nordic democracies (Figure 5.5). The preparation materials are public as well as the local government meetings that are videostreamed via internet.

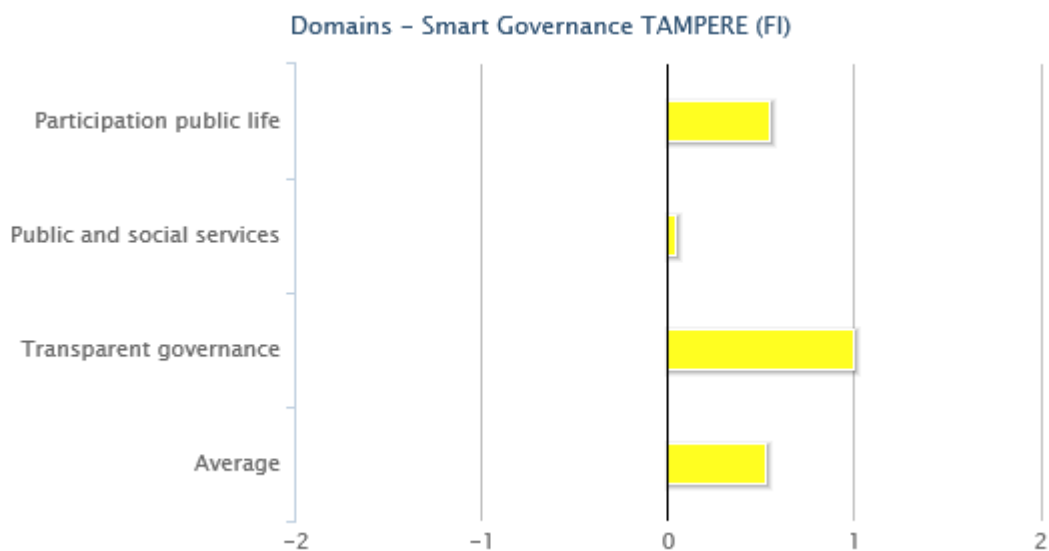


Figure 5.5. Smart Governance factors in Tampere.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under agreement N° 774094.



Finland and Tampere have been a test field for the introduction of communication technologies. Thanks to good availability of IT-infrastructure Finnish people use mobile data twice as much as people in other countries⁶. Energy carriers in local traffic have been diesel and gas. The first eBus started in the end of 2016 and the first tramline is under construction, expected start of traffic year 2021. (Figure 5.6)

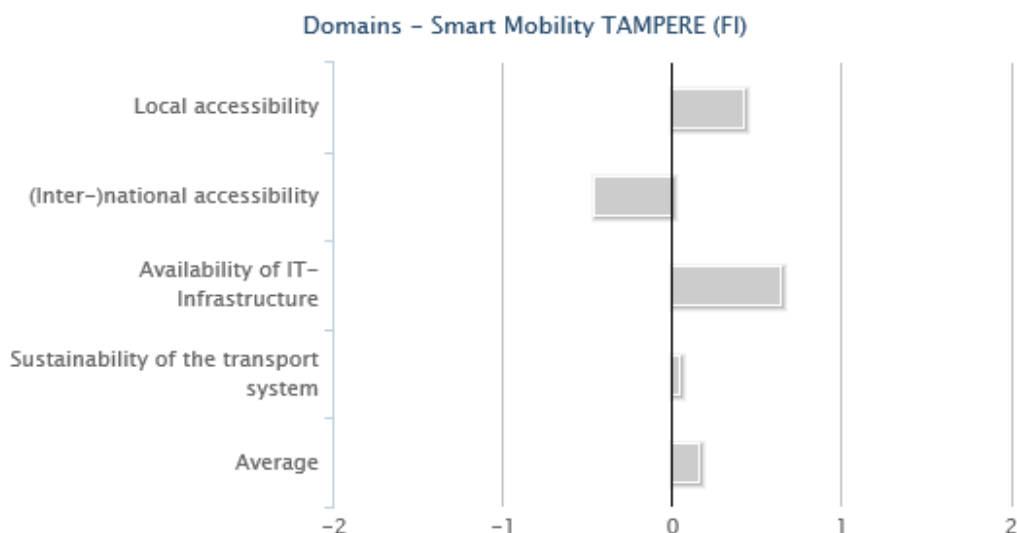


Figure 5.6. Smart Mobility factors in Tampere.

Because of its location and climate, Tampere loads the environment: the sun shines only a part of the year and winters are cold. Electricity uses for lighting and heating systems, even district heating has a significant market share. In district heat production remarkable investments to renewable energy sources and efficiency have been made after the year 2014 (Figure 5.7).

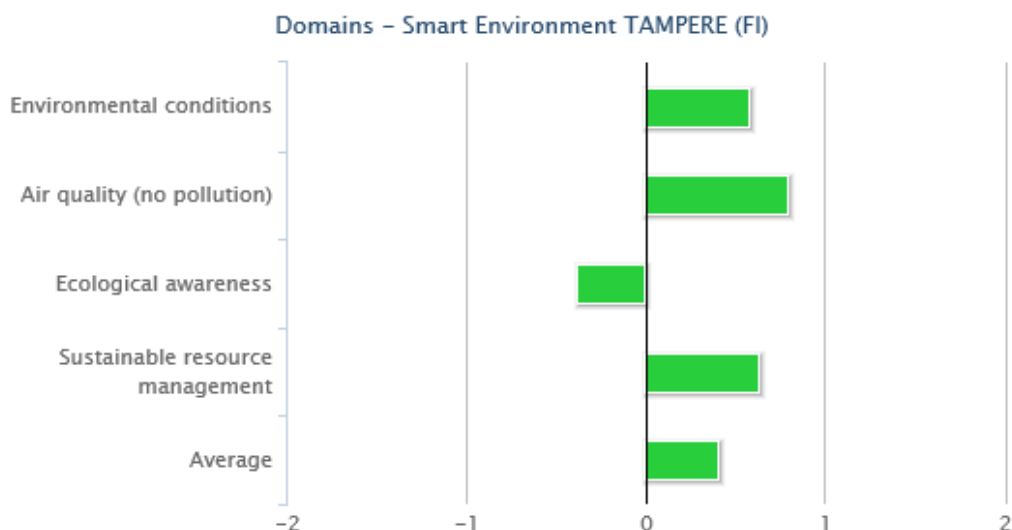


Figure 5.7. Smart Environment factors in Tampere.

⁶ <http://media.tefficient.com/2016/12/tefficient-industry-analysis-5-2016-mobile-data-usage-and-pricing-1H-2016-ver-2.pdf>



Year after year Tampere is the most desired place to move to in Finland, most wanted city to study in and the most popular travel destination in Finland. The fact is, that dwellings are smaller in Finland than many other EU countries. Tampere, like other local communities, has neglect the maintenance of school buildings. (Figure 5.8)

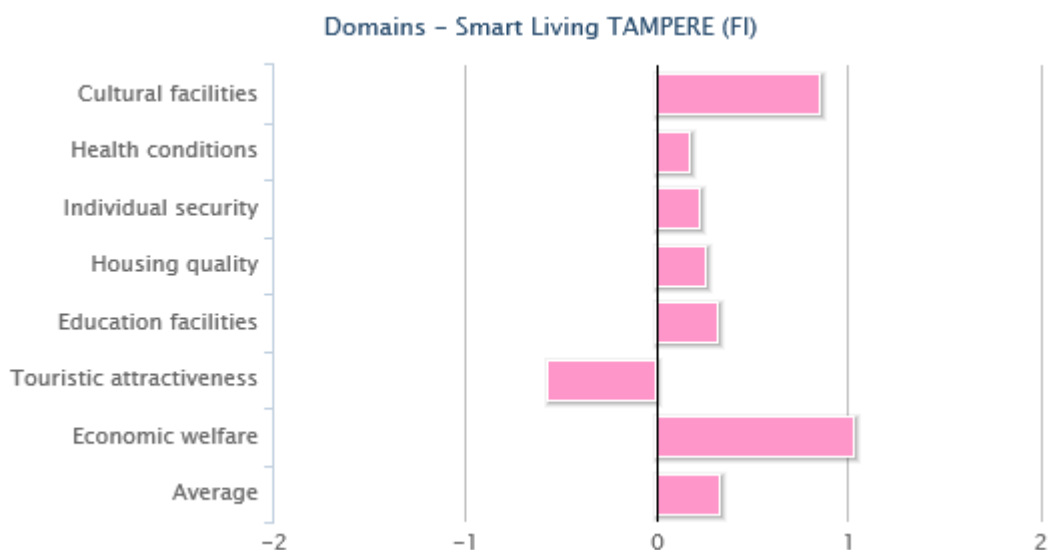


Figure 5.8. Smart Living factors in Tampere.

Smart people get good scores and Smart mobility get not so good scores in Smart City assessment (Figure 5.9). In both, the half of indicators are national and only the second half is local or regional. The assessment could be better in both, if more local indicators could be available. After metropolitan area, Tampere is the second important city in Finland. This have a significant impact on the structure and characteristics of the population as well as mobility system. Other indicators are at quite right level, while more local and regional input data is used.

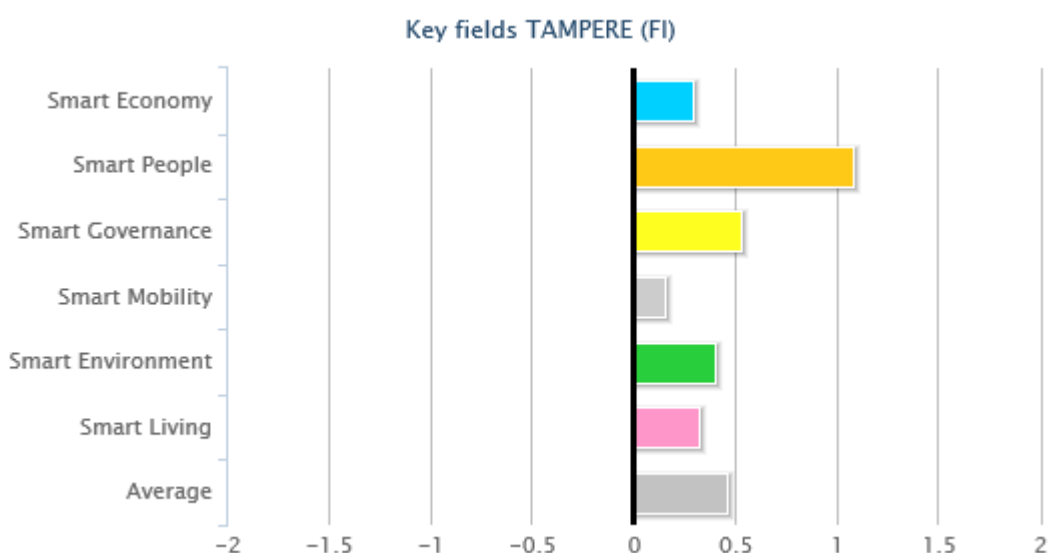


Figure 5.9. Smart City indicators (characteristic averages) in Tampere.



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5.4. Smart city self-assessment (CITYkeys)

The CITYKeys city level indicators focus on monitoring the evolution of a city towards an even smarter city. The city level indicators show what extent over all smart city policy goals are reached, or are within reach.

Figure 5.10 shows the assessment of Tampere. Unlike previous (sub-chapter 5.3) indicator system, CITYKeys focus more on the city's internal activities. The focus of Smart-City indicators is more on services provided to residents. CITYKeys are result of the self-assessment. The city of Tampere considers itself reasonably smart. Improved need is the most in data privacy and monitoring and evaluation of interventions.

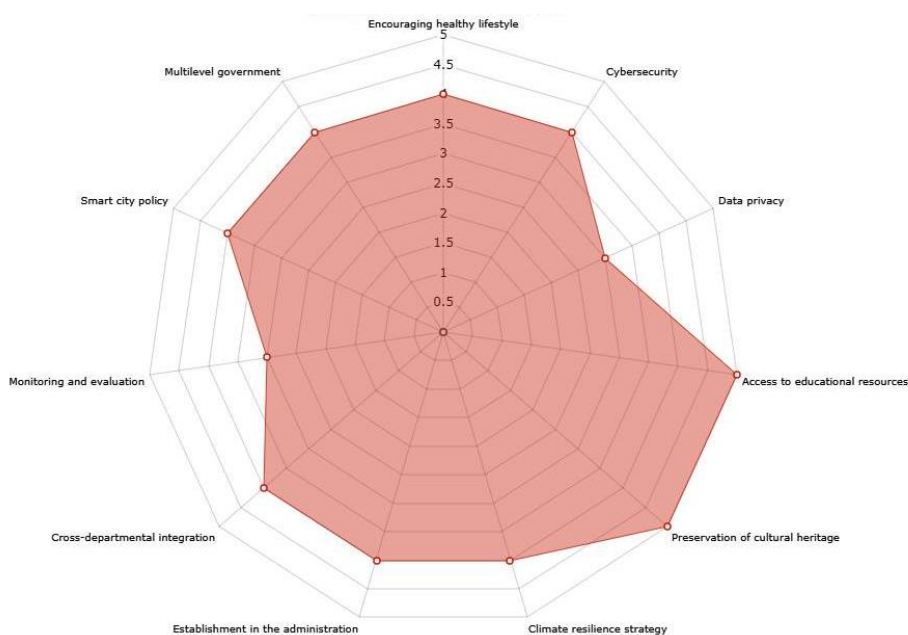


Figure 5.10. CITYKeys of Tampere. The best rate 5 and the worst 0.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under agreement N° 774094.



6. Trento

6.1. Province of Trento

The province of Trento lies in Northern Italy (Figure 6.1). It has an area of 6,207 km² (2396.54 sq. miles) and a total population of 538,579 (as of February 2017). Its capital is Trento.



Figure 6.1. The province of Trento lies in Northern Italy

The province of Trento is a relatively wealthy both in comparison with other Italian regions, and with the EU28 average: the GDP per capita PPS was €35,500 in 2015, corresponding to 123% of the EU28 average and to 128% of the national average. The employment rate (69.3 %), is in line with the European average (71.1%) and higher than the Italian average (57.2%).

The share of services (financial intermediation and real estate, public administration, community services and activities of households) in 2015 account for 73.5% of the gross value added, followed by industry (22.9%) and agriculture (3.6%). The most important manufacturing sectors include textiles, materials for construction, mechanics, food processing, paper and wood making. In future Trento has decided to focus on robotics and human-computer interaction, mechatronics and microsystems, automation, smart materials and sensors.

The regional innovation system is characterized by strong public components (universities, research institutes and foundations), while business R&D investments are still relatively low compared to other sources of funding (i.e. government).



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6.2. Basic information of Trento

Location: Trento is the capital and educational, scientific, financial as well as political centre of the autonomous province of Trento. It lies 194 m over the sea level in a wide glacial valley known as the Adige valley, just south of the Dolomite Mountains, where the Fersina River and Avisio rivers join the Adige river in Trentino-Alto Adige/Südtirol in Italy (Latitude 46° 04' N and Longitude 11° 07' W). The area of the city is 158 km².

Population: Trento has a population around 117,000 inhabitants. In 2016, the density of the city of Trento was 742 persons per km². Trento is ranked 5th (2017) among Italian cities for quality of life, standard of living, and business and job opportunities.

Economy: The city owes much of its unique economy to its position along the main communication route between Italy and Northern Europe and to the Adige River which, prior to its diversion in the mid-19th century, ran through the centre of the city. The Adige River was formerly a navigable river and one of the main commercial routes in the Alps. Today Trento thrives on commerce, services, tourism, high-quality agriculture and food industry (including wine, fruit), and research.

Transport: City has public traffic system and locates along the Brenner railway (Verona–Innsbruck), which is the main rail connection between Italy and Germany. The Trento railway station is also the junction with the Valsugana railway, which connects Trento to Venice. The A22-E45 highway connects Trento to Verona and to Bolzano, Innsbruck and Munich.

Climate: Trento's climate is warm and temperate. This climate considers Cfa according to the Köppen-Geiger climate classification. The average annual temperature in Trento is 12.5 °C. The temperatures are highest on average in July, at around 22.9 °C. The lowest average temperatures in the year occur in January, when it is around 1.1 °C. There is a lot of rainfall in Trento, even in the driest month. The average annual rainfall is 900 mm. The least amount of rainfall occurs in January. The greatest amount of precipitation occurs in November, with an average of 98 mm.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under agreement N° 774094.



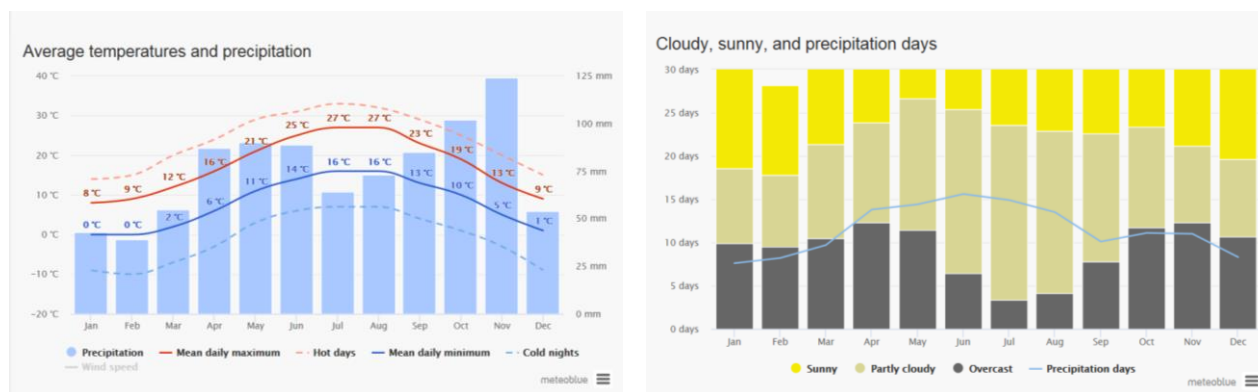


Figure 6.2. Average temperatures, precipitation, cloudy and sunny days in Trento (Source: Meteoblue).

6.3. Smart City assessment (medium-sized EU cities)

Following figures introduces factors by characteristic of Trento. Factors have get their values from statistics and comparison of 77 medium-sized cities⁷.

In the Smart Economy area Trento (Figure 6.3) performance was almost average with a positive peak in productivity spirit. Trento is now putting much effort in improving this classification by facing the challenges related to green and circular economy.

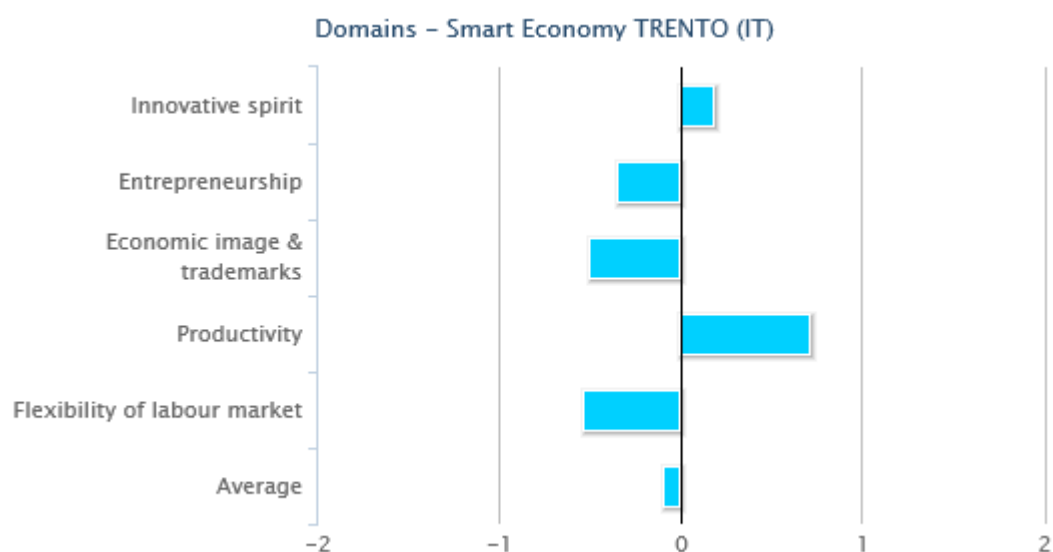


Figure 6.3. Smart Economy factors in Trento.

⁷ www.smart-cities.org / Trento cityprofile



In the Smart People area Trento (Figure 6.4) performance was little below average owing in particular to the well-known characteristic of Trento people of being not so open-minded. The score about qualification and learning are a bit surprising, considering the quantity and the quality of educational resources (in particular at the academic and post academic level) that are available in Trento and its surroundings.

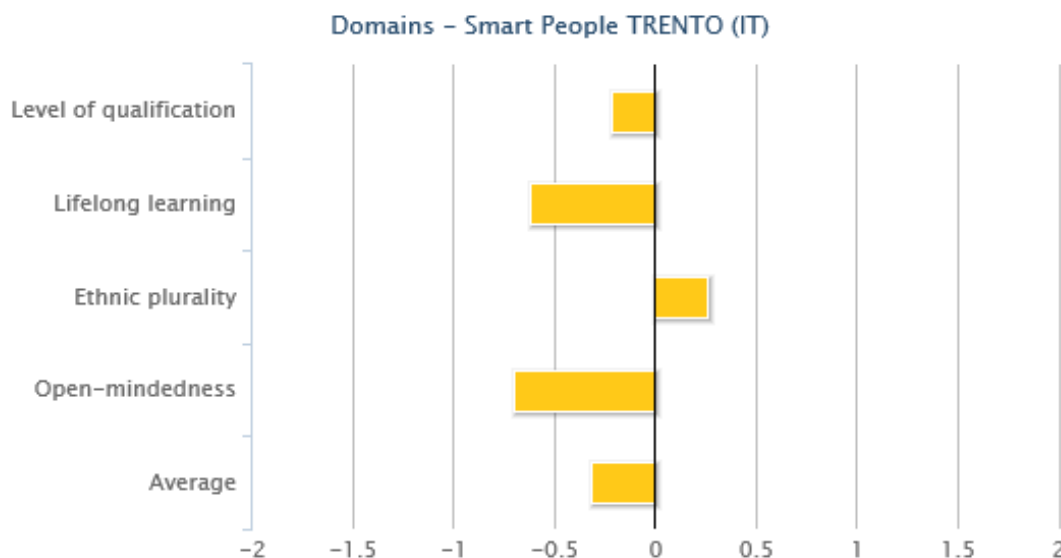


Figure 6.4. Smart People factors in Trento.

Smart Governance (Figure 6.5) represented the area in which most improvement was needed. This is actually what has happened in the following years with much efforts in services and participation. The bad performance with respect to public and social services until 2014 is witnessed also by other national assessments in which Trento demonstrates some difficulty in reaching the same excellence level as for other indicators.

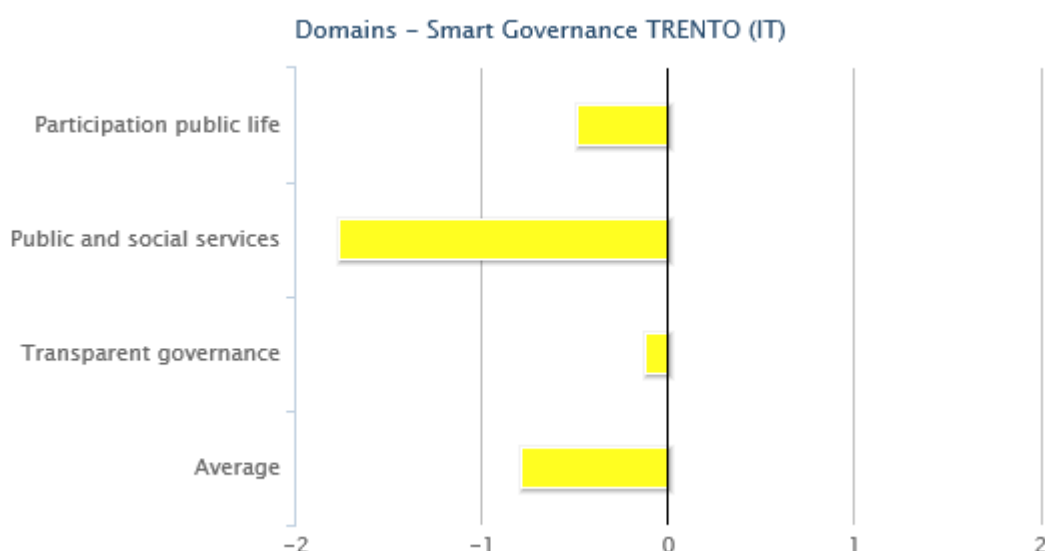


Figure 6.5. Smart Governance factors in Trento.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under agreement N° 774094.



The acknowledgement of flaws in local accessibility has been very important to guide the strategy of the municipality of Trento in the following years with respect to the Smart Mobility domain, which for the remaining factors showed to be in line with the European standards. It has to be considered that the position of Trento and its distribution over a very heterogeneous territory makes the actuation of effective mobility strategies a real challenge. The future goals related to e-mobility and infrastructures will improve the results shown here. (Figure 6.6)

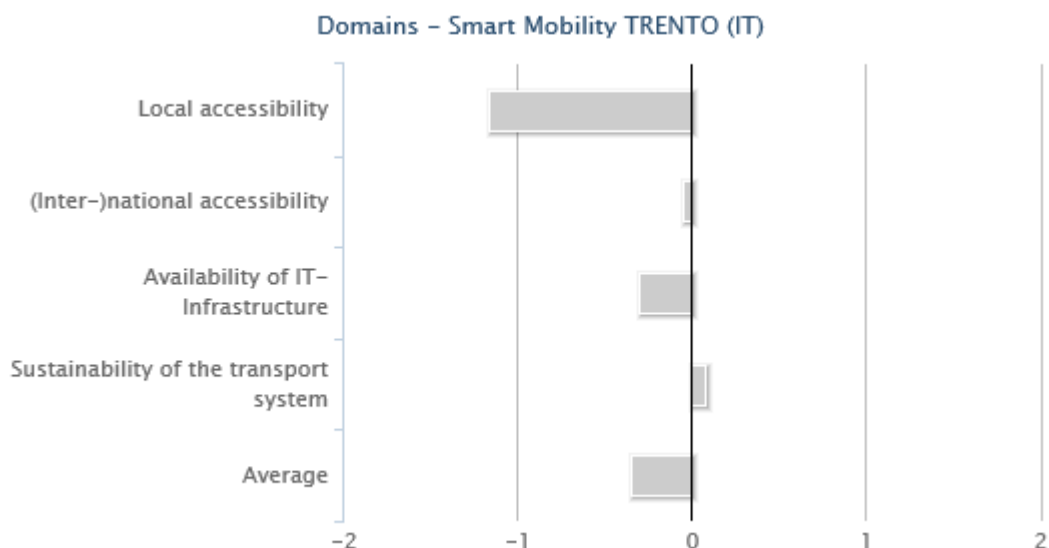


Figure 6.6. Smart Mobility factors in Trento.

Despite the presence of some room for improvement, environment represent a domain which Trento has ever performed well (Figure 6.7). In the future focus will be put in particular on the resilience to climate changes.

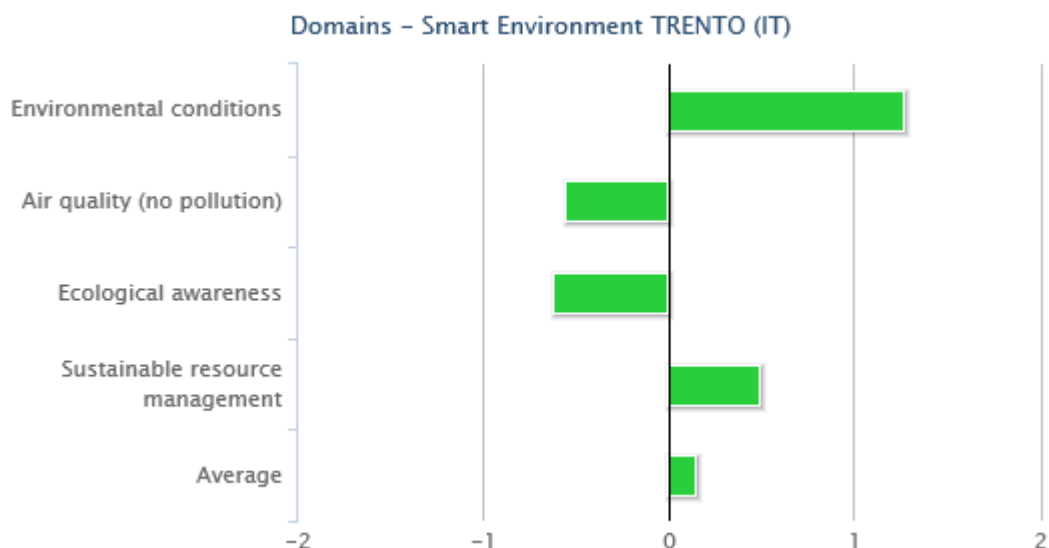


Figure 6.7. Smart Environment factors in Trento.



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The results of the Smart Living domain confirms also at the european level the Italian national feeling about the quality of life in Trento, which is considered on of the best cities where to live in the country (Figure 6.8). Once again the result about education is a bit surprising considering the quantity and the quality of the offer both for the lowest and the highest levels of the education system and is probably due to the offerings in the medium levels.

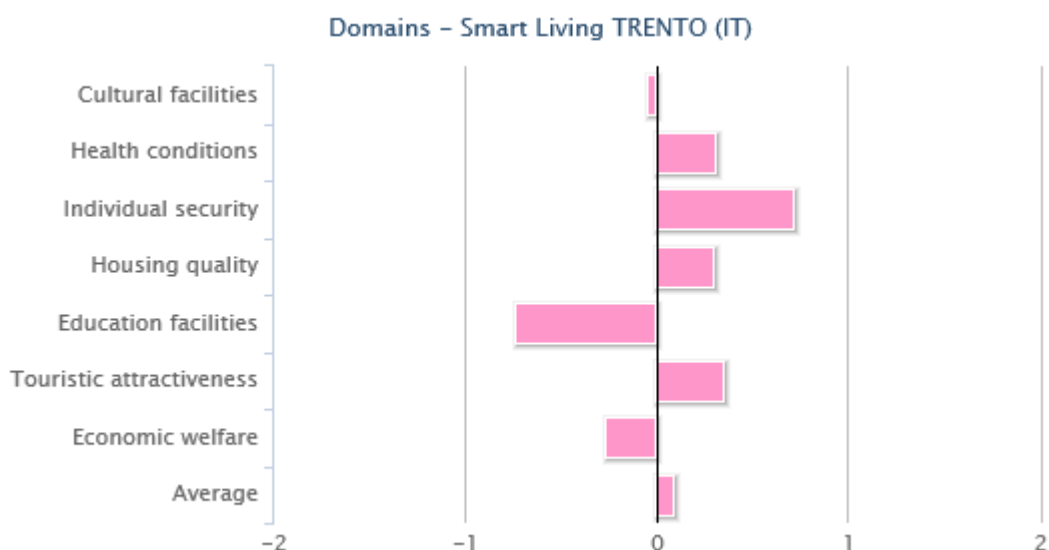


Figure 6.8. Smart Living factors in Trento.

The next picture (Figure 6.9) shows a summary of the overall score obtained by Trento in 2014, with the average on each of the key fields that have analyzed and commented above.

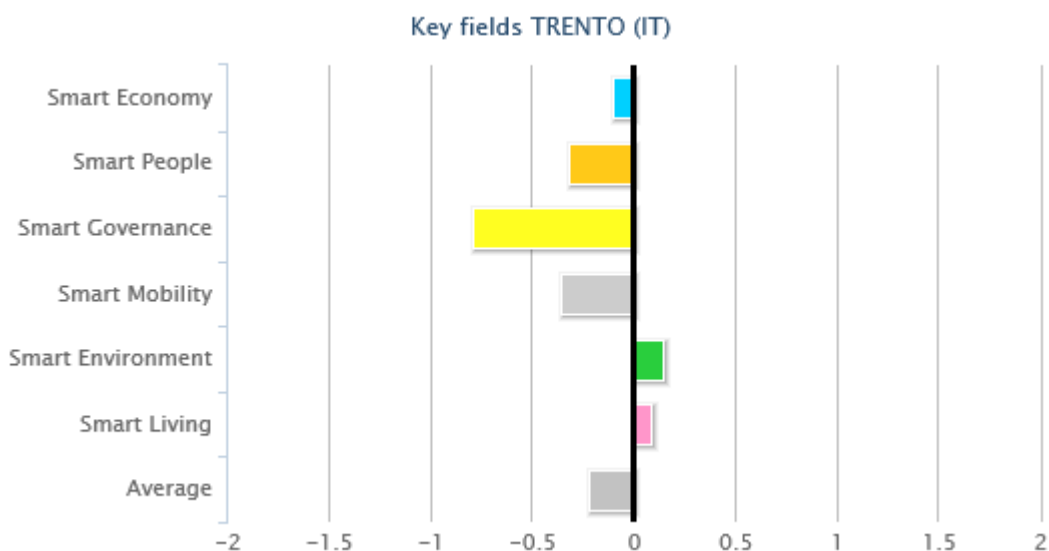


Figure 6.9. Smart City indicators (characteristic averages) in Trento.



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The year 2014 represents a turning point in the evolution of Trento as a Smart City. Until then, no specific vision of Smart City had been conceived and no integrated plan was in place. Nevertheless, owing to a number of actions, initiatives, partnerships, collaboration and to the execution of several, though unrelated projects, Trento scored high as a Smart City in national and international rankings.

In particular, a set of programs about culture, tourism, land use, social and youth policies, urban mobility, environment were developed which have brought Trento on top of Italian standings and in good positions in European ones. The lack of global strategy until 2014 reflected in some average or low performance for some of the indicators assessed with respect to the rest of medium-sized cities.

In most of the domains a remarkable shift has occurred since 2014 when a change of pace has occurred and a more integrated and global approach has been undertaken by the municipality, thanks to a comprehensive Smart City Plan. This reflected in the improvements described in section 6.5.

6.4. Smart City assessment (Smart City Index - Italy)

Recent national assessments shows a situation has improved after 2014. Such an improvement is evident considering both absolute positioning and the improvement with respect to the previous years. In particular we will consider two different assessments: the Ernst & Young report “SMART ITALY - Smart City Index 2016”⁸ and Public Administration Forums ICity Lab report “ICity rate 2017”⁹.

According to EY report, in 2016 Trento has been the second medium-sized smart city in Italy amongst top cities, overtaken by Parma, and sixth overall behind Milan, Bologna, Turin, Mantua, and indeed Parma (see Figure 6.10).

⁸the Ernst & Young report “SMART ITALY - Smart City Index 2016
[http://www.ey.com/Publication/VWLUAssetsPI/EY-smart-city-index-2016/\\$FILE/2016-EY-smart-city-index.pdf](http://www.ey.com/Publication/VWLUAssetsPI/EY-smart-city-index-2016/$FILE/2016-EY-smart-city-index.pdf)

⁹ Public Administration Forums ICity Lab report “ICity rate 2017
<http://www.icitylab.it/il-rapporto-icityrate/edizione-2017/>



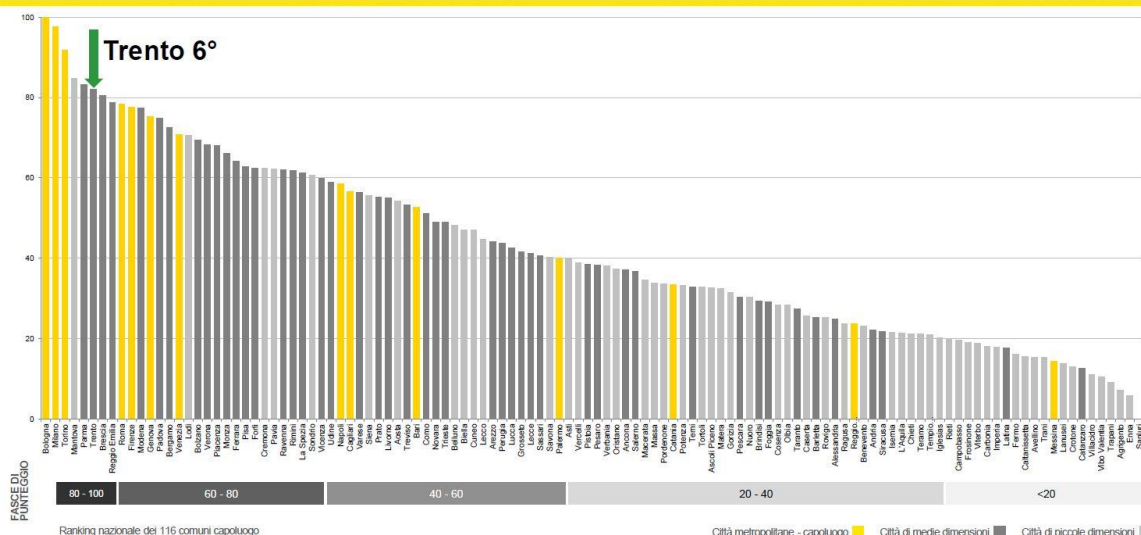


Figure 6.10. Italian national ranking of the 116 top towns.

In particular, Trento performed well (5th place) in infrastructure and sensors but might have done better (31st place) about delivery platform and services (see Figure 6.11).

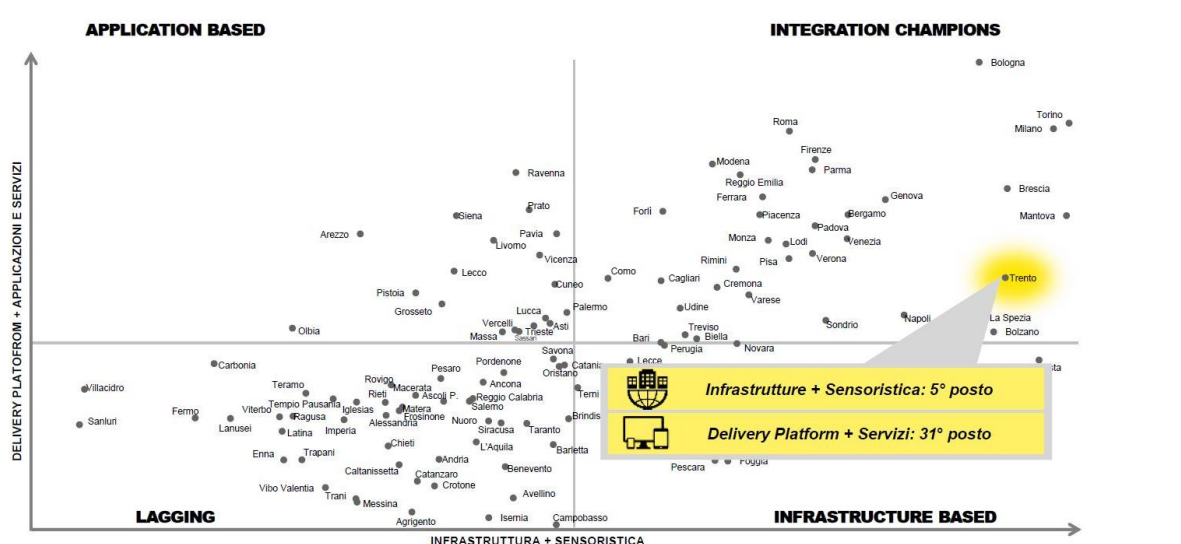


Figure 6.11. Infrastructure vs. services

With respect to the average of other Italian top cities, Trento improved a lot in terms of infrastructures and quality of life. Vision and strategy is the dimensions on which more attention is required. Other indicators for which Trento performed well with respect to other Italian cities are “renewable energies network”, “district heating”, and “ecological islands” (see Figure 6.12 and Figure 6.13).

ICity Rate is the annual report produced by the Public Administration Forum to photograph the situation of Italian cities on the way to more intelligent cities that are closer to the needs of citizens, more inclusive, more liveable.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under agreement N° 774094.



To realize the report, the ICity Lab identifies and analyses different urban dimensions and, for each of these, a certain number of variables and indicators. The values obtained from the examination of the variables / indicators based on the existing sources, are then transformed and aggregated into a single synthesis value, which allows drawing up a final index (ICity index).

Trento showed rapid accelerations with respect to 2016 earning three positions owing mainly to the factors “environment” and “circular economy”. The dynamism of Trento is witnessed a set of values above the national average for all 15 policy areas, the first place in urban waste management and positioning in the top 10 cities of Italy for tourism and culture (9th) and policies to combat poverty (10th).

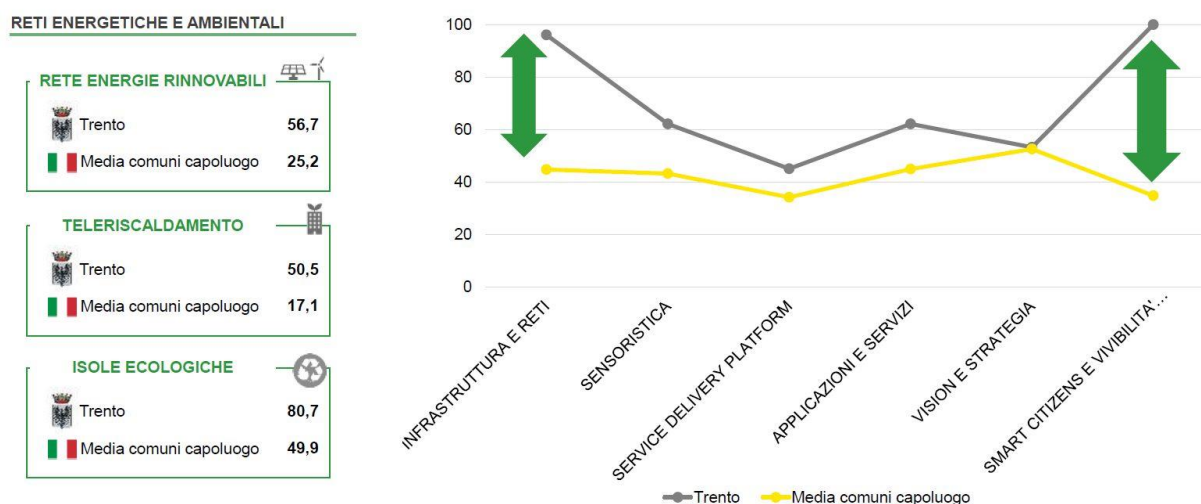


Figure 6.12. Trento compared with average level of Italian cities.

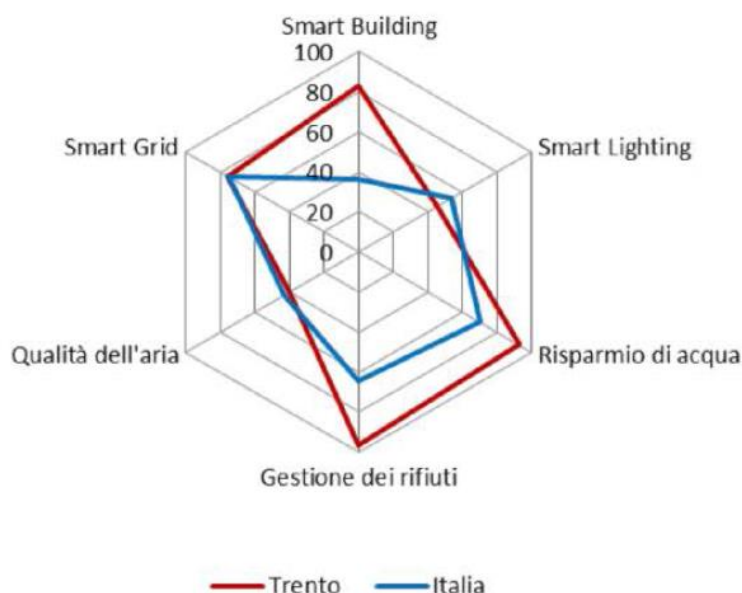


Figure 6.13. Energy efficiency indicators. The best rate 100 and the worst 0.



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7. Follower cities

7.1. Cluj-Napoca

Location: Cluj-Napoca locates 340 m over the sea level in the Someşul Mic River valley surrounded by forests and grasslands (Latitude: 46° 46' N - Longitude: 23° 35' E). It has roughly equidistant from Bucharest (324 km), Budapest (351 km) and Belgrade (322 km).

Population: The metropolitan area consists of Cluj-Napoca and 17 other communes. The area of the municipality of Cluj-Napoca is 180 km² and metropolitan area is 1538 km². In 2011 (the last Census year), 324 576 inhabitants lived within the city limits (1.6% of the total population of Romania). It is the fourth populous city with the highest living standards in the country. In 2011, the density of Cluj-Napoca was 1808 persons per km², and the density of the Cluj-Napoca metropolitan area was 268 persons per km².



Figure 7.1. Cluj-Napoca is the largest city in the Romanian Nord-Vest development region

Economy: Cluj-Napoca is an important economic, industrial, business, academic and cultural centre in Romania. The city is at a relatively advanced stage in the evolution of the service-based economy with a small and highly specialized manufacturing component with a focus on commercial activities.

Transport: Cluj-Napoca has a complex system of regional transportation, providing road, air and rail connections to major cities in Romania and Europe. It also features a public transportation system consisting of bus, trolleybus and tramlines. It is an important node in the European road network, being on three different European routes (E60, E81 and E576). At the national level, Cluj-Napoca is located on three different main national roads: DN1, DN1C and DN1F. Motorway A3 links the city with Bucharest and Romania's western border.

Climate: Cluj-Napoca has a continental, temperate climate (Köppen-Geiger classification: Dfb). Winter temperatures are often below 0 °C, even though they rarely drop below -10 °C. On average, snow covers the ground for 65 days each winter. In summer, the average temperature is approximately 18 °C (the average for July and August), despite the fact that temperatures sometimes reach 35 °C to 40 °C in mid-summer in the city centre.



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Although average precipitation and humidity during summer is low, there are infrequent yet heavy and often violent storms. During spring and autumn, temperatures vary between 13 °C to 18 °C, and precipitation during this time tends to be higher than in summer, with more frequent yet milder periods of rain.

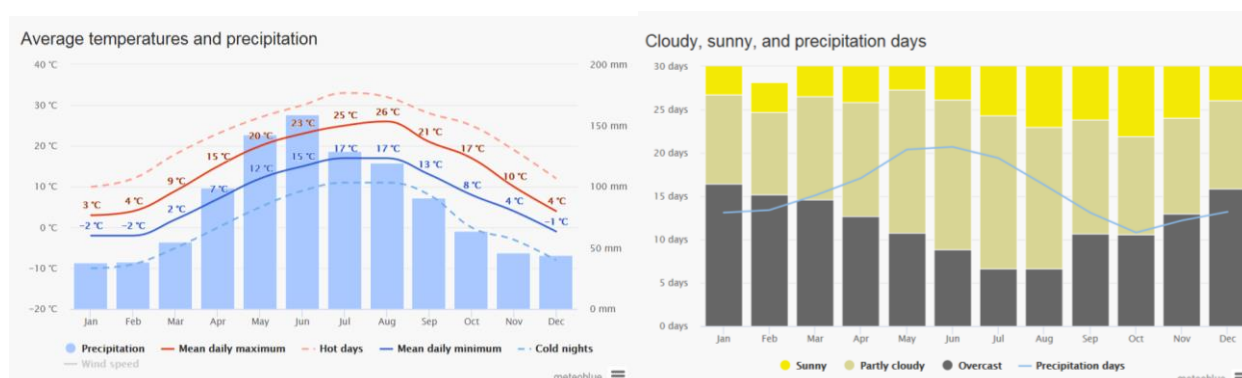


Figure 7.2. Average temperatures, precipitation, cloudy and sunny days in Cluj-Napoca (Source: Meteoblue).

7.2. Derry

County Derry: Also known as County Londonderry, is one of the six counties of Northern Ireland. Adjoining the north-west shore of Lough Neagh, the county covers an area of 2,074 km² and had a population of about 247,132 in 2011. Since 2015, the area consists three different districts: Derry and Strabane, Causeway Coast and Glens and Mid-Ulster.



Figure 7.3. County of Derry and Derry locates in Northern Ireland.

The Derry City and Strabane District created on 2015 by merging the City of Derry District and Strabane District. It covers most of the northwest of Northern Ireland. The latest population estimates (in 2016) for the Derry City and Strabane District Council (DCSDC) area gave a total population of 150 140. Over the 10 year period from mid-2016 to mid-2026, DCSDC's total population is projected to grow 0.1 per cent (200 people), and its working age population is projected to reduce by 4.5 per cent, equivalent to 4300 people.



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Location: The name Derry, officially Londonderry, is an angliciation of the Old Irish name *Daire* (modern Irish: *Doire*) meaning "oak grove". It is the second-largest city in Northern Ireland and the fourth-largest city on the island of Ireland. The city's coordinates are Latitude 54° 59' 44.88" N and Longitude 7° 18' 26.64" W.

The area of the old City of Derry District is 387 km² and the old Strabane district is 862 km². The old Derry district includes rolling lowlands and valleys (near the sea level) that gradually rise to the wooded slopes of the Sperrin Mountains (highest point about 600 m) in the southeast.

The old city lies on the west bank of the river Foyle, and is characterised by its distinctively hilly topography. The river Foyle forms a deep valley as it flows through the city. The city now covers both banks (Cityside on the west and Waterside on the east). The district administered by Derry City and Strabane District Council contains both Londonderry Port and City of Derry Airport.

Modern Derry extends considerably north and west of the city walls and east of the river. The district also extends into rural areas to the southeast of the city. This much larger city, however, remains characterized by the often extremely steep hills that form much of its terrain on both sides of the river.

Population: The area covered by the former Derry City Council (the City of Derry District) had a population of 109,853 residents in the 2016 population estimates, and 107,877 residents according to the 2011 Northern Ireland census, making it the third largest of the then 26 district councils in Northern Ireland by population.

In 2016, the average density of the former City of Derry District (the Derry Local Government District) was 284 persons per km². The density of the former Strabane District was 47 persons per km². The average density of the Derry City and Strabane District was 120 persons per km². Derry have many life quality advantages - such as an excellent education system, relatively short commuting times, and a vibrant cultural scene.

Economy: A comprehensive modernization program has resulted in extensive redevelopment within the old Derry city; several industrial estates have established at the mouth of the River Foyle, along with new outlying residential areas and a second bridge across the Foyle. The region has since repositioned itself as one of the most creative and cultural areas in Northern Ireland and is now a strong global competitor in tourism, life sciences and digital and creative industries.

Transport: The transport network includes both old and modern roads and railways throughout the city and county as well as sea connection via Londonderry Port. Derry also serves as a major transport hub for travel throughout nearby County Donegal.



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Climate: Derry has, like most of Ireland, a temperate maritime climate according to the Köppen climate classification system. Most weather comes from the southwest in a series of low-pressure systems bringing the rain and high winds. A relatively dry spring gives way to a wet summer and wetter winter. Daily conditions generally are highly changeable, but there are no extremes of heat and cold. Figure 7.4

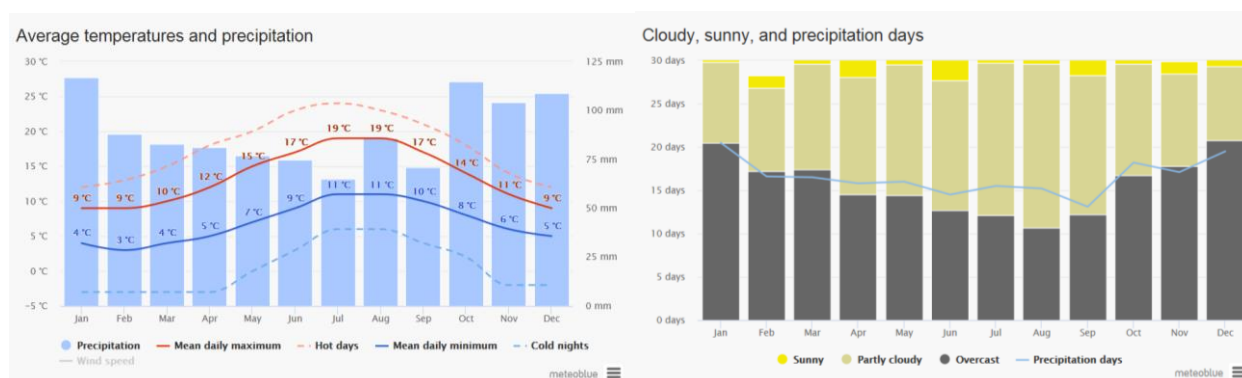


Figure 7.4. Average temperatures, precipitation, cloudy and sunny days in Derry (Source: Meteoblue).

7.3.Kozani

Western Macedonia: The Municipality of Kozani is administratively and geopolitically part of the Regional Group Kozani and decentralized administration of Epirus - Western Macedonia.

Location: Kozani (Κοζάνη) lies 15 kilometres northwest of the artificial lake Polyfyto, 120 km south-west of Thessaloniki, between the mountains Pieria, Vermio, Vourinos and Askio 710 metres above sea level (Latitude: 40° 18' 04" N - Longitude: 21° 47' 11" E). Due to the constant expansion of the mining activities in the Kozani area several communities have already been moved closer to city of Kozani and more are scheduled to be moved by 2020.



Figure 7.5. Western Macedonia and Kozani situate in northern Greece.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under agreement N° 774094.



Population: The Municipality of Kozani is the 35th in populated municipality in Greece with 71,388 inhabitants. The density (the town) was 1240 persons per km², and the density of the Kozani municipality was 67 persons per km².

Economy: Kozani is the main energy producing area of Greece supporting the function of thermoelectric plants (more than 50% of total country's power produced in the Region). Other important sectors in the area include agricultural activities, mainly the production of saffron, as well as commerce and logistic services. The city of Kozani is also important urban center, especially as regards the operation of administrative services, the provision of health services and social care. The provision of education services is of national scope and is strengthened over time, due to the operation of higher education institutions.

Transport: Minibuses and Transit buses provide the public transit in the city. Kozani is a transport node between Central Macedonia, Thessaly and Epirus. Kozani is accessed with Motorway Egnatia (or GR-2, or E90) from Ioannina and Thessaloniki (GR-2 connects the coast of the Ionian Sea with Thessaloniki and Turkish borders), GR-3 (or E65) from Larissa and Florina, GR-4 and GR-20. Kozani has a national airport (KZI).

Climate: The climate of the area is continental with cold and dry winters, and hot summers. Under the Köppen climate classification, it has a humid subtropical climate (Cfa). The average annual temperature in Kozani is 12,9 °C. Rainfall spreads evenly throughout the year. Even the driest month has a lot of rainfall. About 508 mm of precipitation falls annually. The climate of Kozani has changed over the years while the environmental degradation brought by the extensive lignite mining in the area.

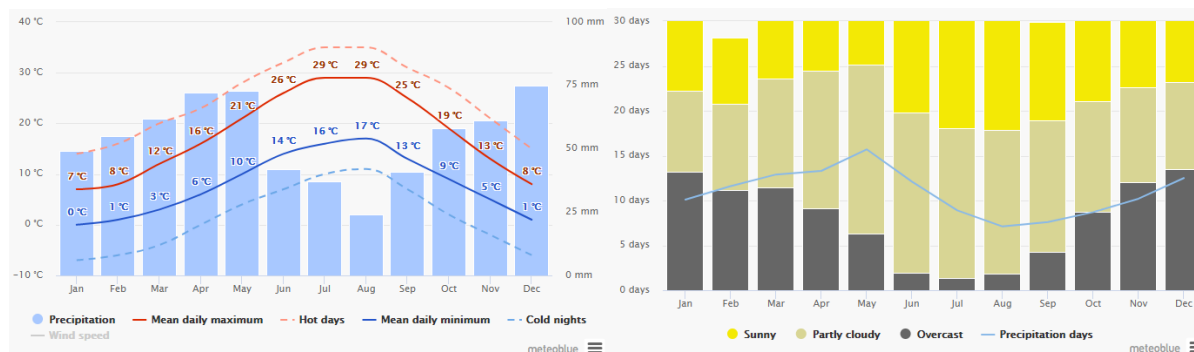


Figure 7.6. Average temperatures, precipitation, cloudy and sunny days in Kozani (Source: Meteoblue).

7.4. Litoměřice

Location: Litoměřice locates at the junction of the rivers Elbe (Czech: Labe) and Ohře in northern Bohemia on the western edge of the Polabské nížiny in the Ústí nad Labem Region, 36 m over the sea level (Latitude 50°32'3" N and Longitude 14°7'58" E), approximately 64 km northwest of Prague. The area of Litoměřice is 17.99 km².



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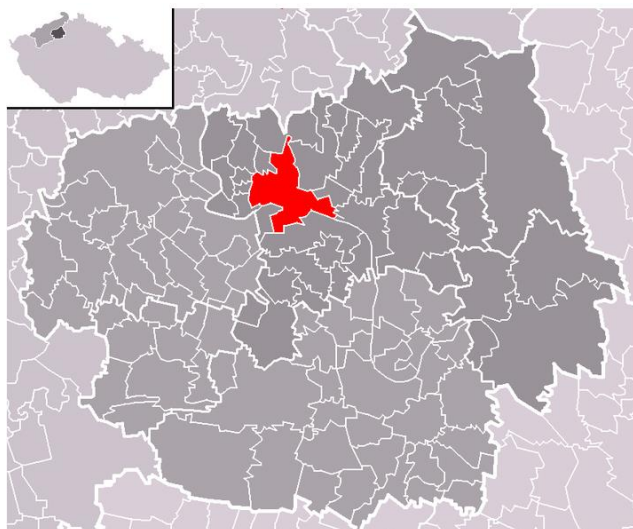


Figure 7.7. Litoměřice situates in the north part of the Czech Republic.

Population: Litoměřice has about 25.000 inhabitants. Population has been stable during recent years. In the beginning of 2015, the average density of Litoměřice was 1340 persons per km².

Economy: The city and its surroundings are well-known agricultural centre, known mainly for traditional fruit growing and greengrocery, which practiced in the whole territory of Litoměřice. Thanks to its location and warm climate, it is also a traditional vineyard area. Litoměřice has a wide network of providers of public, social and charitable services.

Climate: Litoměřice's climate is warm and temperate. The rainfall is significant, with precipitation even during the driest month. The Köppen-Geiger climate classification is Cfb. The average temperature is 8.1 °C. Precipitation here averages 520 mm.

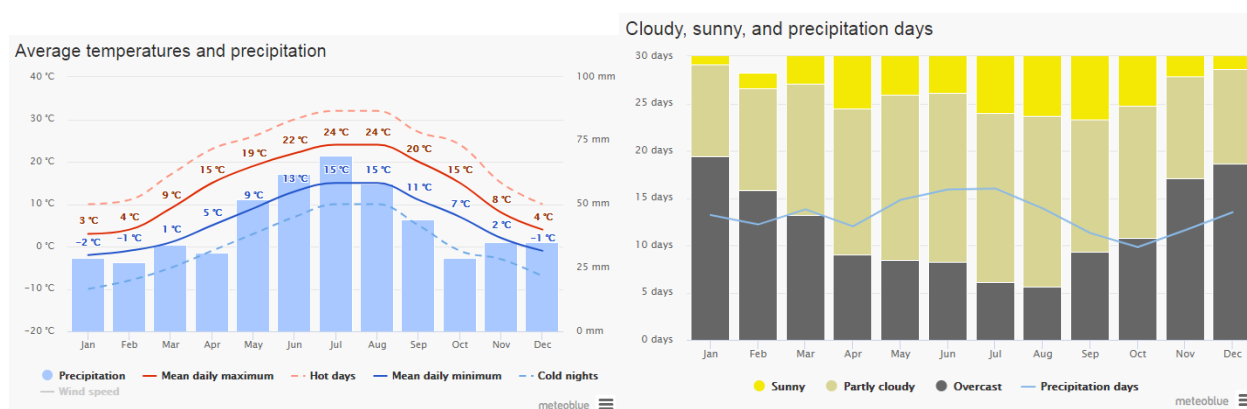


Figure 7.8. Average temperatures, precipitation, cloudy and sunny days in Litoměřice (Source: Meteoblue).



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9. Annex: List of factors and indicators

factor	indicator	spatial level
Innovative spirit	R&D expenditure in % of GDP	regional
Innovative spirit	Employment rate in knowledge-intensive sectors	regional
Innovative spirit	Patent applications per inhabitant	regional
Entrepreneurship	Self-employment rate	local
Entrepreneurship	New businesses registered in proportion of existing companies	local
Economic image & trademarks	Importance as decision-making centre	regional
Productivity	GDP per employed person	local
Flexibility of labour market	Unemployment rate	regional
Flexibility of labour market	Proportion in part-time employment	local
International embeddedness	Companies with HQ in the city quoted on the national stock market	local
International embeddedness	Air transport of passengers	regional
<u>International embeddedness</u>	<u>Air transport of freight</u>	<u>regional</u>
Level of qualification	Importance as knowledge centre	regional
Level of qualification	Population qualified at levels 5-6 ISCED	local
Level of qualification	Language skills	national
Affinity to life long learning	Book loans per resident	local
Affinity to life long learning	Participation in life-long-learning in %	regional
Affinity to life long learning	Participation in language courses	national
Social and ethnic plurality	Share of foreigners	local
Social and ethnic plurality	Share of nationals born abroad	local
Flexibility	Perception of getting a new job	national
Creativity	People working in creative industries	national
Cosmopolitanism/Open-mindedness	Voters turnout at European elections	local
Cosmopolitanism/Open-mindedness	Immigration-friendly environment	national
Cosmopolitanism/Open-mindedness	Knowledge about the EU	national
Participation in public life	Voters turnout at city elections	local
<u>Participation in public life</u>	<u>Participation in voluntary work</u>	<u>national</u>
Participation in decision-making	City representatives per resident	local
Participation in decision-making	Political activity of inhabitants	national
Participation in decision-making	Importance of politics for inhabitants	national
Participation in decision-making	Female city representatives	local
Public and social services	Expenditure of the municipal per resident in PPS	local
Public and social services	Children in day care	local
Public and social services	Perception of quality of schools	national
Transparent governance	Perception on transparency of bureaucracy	national
<u>Transparent governance</u>	<u>Perception on fight against corruption</u>	<u>national</u>
Local accessibility	Public transport network per inhabitant	local
Local accessibility	Access to public transport	national
Local accessibility	Quality of public transport	national
(Inter-)national accessibility	International accessibility	regional
Availability of ICT-infrastructure	Computers in households	national
Availability of ICT-infrastructure	Broadband internet access in households	national
Sustainable, innovative and safe transport systems	Green mobility share	local
Sustainable, innovative and safe transport systems	Traffic safety	local
<u>Sustainable, innovative and safe transport systems</u>	<u>Use of economical cars</u>	<u>national</u>
Attractivity of natural conditions	Sunshine	local
Attractivity of natural conditions	Green space share	local
Pollution	Summer smog	local
Pollution	Particulate matter	local
Pollution	Fatal chronic lower respiratory diseases	regional
Environmental protection	Individual efforts on protecting nature	national
Environmental protection	Opinion on nature protection	national
Sustainable resource management	Use of water per GDP	local
<u>Sustainable resource management</u>	<u>Use of electricity per GDP</u>	<u>local</u>
Cultural facilities	Cinema attendance	local
Cultural facilities	Museums visits	local
Cultural facilities	Theatre attendance	local
Health conditions	Life expectancy	local
Health conditions	Hospital beds per inhabitant	local
Health conditions	Doctors per inhabitant	local
Health conditions	Perception on quality of the health system	national
Individual safety	Crime rate	local
Individual safety	Death rate by assault	regional
Individual safety	Perception on personal safety	national
Housing quality	Share of housing fulfilling minimal standards	local
Housing quality	Average living area per person	local
Housing quality	Satisfaction with personal housing situation	national
Education facilities	Students per inhabitant	local
Education facilities	Access to the educational system	national
Education facilities	Quality of the educational system	national
Touristic attractiveness	Importance of tourist location	regional
Touristic attractiveness	Overnights per year per resident	local
Social cohesion	Perception on personal risk of poverty	national



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