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MASTER'S DEGREE
IN CIVIL ENGINEERING

**SMARTNESS ASSESSMENT OF RURAL AREAS:
MULTICRITERIA RATING WITH ALPINE
STAKEHOLDERS**

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*A Federica,
per il suo affetto spontaneo e autentico*

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Abstract

This thesis proposes a methodology to assess and rate the smartness in rural and mountain areas using a newly developed list of indicators encompassing the six classical smart dimensions (Economy, Environment, Governance, Living, Mobility and People) that have been validated by literature on the more consolidated concept of “Smart City”. The methodology proposed consists in the use of the ELECTRE TRI multi-criteria-analysis method, aiming to assess and rate the smartness of the “Alpine Space Smart Villages” project’s Test Areas with the direct involvement, via surveys and interviews, of local stakeholders and experts, whose technical backgrounds are associated to the six Smart Dimensions. This thesis has developed two different approaches: the self-assessment approach and the expert-based assessment approach in order to capture both the local stakeholders’ perceived level of smartness and a possibly more “objective” assessment by external experts. In addition, four different categories in which the Test Areas can be classified in terms of “smartness” are proposed. The procedure was submitted to six Test Areas located in Italy, Austria, Germany, Slovenia and Switzerland and the results obtained indicate that three of them scores “CATEGORY C: medium level of smartness or work in progress level”, while the remaining half “CATEGORY B: good level of smartness or satisfactory level”. These outcomes are roughly confirmed by the expert-based assessment method with some exceptions.

As regards to further developments, it could be significant to submit the procedure to the regional stakeholder groups, specifically organized in a 4-helix logic, of a larger number of Test Areas in order to define whether and to which extent the six dimensions of smartness are suitable for rural and mountainous areas. Moreover, it would be worth analyzing the results registered by each Test Area in correlation with their specific geographical, demographic and economic characteristics and consequently, identifying some reference profiles.

The approach and main results of the thesis have been submitted in an abstract that has been accepted as a discussion paper for the 89th meeting of the EURO Working Group in Multi Criteria Decision Aiding.

Sommario

Questa tesi propone una procedura per valutare e categorizzare la “smartness” di aree rurali e montane, per la quale è stata sviluppata la prima lista di indicatori strutturata considerando le sei classiche “smart dimensions”, consolidate in letteratura grazie al concetto di Smart City. La metodologia proposta consiste in un modello basato sul metodo di analisi a multicriteri ELECTRE TRI e ha lo scopo di valutare e successivamente categorizzare la “smartness” delle Aree di Test partecipanti al progetto “Alpine Space SmartVillages” coinvolgendo, attraverso questionari ed interviste, stakeholder locali ed esperti in materie inerenti alle sei dimensioni. Questa tesi ha sviluppato due diversi approcci, il “self-assessment approach” e l’“expert-based assessment approach”, in modo da individuare sia il livello di “smartness” percepito dagli stakeholder locali che fornire una valutazione più oggettiva da parte di esperti esterni. Inoltre, sono proposte quattro differenti categorie nelle quali le Aree di Test possono essere classificate considerando il loro livello di “smartness”. Questa procedura è stata sottoposta a sei Aree di Test situate in Italia, Austria, Germania, Slovenia e Svizzera e i risultati ottenuti indicano che tre di queste si classificano nella “CATEGORIA C: good level of smartness or work in progress level”, mentre la restante parte nella “CATEGORIA B: good level of smartness or satisfactory level”. Questi esiti sono in buona parte confermati dall’“expert-based assessment approach”.

Per quanto concerne gli sviluppi futuri, potrebbe essere significativo presentare la procedura ai gruppi di stakeholder regionali, organizzati in una logica a quadrupla elica, di un campione più esteso di Aree di Test in modo da definire l’effettiva adattabilità delle sei dimensioni di “smartness” alle aree rurali e di montagna. Inoltre, potrebbe essere interessante profilare le Aree di Test definendo una correlazione tra i risultati ottenuti da ogni Area di Test e il contesto geografico, demografico ed economico nel quale sono inserite.

L’approccio e i relativi risultati presentati in questa tesi sono oggetto di un Abstract che è stato selezionato come documento di discussione per l’89th meeting dell’EURO Working Group in Multi Criteria Decision Aiding.

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Introduction to this Master Thesis

A brief personal introduction can help understanding the reasons behind the choice of the issue of “Smart Villages” for my Master Thesis in Civil Engineering.

I come from Tolmezzo: a small and mountain village in Friuli-Venezia Giulia. During my childhood I really enjoyed living there because I was free to reach my school by myself, all my relatives lived nearby and I was completely surrounded by nature. However, the more I grew, the more I perceived Tolmezzo like a cocoon: the services for the younger generations were limited, the education opportunities covered only the basic courses, practicing ballet (my favourite sport since I was six years old) was becoming more difficult because all the performances were held far from my hometown and, above all, I started to realize that people my own age who lived in larger cities appeared to be more open-minded, more digitalized and more aware about their future choices.

Therefore, I decided to move to Trieste to attend the Civil and Environmental Engineering course at the Università degli Studi di Trieste. After my Bachelor degree, I moved to Milan to further my studies in Civil Engineering-Transport Infrastructure at the Politecnico di Milano. I believe that this University provides students with more chances to develop their mindset and to approach new opportunities. Moreover, Milan and the Politecnico are characterized by an international context so, every day, students can experience a dynamic environment. Nowadays, I can confirm that my personal experience has lived up to those expectations.

Unfortunately, I was not the only student that decided to leave Tolmezzo to have more chances and to be able to experience more a stimulating environment: year after year, more and more young people make the decision of leaving rural and mountain areas to move to bigger cities for their studies and future career.

In August 2018 a cooperation between professor Roberto Maja and Poliedra proposed me to study the issue of the assessing and rating of smartness of mountain and rural areas for my Master Thesis: I was immediately captured by the idea to

develop a strategy to define and contribute to study the problematic issues affecting rural and mountain villages, due to my interest in that subject and my personal background. I personally think that behind a good work there has to be a considerable motivation, in fact I tried and conduct this analysis with passion and determination because it seemed to me like seeking to ‘resolve’ the current situation of my hometown. In this sense, and in furthering this context of personal commitment to the Thesis, I also decided to involve Tolmezzo directly in the testing phase of the method developed to evaluate the level of smartness of rural areas, with the agreement of my Thesis Advisor and co-advisor.

At this point a question might spring to mind: *Why is a Civil Engineer interested in Smart Villages?*

In general, an Engineer is tasked with planning, managing and solving critical situations. A Civil Engineer specifically is often asked to deal with planning issues and this thesis project perfectly reflects the initial phases that are necessary for it. Before starting any kind of construction, be it a highway, social housing, a bridge, a skyscraper, a playground, an airport, a hospital, a school or a railway station, it is essential to identify the territory’s situation, its needs, its desires, its vision for the future and the actors living and working on the very same territory. Therefore, analysing the site location and the surrounding area is one of the primary responsibilities for a Civil Engineering. This includes a search and investigation phase, and the verification of its feasibility for construction purposes. After that, a plan is designed, outlining the key variables and what needs to be changed prior to the construction.

During 2018, the European Commission started to promote projects and initiatives in order to tackle the decline of rural and mountain areas in Europe with a smart approach, similarly to what the European Commission did with initiating the concept of ‘Smart Cities’. The initial difficulty was that there was not even a definition of “smart villages” and therefore a pilot project to even define what a ‘smart village’ is supposed to be was essential.

In this context of emerging definitions and needs to kickstart actual activities fostering the smart transformation of rural and mountain villages, the support of

Poliedra has given me the opportunity to be involved in a European Alpine Space project called “SmartVillages” that works on the definition of an approach to unlock the smart potential of rural and mountain areas. Furthermore, while working on my thesis I had the chance to interact directly with the project partners in several instances, especially during the meeting held the 28th of November, hosted by Regione Lombardia at Palazzo Pirelli and organised by Poliedra and in the testing phase of the assessment and rating model developed in this Thesis.

The assessment and rating the level of smartness of mountain and rural areas through the use of the ELECTRE TRI Method and considering the project Alpine Space SmartVillages as a pilot case are the main aims of this Master Thesis.

Below, the key issues to be addressed by this Master Thesis are summarized:

- Providing an overview of all the challenges and problems experienced by rural and mountain communities and analysing in detail the Test Areas of the project.
- Defining of a List of Indicators of smartness for smart villages, which represent not only a method to define the current smartness of the Test Areas (TA), but also a way to track changes due to the activities of the project (performance indicators) and to accompany the smart transformation towards the expected results (indicators of result). A specific tool, called Indicator Card, has been developed to support the TA in the organisation of all the information required.
- Rating the level of smartness of each Test Area by the use of the ELECTRE TRI method which use the data provided by the project partners. A self-assessment approach and an expert based assessment approach have been developed, whose weight systems are defined using the Analytic Hierarchy Process.
- Evaluating the issues surrounding Smart Mobility within specific Test Areas of the project, in a dedicated focus on accessibility and good practices in smart mobility in rural and mountain areas.

I think it could also be useful to specify the chapters in which there is my specific contribution: Chapter 3 and Chapter 4 illustrates the process of my research behind the definition of the ELECTRE TRI Model to assess the level of Smartness of the project's rural an mountain TA; in particular: the 3.5 paragraph provides all the issues discussed during the Capacity Building Seminar that led me contributing to the definition of the survey form submitted to some selected Test Area. Furthermore, I also cooperated in establishing the procedure to structure and organise the Regional Stakeholder Groups and to define and assess the needs and challenges in terms of smart transformation of each Test Area.

It is worth mentioning that my hometown Tolmezzo has been directly involved by me in the analysis and has henceforth been considered one of the selected Test Areas providing its own data to test the ELECTRE TRI Model.

It is also worth noting that this dissertation has provided an effective contribution to the activities of the European project "Alpine Space SmartVillages", including three of the project's reports and deliverables submitted by Poliedra (see first page in Appendix D), and that it has also led to the preparation and subsequent acceptance of an abstract entitled "*Assessing and rating the level of smartness of mountain areas by the use of Electre Tri: the pilot case of the ongoing Alpine Space project SmartVillages*" centred on the work performed in this Thesis, selected for the 89th meeting of the EURO Working Group in Multi Criteria Decision Aiding (EWG-MCDA) organised by the Department of Industrial Engineering of the University of Trento (see Appendix E).

Chapter 1

The concept of “Smart Villages”

Mountain and rural areas¹ across Europe are undergoing rapid change. This transition contains risk but also real opportunity for these areas to play a new and distinct role. In this context, villages can be defined smart when their communities refuse to simply wait for change to happen to them: smart villages are composed of rural people who take the initiative to explore practical solutions to the underlying challenges they face and to seize new opportunities (ENRD 2018).

Thousands of rural communities are doing this in various ways: many are taking advantage of new digital technologies, but these are just one of the tools available. There are also many examples of social innovation in rural services and activities which reinforce the role of rural areas in the transition to a greener, healthier and more caring society. To create an enabling environment to develop and put into practise the concept of Smart Villages, rural policies need to evolve. This is why policy-makers and project promoters at the EU, national, regional and local levels are also exploring new approaches. The crucial point in the process is to put the communities themselves behind the steering wheel and not impose developmental paradigms that would not be compatible with community’s desires and cultural environments (Zavratnik, Kos e Stojmenova 2018).

The following paragraphs explain extensively what the concept of “Smart Villages” means and analyse in detail the reasons behind the need to address this issue. In addition, an entire paragraph is dedicated to compare Smart Villages and Smart Cities underlining the differences between them. After that, two sections provide an overview of the main European policies and already existing initiatives with a top-down approach related to Smart Villages.

¹ Although, it is perfectly well known that rural and mountain express two different environments and situations, in this thesis, the word rural will refer to the mountain context as well.

1.1 What are Smart Villages?

The emerging concept of Smart Villages does not propose a one-size-fits-all solution. It is territorially sensitive, based on the needs and potentials of the respective territory and strategy-led, supported by new or existing territorial strategies (European Commission 2017). Furthermore, the adjective smart may be differently interpreted based on the field considered as it is explained below.

Smart means using digital technologies when they are appropriate, not because they are fashionable. Smart means thinking beyond the village itself. Some initiatives are taking place at village spatial level, but many involve surrounding countryside, groups of villages, small towns and links to cities. Smart means building new forms of cooperation and alliances between farmers and other rural actors; between municipalities; the private sector and civil society; from the bottom-up and the top-down. Smart means thinking for yourself. There is no standard model or solution for smart villages; it is about local people taking stock of local assets, drawing on the best available knowledge, and taking the initiative. (ENRD 2018)

In conclusion, the EUROMONTANA² definition of a Smart Village, circulated in the context of the pilot project on Eco-Social Smart Villages³, claims that “Smart Villages are communities in rural areas that develop smart solutions to deal with challenges in their local context. They build on existing local strengths and opportunities to engage in a process of sustainable development of their territories. They rely on a participatory approach to develop and implement their strategies to improve their economic, social and environmental conditions, in particular by promoting innovation and mobilizing solutions offered by digital technologies. Smart villages benefit from cooperation and alliances with other communities and actors in rural and urban areas. The initiation and the implementation of smart

² EUROMONTANA is the European association of mountain areas. Since its foundation in 1996, EUROMONTANA has been active in several working themes that are identified to be a priority for the sustainable development of mountain areas. EUROMONTANA today represents around 75 organisations of all kinds in 20 European countries.

³ The pilot project on Smart Eco-Social Villages was initiated by the European Parliament. It explores characteristics of smart eco-social villages and identifies best practices upon which decision makers and rural communities can build future development strategies. A specific focus is connectivity and digital solutions.

village strategies may build on existing initiatives and can be funded by a variety of public and private sources”.

Some specific terms that appear in the aforementioned definition are analysed in detail in paragraph 3.2 about Indicators for Smart Villages.

1.2 What is driving Smart Villages?

During the ENRD (European Network for Rural Development) Thematic Group on smart villages set up in October 2017, it was highlighted that many rural areas are locked into a “**circle of decline**” by two mutually reinforcing trends: firstly, a shortage of jobs and sustainable business activity; and secondly, inadequate and declining services.

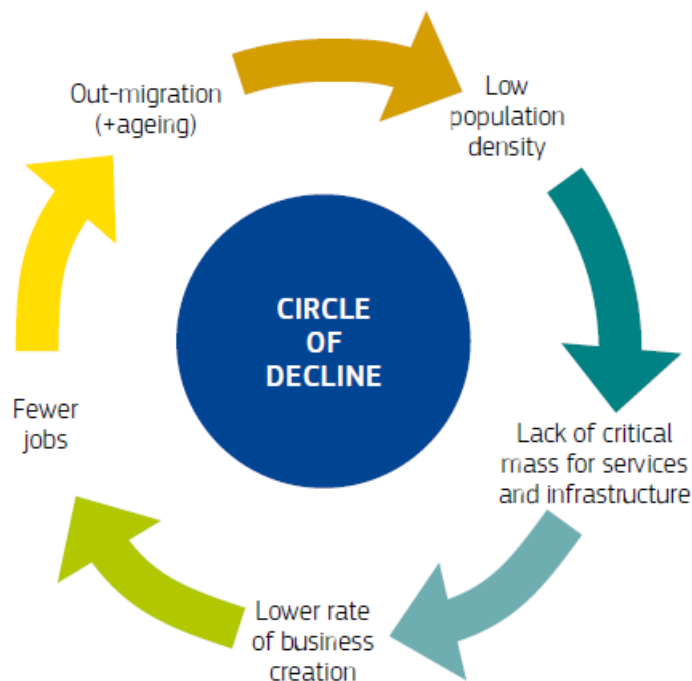


Figure 1: circle of decline (from ENRD 2018)

Smart villages are laboratories where local people and policy-makers at different levels are experimenting innovative solutions to some of the major challenges of rural life. In this way, they are seeking to seize opportunities that can strengthen rural vitality in Europe. Both the challenges and the opportunities vary enormously across rural areas and between different parts of Europe. It is always important to understand the context and starting point of the broader strategies and individual projects that contribute to smart villages (ENRD 2018).

The ENRD’s thematic work has uncovered at least five main drivers that lead to the need to develop the concept of Smart Villages.

These drivers are closely intertwined and digitisation can be considered as a cross-cutting theme (ENRD 2018):

1. Responding to depopulation and demographic change

There is a seemingly unstoppable worldwide trend towards urbanisation and by 2050, the EU population living in cities is expected to grow by 24.1 million, while the population in predominantly rural areas is expected to shrink by 7.9 million.

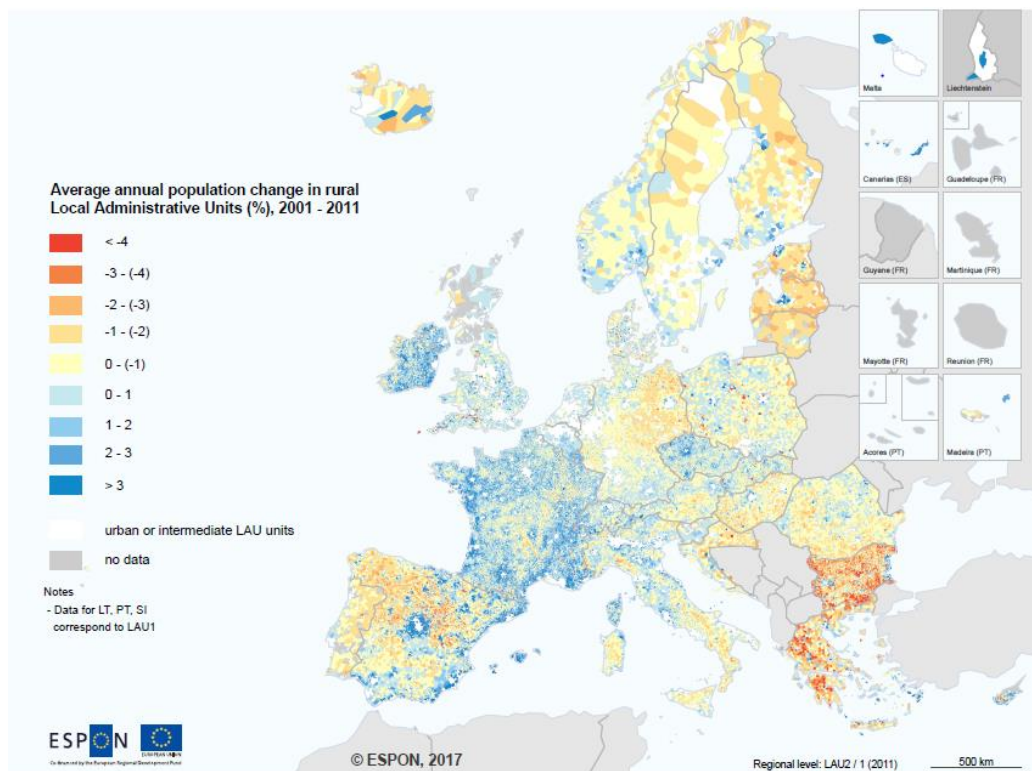


Figure 2: rural population loss (from Eurostat, ESPON, 2017)

Figure 2 shows major population loss:

- In rural areas in the east Europe where significant agricultural restructuring is still taking place;
- In the interior of the southern European countries;
- In the sparsely populated Nordic and Baltic countries.

2. Finding local solutions to public funding cuts and the centralisation of public services

Even when the population of rural areas is stable or growing, lower population densities, together with complicated logistics drive up the unit

costs of providing certain basic services like education, healthcare, commerce and public transport. The situation is particularly acute in places like the north of Finland, the centre of Spain and Portugal, and many mountainous regions. The costs of providing services are also much higher when the population is spread around many small settlements rather than concentrated in larger ones.

Higher-cost rural services for smaller numbers of people are often the first to be cut when public budgets are tight.

As a result of the financial crisis public budgets were cut and social spending reduced in many EU countries. Throughout this period, public administrations have been looking for cost savings by reducing the level of service provision and increasingly, privatisation and outsourcing.

Local authorities in many EU Member States have been or are in the process of being reorganised into larger units. One of the obvious consequences has been a reduction in the services in rural areas and their concentration in larger towns and cities.

3. Exploiting linkages with small towns and cities

Rural areas have a symbiotic relationship with cities and towns. Historically, what the cities gained, rural areas were thought to lose. However, some organisations have analysed the complex web of linkages between cities and rural areas and shown that, if carefully managed, there is much potential for win-win arrangements between the two. The OECD (Organisation for Economic Co-operation and Development) finds that in nearly all of its member countries, it is the rural areas close to⁴ or accessible from cities that are the fastest growing in terms of GDP (Gross Domestic Product), productivity and population.⁵

4. Maximising the role of rural areas in the transition of low-carbon, circular economy

Rural areas are front-and-centre in the shift to a low-carbon economy, according to the OECD.⁶ Rural and intermediate areas account for 88.2% of

⁴ The definition of “rural areas close to cities” refers to any city of more than 50000 inhabitants.

⁵ OECD, “OECD Regional Outlook 2016: Productive regions for inclusive societies”, 2016.

⁶ OECD, “OECD Regional Outlook 2016: Productive regions for inclusive societies”, 2016.

the EU's territory and the clear majority of its natural assets. These natural assets often form the cornerstone of their competitive advantage as well as their identity and attractiveness as places to live.

They are, therefore, both particularly exposed to the risks of climate change and environmental degradation, and in a privileged position to make a difference.

In this context, it is not surprising that there are now around 15000 ecovillages⁷ in six continents, and that many villages in different parts of Europe are implementing projects for energy saving, renewable energy production and sustainable transport, as well as promoting local clusters of activity in the circular and bio-economies.

5. Promoting the digital transformation of rural areas

Digital technologies have the capacity to radically transform the disadvantages that rural areas face in terms of distance and low population density by permitting instantaneous virtual communication and access to e-services. Although the potential opportunities and benefits are great, there are also risks that could, for example, lead to closures of local shops.

Rural areas are often characterized as suffering from a triple digital divide: broadband connectivity, skills and uptake. In addition to the lack of supply of NGA (Next Generation Access)⁸ to the internet (only 47% of rural households have NGA, compared to 80% of total EU households, see Figure 3), many rural populations lack the necessary digital skills and the use of digital technologies is lower than urban areas.

The creation of a high-speed digital infrastructure in rural areas, accompanied by digital education and training, has to be a continued investment priority.

⁷ An ecovillage is an intentional, traditional or urban community that is consciously designed through locally owned participatory processes in all four dimensions of sustainability (social, culture, ecology and economy) to regenerate social and natural environments.

⁸ Next Generation Access describes modern forms of superfast broadband access commonly defined as at least 30 Mbps. NGA marks a step change in speed and quality of internet access compared to standard broadband services.

Smart villages' aim is not simply to catch up with urban area by bridging the divide, they want to increase the attractiveness of rural areas and to develop new roles for them in Europe's transformation to a digital economy.

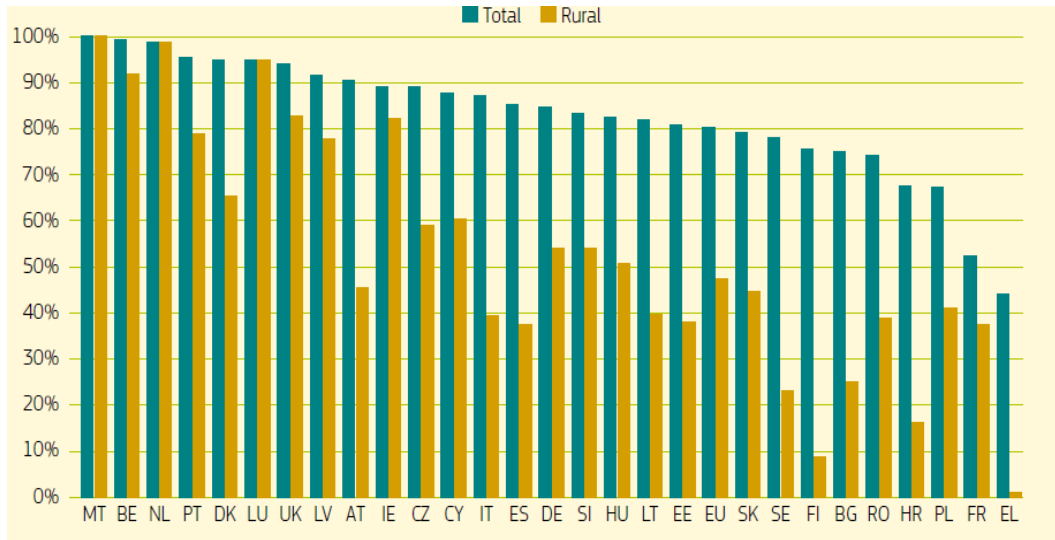


Figure 3: NGA coverage (percentage of households), 2017 (from IHS and Point Topic)

1.3 Smart Villages and Smart Cities

All the points aforementioned emphasise the challenges, risks and opportunities for rural areas. It is clear that the approach required to face all the topics explained by the five drivers, needs to be specifically defined for the concept of Smart Villages and that it is not possible to apply the same strategies used in the context of Smart Cities only because the smartness issue is taken into consideration.

In general, the concept of smartness for cities tend to focus more on big data and the opportunities for transforming the way in which cities function through interrelated digital technologies (Lombardi, et al. 2011). The idea of smart villages is not simply an extension of these principles to dispersed areas: it focuses more on local communities taking their future into their own hands, often but not exclusively with the help of digital technologies.

At this point, some details about the concept of Smart Cities are essential in order to clarify the definition and the different aspects taken into consideration on this issue.

The concept of Smart Cities has become more and more popular in scientific literature and international policies in the last two decades. Cities worldwide have started to look for solutions which enable transportation linkages, mixed land uses and high-quality urban services with long-term positive effects on the economy (Albino, Dangelico e Berardi 2015).

There are many definitions of Smart Cities, a range of conceptual variants is often obtained by replacing smart with alternative adjectives, for example, “intelligent”, or “digital”. A very broad definition states that “smart cities use ICT⁹ to be more intelligent and efficient in the use of resources, resulting in the cost and energy savings, improved service delivery and quality of life, and reduced environmental footprint; all supporting innovation and the low-carbon economy” (Zavratnik, Kos e Stojmenova 2018). This assertion clarifies that the diffusion of ICT in cities has

⁹ ICT means Information and Communication Technologies and refers to technologies that provide access to information through telecommunications. It is similar to Information Technology (IT), but focuses primarily on communication technologies. This includes the Internet, wireless networks, cell phones, and other communication mediums.

to improve the way every subsystem operates, with the goal of enhancing the quality of life. The idea of Smart City is no longer limited to the diffusion of ICT, but it looks at people and community needs (Kourtit, Macharis e Nijkamp 2014).

The most representative features of the Smart Cities are shared ICT structures, time optimisation, open government, energy efficient technologies, reduced emissions, and orientation towards green environment. Meanwhile to apply the Smart Villages concept, it is necessary to use bottom-up integrated approaches, build effective public-private-community partnerships, develop supportive policy frameworks and enable access to financing mechanism (Zavratnik, Kos e Stojmenova 2018).

1.4 EU policies for Smart Villages

The European Conference on Rural Development in September 2016 held in Cork, a city in south-west Ireland, organised by the European Commission, gathered more than 300 policy makers and stakeholders involved in rural development and discussed the current and future challenges of farming and rural areas, as well as potential policy responses.

Under the heading “A Better Life in Rural Areas”, the Cork declaration 2.0 sets out the expectations and aspirations of rural areas. Among the priorities to be addressed, it demands policies to focus particular attention on overcoming the digital divide between urban e rural areas and to develop the potential offered by connectivity and digitisation of rural areas. Emphasis was given to the need for integrated approaches and the interaction between different policy fields in view of increasing complementary and coherence (European Commission 2017).

As the European Commission claims in the document “EU Actions for SMART VILLAGES” “in order to construct something solid and future-proof, we need more than just building blocks. We need strategic approaches which will help policy makers, stakeholders and project promoters on the ground to deliver results, taking into account the comparative strengths and needs of their respective territory. This is why we envisage a number of concrete actions, currently planned or underway, which will help further developing and delivering on such strategic frameworks to improve the implementation of EU policies in rural areas in this programming period”. Several EU policies are actively promoting aspects of the development of Smart Villages and they are submitted below.

1. The Common Agricultural Policy – Rural Development

The Common Agricultural Policy continues to be the most important EU policy intervening in the EU rural economy in terms of funding and the range of instruments.

Rural development policy provides an ample toolbox for supporting the development of smart villages in rural areas. Based on integrated strategic

approaches that reflect EU priorities as well as the needs of a territory, Rural Development Programmes support a mix of measures. These measures target rural business development, including the modernisation of farms, investments in small-scale local infrastructure and connectivity projects, village renewal, knowledge development, knowledge sharing, and bottom-up initiatives.

A new element in rural development policy is the European Innovation Partnership for Agriculture (EIP-AGRI) which is designed to speed up innovation on the ground. Through networking activities and projects, the EIP-AGRI supports the development and dissemination of new knowledge, practices, processes and technologies in agri-food and forestry value chains.

2. EU Cohesion Policy

Cohesion Policy for growth and jobs is implemented across the whole EU territory, both urban and rural areas. The financial support of the European Regional Development Fund (ERDF) and the Cohesion Fund (CF) is focused on Research and Innovation, ICT, SME competitiveness and Low Carbon Economy. These funds also deliver important investment in the fields of environment, climate action, transport, poverty reduction and administrative capacity. There is a close cooperation with the European Social Fund.

Cohesion Policy is implemented through programmes at national, regional and local level, based on thorough thematic and territorial needs analysis and using integrated approach. Specific instruments and tools such as smart specialisation strategies, integrated territorial investment (ITI) and community-led local development (CLLD) allow to further target programme resources to territorial needs and to combine support from different sources and funds. Cohesion Policy programmes and tools could foster smart villages.

3. Horizon 2020 – the 8th EU Framework Programme for Research and Innovation

The 2016-2017 Work Programme of the 8th EU framework programme for research and innovation, Horizon 2020, includes several elements that are relevant for the development of smart villages.

4. Connecting Europe Facility and Trans-European Networks for Transport

The Connecting Europe Facility (CEF) funds targets infrastructure investment at European level. It supports the development of high performing, sustainable, and efficiently interconnected trans-European networks in the fields of transport, energy and digital services. CEF investments fill the missing links in Europe's energy, transport and digital backbone.

1.5 Already existing top-down initiatives in Europe

Although smart villages are fundamentally about rural people taking the initiative, national regional and local governments can provide an enabling environment for their activities.

Below are some prime examples of how vibrant, sustainable and attractive rural areas are being created (ENRD 2018):

- 1. Inner Area Strategy in Italy:** in the 2014-2020 programming period, Italy has put in place a new integrated policy called NSIA (National Strategy for Inner Areas). Italy's inner areas are rural areas characterised by their distance from the main services centres. These areas are home to 23% of the country population and cover 60% of the national territory. The NSIA focuses on the most peripheral and ultra-peripheral inner areas where demographic decline and ageing population are most pronounced. The aim is to foster job creation, social inclusion and to reverse demographic decline.
- 2. Services in peripheral and rural areas of Sweden:** the strategy supports actions to promote accessibility to private and public services.
- 3. The Spanish law for sustainable rural development:** an integrated approach to support rural infrastructure, ICT (Information and Communication Technology) and a wide range of rural services, as well as economic development. The Spanish government is also developing a strategy against depopulation.
- 4. “Reciprocity contracts” in France:** in 2015, France launched an experimental scheme to promote inter-municipal cooperation, called “city countryside reciprocity contracts”. The aim is to close the gap between urban and rural areas by promoting win-win partnerships in areas of common interest.
- 5. The “Service Design” strategy in Flanders:** it aims to improve transport and mobility in the Belgian western Flemish municipalities by involving citizens in decision making processes.
- 6. The “Smart Countryside” Initiative in Finland:** in 2016, the Finnish government carried out a study to investigate the challenges facing rural

areas and the opportunities offered by digitisation. The goal was to explore possibilities for developing and diversifying rural services through digitisation and experimentation. Digitisation can bring services nearer to the customer, reduce costs and have a major impact on the countryside where structural change is rapid and distances to physical services are increasing. It is important to familiarise people with digital tools to invest in building their capacity and willingness to use digital services.

- 7. The Digital Villages initiatives in Germany:** this project is testing a holistic approach to the digitisation of rural services in three pilot areas in the Rhineland-Palatinate state. Examples of services developed so far include an online marketplace with a system of voluntary deliveries and a local news portal.

Chapter 2

The Alpine Space project SmartVillages

As briefly discussed in the introduction, this dissertation is strongly linked to the project Alpine Space SmartVillages¹⁰: the connection to an actual and ongoing project of this magnitude is considered a worthwhile occasion to work with official documents in an international context interacting directly with other characters coming from different European countries. The project "Alpine Space SmartVillages" is a strategic initiative of EUSALP AG5¹¹ and follows an integrative, participatory approach implying a city-village dialogue. The direct beneficiaries are local or regional authorities and administrations, small and medium sized enterprises, public service providers, regional development agencies and NGOs which will receive a concrete guidance to implement the SmartVillages approach. The project is in perfect line with the Cork declaration 2.0, see paragraph 1.4, that recognised the digital divide between rural and urban areas and the need to develop the potential offered by connectivity and digitisation of rural areas as major priorities. Furthermore, it builds up on the AS INTESI project¹², that focuses on the integration of services of general interest in mountain areas, to move further towards tackling the issue of smart transition of Alpine villages.

The following paragraphs provide, first of all, more precise details about the project objectives, expected results and outputs. Then, the method used to collect Regional Stakeholder Groups is explained and the descriptions of each Test Area are presented.

¹⁰ The official name of the project is: "Smart Digital Transformation of Villages in the Alpine Space". During the dissertation may be also used the shortest version of the title which is SmartVillages.

¹¹ An Alpine macro-regional strategy would provide an opportunity to improve cooperation in the Alpine States as well as identifying common goals and implementing them more effectively through transnational collaboration. EUSALP constitutes a strategic agenda that should guide relevant policy instruments at EU, national and regional level, by closely aligning and mutually reinforcing them.

In particular, EUSALP AG5 refers to the Action Group 5, whose focus is twofold. On the one hand to draw up a comprehensive strategy for guiding and shaping the ongoing process of digitisation in the Alpine Region and on the other hand the accessibility to services which are provided by public authorities to people living within a certain area.

¹² INTESI is an Interreg Alpine Space project (2016-2018) involving 10 partners in 5 countries.

2.1 Project focus and description

The project assumes a great relevance in the European context because a SmartVillages approach for mountain areas could unlock the potential of local actors to make their region a more attractive place to live and work. Whereas for centres and agglomerations in the Europe many initiatives in the domain of Smart Cities already exists, the rural alpine areas are left behind.

Alpine space rural communities are deprived of highly needed jobs, good provision of services as well as a favourable climate for entrepreneurship and social innovation, which result in a brain drain.



Figure 4: The Alpine Space

Digitalization is a promising approach to counter the situation. However, the digital divide between rural and urban areas has even increased in the last years. A smart village approach for mountain areas could unlock the potential of local actors to make their region a more attractive place to live and work.

The project “Alpine Space SmartVillages” creates opportunities for a smart transition of municipalities and regions in mountainous areas through bringing together - in so called Regional Stakeholder Groups (RSGs) – policy makers, business, academia and civil society in a quadruple helix approach (4H) to improve the framework for innovation through new forms of stakeholder involvement facilitated by Information and Communication Technologies (ICT).

The project contributes to improve the framework conditions for innovation in the Alpine Space by:

- assessing the level of smartness in the Test Areas highlighting where further action is needed to improve framework conditions for innovation in Smart Specialisation Strategy (S3)¹³ key sectors;
- interlinking policy level, academia, business and civil society in Regional Stakeholders Groups that collaborate transnationally, thus enabling good framework conditions for generating innovation processes;
- designing a Digital Exchange Platform that enables the key findings and knowledge exchange with regard to a SmartVillages approach among different stakeholders;
- creating a toolbox that provides access to digital tools that support the development of framework conditions for innovation;
- transferring results to the policy level to improve the political framework conditions for digital innovation.

In order to initiate understanding and mutual learning on the SV ecosystem, regional analyses to identify stakeholders, innovation resources, obstacles, opportunities and business models linked to the Alpine smart village approach are performed. The smart villages Digital Exchange Platform and the smart villages Toolboxes are developed in parallel. Whereas the DEP brings together different stakeholders to a transnational knowledge sharing, the smart villages toolboxes are developed in the Test Areas on a local level. The results of the regional analyses, the smart villages DEP and the toolboxes are accessible for all interested stakeholders on the project websites.

The partnership consists in 13 partners from six countries included in the Alpine space region, thus covering a great majority of the regional territory:

¹³ Conceived within the reformed Cohesion policy of the European Commission, Smart Specialisation is a place-based approach characterised by the identification of strategic areas for intervention based both on the analysis of the strengths and potential of the economy and on an Entrepreneurial Discovery Process (EDP) with wide stakeholder involvement. It is outward-looking and embraces a broad view of innovation including but certainly not limited to technology-driven approaches, supported by effective monitoring mechanisms.

1. SAB, Swiss centre for mountain regions: Lead partner of the project (Switzerland)
2. University of Maribor: ERDF Lead partner of the project (Slovenia)
3. University of Ljubljana (Slovenia)
4. SmartIS City, business consultations Ltd. (Slovenia)
5. Software Competence Centre Hagenberg (Austria)
6. BeNu, energy and environment company of lower Austria (Austria)
7. Development Agency Gal Genovese s.r.l (Italy)
8. Bodensee Standort Marketing GmbH (Germany)
9. Standortagentur Tirol (Austria)
10. Region Luzern West (Switzerland)
11. Regionalverband Sudlicher Oberrhein (Germany)
12. ADRETS, Association for networking services and territorial development (France)
13. Poliedra, service and consultancy centre of the Politecnico di Milano on the environmental and territorial planning (Italy)

The project defines a work plan divided in six work packages in which one of the partners is the responsible of all the activities and deliverables included and all the other partners are involved.

Poliedra is the responsible partner for the Work Package one (WPT-1) whose aim is to determine how advanced the Test Areas are already in the smart transition process and their own Smart Specialisation Strategy. WPT-1 involves the assessment of the level of smart readiness of the Test Areas, including the identification and collection of the relevant data on a regional level and on Test Area level. Furthermore, the definition of Regional Stakeholders Groups considering the 4H logic is accurately exposed in this WP.

2.2 Regional Stakeholder Groups in a quadruple helix logic

One of the WPT-1 main outputs is the definition of the Regional Stakeholder Groups (RSG), as said in the previous paragraph. The definition of the RSG is required in order to assist the assessment of the level of smartness of each Test Areas, give input for best practices and test the digital exchange platform (DEP), codesign the toolbox and facilitate the transfer of project results to the policy level. The selection of the stakeholders depends on the issue in which each Test Area is set to be working, thus the aims of each Test Areas need to be clearly defined (Lentini, Gemini, et al. 2019).

The RSG mapping works in a quadruple-helix (4H) logic, a conceptual framework that sees innovation at the intersection of the converging interests of:

- public entities/policy makers,
- academia/research institutions,
- business/firms/enterprises/economic actors,
- civil society/NGOs/citizen organizations.

The mapping represents the starting point of the activities in the Test Areas, and aims at kickstarting the evaluation of the state of the art for Smart Transition, the first activity of the RSG.

The number of stakeholders to be involved is critically linked to the dimensions and demographics of the Test Area. Ideally, all elements of the quadruple helix should be covered, but the societal, demographical and economical structure of the Test Area influence the distribution of RSG.

All identified stakeholders have been evaluated in terms of their:

- Power or Influence: it is a measure of the relative power each stakeholder has on decision-making in the Test Area, and on other local stakeholders; influence can be evaluated on a scale from 1 (little power over decision-making) to 5 (high power over decision making).
- Interest or Relevance: it is a measure of the interest each stakeholder has in the SmartVillages project and its aims as regards the Test Area; relevance

can be evaluated on a scale from 1 (low interest for the project and its aims) to 5 (high interest for the project and its aims in the Test Area).

The clustering of Regional Stakeholders according to Power or Influence and Interest or Relevance allows us to classify them in four possible categories:

- **Responsible Stakeholders:** Stakeholders with high(-er) Influence and high(-er) Relevance, ready to lead the activities and suitable for implementing actual policy decisions/changes; for example, the SmartVillage partners who are responsible for the project's Test Area and who are also policy makers.
- **Accountable Stakeholders:** Stakeholders with low(-er) Influence on implementing decisions but with high(-er) Relevance for motivating others (including R Stakeholders) in implementing changes; for example, a research institution that is active in the Test Area or a business institution working in the Area.
- **Consulted Stakeholder:** Stakeholders with high(-er) Influence on Implementing decisions but with low(-er) interest in the project and its activities; for example, a public entity outside the SmartVillages partnership, a business institution interested in the Area but not (yet) active within it.
- **Informed Stakeholder:** Stakeholders with low(-er) Influence and low(-er) relevance; for example, citizen organisations (if they are not actually powerful as lobbies to the public administrations), NGOs.

Figure 5 shows the evaluation table constructed by assigning values from 1 to 5 to relative power or influence and interest or relevance of stakeholders.

Furthermore, all identified stakeholders have been evaluated also in terms of their:

- **Motivations (directly influenced by Expectations and directly influencing Commitment):** they are evaluated from intrinsic (enjoyment/interest in

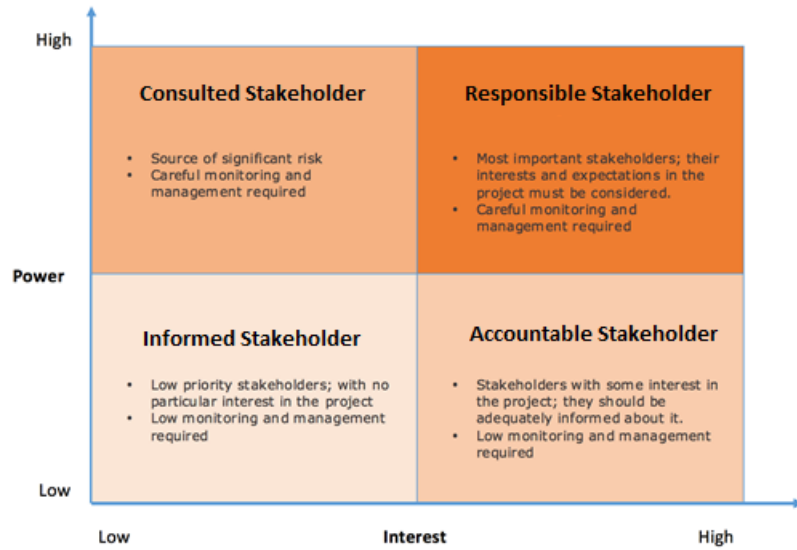


Figure 5: Evaluation table in terms of power and interest

taking part in the SmartVillages activities) to extrinsic (material expectations in taking part in the SmartVillages activities).

- Orientations (evaluating the source of their self-satisfaction in SmartVillages activities): they are measured on a scale from self-oriented (the core of decisions from the stakeholder comes from internal sources) to other-oriented (the core of decisions from the stakeholder comes from external sources).

Motivations and Orientations can be both explicitly stated by the stakeholders or inferred by the project partner compiling the mapping.

The clustering of Regional Stakeholders according to Motivations and Orientations allows us to classify them in four possible categories:

- Extrinsic Self-oriented Stakeholders: Stakeholders who are motivated by external, possibly material rewards for themselves/their institution; for example, Business associations expecting to enhance their economic activities in the Test Area, or Public Administrations widening their actions in the Test Area.
- Extrinsic Other-oriented Stakeholders: Stakeholders who are motivated by external non-material recognitions and appraisal of status; for example, a

research institution that aims at creating new interesting research and implementation activities thanks to the actions in the Test Area.

- **Intrinsic Self-oriented Stakeholders:** Stakeholders who are motivated by internal self-satisfaction coming from taking part in the activities in the Test Area; for example, private (senior) citizens feeling valued by being involved in a smart transition, public servants finding the sector of activity and the project stimulating.
- **Intrinsic Other-oriented Stakeholder:** Stakeholders who are motivated by altruistic reasons for taking part in the project; for example, citizen organisations and public administrations striving to improve the living conditions in an area, businesses wishing to experiment new (free) activities in the Test Area.

Figure 6 shows how to cluster stakeholders considering their Motivation and Orientation.



Figure 6: Evaluation table in terms of motivation and orientation

2.3 The Test Areas and their main Regional Stakeholders

The selection of the stakeholders depends on the issue in which each Test Area is set to be working, thus a detailed description of each Test Area is fundamental in order to understand the reason why the partner selected that precise person to guide the Test Area's activities.

It is necessary specify that all the Test Area are proposed by a Partner, but it is not mandatory for a Partner to define a Test Area (for example, Poliedra does not manage with any Test Area).

It is important to notice where the Test Areas are located in the Alpine Space, see Figure 7, because its position respect with other entities could influenced its performances.

In the following paragraph the Partners that decided to practice with a Test Area are listed and the detailed Test Area description submitted by each partner in the first phase of the project is provided. In addition, my home town Tolmezzo is described considering that it is involved to test the method developed to evaluate the level of smartness.



Figure 7: Test Areas in the Alpine Space

2.3.1 University of Ljubljana and SmartIs City: Padna, Idrija, Kungota

University of Ljubljana in collaboration with SmartIs City submit three Test Areas located in Slovenia: Padna, Idrija and Kungota. The first one is the smallest, it counts less than 200 inhabitants, while Idrija is the most extended, with an area of approximately 300 km² and less than 6.000 inhabitants.

2.3.1.1 Idrija

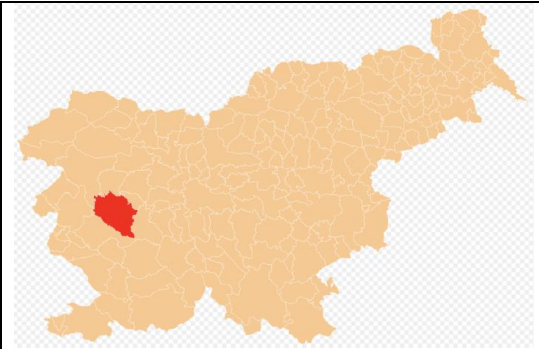
Idrija, Municipality of Idrija, Slovenia		
Area	293,7 km ²	
Inhabitants	5.878	

Table 1: Territory covered by Idrija and population

Idrija is a UNESCO heritage small town in the western Slovenia. It is the seat of the Municipality of Idrija. It is located in the traditional region of the Slovenian Littoral and in the Nova Gorizia Statistical Region. It is notable for the once operating mercury mine with stores and infrastructure, as well as miners' living quarters, and a miners' theatre. In 2012 Idrija was the Alpine Town of the Year. Currently, the Municipality of Idrija is already involved in other smart-themed initiatives.

In terms of smart transition, the attention is focused more on: E-mobility, tourism and young generations.

The RSG in a quadruple helix logic is composed by:

- Public Administrations: Idrija Municipality
- Academia: Centre for managing Mercury Heritage
- Businesses: ICRA ltd.
- Citizens organisations: Youth Centre Idrija

The Youth Centre Idrija (Mladinski Centre Idrija) is the largest youth organisation and creative social hub with rich programme, youth hostel and information point for young people. It is partly financed by the municipality of Idrija and it is provider of many activities for younger generations. It is also developer of potentials in local environment, running also several international youth projects.

2.3.1.2 Padna


Padna, Municipality of Piran, Slovenia		
Area	2,91 km ²	
Inhabitants	188	

Table 2: Territory covered by Padna and population

Padna is a village located in rural area of Coastal Region of Slovenia. It is situated on the end of the ridge, with steep slopes of terraces, where mixes crop is grown. The region has a sub-Mediterranean climate conditions, which enable the development of tourism and some special agricultural crops production. The coastline has many small peninsulas and bays, but the inner part of the region is hilly, featuring various types of landscapes, including karst landscape.

Economy of the region is strongly based on services such as trade, accommodation, and transport that are generated by the activities of the port of Koper. In the port of Koper also tourists cruise ships have their stopping point.

Padna provides a genuine experience of the coastal countryside to tourists, in fact they are an important source of income.

In terms of smart transition, the attention is focused more on: E-mobility especially for elderly, tourism, in particular on the topic of dispersed hotel, and farming.

The RSG in a quadruple helix logic is composed by:

- Public Administrations: Municipality of Piran, LAG Istra

- Academia: University of Primorska, Faculty of Tourism Studies; University of Ljubljana, Faculty of Civil and Geodetic Engineering
- Businesses: Istrske hiše Padna, public-private partnership for Dispersed hotel Padna
- Citizens organisations: Local community Padna, Tourist organization Padna, local farmers

2.3.1.3 Kungota

Kungota, Municipality of Kungota, Slovenia		
Area	49 km ²	
Inhabitants	4.317	

Table 3: Territory covered by Kungota and population

The Municipality of Kungota is a small municipality situated in the north-eastern part of Slovenia in the hilly region of Slovenske gorice. It is a part of Podravska statistical region. The Municipality of Kungota is comprised of four local communities: Zgornja Kungota, Spodnja Kungota, Svečina and Jurij ob Pesnici. It borders on three Slovenian municipalities to the east and south (City Municipality of Maribor, Municipality of Pesnica and Municipality of Šentilj) and the state border with Austria to the north.

According to Statistical office of the republic of Slovenia (2016), the average age of inhabitants of the Municipality of Kungota was 43,4 years. The number of elderly people exceeded the number of young people: there were 125 people, aged 65 or more, per 100 people aged 0–14, with a higher proportion of women over 65 years of age. Among people in working age population aged 15–64 about 50% were employed persons (i.e. persons in paid employment or self-employed persons). The registered unemployment rate was 14%, which is more than the national average (11.2%). As in most Slovenian municipalities, more women than men were

unemployed. In the Municipality of Kungota, average monthly gross income per person employed by legal persons were about 20% lower than the annual average monthly income in Slovenia (net income is about 17% lower).

In the Municipality of Kungota around 80% of inhabitants are farmers, primarily traditional winegrowers on family farms by working on own land and also rented land.

In terms of smart transition, the attention is focused more on: establishing an organisational structure, improving the facilities to be more accessible to disabled and elderly people and tourism, especially on the topic of dispersed hotels.

The RSG in a quadruple helix logic is composed by:

- Public Administrations: Municipality of Kungota, House of all Generations
- Academia: University of Maribor, education centre Greta
- Businesses: local farmers
- Citizens organisations: association of pensioners

The House of all Generations (Hiša vseh generacij Kungota) was established by the Municipality of Kungota in the year 2013. It hosts and organises numerous activities and events and is developing as a core hub for a wide range of diverse smart actions ensuring intergenerational involvement and cooperation within the municipality and beyond.

2.3.2 Region Luzern West: Luzern West


Region Luzern West, Switzerland		
Area	745 km ²	
Inhabitants	69.615	

Table 4: Territory covered by Region Luzern and population

The Region Luzern West start a process on digitalization in 2014 when the vice director of the federal bureau of communication held a presentation about highspeed internet in rural areas at the assembly of the 28 swiss communities. In 2017, two main goals were defined: the definition of a Think Tank Digitalisation in the region and an analysis on the possibilities to establish some hubs like coworking spaces. One year later, in the cantonal parliament the CEO of the association Region Luzern West successfully placed a postulate, which will lead to an internet connection of a minimum of 10 MB Download in every household in rural areas.

In terms of smart transition, the attention is focused more on digitalisation and participation of citizens during meetings and events.

The RSG in a quadruple helix logic is composed by:

- Public Administrations: Councillor in the cantonal parliament, Communal councillor, Local Mayor
- Academia: President of the professional and economy school, Co-President of a vocational education and training centre, Student of history at the University of Fribourg
- Businesses: CEO of InnovationsTransfer Central Switzerland
- Citizens organisations: Deputy director of a regional organisation

2.3.3 ADRETS: Royans-Vercors

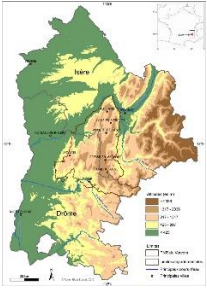
Royans-Vercors, France		
Area	km ²	
Inhabitants	9.000	

Table 5: Territory covered by the Test Area and population

A decision-making tool has been designed in order to identify the fields on which every potential TA wants to work on. The TA selected is Royans-Vercors and it is

situated in the pre-Alpine and Alpine area of France’s region of Auvergne-Rhone Alps.

In terms of smart transition, the attention is focused more on digitalisation, participation of citizens during meetings and events and on ensuring that young generation continue to live in the area.

2.3.4 Development Agency Gal Genovese s.r.l.: Valli del SOL


Valli del SOL, Liguria, Italy		
Area	142,24 km ²	
Inhabitants	12.518	

Table 6: Territory covered by Valli del SOL and population

Valli del SOL is a rural mountainous area composed by 3 main Valleys (Stura, Orba and Leira) and 5 Municipalities (Campo Ligure, Masone, Mele, Rossiglione and Tiglieto), that belongs to the national “Strategia Aree Interne Beigua SOL”. These three valleys are part of the Beigua Regional Natural Park, UNESCO Geopark.

In terms of smart transition, the attention is focused more on digitalisation, reinforcing and disseminating Broadband connection, and Mobility, in particular on ensuring the public transport offer in order to increase the attractiveness and to satisfy the youngest’s demand, developing new sharing mobility management and smart solutions systems.

The RSG in a quadruple helix logic is composed by:

- Public Administrations: Metropolitan Area of Genoa, Regione Liguria - Dipartimento territorio, Ambiente, Infrastrutture e Trasporti, Municipalities of Masone, Campo Ligure, Rossiglione, Mele and Tiglieto (Unione di Comuni), Beigua Park, Camera di Commercio di Genova

- Academia: University of Genoa – Economia dei trasporti e Ingegneria, Polo Tecnologico TRANSIT, Distretto Tecnologico SIIT
- Businesses: ATP, Car-sharing Enterprises (Genova Car Sharing), Bicycle hire operators

2.3.5 University of Maribor: Pohorje region, Pomurje region

University of Maribor submits two Test Areas both near the city of Maribor: Pohorje and Pomurje region. The first one is basically a mountain range with a great ski resort which attract a lot of tourist during winter season. Meanwhile the second one is a rural area in the north east of Slovenia already involved in a European project called AGRIFOOD.

2.3.5.1 Pohorje region

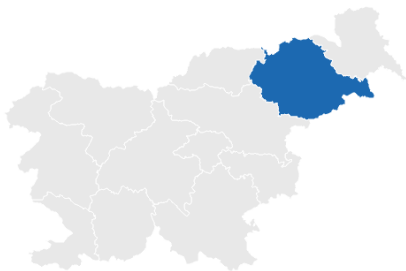
Pohorje Region, Slovenia		
Area	2.170 km ²	
Inhabitants	322.000	

Table 7: Territory covered by Pohorje region and population

Pohorje Region is a mountainous region in the north eastern Slovenia. It roughly lies in the triangle formed by the towns of Maribor (to the east), Dravograd (to the west) and Slovenske Konjice (to the south).

In terms of smart transition, the attention is focused more on tourism, in particular from a sustainable point of view.

The RSG in a quadruple helix logic is composed by:

- Public Administrations: Ministry of Economic Development and Technology, Tourism and Hospitality Chamber of Slovenia, Government

office for Development and European Cohesion Policy, Regional municipalities, Slovenian Chamber of Commerce

- Academia: University of Maribor
- Businesses: Local winemakers, Small and medium hostellers, Technology transfer providers (ITC Cluster), Entrepreneurs in ICT for tourism, Local passenger transport (MARPROM)
- Citizens organisation: Maribor - Pohorje Tourist Board, Maribor Development Agency

2.3.5.2 Pomurje region

Pomurje Region, Slovenia		
Area	1.337 km ²	
Inhabitants	117.000	

Table 8: Territory covered by Pomurje region and population

Pomurje Region is one of the twelve statistical regions in Slovenia. It is a flat rural area and the most important area suitable for food production in Slovenia: agricultural holdings of this region cultivate almost 13% of all agricultural land in Slovenia and raise almost 12% of all the livestock.

In terms of smart transition, the attention is focused more on smart farming and sustainable agriculture, in particular creating new and efficient networks between regional food production stakeholders and a catalogue of short food supply chains for digital farm shops.

Furthermore, the Test Area is already involved in another European project called DIH AGRIFOOD¹⁴ and it is clear that an integration of results provided by this

¹⁴ DIH AGRIFOOD is a digital innovation hub for agriculture and food production.

project and SmartVillages could be a great solution (Zavratnik, Kos e Stojmenova Duh 2019).

The RSG in a quadruple helix logic is composed by:

- Public Administrations: Ministry of Agriculture, Forestry and Food
- Academia: University of Maribor, University of Ljubljana
- Businesses: DIH AGRIFOOD, ITC Cluster, Pomurje Technology Park
- Citizens organisation: Farmer association Vrtovi Panonski, Zelena točka, Kulturnatura, Panvita

2.3.6 Standortagentur Tirol: Pitztal

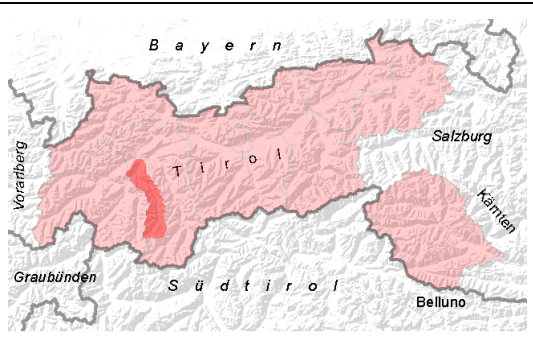
Pitztal, Tirol, Austria		
Area	312,98 km ²	
Inhabitants	7.496	

Table 9: Territory covered by Pitztal and population

The Pitztal is an alpine valley located in Tyrol, Austria. The prime activity is agriculture in fact the 68% of people work in this field¹⁵.

In terms of smart transition, the attention is focused more on mobility and digitalisation.

The RSG in a quadruple helix logic is composed by:

- Public Administrations: provincial government, economic department, planning department, transport department, tourism department
- Academia: University of Innsbruck

¹⁵ Documents dating from 2015.

- Businesses: transport association Tirol, business agency “Standortagentur”, central marketing organisation of “Tirol Werbung”, Austrian Railways

2.3.7 Regionalverband Sudlicher Oberrhein: Löffingen

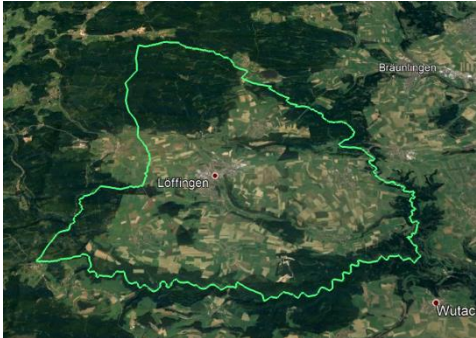
City of Löffingen, Baden-Württemberg, Germany		
Area	88 km ²	
Inhabitants	8.000	

Table 10: Territory covered by Löffingen and population

The city of Löffingen is far 50 km from Freiburg and 140 km from Stuttgart.

In terms of smart transition, the attention is focused more on mobility and integration of young generations.

The RSG in a quadruple helix logic is composed by:

- Public Administrations: Mayor and his Public Administration, Regional Planning Authority, Broadband Manager of the District
- Academia: City App Developer

2.3.8 Bodensee Standort Marketing GmbH: Bodensee


Bodensee, Germany, Switzerland, Austria,		
Area	664 km ²	
Inhabitants	214.655	

Table 11: Territory covered by Bodensee and population

Bodensee or Lake Constance is situated in Germany, Switzerland, and Austria. The whole area around the lake counts about 2.2 million people without Zurich and spread on almost 11.000 Km².

Thirty-five universities, three international airports, three international fair trade centres, ten congress centres and diverse technology and business parks increase the attractiveness and liveability of this region.

In terms of smart transition, the attention is focused more on mobility and on developing new strategies in the tourism sector.

The RSG in a quadruple helix logic is composed by:

- Public Administrations: government district of Konstanz
- Academia: HTWG Konstanz (College of Engineering, Works and Design)
- Businesses: GmbH (editing web solutions)
- Citizens organisation: local community of the village Tengen

2.3.9 My hometown Tolmezzo

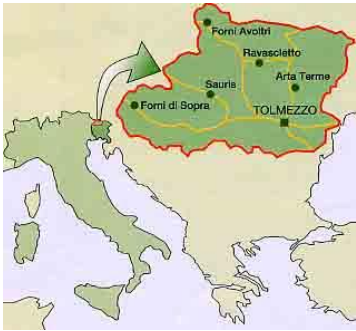
Tolmezzo, Italy		
Area	64,62 km ²	
Inhabitants	10.219	

Table 12: Territory covered by Tolmezzo and population

Tolmezzo is the capital of Carnia subregion situated in the Autonomous Region of Friuli-Venezia Giulia. Since 2015, year during which provinces have been abolished, Tolmezzo is the capital of a new regional entity called UTI (unione territoriale intercomunale) which includes twenty-seven municipalities situated in Carnia.

It is important to mention the presence of one of the most significant ethnographic museums named Museum of arts and folk traditions “Michele Gortani” which is very popular with tourists. The inhabitants are very attached to traditions, and in fact they also use the friulano carnico language as often as Italian not only to talk to each other but also in the road signs. Tolmezzo is considered the reference point for the Carnia territory there is a great availability of SGI. In addition, there are some appealing companies that are considered the main important enterprises in the area, such as the Automotive Lighting, Burgo Group Spa and Pigna.

In terms of smart transition, the attention is focused more on digitalisation and on increasing the presence of innovative approaches in tourism in order to enhance the attractiveness of the area and to further market the community as a hub to discover its pristine surrounding mountainous environment.

2.3.10 Overview of the main problem issues affecting the Test Areas

All the aforementioned Test Areas reveal similar needs and problematics that perfectly reflects the circle of decline described at the beginning of this analysis in Figure 1.

Firstly, depopulation and demographic aging affects the vast majority of the TAs and as a consequence lots of public services are centralized in the nearest larger city. Furthermore, it is currently complicated to plan some digital technologies because elderly people, which is the higher percentage of population, often lacks knowledge and awareness in digital technologies.

Secondly, the access to transport services is difficult especially for elderly people. Sometimes roads are strongly characterized by the tortuosity of the routes and travel times are dilated in the winter season due to possible adverse weather conditions. Moreover, creating a new business but also maintaining a pre-existing company in a rural area with these problems is not cost-effective, resulting in severe job losses.

Finally, some TAs indicate the weak connection between Public Administrations and citizens as well as a citizens’ low feeling of belonging to community. This leads to difficulties in involving inhabitants in public initiatives and activities aimed at increasing their awareness of the situation the village is facing.

Chapter 3

Indicators of Smartness for Villages

After providing a description of all the Test Areas involved in the project, with particular reference to their needs and vision for their own possible smart transformation, my work aimed at defining a list of Indicators of smartness for rural villages.

The process to create this list has started from the analysis of all the literature about smart cities in order to capture the main essential key points that could possibly be relevant also for villages: the criteria to collect the indicators are in fact based on the six Smart Dimensions defined for smart cities. However, the use of the dimensions and indicators of smart cities represent only reasonable working point; in fact, at the end of this analysis, some reflections are provided about their suitability as a reference system also for rural areas.

In the following paragraphs, all the phases of the creation of the final configuration of the indicators of smartness for rural and mountain areas are described: the first version of the indicator list contains ninety indicators and most of them are quantitative, then a subset of twenty-four indicators has been defined and submitted to all the project partners during the Capacity Building Seminar. Finally, an adjustment considering the results, discussions and feedbacks obtained from the CBS of these twenty-four indicators is provided in a survey form and this last configuration represents the final version of the indicators that I have used to define the model to assess the level of smartness.

We have found it undoubtedly true that the research process described in the following paragraph is necessary to define a reference system as objective and unambiguous as possible to evaluate the level of smartness in rural contexts, especially since we are working on a subject on which the scientific consensus has not been reached yet.

3.1 Theoretical introduction

First, it is important to clarify the differences between indicators and data or variables observed. A datum or variable observed becomes an indicator only once its role in the evaluation of a phenomenon has been established. For example, the number of unemployed people is a datum or key variable in economics. Once it is determined that an increase in the number of unemployed expresses negative economic performance for a given territory, this number becomes an indicator. The datum or variable pertaining to the number of unemployed can then be standardized, transformed or formulated in any way that can account for economic performance (Tanguay, et al. 2010).

To understand the definition of an indicator, the concept of measurement must be reminded. According to the Representation Theory of Measurement¹⁶, a measurement is a ‘mapping’ from an empirical relational system (the ‘real world’) onto a representational relational system (usually, a numerical system). The definition of measurement is strictly related to the notion of representation-target. A representation target is the operation aimed to make an empirical system, or part of it, ‘tangible’ to perform evaluations, make comparisons, formulate predictions, take decisions, etc. In a given process, one or more different representation-targets can be defined (Franceschini, Galetto e Maisano 2006).

According to a representation-target and referring to the Representation Theory, an indicator ‘I’ can be considered as a homomorphism¹⁷ from the manifestations of an empirical system onto the manifestations of a symbolic system. In other words, an indicator operationalises the concept of representation-target. As a result, the concept of an indicator includes the concept of measurement, but vice versa is not true. On the basis of the Representation Theory, measurements can be considered as a subset of indicators. Furthermore, a complex representation-target can be split up into different dimensions. Each dimension can be described using one or more

¹⁶ Representation Theory is a branch of mathematics that studies abstract algebraic structures by representing their elements as linear transformations of vectors spaces, and studies modules over these abstract algebraic structures.

¹⁷ It should be noted that the homomorphism is not one-to-one. Separate but indistinguishable manifestations, according to the representation-target, are mapped onto the same symbol.

indicators. Consequently, to represent and to operationalise a complex representation-target, we may use a set of indicators (each indicator referring to a specific dimension) (Franceschini, Galetto e Maisano 2006).

Generally, for a system modelled by indicators we may define two kinds of performances:

1. Local performance is the performance of a process, from the point of view of a single indicator (single dimension of the representation-target).
2. Global performance is a more general performance, which considers more dimensions of the representation-target. It is based on a full of local performances.

If the process studied is complex, local performances cannot always be summarised by single information. Frequently, the criteria to synthesise the local performances can be questionable and are based on ‘dangerous’ simplifications.

It is reasonable to classify the main typologies of indicators and describe their peculiarities. In the following sections, the fundamental categories of indicators (subjective, objective, basic and derived indicators) are examined and discussed.

3.1.1 Set of Indicators

In the representation of a generic process, selected indicators make up a set or a family. Generally, each indicator represents a dimension, which is a distinguishing aspect of the process studied. The concept of set of Indicators is schematically explained in Figure 8. Additionally, in some specific situations, it is possible to define an aggregated indicator that summarises the performance of the set of indicators.

3.1.2 Objective and subjective indicators

Having identified the empirical and the symbolic systems of the process studied (with the respective manifestations and relations), indicators are classified into two main categories: objective and subjective indicators (McCrea, Shyy e Stimson 2006).

1. Objective indicators objectively associate the manifestations of the empirical system to the manifestations of the symbolic system. The mapping does not depend on the subject performing it. Consider, for example, the indicator: ‘number of goods produced in a plant during a defined period of time’. The empirical manifestation (production of the plant) can objectively be connected to the symbolic manifestation (number of products). Different subjects (or automatic devices even) determine the same final number, by counting the units produced (Franceschini, Galetto e Maisano 2006).
2. Subjective indicators map subjectively empirical manifestations onto symbolic manifestations, on the basis of subjective perceptions or opinions. The result is that distinct individuals can map the same empirical manifestation onto different symbolic manifestations. For example, indicators such as ‘the customer satisfaction for a specific product’ or ‘the personal opinion on the style of a car’ are usually confined to personal perceptions or opinions. In this case, empirical manifestations are mapped onto symbolic manifestations, depending on the subjective evaluation scale for everyone (Franceschini, Galetto e Maisano 2006).

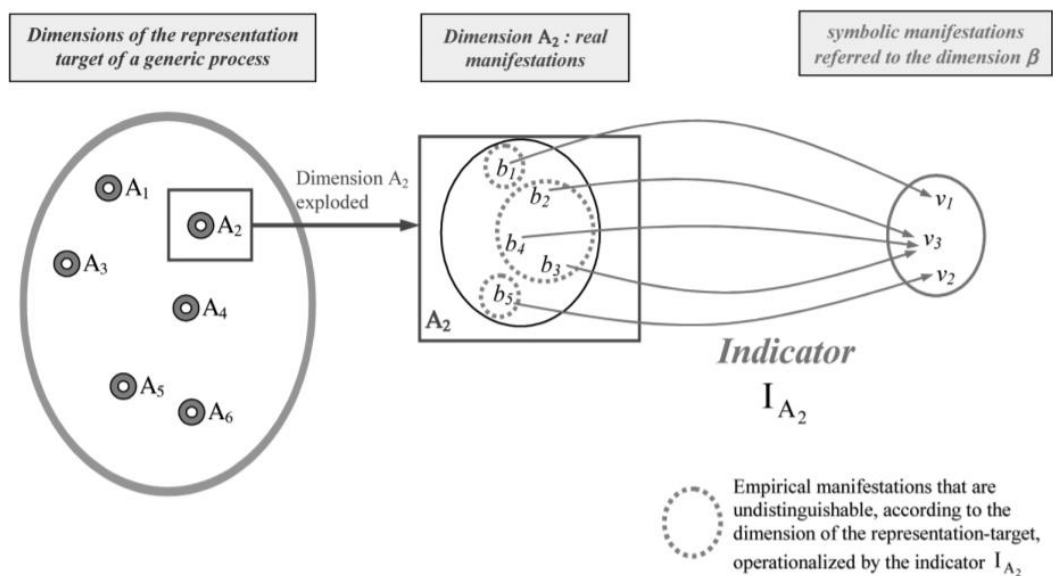


Figure 8: Schematic representation of the concept of set of Indicators (from (Franceschini, Galetto and Maisano 2006))

3.1.3 Basic and Derived Indicators

Indicators can also be classified into two more categories: basic and derived.

1. Basic indicators are obtained as a direct observation of an empirical process (e.g. the ‘number of defectives on a production line’ or ‘the cycle time of a manufacturing process’) (F. Franceschini, et al. 2008).
2. Derived (or aggregated) indicators are obtained combining one or more indicators (basic or other derived). They represent the aggregation or the synthesis of several indicators (F. Franceschini, et al. 2008).

3.1.4 Quantitative and Qualitative Indicators

Indicators can also be classified in:

1. Quantitative indicators can be expressed in a number of ways, depending on the data involved and its use. These can include whole numbers, decimals, ratios, fractions, percentages and monetary values: quantitative factors can always be expressed as a number.
2. Qualitative indicators are usually indicators of change (outcomes) and can be defined as people’s judgements and perceptions about a subject, such as the confidence those people have in sewing machines as instruments of financial independence. Qualitative indicators are non-numerical factors for determining level of progress towards a specific goal. Qualitative data is based on opinions, feelings or viewpoints rather than hard facts or numbers. These factors are used to measure things that have no numerical constant, like a group’s sense of hope for the future.

To sum up, a quantitative indicator is generally the easiest to understand and manipulate since it is based on numbers and hard facts. Meanwhile, when information can’t be measured or reproduced, then it is typically qualitative indicator.

3.2 Criteria used to collect indicators for “Smart Villages”

After specifying the issue on which the Test Area decided to focus on and after mapping the RSG, a list of indicators is necessary to evaluate the level of smartness of each Test Area.

There are several competing lists of indicators for Smart Cities: Smart Cities’ indicators have been at the centre of a very lively debate that has been going on for more than ten years. Conversely, the concept of indicators for Smart Villages is even more new than the concept of Smart Villages itself.

As said before, EUROMONTANA has circulated a working definition on Smart Villages, in the context of the pilot project on Smart Eco-Social Villages. The working definition provides some possible hints on the measurement of the smartness of villages.

For ease of analysis, the whole definition with some specific terms in bold is reported below.

“Smart villages are **communities in rural areas** that develop **smart solutions** to deal with challenges in their local context. They build on existing local strengths and opportunities to engage in a process of sustainable development of their territories. They rely on a **participatory approach** to develop and implement their strategies to improve their economic, social and environmental conditions, in particular by promoting innovation and mobilizing solutions offered by **digital technologies**. Smart villages benefit from cooperation and alliances with other communities and actors in rural and urban areas. The initiation and the implementation of **smart village strategies** may build on existing initiatives and can be funded by a variety of public and private sources”.

The terms in bold require a more detailed reflection because they draw attention to some important topics in the context of this analysis:

- **Communities in rural areas** can include one or several human settlements, without any restrictions regarding the number of habitants. Rural areas are defined as "predominantly rural areas" according to the urban-rural

typology used by the OECD and EUROSTAT for the classification of regions (more than 50% of the population lives in rural areas). The "intermediate region" (20 to 50% of the population lives in rural areas) and the "predominantly urban region" (less than 20% of the population lives in rural areas) are not concerned.

- **A participatory approach** means an active participation of the civil society in the drawing-up and decision-making regarding the smart village strategy.
- **Digital technologies** include for example information and communication technologies, the exploitation of big data or innovations related to the use of the Internet of Things. They act as a lever that enables smart villages to become more agile, make better use of their resources and improve the attractiveness of rural areas and the quality of life of rural residents.
- **The smart village strategies** respond to the challenges and needs of their territory by building on their local strengths and assets. Strategies must determine short, medium, long term goals. Progress must be measurable through performance indicators that will be set in a roadmap. These roadmaps should be reviewed at regular intervals to allow continuous improvement. Strategies may aim, for example, to improve access to services (in various fields such as health, training or transport), to a better valorisation of the cultural heritage for a greater tourist attractiveness, to enhance business opportunities and create jobs, to the development of renewable energies, to development of a circular economy, to a better exploitation of natural resources, to adapt to climate change, to preserve the environment and biodiversity, etc.

The criteria used to collect the indicators for SmartVillages is based on the adjustment of the six dimensions proposed to Smart Cities' indicators to the rural context which embodies all the requests and needs deeply described in the above definition and in all the previous paragraphs.

The six dimensions of smart cities, see Figure 9, originally identified by the Centre of Regional Science at the Vienna University of Technology in 2007, are:

1. **Smart Mobility:** it encompasses the quantity and quality of sustainable transport and mobility systems in the area.
2. **Smart Governance:** it encompasses the level of smartness of the governance systems, the penetration of green public procurement, e-governance, propensity to networking.
3. **Smart Economy:** variously declined in terms of presence of creative and innovative enterprises and business models in the area, level of employment and unemployment, level of economic attractiveness, penetration of ICT in the local economic system.
4. **Smart Environment:** it encompasses the quality of the environment in terms of air, water, soil and biodiversity.
5. **Smart Living:** it encompasses the quantity and quality of services to the population in the area, and the degree of satisfaction in them.
6. **Smart People:** it encompasses participation of local citizens to the job market, the decision-making and the involvement in associations, and the education level of people.

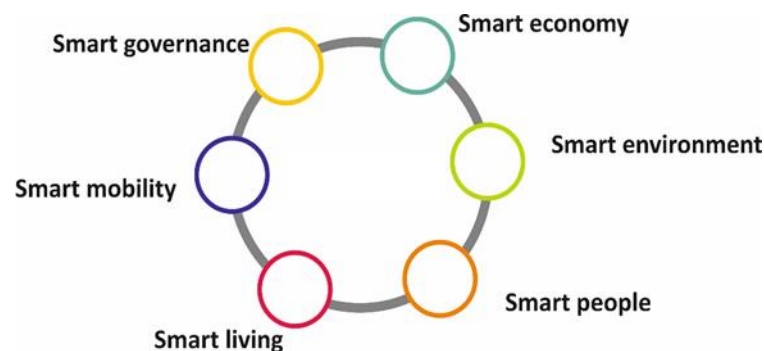


Figure 9: Smart Dimensions

After the definition of the Smart Dimensions and considering the purposes of each Test Area in terms of Smart Transition, the collection of indicators begins: the first version contains thirty indicators because in the first phase a set of core indicators was exclusively considered, while the final one ninety, whose detailed explanation is provided in the following paragraph.

Following this initial classification, some categories are defined in order to better structure the indicators within each Smart Dimension:

- Smart Mobility:
 1. **Accessibility:** it includes all the indicators which describes the accessibility of an area from a transport view-point.
 2. **Transport:** it includes all the indicators related to transport issues.
 3. **Flow Distribution:** it includes all the indicators related to the distribution of flows between railways and roads.
- Smart Governance:
 1. **Access to E-SGI:** it includes all the indicators that evaluate presence and possible accesses to E-services.
 2. **Methods of participation:** it includes all the indicators that describes how Public Administration involves citizens.
 3. **Action plan for the tertiary sector:** it encompasses all the activities dealing with the tourist offer
 4. **Communication tool:** it includes all the indicators that describes how Public Administration communicate to citizens the activities they organise.
- Smart Economy:
 1. **Household income and expenses:** it includes all the indicators that describes the economic situation of the households living in the area analysed.
 2. **Employment:** it encompasses all the issues regarding the job market.
 3. **Agriculture:** it includes all the indicators related to the agricultural industry.
 4. **Businesses:** it includes all the indicators that describes the state of business especially from a smart view-point.
 5. **Tourism:** it includes all the indicators that describes the state and strategies of the tourist filed.
- Smart Environment:
 1. **Energy:** it includes all the indicators related to energy issues, especially focus on renewable energy sources.
 2. **Waste:** it encompasses all the indicators concerning recycling activities.

3. **Housing Conditions:** it includes all the indicators that describes the condition of houses from an energetic point view.
4. **Greenspaces, ecosystems and heritage:** it includes all the indicators useful to describe the land coverage and the presence of some protected areas or heritage sites.
5. Smart Living:
 1. **Demographics:** it encompasses all the indicators necessary to describe the composition of population.
 2. **Education:** it includes all the indicators that evaluate state, supply and demand in the field of education.
 3. **Social and community services:** it includes all the indicators related to facilities available to citizens.
 4. **Health:** it includes all the indicators necessary to describe the health and social care services.
6. Smart People:
 1. **Participation in public life:** it encompasses all the indicators that deal with the level of participation of citizens in public issues.
 2. **Open to innovation:** it includes all the indicators that describes the familiarity of citizens with digitalisation.
 3. **Level of qualification:** it includes all the indicators necessary to describe the composition of population from the educational point of view.

It is worth stressing that in this initial phase we do not know weather and to which extent these Smart Dimensions are suitable for smart villages. Therefore, for each dimension some reflections are necessary:

1. Smart Mobility: Cities are usually transport hubs, and often they represent fundamental nodes offering all sorts of mobility options. But what are the right smart mobility models for sparsely populated areas? Can car sharing be feasible? Can car-pooling be feasible?
2. Smart Governance: Cities often are the centre of political power. But what is the level of decision-making power in smart villages? Is there any decision-making power actually devolved?

3. Smart Economy: Smart Cities are a magnet for enterprises and innovative businesses. But do smart villages have the potential to attract (big) businesses, and/or to create innovative and creative business models?
4. Smart Environment: Cities' environmental discourse is often centred on pollution and on the use of energy. Smart villages are often in areas in which pollution is not a massive problem. Might smart environment, in villages, mean a smart use of environmental resources? Also, mountains can also often be hubs for the production of (clean, renewable) energy.
5. Smart Living: Cities offer all sorts of services, due to population density and economic viability. But what is the level of services in villages? What is the quality, quantity, viability, desirability and feasibility of services in sparsely populated areas?
6. Smart People: the high population of Cities indeed has the potential of covering all types of educated people, and a well-connected society. But do smart villages have the critical mass of people to cover all aspects of a quadruple-helix? Are there the right people for the right tasks?

During the following paragraphs, the analysis aims at answering to all the above questions and defining whether all these dimensions cover the same role in the smartness assessment for rural villages as occurs for cities or some of them are considered slightly less important.

3.3 Indicators for “SmartVillages”

3.3.1 Complete List of Indicators

The Complete List of Indicators includes classification for dimensions, categories within dimensions, name of the indicator, a brief description, one or two driving questions, and possible answers. The answers help in the understanding of the possible ways to respond to the indicator, in terms of unit of measurement, yes/no, quantitative vs. qualitative description. The complete list of indicators is reported in Appendix A and it contains ninety indicators: this list is considered to contain the main topics necessary to describe in detail a rural village. It is obvious that it is difficult to deal with this high quantity of Indicators, in fact since the Indicator Card presentation, see paragraph Indicator card3.4, the number of Indicator is reduced considering only those more related to smartness issues within each Smart Dimension and the specific topics in which each Test Area is set to be working.

The Smart Dimension with a higher quantity of Indicators are: Smart Mobility, Smart Economy and Smart Living. The first two because the Test Areas express more interest in developing these topics during their initial presentations in the first phase of the project, see paragraph 2.3. Meanwhile, the analysis in detail of Smart Living is absolutely essential because it describes how much liveable a Test Area is.

In particular there is a great focus on the Services of General Interest (SGI) because it is clear that rural communities cannot exist without the appropriate public services to meet residents’ needs (Interreg Alpine Space 2018). Accessibility to schools, health and social care and other such services are critical to the well-being of rural residents and the social and economic resilience of these communities.

The Smart Governance Dimension include Indicators regarding the E-SGI¹⁸: E-government administrative and fiscal services and E-health services.

¹⁸ E-SGI are services of general interest which use information and communication technologies (ICTs). The three main components of e-services in general are service provider, service receiver and the channels of service delivery.

Meanwhile the Smart Environment Dimension analyses in detail the issue of renewable resources and recycling, which are very current topics.

The Smart Living Dimension encompasses from demographic topics like population density, population ageing rate and population growth to social and community services. The issue of Healthcare is analysed separately from the other services as well as Education because these are strong topics for rural communities and fundamental to define the level of smartness of a Test Area in terms of Living.

Finally, the Smart People Dimension provide information about the level of qualification among citizens, but also the theme of citizen participation is taken into consideration analysing the number of citizens association devoted to innovation and not only the rate of voting citizens to municipal election, but also the rate of participants in public meetings. Another worth mentioning Indicator considered in this dimension is “Familiarity with Internet”: it tries to illustrate the citizens experience in utilizing technological tools which requires an Internet knowledge.

3.3.2 Detailed explanation of the Indicators of Smart Mobility and Smart Economy

In this section, the Indicators of Smart Mobility and Smart Economy are debated in detail because TAs express more interest in developing these topics during their initial presentations in the first phase of the project.

The topics of Mobility and Economy are closely inter-linked for several reasons. Firstly, it is clear that companies require good infrastructure to transport manufactured goods and raw material necessary for their internal activities.

Secondly, in order to avoid a high rate of individual traffic, employees should easily arrive at their work places using public means of transport or car-pooling services. Otherwise, it is likely that citizens decide to find a job in a more easily reachable area contributing to the undermining of the economy in the village. This also applies to commuters, in fact depopulation could be due to reasons related to finding more comfortable routes to reach work areas, schools or universities: citizens decide to

move to another city in order to be closer to facilities and services necessary in everyday routine.

Finally, it is easy to claim that the more accessible an area is, the more attractive it becomes. This trend leads to an increase in the tourism demand, which directly enhance the economic situation in the village.

The following discussion provide the description of each Indicator included in these two Smart Dimensions.

3.3.2.1 Smart Mobility

The list of Indicators for this Smart Dimension includes:

CATEGORIES	INDICATORS
<i>Accessibility</i>	Linkages with regional hubs
<i>Accessibility</i>	Commuters' estimated % w/r to the active populations
<i>Transports</i>	Presence of/Access to train/bus station
<i>Transports</i>	Presence of/Access to Car-Pooling services
<i>Transports</i>	Presence of/Access to Car-sharing services
<i>Transports</i>	Presence of/Access to E-Bike services
<i>Transports</i>	Presence of/Access to Integrated traffic platform
<i>Transports</i>	Presence of rail infrastructure for freight
<i>Transports</i>	Presence of rail infrastructure for people
<i>Transports</i>	Type of Road infrastructures
<i>Transports</i>	Presence of limited traffic zones
<i>Transports</i>	Bike lanes
<i>Transports</i>	People with annual transport ticket
<i>Transports</i>	Index of motorisation
<i>Flow Distribution</i>	Rail transport flows
<i>Flow Distribution</i>	Road transport flows

Table 13: Smart Mobility Indicators

A detailed explanation of each Indicator is provided below:

- Linkages with regional hubs: it refers to the presence of regional hubs and linkages to them.
- Commuters' estimated percentage w/r to the active population: it refers to the percentage of commuter both for work-related and educational reasons.
- Presence of train or bus station: it refers to the presence of one or more train or bus stations easily reachable by the inhabitants.

- Presence of/ Access to Car-Pooling services: it refers to the presence of services of car-pooling, and actual use of the services.
- Presence of/ Access to Car-sharing services: it refers to the presence of services of car sharing, and actual use of the services.
- Presence of/ Access to E-Bike services: it refers to the presence of e-bikes; access of services of e-bike-sharing.
- Presence of/ Access to Integrated traffic platform: it refers to the presence of a platform collecting all village/Test Area transport services.
- Presence of rail infrastructure for freight: it refers to the ration between rail infrastructure for freight and the overall rail transport network.
- Presence of rail infrastructure for people: it refers to the ratio between rail infrastructure for people and the overall rail transport network.
- Type of Road infrastructures: it refers to ratio between every type of road infrastructure existing in the area and the overall road transport network.
- Presence of limited traffic zones: it refers to the presence of some limited traffic zones in the area.
- Bike lanes: it refers to the presence of bike lanes in the area or close to it.
- People with annual transport ticket: it refers to the ratio between people with annual transport ticket and population.
- Index of motorisation: it refers to the ration between registered vehicles and population.
- Rail transport flows: it refers to the millions of net tons of freight transported per year by train.
- Road transport flows: it refers to the millions of net tons of freight transported per year by trucks.

3.3.2.2 Smart Economy

The list of Indicators for this Smart Dimension includes:

CATEGORIES	INDICATORS
<i>Household Income and Expenses</i>	Mean or median household income per year
<i>Household Income and Expenses</i>	Low income household
<i>Household Income and Expenses</i>	Population receiving social assistance
<i>Communication Tools</i>	Presence of/ Access to Brand, Logo for the region
<i>Employment</i>	Travel-to-work areas
<i>Employment</i>	Job creation for all sectors combined
<i>Employment</i>	Unemployment rate
<i>Agriculture</i>	Presence of digital farming
<i>Agriculture</i>	Changes in the number of farms
<i>Agriculture</i>	Self-sufficiency in the agricultural industry
<i>Businesses</i>	Types of businesses (micro, small, medium)
<i>Businesses</i>	Appealing companies within the radius of 5 km
<i>Businesses</i>	Businesses with environmental certification
<i>Businesses</i>	Presence of platforms for producers
<i>Businesses</i>	Young-led enterprises
<i>Businesses</i>	Women-led enterprises
<i>Businesses</i>	Economic-growth
<i>Tourism</i>	Tourism intensity
<i>Tourism</i>	Average length of stay
<i>Tourism</i>	Tourist facilities annual occupancy
<i>Tourism</i>	Presence of/Access to tourist-related apps
<i>Tourism</i>	Tourist Trails (ICT, apps, e-trails...)

Table 14: Smart Economy Indicators

A detailed explanation of each Indicator is provided below:

- Mean or median household income per year: it refers to the median household income per year.
- Low income household: it refers to the ratio between the households with income below 10.000 € per year and the number of households living in the area.
- Population receiving social assistance: it refers to the ratio between workforce receiving social assistance and population.

- Presence of/Access to Brand, Logo for the region: it refers to the presence of a brand, logo for territorial communication and the number of enterprises using it.
- Travel-to-work areas: it shows the presence of functional urban areas (MUAs) and morphological urban areas (MUAs) (Permanent Secretariat of the Alpine Convention 2017).
- Job creation for all sectors combined: it refers to the ration between number of new jobs per year for all sectors and population.
- Unemployment rate: it refers to the ratio between number of unemployed people for at least one year and population.
- Presence of digital farming: it refers to the presence of digital farms or presence of consortia of digital farming.
- Changes in the number of farms:
- Self-sufficiency in the agricultural industry: it refers to the ratio between imported goods and domestically produced goods.
- Types of businesses (micro, small, medium): it refers to the percentage of micro, small and medium business existing in the area.
- Appealing companies within the radius of 5 km: it refers to the ratio between the companies with the highest number of employees within the radius of 5 km and population.
- Businesses with environmental certification: it refers to the ratio between businesses with environmental certification and the overall number of businesses existing in the area.
- Presence of platforms for producers: it refers to the presence of some platform useful to create a producer's network.
- Young-led enterprises: it refers to the ratio between the number of companies owned/directed by people under 30 and the number of companies.
- Women-led enterprises: it refers to the ratio between the number of companies with female owner and the number of companies.
- Economic-growth: it refers to the GDP growth rate.
- Tourism intensity: it refers to ratio between overnight stays and population.

- Average length of stay: it refers to the average length of stays and population.
- Tourist facilities annual occupancy: it refers to the ratio between available rooms and sold rooms.
- Presence of/Access to tourist-related apps: it refers to the presence of tourist-dedicated apps, and actual access to them.
- Tourist Trails (ICT, apps, e-trails...): it refers to the presence of tourists trails in the area.

3.4 Indicator card

First of all, it is noteworthy to specify that I presented this Indicator Card during the Capacity Building Seminar for SmartVillages Regional Stakeholders Group held the 28th of November, hosted by Regione Lombardia at Palazzo Pirelli and organised by Poliedra (see Figure 10). During this event, I had the opportunity to attend personally to the activities designed specifically for this meeting and to interact with the project partners in an international context: this experience provided an added value to the whole analysis because the List of Indicators was lively discussed and the work on the Indicator Card enables to gather more valuable ideas and relevant information to continue with this study.

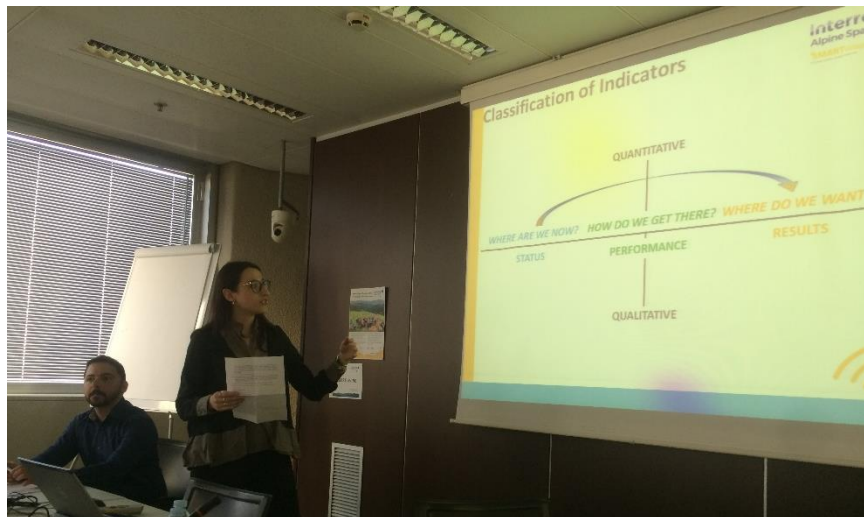


Figure 10: Indicator Card explanation during CBS

All the analysis and consideration useful to create the Indicator Card and its detailed explanation are reported below.

Indicators capture the state of the art of the Test Area, the future target set by the Area and the way to monitor progress or lack thereof. Therefore, it is possible to define:

1. **Indicators of status:** that provide an accurate description of the state of the art of the Test Area with respect to the agreed issue on which the Test Area aspiring to be smart, intends to work.

2. **Indicators of result:** that embody quantitatively or qualitatively the preferred vision, and represent the value or threshold towards which the smart transition in each of the Test Areas tends. The indicators of result might be already explicitly included in the relevant policy instrument(s) that represent the policy framework in which the smart transition operates, with specific reference to the Smart Specialisation Strategy that is relevant for each Test Area.
3. **Indicators of performance:** that accompany the step-wise process, and can and should be linked to the specific Actions described in the Action Plan, which each RSG has to create in order to develop its Smart Transition.



Figure 11: Indicators of status, result and performance

The Oregon Model¹⁹, slightly customised and integrated to take into account the specific needs for a smart transition within “SmartVillages”, normally encompasses five main steps, that support the whole community visioning process, define activities and allow for the elaboration of products.

Not all these steps are inherently necessary for the work on Indicators of SmartVillages RSG, in fact the specifically-designed Indicator Card essential to guide RSG in providing information for each Indicators considers only three steps of the Oregon Model customized for SmartVillages: “*Where are we now?*”, “*Where do we want to be?*” and “*How do we get there?*”. It is clear that these three questions are linked respectively to Indicators of status, Indicators of performance and Indicators of result.

¹⁹ The Oregon Model, named after the US State in which the described model was first conceived and used, represents a comprehensive platform of community visioning on which to build the Guidelines for the work of the Regional Stakeholder Groups

Figure 12 illustrates a flow diagram which is fundamental to understand how to fill out the Indicator Card, see Appendix B.

The first question it is asked to consider concerns the meaningfulness of the Indicator for the Test Area: if not, it is required to suggest an Indicator fitting within the same dimension and category. On the other hand, if the Indicator represents a meaningful issue for the Test Area it is important to define if the Indicator is quantitative or qualitative.

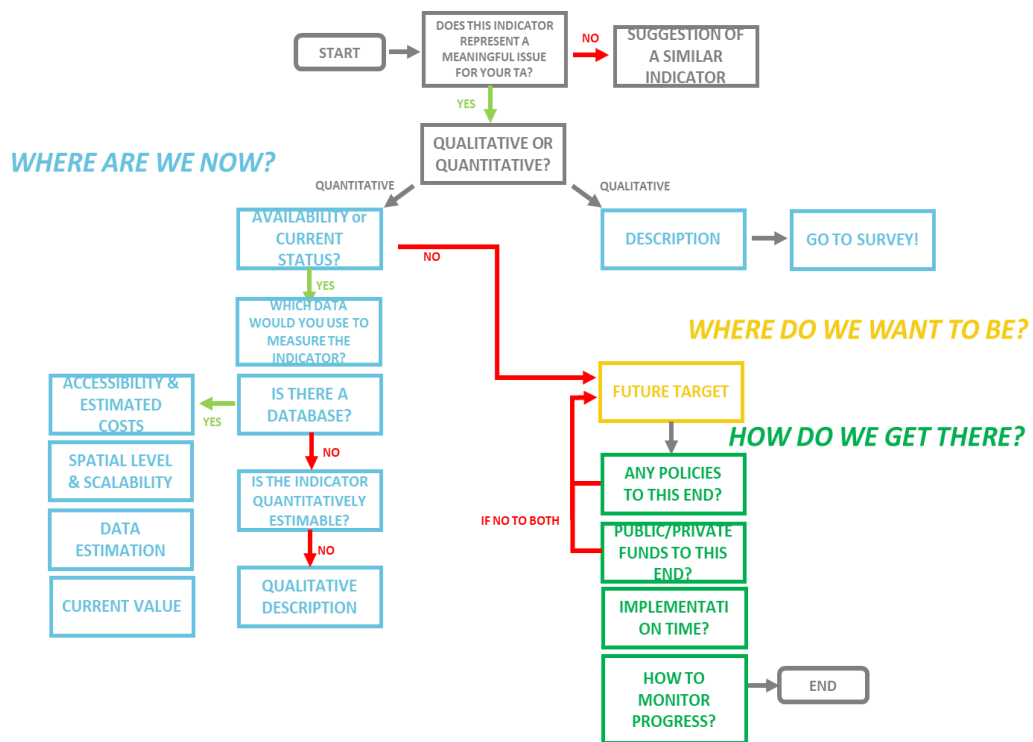


Figure 12: Flow Diagram

At this point the analysis is focused on the definition of the indicator of status, in other words on answering the question “Where are we now?”.

Furthermore, if the Indicator is a qualitative Indicator it is important to give a description. On the contrary, if the Indicator is quantitative and describes a service or an item, for example a logo or a platform, it is required to consider if this service or item is already available in the Test Area, while the Indicator it is not a service or item, like the energy performance certification for buildings, it is asked to provide a description of its current status.

After that, it is required to consider which data is possible to use to measure this Indicator and to provide information on the possible data sources for the data sets listed.

Data can be already available, if so, some more detailed questions regarding the data themselves are required to be considered: accessibility to data, estimated costs to obtain data, spatial level²⁰ at which the data are available (unless they are obtainable at the village spatial level, they must be scalable, otherwise they are completely useless) and time needed to estimate data. Finally, at the end of all these questions it is required to indicate the current value.

On the other hand, the Indicator might be quantitatively estimable by using information from official data sources, or the Indicator might not be quantitatively or numerically estimable, in that case it is required to describe qualitatively the Indicator.

At this point “*Where do we want to be?*” is considered. The first element required to be indicated is the future target in terms of smart transition for this indicator. The future target can be either qualitative and qualitative.

As the flow diagram illustrates, this point is reachable even in the case where the service or item is not available.

After that, the question is “*How do we get there?*”: it is significant know if there are policies which take this target into consideration, if there are public or private funds allocated in the nearest future for this target.

Then, the implementation time estimated to get the declared target and some ideas on how to monitor if the implementation proceeds are required. It is clear that if there are neither policies nor private or public funds allocated, the future target might be reconsidered.

²⁰ The spatial level can be express using the NUTS (from French *Nomenclature des unités territoriales statistiques*): a geocode standard for referencing the subdivisions of countries for statistical purposes. The standard is developed and regulated by the European Union, and thus only covers the member states of the EU in detail. In the Indicator is only indicate to specify if the data are available at national, regional, cantonal or municipal level in order to simplify its completion.

DIMENSIONS	CATEGORIES	INDICATORS
SMART MOBILITY	<i>Transports</i>	Presence of /Access to Car-Pooling services
	<i>Transports</i>	Presence of /Access to Car-sharing services
	<i>Transports</i>	Presence of /Access to E-Bike services
	<i>Transports</i>	Presence of /Access to an integrated traffic platform
SMART GOVERNANCE	<i>Access to e-SGI</i>	Presence of /Access to E-government administrative/fiscal services
	<i>Access to e-SGI</i>	Presence of /Access to E-health services
	<i>Methods of participation</i>	Presence of participation events organised by PA
	<i>Action plan for the economy</i>	Re-orientation of tourist offer
SMART ECONOMY	<i>Communication Tools</i>	Presence of /Access to Brand, Logo for the region
	<i>Agriculture</i>	Presence of digital farming
	<i>Tourism</i>	Presence of /Access to tourist-dedicated apps
	<i>Businesses</i>	Young-led enterprises
SMART ENVIRONMENT	<i>Energy</i>	Energy produced from renewable resources
	<i>Energy</i>	Annual energy consumption from renewable sources
	<i>Greenspaces, ecosystems and heritage</i>	Protected areas
	<i>Housing</i>	Energy performance certification for buildings
SMART LIVING	<i>Social and community services</i>	SIGI availability and access
	<i>Social and community services</i>	Type of internet connection
	<i>Health</i>	Maternity ward in the closest hospital
	<i>Work</i>	Smart working
SMART PEOPLE	<i>Participation in public life</i>	Citizen participation in meetings/assemblies of public interest
	<i>Participation in public life</i>	Citizen participation in municipal elections
	<i>Participation in public life</i>	Citizen associations or organizations; especially if related to innovation
	<i>Digital dimension</i>	Familiarity with Internet

Table 15: Sub-set of twenty-four indicators for the CBS

After the Indicator Card presentation, during the section called “Indicators in Action” animated by Poliedra a subset of twenty-four Indicators, selected from the complete list considering the specific issues in which each Test Area is set to be working and those more related to smartness issues, was proposed. In particular, each participant worked on two Smart Dimension and on a total of eight Indicators.

From an academic point of view, the chance to participate at the CBS is considered like a “road test” because it was an opportunity to experiment the Complete List of Indicators with all the project partners and to collect their proposals and starting points for other analysis.

The results obtained during the session “Indicators in Action” are explained in the following paragraph.



Figure 13: Project partners during the CBS

3.5 Results obtained from Capacity Building Seminar for SmartVillages Regional Stakeholder Groups: Indicators in Action!

The Capacity Building Seminar for SmartVillages Regional Stakeholder Groups was divided in two sections: the first one regarding the Guide Lines for the RSG and the second one is called “Indicators in Actions”. In this paragraph, the results obtain from the second session are discussed and the analysis is structured considering the Smart Dimensions.

1. Smart Mobility

Mobility issues are considered essential to a smart transition to the majority of the project partners attending the meeting. In particular they are more focused on designing a digital integrated traffic platform in order to manage all the transport facilities in the TA and make the access to public transports more comfortable for the users. The partner ADRETS propose solutions involving the mobility of services to enhance the situation among elderly people as well as the concept of “*reverse mobility*”.

2. Smart Governance

This Smart Dimension seems not be as important as in the context of a Smart Cities. The discussion revealed that bottom-up initiatives with the support of a smart decision maker are more effective than imposed top-down activities. Thus, an involvement of rural communities is essential to create a smart village.

3. Smart Economy

New and innovative approaches in the economic filed are theme of special interest to all the project partner, in particular the digital farming turned to be a focus for the smart transition of both the Slovenian partner. Furthermore, it is revealed that the vast majority of the TA already perceived the topic of tourism as a fundamental area to invested in, thus all of them

are motivated in developing this sector from a smarter point of view, for example designing a tourist-related app or ensuring that the tourism strategy has not a negative impact on the environment. Finally, the definition of a unique brand or logo for the TA is fundamental for the recognisability of the village among the others and may help the growth in the tertiary sector activities.

4. Smart Environment

Worldwide, renewable energy resources (RES) issues are the centre of attention of a lot of discussion, in fact all the project partners are very focus on this: the TAs are working towards a zero-waste economy and they are implementing even more strategies to produce and/or consume even more energy from RES. Unfortunately, some partners feel that it is likely that data are not always available at the village spatial level, so it is necessary to verify if data submitted are scalable. Finally, a community with a high perception of the natural risk could help the implementation of the aforementioned initiatives.

5. Smart Living

This Smart Dimension is the widest because it is possible to range from topics concerning the Service of General Interest to the recently developed service of Smart Working. However, before considering all the most innovative activities that could be developed to improve rural community life there is an essential topic that need to be discussed: the coverage and the kind of internet connection. In fact, the TAs recognise that an adequate infrastructure for internet connection is essential to develop any kind of service which could enable all the inhabitants to continue living in the village and thus, avoiding the depopulation of rural areas.

6. Smart People

All the project partners revealed an interest in defining the digital literacy level of the TAs: these data are necessary to start the digital transformation of rural areas considering that there is the evidence that rural populations

lack the necessary digital skills and the use of digital technologies is lower than urban areas. Other important issues emerged during the meeting are not only the presence of citizen assemblies or associations, but also the participation of citizens during public meeting. Therefore, it is clear that the basis for starting a Smart Transition is a community with a great initiative and social, environmental and digital awareness, but above all informed of the situation that the village will face if everything remains unchanged.

The lively discussions and feedbacks during and after the Capacity Building Seminar have led the partnership, and most notably Poliedra, ADRETS, SCCH and the University of Maribor for WP-M, WPT-1 and WPT-2, to intensify efforts to harmonise their work and create a common framework for deliverables.

This has resulted in a closer cooperation especially on the Digital Exchange Platform and in a renewed attention for a common logical structure for the assessment of smartness for villages.

A survey for smartness assessment, including twenty-four core indicators in the form of questions with multiple answers, basically organised from the 'most negative' to the 'most positive', has been created, see Appendix C. These core indicators are the result of a merge between the list submitted to partners and aforementioned feedbacks obtained during the CBS.

It was clear from the debates that obtaining quantitative data would have been a very long and difficult process because databases are not accessible and in many cases data available at different spatial levels are not scalable, consequently the vast majority of indicators submitted in the survey refers to qualitative answers.

Below, there is a detailed explanation of the adjustments made to the subset of twenty-four Indicators submitted during the CBS.

- Smart Mobility:

Car-pooling and car-sharing services are included in one Indicator called Sharing Mobility, while the Indicator regarding the integrated traffic platform remains the same. Furthermore, an indicator asks to consider if

the offer of public transport is adequate and another one takes into account the presence of a multimodal transport infrastructure.

- Smart Governance:

E-government administrative and fiscal services are represented by one indicator as in the previous version, while a new indicator regarding the communication strategies adopted by PA is added. Moreover, the involvement of citizens in decision making process is taken into consideration with one indicator and it is also asked to consider if PA facilitate partnerships with private enterprises.

- Smart Economy:

In the survey form, this dimension is more oriented to the tourist sector in fact three indicators refers to this field. In particular, the indicator concerning the presence of a tourist dedicated Apps remains the same, while a new indicator deals with the impact of tourism on the environment. The presence of new and innovative approaches in economic activities is taken into account with two indicators: one concerning only the tourist sector and another one for all the other sectors like forestry, farming and productive sectors.

- Smart Environment:

The indicators dealing with production and consumption of energy from RES remains the same. The issues of recycling and circular economy are considered with the zero-waste economy indicator. Furthermore, the discussions during the CBS reveal that it is important to take into consideration the awareness of natural risks, so an indicator dealing with it is included in the survey.

- Smart Living:

The indicators regarding the basic services to population and the presence of smart working remains the same. The type of internet connection is considered a specific detail compared to the coverage of internet

connection, so an indicator for this is added. Moreover, the indicators regarding the health and social care are grouped in only one indicator asking the level of this services.

- Smart People:

Depopulation and ageing are considered fundamental factors to be taken into consideration, so one indicator is dedicated to this in the survey form. Furthermore, the indicators for citizens participations and the presence of active citizens associations and organisations remain the same, while the familiarity with internet is still present but it is expressed with an indicator a more appropriate indicator called digital literacy.

It is worth stressing to specify that the Indicator Card reveals to be a very useful tool to refine the survey and it will be use by the TA to analyse in detail the Dimensions in which the performance is low according to the ELECTRE TRI model to rate the smartness and to define the future targets for this issue.

Chapter 4

Multi criteria methodology to assess the level of smartness of rural areas

One of the main objectives of this dissertation is to define a methodology to assess the level of smartness of rural areas. Considering that the subset of twenty-four indicators refers to different issues divided into six dimensions, I decided that the closest decision aiding methodology to define a model that assesses the level of smartness is a multicriteria procedure. Among these procedures, there are four main reference problem types: choosing, rating, ranking and description problematic. The result of the first one is a choice or a selection procedure, the result of the second one is a rating or an assignment procedure, the third one results in a ranking or an ordering procedure and finally the description problematic results in a description or a cognitive procedure.

Our case study could be associated to both the second and the third problem types. However, it is thought that a **ranking procedure** could provide results that, in a sense, “judge” the areas considered and consequently would create an uninspiring context. As a result, I decided to define a rating procedure to assess the level of smartness of rural areas using a multicriteria methodology, specifically one of the ELECTRE Methods, analysed in detail in the following paragraphs.

4.1 Theoretical introduction to the ELECTRE Methods

Since their conception, which dates from the 1960s in France, ELECTRE (ELimination Et Choix Traduisant le REalité - ELimination and Choice Expressing the REality) methods have been widely used for Multiple Criteria Decision Aiding (MCDA) in many real-world decision problems, ranging from agriculture to environment and water management, from finance to project selection, from personnel recruiting to transportation, and many others (Figueira, et al. 2012).

In this chapter, it is explained at first the meaning of a decision-aiding situation and its key elements, then, before introducing the “European”²¹ conception of MCDA, its three fundamental supporting pillars are presented. After that the main feature of ELECTRE Methods are presented with more emphasis on the ELECTRE TRI Method procedures.

To fully capture the decision-aiding situation, an easy example is needed. Consider a company or a public institution, where a manager or a group of people, called stakeholders, are confronted with a situation that requires them to make a decision. To obtain help in clarifying the decision process, they can lean on an in-house operational research service or an outside consultant or even a university research team. This aspect allows to characterize a decision-aiding situation, where two key actors are relevant for co-interaction²² that will lead to build and make evolve the decision-aiding process; a process that comprises several phases (Roy 1996). The two key actors will be designated in what follows as the analyst, who is appointed to give this decision aiding, and as the decision maker, in whose name or for whom this decision aiding is to be given (Figueira, et al. 2012).

In the operational research, the decision-aiding activity is founded on three pillars:

1. The actions: the objects of the decision. When two distinct actions cannot be put conjointly into operation, they are called alternatives.

²¹ The term “European” does not mean that the conception illustrated was only developed and followed by Europeans. A large number of researchers all over the globe are being working in the field of MCDA methodology and are applying the techniques to real-world problems.

²² The prefix “co” stems for the interaction between decision maker and analyst.

2. The consequences: all the aspects that allow to compare one action to another.
3. The modelling of one or several preference systems: implicit or explicit process, that for each pair of actions envisioned, assigns one and only one of the three main situations: preference, indifference and incomparability. When given two possible actions, any individual on the basis of actions' consequences and the value system adopted, can comment on this with three different statements: "I prefer the first to the second", "I am indifferent between the two" or "I am unable to compare these two". Modelling a preference system means to specify a process that will provide these outputs on the basis of model of the actions' consequences a previously established.

According to the "European" conception, the analyst must seek for obtaining a coherent and structured set of results. These results should be sought to guide the decision-aiding process and facilitate communication about the decision. To perform this, the analyst has to use an approach with the purpose of producing knowledge from working hypotheses, taking into account the objectives and the value systems involved in a particular decision context. This procedure should be based on models that are co-constructed through interaction between the analyst and the decision-maker. Firstly, this co-construction refers to the way the actions and their consequences are taken into consideration. Secondly, this process concerns the way that the main characteristics of the preferences model are judged the most appropriate considering the peculiarities of the decision context and the working hypothesis maintained (Figueira, et al. 2012). In this scheme, it is not necessary to assume that the decision maker acts following a stable procedure capable of defining the decision maker's preference system, before even beginning the decision aiding process as in Multiple Attribute Utility Theory methods (Keeney e Raiffa 1976).

To guide this process of co-construction, the analyst must interact with the decision maker, who is supposed to understand the questions asked. However, in the "European" conception, it is not necessary to consider that the answers are produced through a stable pre-existing process, but only that these responses are conceived

through interaction with the decision maker's value system, which is rarely free of ambiguity or even contradiction (Figueira, et al. 2012).

In accordance with the "European" conception, the knowledge produced does not aim to help the decision maker to discover a good approximation of a decision that would objectively be the best one, but rather to provide the decision maker with a set of recommendations derived from the reasoning models and working hypothesis (Figueira, et al. 2012) (Roy 2010).

In conclusion, it is possible to claim that the interaction which underlies the "European" conception makes the decision maker a co-constructor of the knowledge process and so not outside of the decision-aiding process.

4.1.1 Main features of ELECTRE Methods

It is relevant utilizing ELECTRE Methods when dealing with situations with the following characteristics (Figueira, Roy e Mousseau 2005) (Roy 1991):

1. At least three criteria have to be included in the model.

And, at least one of the following situations must occur.

2. Actions are judged on an ordinal scale²³ or on an interval scale²⁴. These kinds of scales are not suitable for the comparisons of differences. Therefore, it is considered artificial to define a meaningful coding in terms of preference differences of the ratios $\frac{g_j(a_1)-g_j(a_2)}{g_j(a_3)-g_j(a_4)}$, where $g_j(a_i)$, with row $i = (1, \dots, m)$ and column $j = (1, \dots, n)$, is the evaluation of action a_i on criterion g_j .
3. A strong heterogeneity related with the nature of evaluations exists among criteria. Consequently, aggregate all the criteria in a unique and common scale is complicated.

²³ Ordinal scale means a scale on which data is shown simply in order of magnitude since there is no standard of measurement of differences (Collins Dictionary, 2018).

²⁴ Interval scale means a scale of measurement of data according to which the differences between values can be quantified in absolute but not relative terms and for which any zero is merely arbitrary (Collins Dictionary, 2018).

4. The decision maker may not accept a compensation of the loss on a given criterion by gain on another one.
5. For at least one criterion the following has to be verified: small differences of evaluations are not significant in terms of preferences, while the accumulation of several small differences may become significant.

The basic data needed for the ELECTRE Method, and basically for any MCDA problem can be represented as follows (Figueira, et al. 2012):

1. $A = (a_1, a_2, \dots, a_i, \dots, a_m)$ is the set of m potential actions.
2. $F = (g_1, g_2, \dots, g_j, \dots, g_n)$ is a coherent family of criteria²⁵ with $n \geq 3$.
3. $g_j(a_i)$ is the performance of action a_i on criterion g_j , for all $a_i \in A$ and $g_j \in F$; an $m \times n$ performance matrix M can be built, with $g_j(a_i)$ in row $i = (1, \dots, m)$ and column $j = (1, \dots, n)$.

The relative importance coefficient of criterion g_j , for all $g_j \in F$, can be defined w_j assuming that: $\sum_{j=1}^n w_j = 1$. This coefficient is considered an **intrinsic weight**, in other words it can be viewed as the voting power of each criterion: the higher w_j , the more important the criterion is.

4.1.1.1 Modelling the main preference situations using an outranking relation

Preferences in ELECTRE Methods are modelled by using binary outranking relations, S , whose meaning is “at least as good as”. Considering two actions a_1 and a_2 , the following four preference situations may be handled (Figueira, et al. 2012):

²⁵ Any family of criteria satisfying the following three requirements is said to be coherent (Roy, Multicriteria Methodology for Decision Aiding 1996):

- Exhaustiveness: the loss of information that inevitably occurs when going from the problem itself to a family F of n criteria must be carefully monitored. The family F of n criteria have to describe the problem in its entirety.
- Cohesiveness: this requirement deals with the compatibility that must exist between the role that each criterion plays when considering preferences along its specific significance axis and the more comprehensive role that a family F plays when integrating all the consequences into comprehensive preferences.
- Non-redundancy: none of the n criteria of F is considered redundant if leaving out some criterion would form a family that would no longer satisfy one or both of the preceding requirements.

- **Strict Preference:** a_1Sa_2 and not a_2Sa_1 means “ a_1 is strictly preferred to a_2 ”. It refers to a situation where there are clear and positive reasons in favour of one of the two actions.
- **Indifference:** a_1Sa_2 and a_2Sa_1 means “ a_1 is indifferent to a_2 ”. It refers to a situation where there are clear and positive reasons that justify an equivalence between the two actions.
- **Incomparability:** not a_1Sa_2 and not a_2Sa_1 means “ a_1 is incomparable to a_2 ”. It refers to an absence of clear and positive reasons that would justify any of the three preceding relations. This relation is useful to account for situations in which the decision-maker or the analyst is not able to compare two actions (Figueira, Roy e Mousseau 2005) (Roy e Vincke 1984).

It is worth stressing to specify that in general an outranking relation is not transitive.

Given a binary relation on set A it is extremely helpful to build a graph $G = (V, U)$, where V is the set of vertices and U the set of arcs. For each action $a_i \in A$ we associate a vertex $i \in V$ and for each pair of actions $(a_i, a_j) \in A$ the arc (i, j) exists if and only if a_i outranks a_j . If there is no arc between vertices, it means that a_i and a_j are incomparable; if two reversal arcs exist, there is an indifference between both a_i and a_j .

The meaning of “clear and positive reasons” is related to the concepts of concordance and non-discordance that are explained below.

4.1.1.2 *The concepts of concordance and discordance*

All the methods based on outranking relations rely on the concepts of concordance and discordance that represent the reasons for and against required to make an assertion (Colomi 2017).

- **Concordance** corresponds to the strength of the coalition of criteria being in favour of the outranking relation a_1Sa_2 .
- **Discordance** refers to criteria that are in opposition to the assertion a_1Sa_2 . When the concordance condition is verified, none of the criteria in the minority should oppose too strongly to the outranking relation a_1Sa_2 (Figueira, Roy e Mousseau 2005).

4.1.1.3 Structure of ELECTRE Methods: Aggregation and exploitation procedure

By definition, the Multiple Criteria Aggregation Procedure (MCAP) is a procedure based on one or more outranking relations considering the performances of each action on each criterion, which leads to assign to each ordered pair of actions one and only one of the four aforementioned preference situations. This procedure takes into account that some criteria reflects a very important role, whereas others can play a totally secondary role (Figueira, et al. 2012) (Roy 2010).

The exploitation procedure is used to elaborate recommendations from the results obtained in the first phase. Each exploitation procedure is adapted to a particular problematic:

- **Choosing:** selecting a restricted number of the most interesting potential actions, as small as possible, which will justify to eliminate the others (Figueira, et al. 2012).
- **Ranking:** all the actions belonging to a set of actions are ranked from the best to the worst.
- **Sorting:** assigning each potential action to one of the categories among a family previously defined; the categories are ordered from the worst to the best one (Figueira, et al. 2012).

The sorting problematic is illustrated in detail in the following paragraph because our case study can be perfectly associated to this particular problematic.

4.1.1.4 The concepts of discriminating thresholds

The evaluation of actions can be imperfect: the ELECTRE Methods make use of discriminating thresholds to take into consideration this character.

Discriminating thresholds account for the imperfect nature of evaluations, and are used for modelling situations in which two different actions are associated to evaluations whose difference may either (Figueira, Roy e Mousseau 2005):

- Justify the preference in favour of the two actions: preference thresholds, p_j ;
- Be compatible with indifference between the two actions: indifference thresholds, q_j ;

- Be interpreted as a hesitation between opting for a preference or an indifference between the two actions.

It is necessary to specify that there is no true value for thresholds: the values assigned are the most convenient for expressing the imperfect character of actions.

4.1.1.5 *The concept of veto thresholds*

Veto thresholds defines the power given to a criterion to be against the statement “ a_1 outranks a_2 ”, when the difference of the evaluation between $g(a_1)$ and $g(a_2)$ is greater than this threshold.

4.1.2 Rating problematics: ELECTRE TRI Method

In this kind of problematics, a **set of categories** must be a priori defined (Mailly, Abi-Zeid e Pepin 2013). All potential actions assigned to a category will be considered further in the same way.

In sorting problematics, each action is considered independently from the others in order to define the category to which it seems justified to associate it, by means of comparisons to profiles, norms and references. Therefore, this kind of problematic refers to **absolute judgements**: it consists of assigning each action to one of the pre-defined categories which are defined by norms or typical elements of the categories. It is important to notice that the assignment of an action to a specific category does not influence the category to which another action should be assigned (Figueira, Roy e Mousseau 2005).

Since that, the ELECTRE TRI Method is designed to assign a set of actions, objects or items to ordered categories, each category must be characterized by a **lower and upper profile**, to which compare actions (Norese e Carbone 2014).

Let $C = (C_1, \dots, C_h, \dots, C_k)$ denote the set of categories: the allotment of a given action a_i to a certain category C_h is the result of a comparison between the action a_i and the upper and lower profiles defining the category. Being b_h the upper limit of the category C_h and the lower limit of category C_{h+1} it is clear that a_i belongs to C_h if and only if $b_h \leq a_i$.

It is fundamental to define a **λ -cutting level** establishing the comprehensive voting power in favour to the assertion, necessary for that action to be assigned to that category. Consequently, the winning coalitions, determining the criteria without them it is impossible to reach the λ -cutting level value imposed, are denominated (Colomni 2017). Considering that the value of this parameter provokes a strong impact on the results, it is important to evaluate how its variation influences them: a frequent approach used is the sensitivity analysis (Pomerol e Barba-Romero 2000).

4.1.2.1 *The exploitation procedure*

The exploitation procedure aims at exploiting the binary preference relations. The role of this exploitation is to propose an assignment which can be supported by two well-known logics (Figueira, Roy e Mousseau 2005):

- The **conjunctive logic**: an action can be associated to a category when its evaluation on each criterion is at least as good as the lower limit which has been defined on the criterion to be in this category. The action is assigned to the highest category fulfilling this condition. This rule is usually interpreted as a **pessimistic logic**.
- The **disjunctive logic**: an action can be assigned to a category, if it has, on at least one criterion, an evaluation at least as good as the lower limit which has been defined on the criterion to be in this category. The action is assigned to the highest category fulfilling this condition. This rule is usually interpreted as an **optimistic logic**.

ELECTRE TRI is a generalisation of the two aforementioned rules. Therefore, it is possible to replace some words to obtain the official conditions:

- In the conjunctive rule: “*on each criterion*” is replaced by “*on a sufficient majority of criteria and in the absence of veto*”.
- In the disjunctive rule: “*on at least one criterion*” is replaced by “*on a sufficient minority of criteria and in the absence of veto*”.

4.2 ELECTRE TRI model to rate the level of smartness

The assessment and rating model proposed uses the ELECTRE TRI method and it is based on the set of twenty-four Indicators, grouped into the six Smart Dimensions, submitted to all the TA through a survey implemented on the Digital Exchange Platform, precisely customized for the project “SmartVillages”, see 2.1 paragraph.

The survey was supposed to be online on January 31st, but there were some practical implementation delays; to counter those delays and to test both the system and the mathematical method behind it, it was decided that Poliedra started interviewing some selected TA. I actively participated in all the interviews interacting directly with the partners of those selected TA.

As explained in paragraph 4.1.1, the importance of each Dimension, and then of each Indicator, with respect to the others is expressed using weights. In order to determine these weights, I chose to proceed with pairwise comparisons as in the **Analytic Hierarchy Process (AHP)**²⁶ by Thomas L. Saaty (Camagni, et al. s.d.).

Two different weight systems are considered and so two different approaches are designed:

- The self-assessment approach,
- The expert-based assessment approach.

In the first approach, the weight system is different for each TA because it is based on the answers each partner provides during the interviews about the Dimensions’ pairwise comparisons. Using this approach, it is possible to assess the level of smartness perceived from each TA’s partner.

Meanwhile, in the expert-based assessment the weight system is the same for all the TA and it is a linear combination of the weight systems provided by four experts whose technical backgrounds are associated to the six Smart Dimensions. It is clear

²⁶ The analytic hierarchy process (AHP) is a structured technique for organizing and analysing complex decisions, based on mathematics and psychology. It was developed by Thomas L. Saaty in the 1970s and has been extensively studied and refined since then.

that this assessment allows a rating from a more objective perspective and an evaluation of the level of smartness on common basis.

The following paragraphs are dedicated to describing in detail the aforementioned approaches.

4.2.1 Self-assessment approach

4.2.1.1 Weight system

The definition of the weight system follows the same procedure of the AHP by Saaty. Firstly, the definition of a **relative scale** to measure how much you “prefer” a dimension compare to another is required. Although, Saaty proposes a 1 to 9 scale in which 1 means equality and 9 absolute preference, I decided to use a 1 to 6 scale because it was revealed easier to use during the interviews and I noticed that values higher than 6 are difficult to manage with (T. Saaty 2008). The relative scale used is the following:

1	Equality
2	Minimum preference
3	Small preference
4	Medium preference
5	Great preference
6	Maximum preference

Table 16: Relative scale of preference

Secondly, the **Comparison Matrix** ($n \times n$) with row $i = (1, \dots, m)$ and column $j = (1, \dots, n)$ is defined from the pairwise comparison. The diagonal elements of the Comparison Matrix are always 1 and it is defined as:

- Positive: $a_{ij} > 0$;
- Reciprocal: $a_{ij} = \frac{1}{a_{ji}}$;
- Consistent: $a_{ij} = \frac{a_{ik}}{a_{jk}}$;

Considering these three properties it is possible to define the Comparison Matrix with only $(n-1)$ comparisons. However, we decided to admit some inconsistencies

asking our interviewees $\frac{n*(n-1)}{2}$ comparisons which are necessary to compile the upper triangular matrix, then the low triangular matrix is obtained assuming reciprocity.

After obtaining the Comparison Matrix, we have to compute the **priority vector** which is, from a mathematical point of view, the normalized eigenvector of the matrix.

The method used to compute the eigenvector is the so called “eigenvector method”: through power iteration, the algorithm produces a nonzero vector which is a good approximation of the eigenvector corresponding to the greatest eigenvalue of the matrix λ_{max} , called Principal eigenvalue. Raising the Comparison Matrix to an increasingly higher power, the inconsistency will distribute among all the elements of the matrix: the columns will be gradually close to proportionality (Colorni 2017).

If the Consistency Ratio is “small enough”, the priority vector expresses the weight system that is subsequently considered in the ELECTRE TRI method to assess the level of smartness; consequently, the evaluation of the Comparison Matrix’s consistency level is fundamental to proceed.

To do so, the computation of the Principal eigenvalue is required. The Principal eigenvalue is obtained from the sum of the products between each element of the priority vector and the sum of the columns of the Comparison Matrix (Teknomo 2006).

Saaty proved that for consistent reciprocal matrix, the largest eigenvalue is equal to the size of the Comparison Matrix. Meanwhile, if some inconsistencies are admitted, Saaty recommends a measure of consistency using the **Consistency Index**, $CI = \frac{\lambda_{max} - n}{n - 1}$. From a mathematical point of view, the Consistency Index measures the level of consistency as a deviation from the size of the Comparison Matrix.

After that, Saaty proposes to compare the Consistency Index to the **Random Consistency Index** RI ²⁷ that exists for almost any matrix order and it is easily obtainable from scientific literature, Table 17 shows the values obtained from one set of such simulations for matrices of size 1, 2, ..., 15. Our analysis deals with a 6×6 matrix considering dimensions and so the RI is 1,25; while concerning the indicators the comparison matrix is 4×4 and consequently RI is 0,89. The result of this comparison is the **Consistency Ratio**: $CR = \frac{CI}{RI}$.

If the consistency ratio is smaller or equal to 10% the inconsistency is acceptable and the priority vector is considered a good approximation of the weight system.

Matrix Order	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
RI	0.00	0.00	0.52	0.89	1.11	1.25	1.35	1.40	1.45	1.49	1.52	1.54	1.56	1.58	1.59

Table 17: Random Index

This procedure is used to defined the Dimensions' weight system for the selected TA; only for one TA, that is Tolmezzo, I decided to submit to the interviewee the Indicators' pairwise comparisons and so an Indicators' weight system is obtain, in the following dedicated paragraph the procedure is explained in detail, see Table 54. For all the other TA, the Indicators' weight system is obtained considering that, within the same dimension, they have equal weight when compared each other (for further details see Table 27, Table 30, Table 33, Table 36 and Table 39).

4.2.1.2 ELECTRE TRI model

The weight system obtained with the previous procedure has been directly implemented in the ELECTRE TRI model to explain the importance of each Dimension, and then of each Indicator, with respect to the others.

It is worth describing how each answer to the survey is quantified: there are 4 answers ordered from the "worst situation" to the "best situation" and quantified with a score from 1 (the worst) to 4 (the best). We considered appropriate to request

²⁷ The Random Index is the result of the average value obtained from 50.000 computation of the consistency ratio of a matrix with the entries above the main diagonal at random from the 17 values {1/9, 1/8, ..., 1, 2, ..., 8, 9} and the entries below the diagonal by taking reciprocals (Saaty e Tran 2007).

also the level of “certainty” with which an answer is provided: dealing with a self-assessment approach, it is essential to define the “strength” of the answers given to the survey because it gives the opportunity to better balance the choice and thus it implies a more detailed analysis on the subject addressed in that question. In order to utilize this additional information in the model, a further 1 to 3 value is assigned to each answer. Consequently, **the scale considered in the model, to quantify the answers, is a 1 to 12 scale**: 1 corresponds to the most negative situation with a low level of certainty, 3 corresponds to the most negative situation with a high level of certainty; while 10 is assigned to the best situation with a low level of certainty, 12 to the best situation with a high level of certainty. All the answers in the middle follow the same logic: the second answer is scored from 4 to 6, the third from 7 to 9.

There are some exceptions, in which the relative scale is not a 1 to 4 scale, with specific reference to the four indicators listed below:

- The indicators “multimodal transport infrastructure”, “tourist-dedicated apps/platforms”; “tourism impact on environment” provide 1 to 3 scale, so the worst situation is scored from 1 to 4, while the best from 9 to 12, see Table 18 and Table 20.
- The indicator “innovative approaches in other sectors” provided a 1 to 2 scale, so the most negative situation is scored 1 to 6, while the best from 6 to 12, see Table 20.

Below, each question is presented on the left with its related indicator on the right and the terms and the scores used in the model for each answer are listed:

1. Smart Mobility

Do you consider the offer of public transport adequate in your TA?	Offer of public Transport	
Not at all	Completely inadequate	1 to 3
Not at the moment, but progress is being made	Inadequate, but in progress	4 to 6
Yes, but the TA is at risk of losing some vital public transport services	Adequate, but at risk	7 to 9
Yes, public transport is adequate and covers all needs	Completely adequate	10 to 12

Are there solutions to share means of transport in your TA?	Sharing Mobility	
No	Completely non existent	1 to 3
Yes, people share on a private basis with no 'official' sharing service	People share on private basis	4 to 6
Yes, car sharing	One kind of service	7 to 9
Yes, car-pooling.	More than one kind of service	10 to 12

Is there any integrated traffic platform for citizens/visitors in your TA to use?	Integrated traffic platform	
No, and there are no plans to build one	Completely non existent	1 to 3
No, but it is planned to build one	Non-existent but in progress	4 to 6
Yes, only for consultation of transport timetables	Existent only timetables	7 to 9
Yes, both for consultation and for buying tickets	Existent timetables and buying	10 to 12

Is there any multimodal transport infrastructure available in your TA (train/bus and car sharing; train/bus and bike sharing; ...)?	Multimodal transport infrastructure	
No, and there are no plans multimodal infrastructures	Completely non existent	1 to 4
No, but there are plans to build multimodal infrastructure	Non-existent but in progress	5 to 8
Yes	Existent	9 to 12
Yes, reverse mobility		

Table 18: Section of the survey on Smart Mobility

2. Smart Governance

Are there e-government administrative and fiscal services, organised and managed by PA?	E-Government administrative and fiscal services	
No, and the PA does not have plans for administrative and/or fiscal services on line	Completely non existent	1 to 3
No, but the PA have plans for implementing administrative and/or fiscal services on line	Non-existent but in progress	4 to 6
Yes, but a low percentage of citizens use them	Existent but rarely used	7 to 9
Yes, and a high percentage of citizens use them	Existent and widely used	10 to 12

Do Public Authorities involve citizens in decision making? (top-down approach to participation)	Participation events organised by PA	
No, decision-making does not involve citizen participation	Completely non existent	1 to 3
No, but PA plans some activities to involve citizens in decision making	Non-existent but in progress	4 to 6
Yes, but not on the topic of innovation or smart transition	Existent	7 to 9
Yes, PA involves citizens on the topic of innovation and smart transition	Existent and on smart topics	10 to 12

Do Public Authorities facilitate partnerships with private enterprises?	Partnerships between PA and private	
No	Completely non existent	1 to 3
No, but there are some plans to facilitate networks and contacts with private enterprises	Non-existent but in progress	4 to 6
Yes, PA and private enterprises cooperate on some topics but not on innovation or smart transition	Existent	7 to 9
Yes, public and private work together for smart transition	Existent and on smart topics	10 to 12

Do Public Authorities communicate (news, decisions, information) in smart ways to the citizens or visitors?	PA ways to communicate with citizens	
No	Traditional ways	1 to 3
No, but PA plans to change the way to communicate	Traditional but in progress	4 to 6
Yes, but PA communication strategy does not cover all the possible social, web or IT channels	Smart but improvable	7 to 9
Yes, the PA communicates decisions, meetings and information using smart (including social) platforms	Completely smart	10 to 12

Table 19: Section of the survey on Smart Governance

3. Smart Economy

Are there any tourist-dedicated apps/platforms in your TA, to present and inform about tourist attractions?	Tourist-dedicated apps/platforms	
No, and they are not planned	Completely non existent	1 to 4
No, but they are planned	Non-existent but in progress	5 to 8
Yes, there are app(s)	Existent	9 to 12

Yes, there are websites/platforms		
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Do tourist activities in your TA use innovative and/or smart approaches?	Approaches used in the tourist filed	
No, just traditional ones	Traditional approaches	1 to 3
No, but some innovation is starting to appear in traditional sectors	Traditional but in progress	4 to 6
Yes, the TA uses some innovative approaches to tourism	Smart but improvable	7 to 9
Yes, the TA offers smart experiences all around	Completely smart	10 to 12

Does your TA ensure that tourism does not have a negative impact on the environment?	Tourism impact on environment	
No, no specific measures are taken	Negative impact	1 to 4
No, only general measures are taken		
Yes, some information is provided to protect soil/air/water/environment	Positive impact	5 to 8
Yes, the TA specifically markets itself as a zero-impact tourism destination	Zero-impact tourism destination	9 to 12

Do economic activities (other than tourism) have new and innovative approaches (i.e. digital technologies in farming, animal husbandry, ...)?	Innovative approaches in other sectors	
No	Completely non-existent	1 to 6
Yes, in the agricultural and/or animal husbandry sector		
Yes, in the forestry sector	Existent	7 to 12
Yes, in other productive sectors		

Table 20: Section of the survey on Smart Economy

4. Smart Environment

Does your TA produce energy from RES?	Energy production from renewable resources	
No, and production of energy from RES is not planned	Completely non-existent	1 to 3
No, but production of energy from RES is planned	Non-existent but in progress	4 to 6
Yes, but in the TA, there is only one RES plant	One plant	7 to 9
Yes, and in the TA, there are more RES plants	More than one plant	10 to 12

Does your TA use energy from RES?	Energy consumption from renewable sources	
No, the TA sells all the energy from its own RES	Null	1 to 3
No, but the TA plans to use some of the energy produced	Null, but in progress	4 to 6
Yes, the TA buys energy produced by RES in other areas	Existent but not from own energy	7 to 9
Yes, the TA consumes the energy from RES produced in the TA	Existent and from own energy	10 to 12

Is your TA working towards a zero-waste economy?	Zero-waste economy	
No	Completely non-existent	1 to 3
No, but the TA has a working recycling policy	Working recycling policy	4 to 6
Yes, the TA is working towards a zero-waste economy thanks to some local initiatives	Local initiatives	7 to 9
Yes, and there are public policies for a zero-waste economy	Public policies	10 to 12

Are citizens in your TA aware of natural risks?	Awareness of natural risks	
No, and no raising awareness activities are planned	Completely non-existent	1 to 3
No, but there are raising awareness activities for natural risks	Non-existent but activities in progress	4 to 6
Yes, but the awareness is not high	Existent, but not high	7 to 9
Yes, and the awareness of natural risks in the TA is satisfyingly high	Existent and high	10 to 12

Table 21: Section of the survey on Smart Environment

5. Smart Living

What would you say is the level of health and social care in your TA?	Level of health and social care	
Low, the TA lacks basic health and social care services	Low	1 to 3
Medium, the hospital is not located in the TA, but the TA is served by doctors/social services on call	Medium	4 to 6
Good level, there is an hospital with all basic medical services in the TA and health and social care services are granted for all age groups	Good	7 to 9

Very good level, the TA has access to the most advanced medical techniques (e-healthcare)	Very good	10 to 12
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What is the coverage of the internet connection in your TA?	Coverage of internet connection	
Low	Low	1 to 3
Medium	Medium	4 to 6
High	High	7 to 9
Very high	Very high	10 to 12

How attractive is your TA, from the point of view of basic services to the population (banks, post-offices, basic-good shops, bars & restaurants, pharmacies, educational services)?	Basic services to population	
Low	Low	1 to 3
Medium	Medium	4 to 6
High	High	7 to 9
Very high	Very high	10 to 12

Is smart working already possible in your TA?	Smart working	
No, and it is not planned	Completely non-existent	1 to 3
No, but it is planned by some PA/enterprises	Non-existent but activities in progress	4 to 6
Yes, but a low percentage of citizens use it	Existent, but rarely used	7 to 9
Yes, a high percentage of citizens use it	Existent and widely used	10 to 12

Table 22: Section of the survey on Smart Living

6. Smart People

Would you say that your TA is subject to depopulation and ageing?	Depopulation and ageing	
Yes, the TA is only inhabited and “lived” by elderly people	Only elderly	1 to 3
Yes, young people (under 30) come back occasionally (for holidays and occasional work	Under 30 came back occasionally	4 to 6
Yes, young people (under 30) study and work away but still live here (e.g., daily commuters)	Under 30 work away but still live here	7 to 9
No, young people (under 30) are staying in the area	Under 30 work and live here	10 to 12

What is the level of digital literacy in your TA?	Digital literacy	
Low, and educational activities to foster digital literacy are not planned	Low	1 to 3
Low, but educational activities to foster digital literacy are in place or planned	Low but in progress	4 to 6
Medium-to-high, but not for all the age groups	Medium to high	7 to 9
High, all people can be defined as digital literates	High	10 to 12

Do citizens in your TA participate in meetings or assemblies of public interest? (bottom-up approach to decision making)	Citizen participation in meetings or assemblies of public interest	
No, there is not much interest (or not many opportunities) in participating in decision making	Completely non-existent	1 to 3
Yes, there are some opportunities but only a low percentage of people participate	Existent but low percentage	4 to 6
Yes, there are some opportunities and a medium-to-high percentage of people participate	Existent and medium-to-high percentage	7 to 9
Yes, there are some opportunities and a very high percentage of people participate	Existent and high percentage	10 to 12

Are there active citizens associations and organisations in your TA?	Citizens associations or organizations	
No, or there were but they are not active any more	Completely non-existent	1 to 3
No, but there are plans for some new associations/organisations to form	Non-existent but in progress	4 to 6
Yes, but they are not focused on innovation	Existent	7 to 9
Yes, and they are focused on innovation	Existent and on innovation	10 to 12

Table 23: Section of the survey on Smart People

In the ELECTRE TRI Method the definition of the categories for the rating and their profiles is required. I decided to consider **four different categories** and consequently **three different profiles**.

It is important to specify that the profiles are described by constant function because we are dealing with qualitative indicators, whose units of measurement are not available and recommendations indicating how handle them cannot be found in scientific references. Consequently, considering different limit values for each indicator to define the same profile is illogical.

Below, the categories are listed and Table 24 shows the values assigned to each profile:

- **CATEGORY A: high level of smartness or new goals level.** It means that the majority of the dimensions registers the highest level of smartness considered reachable in this model. In other words, most indicators score between 10 and 12. It is important to highlight that these are the targets used in this survey and so, placing in this category is only a milestone in a possibly more complex process.
- **CATEGORY B: good level of smartness or satisfactory level.** It indicates that there are numerous activities and initiatives that focus on innovation, the services are adequate and innovative approaches are used in a lot of sectors. However, not the majority of facilities score the highest level of smartness in their services.
- **CATEGORY C: medium level of smartness or work in progress level.** It means that there are some smart services planned and people are aware about the importance of smart transformation.
- **CATEGORY D: low level of smartness or traditional concept level.** It means that there are very few initiatives that focus on innovation and very little is planned to improve this situation.

Profiles	Values
B to A	9,5
C to B	6,5
D to C	2,5

Table 24: Values of the profiles

We considered appropriate to not select integer values to indicate the profiles because, otherwise, it would have been required to define the rule to exploit the binary preference relations choosing between the conjunctive or pessimistic logic and the disjunctive or optimistic logic, see 4.1.2.1 paragraph.

It is noteworthy that **category B is wider when compared to the others**: I decided this to take into account the fact that during the interviews the vast majority of

partners defined their TA in a situation “in the middle” of a transformational process in which a lot of services are on the way of progress or some new initiatives are planned. Furthermore, it is clear that the transformational process is characterized by different stages based on its advancement and each TA can reflect its own situation in one of them. Therefore, in order to identify each TA’s precise position in the transformational process and to note that their self-assessments are different, despite of belonging to the same category, I decide to enlarge the interval of values of this category with respect to the others.

In the self-assessment the veto threshold is not considered because, from my point of view, at this stage, asking the partners to define a veto without being experts of the method used is not significant. The veto threshold, in fact, implies that one or a select number of indicators possesses the power to be definitely against the final category assigned at the end of the process and consequently, to provide a new satisfactory outcome.

Finally, the **λ -cutting level is considered of 70 out of 100** to define both the final category and the category for each specific dimension. This second classification provides further details concerning the single dimension and allows more complex elaborations of the final results. Moreover, considering that, for all the TA, except for Tolmezzo, the indicators are considered of equal weight when compared to the others of the same dimension and that there are four indicators for each dimension, the **winning coalition** necessary to define the category of each specific dimension is of **three indicators**.

The λ -cutting level value implemented in the model is very demanding and requires the TA to be already in a progress stage of the smart transition. In my opinion, the self-assessment obtained with a λ -cutting level of 70 can be a more stimulating starting point for further analyses than a lower one. However, the sensitivity analysis to evaluate the robustness of this assumption and graphs displaying different λ -cutting level values and the corresponding final category are provided in the 4.2.3 paragraph.

The following paragraphs describe in detail the assessment of the selected TA and of Tolmezzo; in particular covering some comments collected during the

interviews, the results obtained from each Dimensions' pairwise comparison, comprehensive of all the indices required to evaluate the consistency of the matrix, the scores for each indicator extracted from the answers to the survey and finally the category of smartness reached with the self-assessment approach. It is noticeable that in Tolmezzo case study an Indicators' pairwise comparison was submitted to the interviewee and the results are shown in a dedicated section.

4.2.1.3 *Valli del Sol, Italy*

In terms of smart transition, Valli del Sol RSG's attention is focused more on increasing digitalisation and on Smart Mobility.

The partner involved is the Development Agency Gal Genovese s.r.l. and the first issue they underlined is that it is likely that their point of view could not correspond to that of the RSG as well as the answers to the survey. This is predictable because we are dealing with a self-assessment approach at its testing stage. Therefore, the RSG, organised in a 4H logic, will answer to the survey and the self-assessment approach will provide different outcomes with respect to those obtained using partners' answers.

Regarding Smart Mobility, some rail transport services are considered to be regressing and it is likely that sharing mobility services alone could not solve the problematic issues in this field. However, there are some initiatives from the SUMP²⁸ of Città Metropolitana di Genova that will directly involve the TA especially concerning the implementation of an integrated traffic platform.

Furthermore, concerning the Smart Economy dimension, there is a Regional Project that will introduce the opportunity of some natural trails designed for E-bikes: this is a good example of innovative approaches for tourist activities. In addition, other productive sectors are implementing some smart approaches but there is not a systematic logic behind. Another interesting issue is the presence of a geopark (regional UNESCO park) App containing a wide list of facilities that can be booked by the App, natural trails, information regarding the traditional cuisine and some slow food restaurants.

²⁸ SUMP means Sustainable Urban Mobility Plan.

Considering the Smart Environment dimension, the TA produces and consumes energy from RES (in particular there are biomass and wind plants) but in general the energy demand is higher than the one covered with RES.

With respect to Smart Living, the broad-band infrastructure is planned for the whole TA and the Municipal of Genoa is working on a project to establish some smart working opportunities for municipal employees

Finally, as regards Smart People, it is worth highlighting their point of view concerning the digital literacy in their TA: although it is defined as medium to high, it is not homogeneous within the territory in fact the more isolated areas do not feel the need to adopt some measures to increase the level of digitalisation. Furthermore, it is can be noted that citizens tend to participate in public initiative only when the issues suggested by the inhabitants are discussed.

Figure 14 illustrates the result of the scores attributed by the partner interviewed to each indicator answering to the survey.

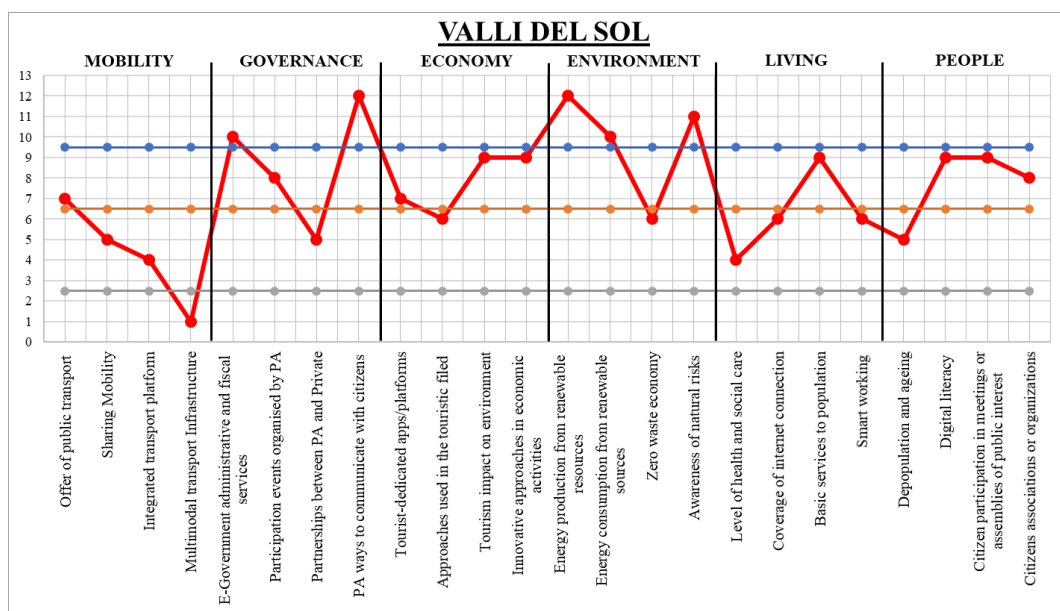


Figure 14: Valli del Sol results obtained from the answers to the survey

The following tables indicate the results obtained from the Dimensions' pairwise comparison, comprehensive of all the indices required to evaluate the consistency of the matrix, and the priority vector.

Valli Del Sol	Mobility	Governance	Economy	Environment	Living	People
Mobility	1	4	2	1	1/2	2
Governance	1/4	1	1/2	1/2	2	1
Economy	1/2	2	1	2	1/2	1/2
Environment	1	2	1/2	1	1	1
Living	2	1/2	2	1	1	2
People	1/2	1	2	1	1/2	1

Table 25: Valli del Sol's Comparison Matrix

Mobility	22,7 %	λ max	6,88
Governance	13,0 %	n	6
Economy	14,5 %	CI	0,18
Environment	15,4 %	RI	1,25
Living	20,9 %	CR	14,04%
People	13,5 %		

Table 26: Valli del Sol's Priority Vector and Consistency Ratio

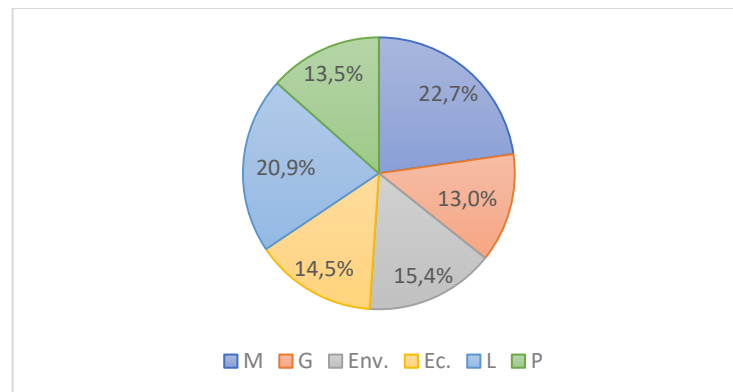


Figure 15: Pie chart showing Valli del Sol's priority vector

It can be noted that the Consistency Ratio CR is slightly greater than 10%: the priority vector cannot be considered a good approximation of the weight system; in fact, Saaty recommends to revise the subjective judgement. Following this procedure would have required an additional interview with the partners: this can be an objective for the future activities of “SmartVillages”.

As can be seen in Table 27, the final category self-assessed by the partner interviewed is:

CATEGORY C: medium level of smartness or work in progress level

Mobility and Living are the two main smart dimensions according to the partners interviewed and these are the dimensions in which the category C is registered. Meanwhile, Environment obtains the highest level of smartness and it is considered quite important; Governance, Economy and People are classified with a good level of smartness, but they are not considered so relevant from the weight system point of view. It is obvious that the category of the dimensions that were weighted the most have influenced the final category.

VALLI DEL SOL									
	Dimensions	Indicators	Answer to the survey	Level of certainty	Total score	Weights		Dimension λ -cutting level	DIMENSION CATEGORY
1	Smart Mobility	Offer of public transport	3	1	7	22,73	5,68	15,91	C
2		Sharing Mobility	2	2	5		5,68		
3		Integrated transport platform	2	1	4		5,68		
4		Multimodal transport Infrastructure	1	1	1		5,68		
5	Smart Governance	E-Government administrative and fiscal services	4	1	10	12,98	3,25	9,09	B
6		Participation events organised by PA	3	2	8		3,25		
7		Partnerships between PA and Private	2	2	5		3,25		
8		PA ways to communicate with citizens	4	3	12		3,25		
9	Smart Economy	Tourist-dedicated apps/platforms	3	3	7	14,50	3,62	10,15	B
10		Approaches used in the touristic filed	2	3	6		3,62		
11		Tourism impact on environment	3	3	9		3,62		
12		Innovative approaches in economic activities	4	3	9		3,62		
13	Smart Environment	Energy production from renewable resources	4	3	12	15,38	3,84	10,77	A
14		Energy consumption from renewable sources	4	1	10		3,84		
15		Zero waste economy	2	3	6		3,84		
16		Awareness of natural risks	4	2	11		3,84		
17	Smart Living	Level of health and social care	2	1	4	20,95	5,24	14,66	C
18		Coverage of internet connection	2	3	6		5,24		
19		Basic services to population	3	3	9		5,24		
20		Smart working	2	3	6		5,24		
21	Smart People	Depopulation and ageing	2	2	5	13,46	3,37	9,42	B
22		Digital literacy	3	3	9		3,37		
23		Citizen participation in meetings or assemblies of public interest	3	3	9		3,37		
24		Citizens associations or organizations	3	2	8		3,37		
FINAL CATEGORY:									
CATEGORY C									

Table 27: Valli del Sol Self-Assessment approach results

4.2.1.4 Pitztal, Austria

In terms of smart transition, Pitztal RSG’s attention is focused more on Smart Mobility.

The partner involved is Standortagentur Tirol and, during the interview, plenty of activities towards smart transitions were declared to be about to start, in fact numerous answers to the survey reveal a “work in progress” situations. The partner interviewed indicated their two main pilot activities: the first one regards Smart Mobility and it is a car-sharing service, the implementation of which will be one of the first examples in a mountainous area. The second one concerns Smart Economy and it is the development of a tourist-dedicated App.

Furthermore, as regards to the Smart Economy dimension, the partner has argued that, considering the low percentage of tourists in the area, it is more important to attract people than to ensure that tourism activities do not have a negative impact on the environment.

Concerning the Smart Living dimension, from the point of view of the basic services to the population, they tend to be more oriented towards tourists than to citizens and, in fact, a great percentage of the population uses online delivery services in order to avoid travelling long distances to reach a pharmacy or a supermarket.

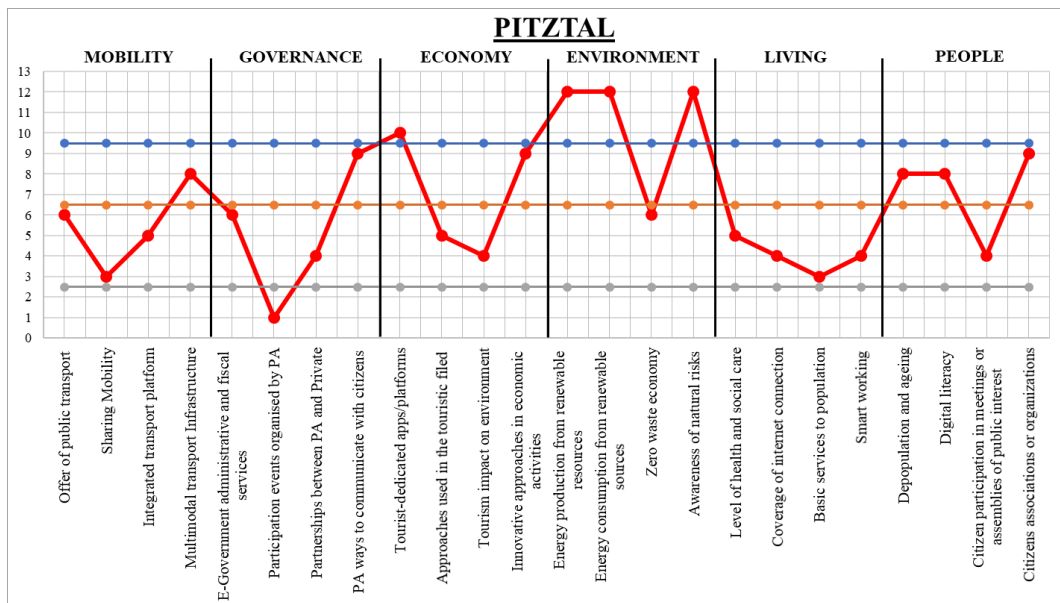


Figure 16: Pitztal results obtained from the answers to the survey

Figure 16 illustrates the result of the scores attributed by the partner interviewed to each indicator answering to the survey.

The following tables indicate the results obtained from the Dimensions' pairwise comparison, comprehensive of all the indices required to evaluate the consistency of the matrix, and the priority vector.

Pitztal	Mobility	Governance	Economy	Environment	Living	People
Mobility	1	3	1	2	3	1/2
Governance	1/3	1	1/2	2	2	1/2
Economy	1	2	1	2	3	1
Environment	1/2	1/2	1/2	1	1	1
Living	1/3	1/2	1/3	1	1	1/3
People	2	2	1	1	3	1

Table 28: Pitztal's Comparison Matrix

Mobility	22,2 %	λ max	6,31
Governance	12,9 %	n	6
Economy	22,1 %	CI	0,06
Environment	11,3 %	RI	1,25
Living	7,6 %	CR	4,93 %
People	23,8 %		

Table 29: Pitztal's Priority Vector and Consistency Ratio

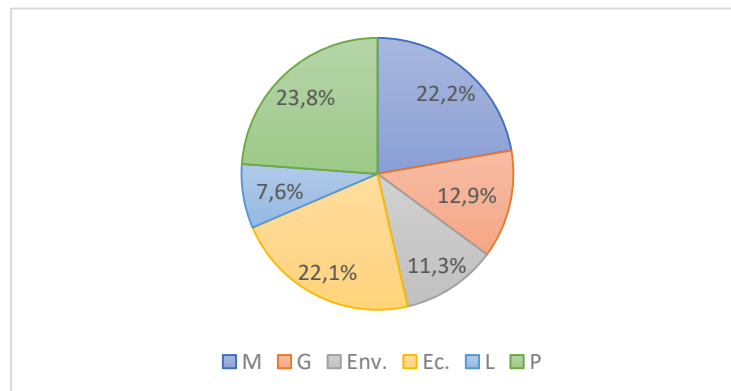


Figure 17: Pie chart showing Pitztal's priority vector

As can be seen in Table 30, the final category self-assessed by the interviewees is:

CATEGORY C: medium level of smartness or work in progress level

The self-assessment test for Pitztal scores category C in Mobility, Economy and People, that are weighted highly by the partner interviewed and consequently, they influence the final category of smartness assessed. Moreover, the medium level is also shown in Governance and Living, but these dimensions are not considered very important by the partner. Meanwhile, high scores are to be found in Environment, but this dimension is not important enough to change the final category.

Although Valli del Sol and Pitztal score the same final category C, the comprehensive voting power of criteria classified in category B as regards Valli del Sol is greater than Pitztal's. This means that Valli del Sol is much more oriented towards upgrading than Pitztal, see paragraph Sensitivity analysis 4.2.3 for more details.

PITZTAL									
	Dimensions	Indicators	Answer to the survey	Level of certainty	Total score	Weights		Dimension λ -cutting level	DIMENSION CATEGORY
1	Smart Mobility	Offer of public transport	2	3	6	22,25	5,56	15,57	C
2		Sharing Mobility	1	3	3		5,56		
3		Integrated transport platform	2	2	5		5,56		
4		Multimodal transport Infrastructure	2	3	8		5,56		
5	Smart Governance	E-Government administrative and fiscal services	2	3	6	12,86	3,22	9,00	C
6		Participation events organised by PA	1	1	1		3,22		
7		Partnerships between PA and Private	2	1	4		3,22		
8		PA ways to communicate with citizens	3	3	9		3,22		
9	Smart Economy	Tourist-dedicated apps/platforms	3	2	10	22,10	5,53	15,47	C
10		Approaches used in the touristic filed	3	2	5		5,53		
11		Tourism impact on environment	1	3	4		5,53		
12		Innovative approaches in economic activities	2	2	9		5,53		
13	Smart Environment	Energy production from renewable resources	4	3	12	11,32	2,83	7,93	A
14		Energy consumption from renewable sources	4	3	12		2,83		
15		Zero waste economy	2	3	6		2,83		
16		Awareness of natural risks	4	3	12		2,83		
17	Smart Living	Level of health and social care	2	2	5	7,63	1,91	5,34	C
18		Coverage of internet connection	2	1	4		1,91		
19		Basic services to population	1	3	3		1,91		
20		Smart working	2	1	4		1,91		
21	Smart People	Depopulation and ageing	3	2	8	23,84	5,96	16,69	B
22		Digital literacy	3	2	8		5,96		
23		Citizen participation in meetings or assemblies of public interest	2	1	4		5,96		
24		Citizens associations or organizations	3	3	9		5,96		
FINAL CATEGORY:									
CATEGORY C									

Table 30: Pitztal Self-assessment approach results

4.2.1.5 Bodensee, Germany

In terms of smart transition, Bodensee RSG's attention is focused more on Smart Mobility and on developing new strategies in the tourism sector.

The partner involved is Bodensee Standort Marketing GmbH and, during the interview, numerous initiatives, that can be considered as examples for the others, were illustrated.

Regarding Smart Mobility, although the offer of public transport is sometimes inadequate, there are plenty of smart services available especially among bike sharing and there are also two projects about autonomous driving.

Furthermore, considering the Smart Economy dimension, a "360° experience" offers all the age groups the opportunity to enjoy the Lake of Constance environment in a smart way: E-bike service customized for elderly people is available and a bike trail all around the lake is planned. It is worth stressing that the area seems to be only dedicated to tourism: the great average of GDP is thanks to other productive sectors which use new and innovative approaches.

As regards the Smart Living dimension, thanks to the good internet connection in Constance, some enterprises are starting to allow smart working. Conversely, seven years ago the implementation of high-speed connection was denied in the whole area because of financial problems, so the coverage of internet connection remains very good only in Constance.

Finally, concerning the Smart People dimension, there are lot of projects and plans to foster digital literacy among citizens and to increase the percentage of E-government services users.

Figure 18 illustrates the result of the scores attributed by the partner interviewed to each indicator answering to the survey.

Meanwhile, Table 31 and Table 32 indicate the results obtained from the Dimensions' pairwise comparison, comprehensive of all the indices required to evaluate the consistency of the matrix, and the priority vector.

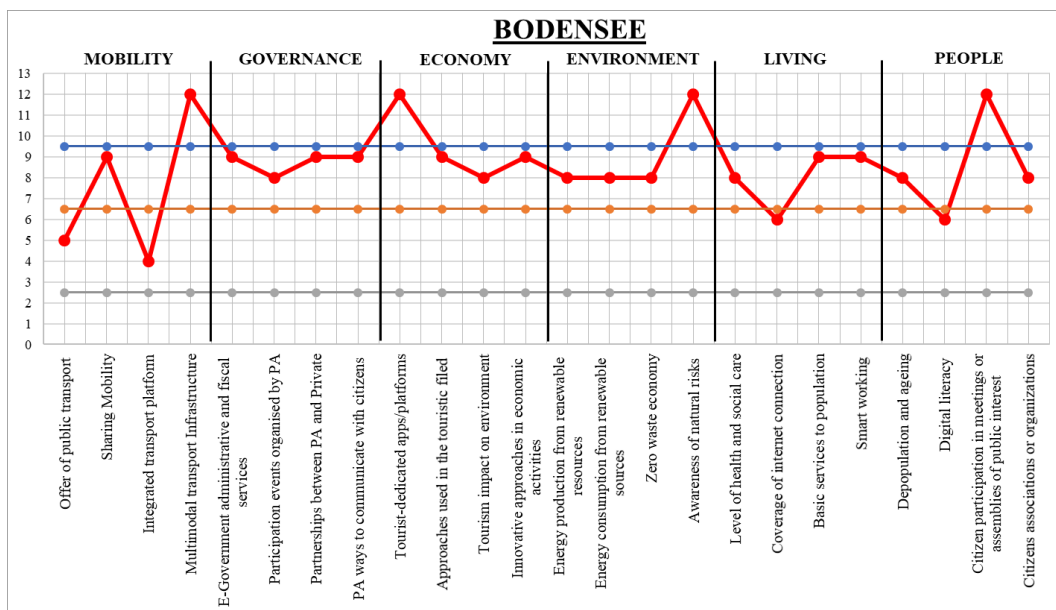


Figure 18: Bodensee results obtained from the answers to the survey

Bodensee	Mobility	Governance	Economy	Environment	Living	People
Mobility	1	3	1	1	2	2
Governance	1/3	1	1/2	1/2	1	1
Economy	1	2	1	1	2	1
Environment	1	2	1	1	2	1
Living	1/2	1	1/2	1/2	1	2
People	1/2	1	1	1	1/2	1

Table 31: Bodensee's Comparison Matrix

Mobility	24,5 %
Governance	10,6 %
Economy	19,6 %
Environment	19,6 %
Living	13,5 %
People	12,2 %

λ max	6,21
n	6
CI	0,04
RI	1,25
CR	3,41 %

Table 32: Bodensee's Priority Vector and Consistency Ratio

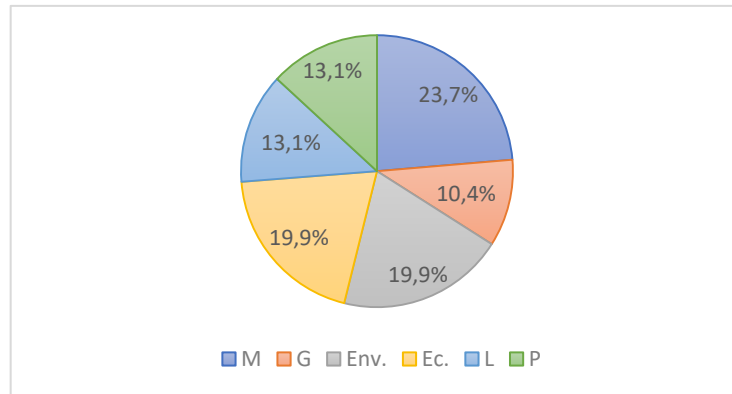


Figure 19: Pie chart showing Bodensee's priority vector

As can be seen in Table 33, the final category self-assessed by the interviewees is:

CATEGORY B: good level of smartness or satisfactory level

Mobility, Economy and Environment represent the three main smart dimensions for the partner interviewed and except from Mobility, all register the category B influencing also the final category. Meanwhile, Mobility obtained a category C but this not affects the final result considering that overall the level is quite high.

BODENSEE									
	Dimensions	Indicators	Answer to the survey	Level of certainty	Total score	Weights		Dimension λ -cutting level	DIMENSION CATEGORY
1	Smart Mobility	Offer of public transport	2	2	5	23,65	5,91	16,56	C
2		Sharing Mobility	3	3	9		5,91		
3		Integrated transport platform	2	1	4		5,91		
4		Multimodal transport Infrastructure	3	3	12		5,91		
5	Smart Governance	E-Government administrative and fiscal services	3	3	9	10,36	2,59	7,25	B
6		Participation events organised by PA	3	2	8		2,59		
7		Partnerships between PA and Private	3	3	9		2,59		
8		PA ways to communicate with citizens	3	3	9		2,59		
9	Smart Economy	Tourist-dedicated apps/platforms	3	3	12	19,87	4,97	13,91	B
10		Approaches used in the touristic filed	3	3	9		4,97		
11		Tourism impact on environment	3	2	8		4,97		
12		Innovative approaches in economic activities	3	3	9		4,97		
13	Smart Environment	Energy production from renewable resources	3	2	8	19,87	4,97	13,91	B
14		Energy consumption from renewable sources	3	2	8		4,97		
15		Zero waste economy	3	2	8		4,97		
16		Awareness of natural risks	4	3	12		4,97		
17	Smart Living	Level of health and social care	3	2	8	13,11	3,28	9,18	B
18		Coverage of internet connection	2	3	6		3,28		
19		Basic services to population	3	3	9		3,28		
20		Smart working	3	3	9		3,28		
21	Smart People	Depopulation and ageing	3	2	8	13,14	3,28	9,20	B
22		Digital literacy	3	3	6		3,28		
23		Citizen participation in meetings or assemblies of public interest	4	3	12		3,28		
24		Citizens associations or organizations	3	2	8		3,28		
FINAL CATEGORY:									
CATEGORY B									

Table 33: Bodensee Self-assessment approach results

4.2.1.6 Pomurje, Slovenia

In terms of smart transition, Pomurje RSG's attention is focused more on Smart Economy, in particular on smart farming and sustainable agriculture.

The partner involved is the University of Maribor.

From the Smart Mobility point of view, it is noteworthy that they illustrate inadequate situations from the public transports offer to the infrastructures and from sharing mobility to the integrated traffic platform. However, in their opinion, mobility is not fundamental in their smart transition process, in fact as it is shown below, this dimension scored a very low weight in the Dimensions' pairwise comparisons.

Conversely, concerning the Smart Economy dimension, they reveal a strong interest in developing innovative solutions for tourists (in fact an App focused on traditional cuisine is already available) as well as in the agricultural sector, in particular on the smart farming issue.

Regarding the Smart Environment dimension, as in the vast majority of the TA selected, the awareness of natural risks is very high. In fact, the area produces energy from solar and biomass sources and a national core system manages all the energy produced from RES: it is mandatory to share your energy production with the rest of Slovenia.

With respect to the Smart Living dimension, in particular from the point of view of basic services to population, the area is not very well furnished, but it is possible to benefit from the advantages of a very high coverage of internet connection: compared to the others TA, the area is on a plain, so it is easier to connect all the settlements and to guarantee access to it. Thanks to this fact, the opportunity of smart working is already available.

Figure 20 illustrates the result of the scores attributed by the partner interviewed to each indicator answering to the survey.

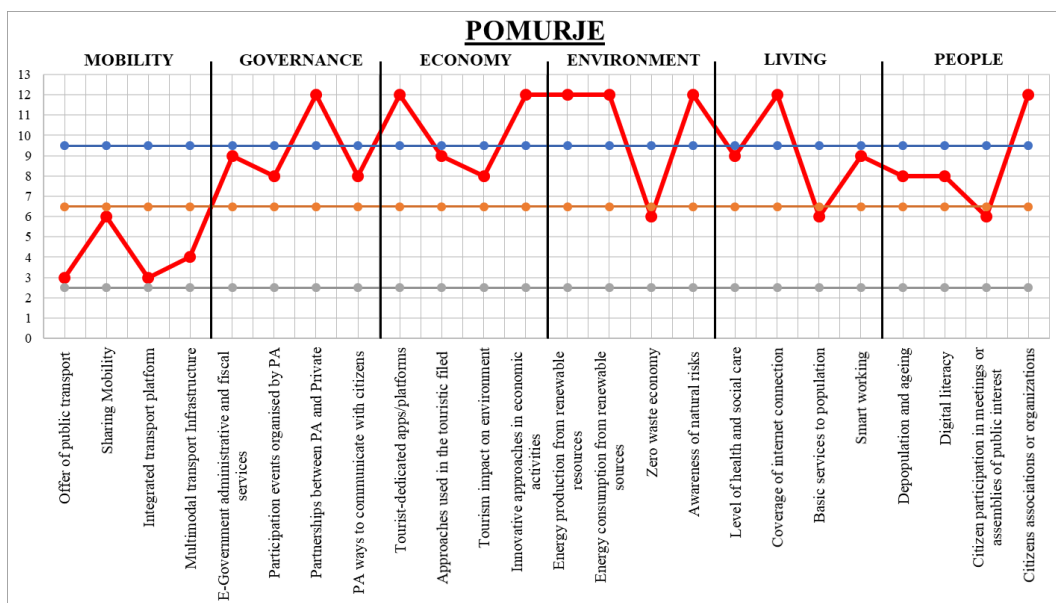


Figure 20: Pomurje results obtained from the answers to the survey

The following tables indicate the results obtained from the Dimensions' pairwise comparison, comprehensive of all the indices required to evaluate the consistency of the matrix, and the priority vector.

Pomurje	Mobility	Governance	Economy	Environment	Living	People
Mobility	1	1/2	1/3	1/3	1/3	1/2
Governance	2	1	1/3	1/2	1/2	1
Economy	3	3	1	1	1	1
Environment	3	2	1	1	2	2
Living	3	2	1	1/2	1	1
People	2	1	1	1/2	1	1

Table 34: Pomurje's Comparison Matrix

Mobility	6,9 %	λ max	6,14
Governance	11,4 %	n	6
Economy	22,2 %	CI	0,03
Environment	25,9 %	RI	1,25
Living	18,3 %	CR	2,25 %
People	15,3 %		

Table 35: Pomurje's Priority Vector and Consistency Ratio

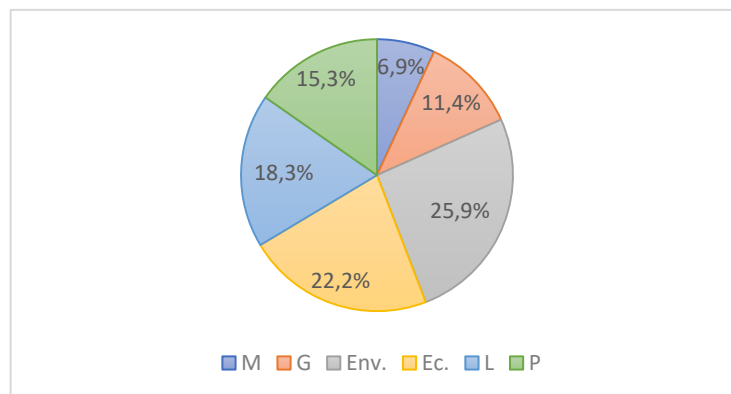


Figure 21: Pie chart showing Pomurje's priority vector

As can be seen in Table 36, the final category self-assessed by the interviewees is:

CATEGORY B: good level of smartness or satisfactory level

Interestingly, Pomurje self-assesses consistently highly in the two dimensions that are considered the most important by the partners interviewed: Economy and Environment; in particular, Environment shows the category A. Meanwhile, in terms of smart Mobility, the TA scores category C: however, this dimension seems to be of very little importance according to the interviewees. It is noteworthy that the final category perfectly reflects the classification obtained within each dimension.

Although Bodensee and Pomurje score the same final category B, the comprehensive voting power of criteria classified in category B as regards Bodensee is greater than Pomurje's. This means that a slightly increase of the λ -cutting level value would lead Pomurje to score category C, see paragraph 4.2.3 for more detail.

POMURJE									
	Dimensions	Indicators	Answer to the survey	Level of certainty	Total score	Weights		Dimension λ -cutting level	DIMENSION CATEGORY
1	Smart Mobility	Offer of public transport	1	3	3	6,90	1,73	4,83	C
2		Sharing Mobility	2	3	6		1,73		
3		Integrated transport platform	1	3	3		1,73		
4		Multimodal transport Infrastructure	1	3	4		1,73		
5	Smart Governance	E-Government administrative and fiscal services	3	3	9	11,40	2,85	7,98	B
6		Participation events organised by PA	3	2	8		2,85		
7		Partnerships between PA and Private	4	3	12		2,85		
8		PA ways to communicate with citizens	3	2	8		2,85		
9	Smart Economy	Tourist-dedicated apps/platforms	3	3	12	22,25	5,56	15,57	B
10		Approaches used in the touristic filed	3	3	9		5,56		
11		Tourism impact on environment	2	3	8		5,56		
12		Innovative approaches in economic activities	2	3	12		5,56		
13	Smart Environment	Energy production from renewable resources	4	3	12	25,86	6,47	18,10	A
14		Energy consumption from renewable sources	4	3	12		6,47		
15		Zero waste economy	2	3	6		6,47		
16		Awareness of natural risks	4	3	12		6,47		
17	Smart Living	Level of health and social care	3	3	9	18,28	4,57	12,80	B
18		Coverage of internet connection	4	3	12		4,57		
19		Basic services to population	2	3	6		4,57		
20		Smart working	3	3	9		4,57		
21	Smart People	Depopulation and ageing	3	2	8	15,30	3,83	10,71	B
22		Digital literacy	3	2	8		3,83		
23		Citizen participation in meetings or assemblies of public interest	2	3	6		3,83		
24		Citizens associations or organizations	4	3	12		3,83		
FINAL CATEGORY:									
CATEGORY B									

Table 36: Pomurje Self-assessment approach results

4.2.1.7 Luzern West, Switzerland

In terms of smart transition, Luzern West RSG's attention is focused more on digitalisation and Smart People, in particular on participation of citizens during meetings and events.

The partner involved is Luzern West and, from the beginning of the interview, a great interest was demonstrated, to the point of asking to implement the survey in their website in order to provide citizens with the opportunity to compile it.

From the Smart Mobility point of view, the offer of public transport is considered adequate but a development is needed in order not to lose some vital services. In addition, there is a sort of official car-sharing service supported by the Government and it could be of inspiration for the other TA interested in developing this type of service. There is a very effective integrated traffic platform both for consultation and buying tickets for the different means of transports as well as the presence of a multimodal transport infrastructure involving train and busses.

Concerning the Smart Economy dimension, innovative approaches are starting to appear in the tourist sector, but they are already available in the forestry sector and among SMEs.

It is noticeable that, although the coverage of internet connection is low, some people work from home and some co-working spaces are planned to be built.

Figure 22 illustrates the result of the scores attributed by the partner interviewed to each indicator answering to the survey.

Table 37 and Table 38 indicate the results obtained from the Dimensions' pairwise comparison, comprehensive of all the indices required to evaluate the consistency of the matrix, and the priority vector.

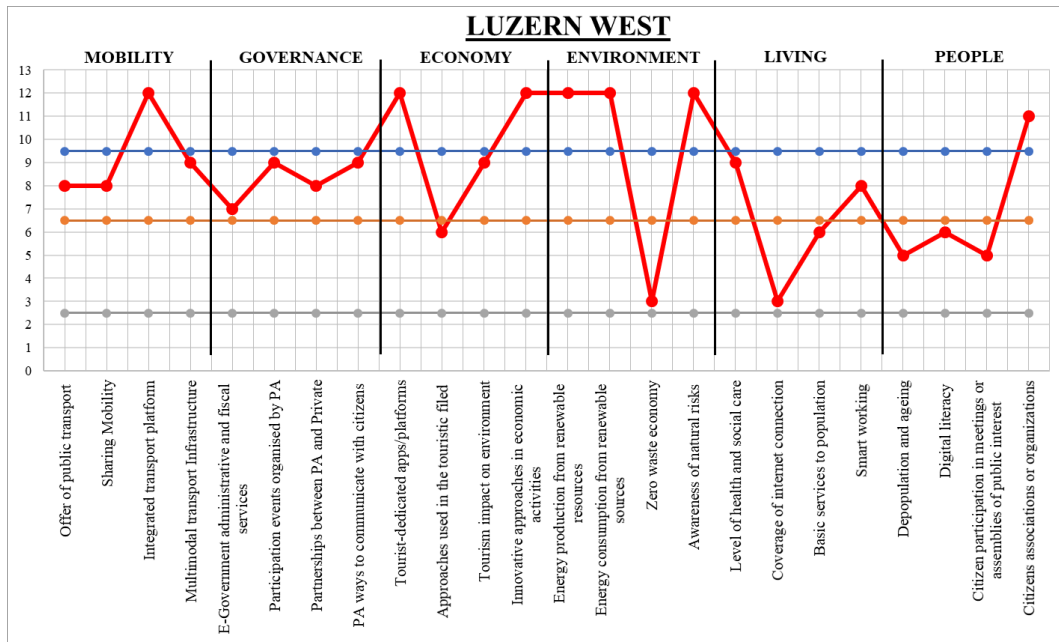


Figure 22: Luzern West results obtained from the answers to the survey

Luzern West	Mobility	Governance	Economy	Environment	Living	People
Mobility	1	1	1/3	1/3	1/5	1/5
Governance	1	1	1/3	1/3	1/3	1/43
Economy	3	3	1	1	1	1/2
Environment	3	3	1	1	1/2	1/3
Living	5	3	2	1	1	1
People	5	4	3	2	1	1

Table 37: Luzern West's Comparison Matrix

Mobility	5,5 %	λ max	6,10
Governance	6,3 %	n	6
Economy	14,9 %	CI	0,02
Environment	17,7 %	RI	1,25
Living	24,5 %	CR	1,64 %
People	30,9 %		

Table 38: Luzern West's Priority Vector and Consistency Ratio

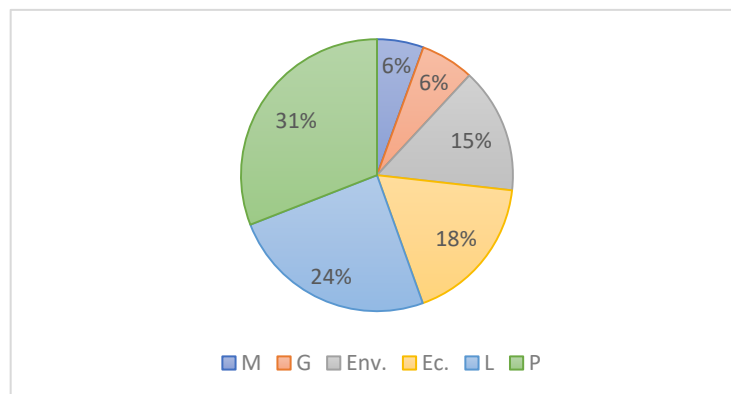


Figure 23: Pie chart showing Luzern West's priority vector

As can be seen in Table 39, the final category self-assessed by the interviewees is:

CATEGORY C: medium level of smartness or work in progress level

Very interestingly, according to the self-assessment of the partner interviewed, Luzern West scores more negatively in the two dimensions that are considered most important, Living and People. As can be seen in the table, another important dimension is Economy which is classified in the category B, while Environment registers the category A. However, these scores are not enough to change the final category which perfectly reflects the situation among the main dimensions. In addition, Governance and Mobility shows a quite high level, but they are not self-assessed as crucial at the moment and, in fact, their weights are the lowest.

LUZERN WEST									
	Dimensions	Indicators	Answer to the survey	Level of certainty	Total score	Weights		Dimension λ -cutting level	DIMENSION CATEGORY
1	Smart Mobility	Offer of public transport	3	2	8	5,55	1,39	3,88	B
2		Sharing Mobility	3	2	8		1,39		
3		Integrated transport platform	4	3	12		1,39		
4		Multimodal transport Infrastructure	3	3	9		1,39		
5	Smart Governance	E-Government administrative and fiscal services	3	1	7	6,34	1,58	4,44	B
6		Participation events organised by PA	3	3	9		1,58		
7		Partnerships between PA and Private	3	2	8		1,58		
8		PA ways to communicate with citizens	3	3	9		1,58		
9	Smart Economy	Tourist-dedicated apps/platforms	4	3	12	17,75	4,44	12,42	B
10		Approaches used in the touristic filed	2	3	6		4,44		
11		Tourism impact on environment	3	3	9		4,44		
12		Innovative approaches in economic activities	4	3	12		4,44		
13	Smart Environment	Energy production from renewable resources	4	3	12	14,89	3,72	10,43	A
14		Energy consumption from renewable sources	4	3	12		3,72		
15		Zero waste economy	1	3	3		3,72		
16		Awareness of natural risks	4	3	12		3,72		
17	Smart Living	Level of health and social care	3	3	9	24,54	6,14	17,18	C
18		Coverage of internet connection	1	3	3		6,14		
19		Basic services to population	2	3	6		6,14		
20		Smart working	3	2	8		6,14		
21	Smart People	Depopulation and ageing	2	2	5	30,93	7,73	21,65	C
22		Digital literacy	2	3	6		7,73		
23		Citizen participation in meetings or assemblies of public interest	2	2	5		7,73		
24		Citizens associations or organizations	4	2	11		7,73		
FINAL CATEGORY:									
CATEGORY C									

Table 39: Luzern West Self-assessment approach results

4.2.1.8 Tolmezzo, Italy

In terms of smart transition, in Tolmezzo the attention is focused more on digitalisation and on Smart Economy, in particular on increasing the presence of innovative approaches in tourism.

The interviewee is the town councillor with responsibilities for cultural and tourist matters, innovation, youth policies and digital agenda. During the interview the dimensions' pairwise comparisons as well as the indicators' pairwise comparisons were submitted: this procedure helped the definition of the weight system of indicators. In addition, the indicators' weights provided with this specific case study are used to identify the indicators on which to establish the veto thresholds considered in the expert-based assessment approach.

Concerning Smart Mobility, it is noticeable that the interviewee illustrated the idea to design a bike sharing service in order to improve the mobility within the town, in particular to facilitate the people arriving at the bus station in reaching the most important facilities.

Furthermore, as regards the Smart Living dimension, the creation of a co-working space in which smart working will be possible is planned: this project could change the habits of a great quantity of workers currently commuting.

Figure 24 illustrates the result of the scores attributed by the interviewee to each indicator answering to the survey.

Table 40 and Table 41 indicate the results obtained from the Dimensions' pairwise comparison, comprehensive of all the indices required to evaluate the consistency of the matrix, while from Table 43 to Table 53 the results obtained from the Indicators' pairwise comparison, and the corresponding priority vectors, are shown. In each of these tables, the first indicator regarding that precise dimension is indicated with number one, the second with number two and so on.

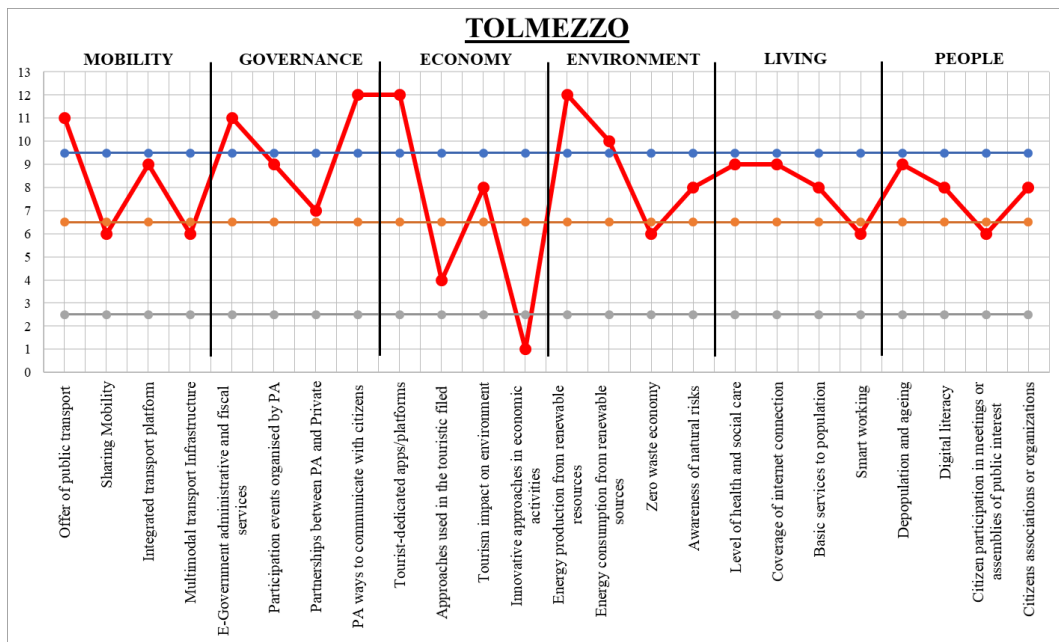


Figure 24: Tolmezzo results obtained from the answers to the survey

Tolmezzo	Mobility	Governance	Economy	Environment	Living	People
Mobility	1	1/4	1/5	1/4	1/5	1/2
Governance	4	1	1	2	2	5
Economy	5	1	1	2	3	4
Environment	4	1/2	1/2	1	1	2
Living	5	1/2	1	1/3	1	3
People	2	1/5	1/4	1/2	1/3	1

Table 40: Tolmezzo's Comparison Matrix

Mobility	4,5 %	λ max	6,15
Governance	27,9 %	n	6
Economy	30,1 %	CI	0,03
Environment	14,9 %	RI	1,25
Living	15,9 %	CR	2,36 %
People	6,8 %		

Table 41: Tolmezzo's Priority Vector and Consistency Ratio

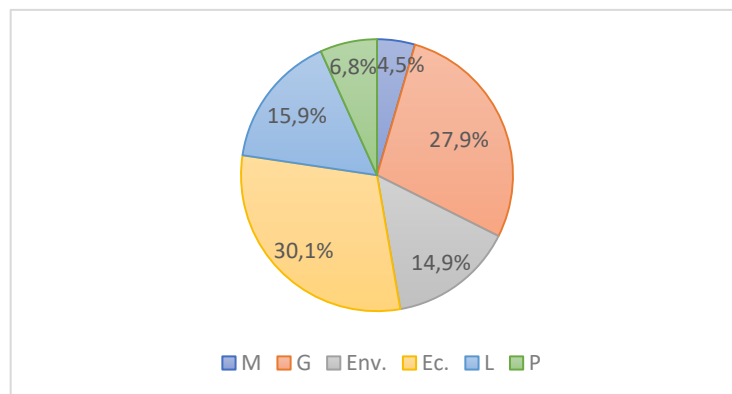


Figure 25: Pie chart showing Tolmezzo's priority vector

Tolmezzo	1	2	3	4
1	1	4	1	2
2	1/4	1	1/3	1/4
3	1	3	1	1/2
4	1/2	4	2	1

Table 42: Tolmezzo's Comparison Matrix regarding Mobility

1	37,1 %	λ max	4,17
2	7,9 %	n	4
3	24,0 %	CI	0,06
4	31,0 %	RI	0,90
		CR	6,33 %

Table 43: Tolmezzo's Priority Vector and Consistency Ratio regarding Mobility

Tolmezzo	1	2	3	4
1	1	2	3	1/3
2	1/2	1	1/2	1/3
3	1/3	2	1	1/2
4	3	3	2	1

Table 44: Tolmezzo's Comparison Matrix regarding Governance

1	26,8 %
2	11,3 %
3	16,6 %
4	45,3 %

λ max	4,26
n	4
CI	0,09
RI	0,90
CR	9,66 %

Table 45: Tolmezzo's Priority Vector and Consistency Ratio regarding Governance

Tolmezzo	1	2	3	4
1	1	1/2	1/2	2
2	2	1	2	3
3	2	1/2	1	1
4	1/2	1/3	1	1

Table 46: Tolmezzo's Comparison Matrix regarding Economy

1	19,7 %
2	41,6 %
3	23,7 %
4	15,0 %

λ max	4,17
n	4
CI	0,06
RI	0,90
CR	6,32 %

Table 47: Tolmezzo's Priority Vector and Consistency Ratio regarding Economy

Tolmezzo	1	2	3	4
1	1	1/3	1/3	2
2	3	1	1	2
3	3	1	1	2
4	1/2	1/2	1/2	1

Table 48: Tolmezzo's Comparison Matrix regarding Environment

1	16,1 %
2	35,1 %
3	35,1 %
4	13,7 %

λ max	4,15
n	4
CI	0,05
RI	0,90
CR	5,72 %

Table 49: Tolmezzo's Priority Vector and Consistency Ratio regarding Environment

Tolmezzo	1	2	3	4
1	1	3	3	3
2	1/3	1	1/2	4
3	1/3	2	1	5
4	1/3	1/4	1/5	1

Table 50: Tolmezzo's Comparison Matrix regarding Living

1	47,3 %
2	18,0 %
3	27,0 %
4	7,7 %

λ max	4,34
n	4
CI	0,11
RI	0,90
CR	12,60 %

Table 51: Tolmezzo's Priority Vector and Consistency Ratio regarding Living

Tolmezzo	1	2	3	4
1	1	1/4	1/3	1/2
2	4	1	1	1
3	3	1	1	1
4	2	1	1	1

Table 52: Tolmezzo's Comparison Matrix regarding People

1	10,4 %	λ max	4,05
2	32,44 %	n	4
3	29,86 %	CI	0,02
4	27,29 %	RI	0,90
		CR	1,70 %

Table 53: Tolmezzo's Priority Vector and Consistency Ratio regarding People

It can be noted from Table 51 that the Consistency Ratio CR is slightly greater than 10%: the priority vector cannot be considered a good approximation of the weight system; in fact, Saaty recommends to revise the subjective judgement. Following this procedure would have required an additional interview: this can be an objective for the future activities of “SmartVillages”.

As can be seen in Table 54, the final category self-assessed by the interviewees is:

CATEGORY B: good level of smartness or satisfactory level

Economy and Governance are self-assessed as the most important dimensions for Tolmezzo: the area is perceived to score category C in Economy, whereas it is fairly highly rated in Governance registering category A. Furthermore, the third dimension according to the weights system is Living which scores category B: these result directly influence the final category. Mobility and People register category C: however, this dimension seems to be of very little importance according to the interviewee.

TOLMEZZO									
	Dimensions	Indicators	Answer to the survey	Level of certainty	Total score	Weights		Dimension λ -cutting level	DIMENSION CATEGORY
1	Smart Mobility	Offer of public transport	4	2	11	4,52	1,68	3,16	C
2		Sharing Mobility	4	3	6		0,36		
3		Integrated transport platform	3	3	9		1,09		
4		Multimodal transport Infrastructure	2	2	6		1,40		
5	Smart Governance	E-Government administrative and fiscal services	4	2	11	27,88	7,48	19,51	A
6		Participation events organised by PA	3	3	9		3,15		
7		Partnerships between PA and Private	3	1	7		4,63		
8		PA ways to communicate with citizens	4	3	12		12,62		
9	Smart Economy	Tourist-dedicated apps/platforms	3	3	12	30,09	5,94	21,07	C
10		Approaches used in the touristic filed	2	1	4		12,51		
11		Tourism impact on environment	3	2	8		7,14		
12		Innovative approaches in economic activities	1	1	1		4,50		
13	Smart Environment	Energy production from renewable resources	4	3	12	14,86	2,39	10,40	C
14		Energy consumption from renewable sources	4	1	10		5,22		
15		Zero waste economy	2	3	6		5,22		
16		Awareness of natural risks	3	2	8		2,03		
17	Smart Living	Level of health and social care	3	3	9	15,88	7,51	11,12	B
18		Coverage of internet connection	3	3	9		2,86		
19		Basic services to population	3	2	8		4,29		
20		Smart working	2	3	6		1,22		
21	Smart People	Depopulation and ageing	3	3	9	6,77	0,70	4,74	B
22		Digital literacy	3	2	8		2,20		
23		Citizen participation in meetings or assemblies of public interest	2	3	6		2,02		
24		Citizens associations or organizations	3	2	8		1,85		
FINAL CATEGORY:									
CATEGORY B									

Table 54: Tolmezzo Self-assessment approach results

4.2.2 Expert-based assessment approach

I directly interviewed four experts whose technical backgrounds can be associated to the six Smart Dimensions and, working alongside them, the veto thresholds were identified. It is worth highlighting that, with this approach, there is only one weight system for all the selected TA and the answers to the survey implemented in the model are the same of those used in the self-assessment approach.

The expert-based assessment approach aims to evaluate the smartness level from an outside perspective and to provide results using the same assumptions (profiles, relative scale of preference, weight system, λ -cutting level and veto thresholds) for all the selected TA. Therefore, the TA differentiates only in terms of their answers to the survey.

4.2.2.1 Weight system

The definition of the weight system follows the same procedure adopted for the self-assessment approach: for each expert, the Comparison Matrix and its corresponding priority vector were obtained by using the “eigenvector method”. Therefore, there were four different weight system, one for each expert. In order to define only one weight system to implement in the model, it was necessary to compute a weighted average of the weight systems of the four interviewees considering their expertise. To take into account the expert’ technical background, different values from 1 to 2,5 were assigned to each Smart Dimension ensuring that their sum was 10. The experts, with the corresponding values assigned to consider their expertise, are presented in the following tables:

Expert 1	
Mobility	1,50
Governance	2,00
Economy	1,50
Environment	2,50
Living	1,50
People	1,00

Table 55: Expert 1 and values from 1 to 2,5 assigned to each Smart Dimension

Expert 2	
Mobility	2,50
Governance	1,50
Economy	1,50
Environment	2,00
Living	1,50
People	1,00

Table 56: Expert 2 and values from 1 to 2,5 assigned to each Smart Dimension

Expert 3	
Mobility	2,50
Governance	2,00
Economy	1,50
Environment	1,50
Living	1,50
People	1,00

Table 57: Expert 3 and values from 1 to 2,5 assigned to each Smart Dimension

Expert 4	
Mobility	2,50
Governance	1,50
Economy	1,50
Environment	2,00
Living	1,50
People	1,00

Table 58: Expert 4 and values from 1 to 2,5 assigned to each Smart Dimension

As can be seen in the tables, the second and the fourth expert possess the same distribution of values: their technical background is mainly focus on Mobility and Environment. Meanwhile, the first expert shows the highest value in Environment, immediately followed by Governance; whereas expert 3 is considered more informed about Mobility and Environment. Smart Economy, Smart Living and Smart People have the same value for each expert. This indicates that they are not significant in the definition of experts' specific profiles.

The tables below illustrate, for each expert, the results obtained from each Dimensions' pairwise comparisons, comprehensive of all the indices required to evaluate the consistency of the matrix, and the priority vector. At the end of the paragraph, the weight system used in the model is provided.

Expert 1	Mobility	Governance	Economy	Environment	Living	People
Mobility	1	1/3	1/3	1/2	1/3	1
Governance	3	1	1/2	1	1	3
Economy	3	2	1	1	2	3
Environment	2	1	1	1	1/2	3
Living	3	1	1/2	2	1	3
People	1	1/3	1/3	1/3	1/3	1

Table 59: Comparison Matrix of Expert 1

Mobility	7,45 %	λ max	6,17
Governance	18,67 %	n	6
Economy	27,42 %	CI	0,03
Environment	17,93 %	RI	1,25
Living	21,57 %	CR	2,67%
People	6,96 %		

Table 60: Priority vector and Consistency Ratio of Expert 1

Expert 2	Mobility	Governance	Economy	Environment	Living	People
Mobility	1	4	1	3	3	2
Governance	1/4	1	1/3	1/3	1/2	1/2
Economy	1	3	1	1/3	2	3
Environment	1/3	3	3	1	2	3
Living	1/3	2	1/2	1/2	1	3
People	1/2	2	1/3	1/3	1/3	1

Table 61: Comparison Matrix of Expert 2

Mobility	30,41 %	λ max	6,53
Governance	5,83 %	n	6
Economy	19,02 %	CI	0,11
Environment	24,22 %	RI	1,25
Living	12,31 %	CR	8,51 %
People	8,20 %		

Table 62: Priority vector and Consistency Ratio of Expert 2

Expert 3	Mobility	Governance	Economy	Environment	Living	People
Mobility	1	1/2	2	1	1/2	1/2
Governance	2	1	2	2	2	2
Economy	1/2	1/2	1	1/2	1/2	1/2
Environment	1	1/2	2	1	1/2	1/2
Living	2	1/2	2	2	1	1
People	2	1/2	2	2	1	1

Table 63: Comparison Matrix of Expert 3

Mobility	12,25 %	λ max	6,16
Governance	27,92%	n	6
Economy	12,25 %	CI	0,03
Environment	8,83 %	RI	1,25
Living	19,37 %	CR	2,60 %
People	19,37 %		

Table 64: Priority vector and Consistency Ratio of Expert 3

Expert 4	Mobility	Governance	Economy	Environment	Living	People
Mobility	1	3	2	4	2	1
Governance	1/3	1	1/2	1/2	1/2	3
Economy	1/2	2	1	1	1/2	2
Environment	1/4	2	1	1	3	3
Living	1/2	2	2	1/3	1	2
People	1	1/3	1/2	1/3	1/2	1

Table 65: Comparison Matrix of Expert 4

Mobility	30,49 %	λ max	6,90
Governance	10,74 %	n	6
Economy	14,11 %	CI	0,18
Environment	19,93 %	RI	1,25
Living	15,34 %	CR	14,34 %
People	9,41 %		

Table 66: Priority vector and Consistency Ratio of Expert 4

As can be seen in the Table 66 regarding Expert 4, the Consistency Ratio is slightly greater than 10%. According to Saaty, the priority vector cannot be a good approximation of the weight system and so, a revision of the subjective judgement is necessary. Following this procedure would have required an additional interview with this expert: as recommended for Valli del Sol self-assessment, this can be an issue for additional activities of “SmartVillages”.

The histogram below summarizes the four different weight systems obtained from each expert.

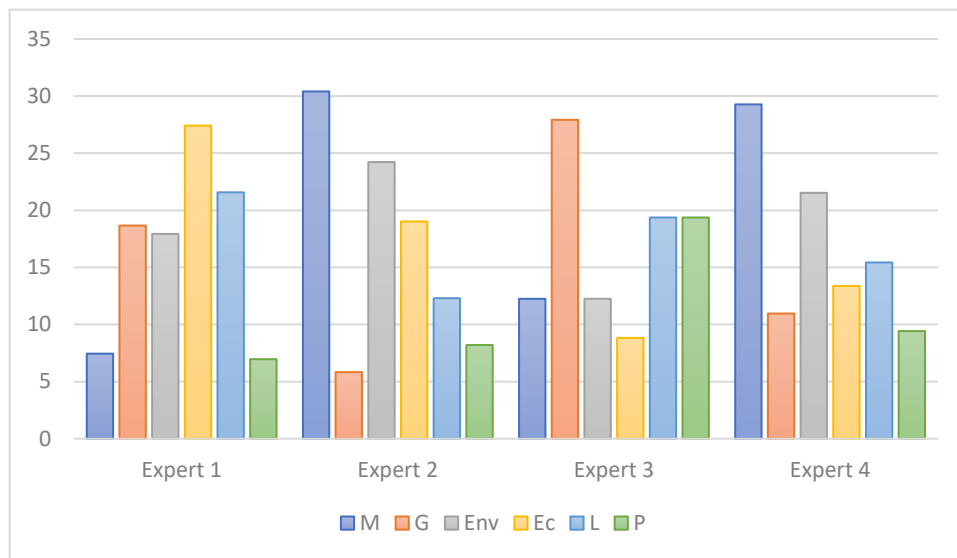


Figure 26: Experts' weight system

The weight system of expert 2 and 4 is similar: the reason could be that their technical background is similar. However, as regards expert 3, whose main interest is Mobility as the second and the fourth experts, the weight system is completely different: according to his point of view the main dimension is Governance, immediately followed by Living and People with equal score. Meanwhile, although expert 2 is more informed about Environment, his weight system reveals Economy as the main dimension.

As previously explained, these weight systems are combined considering the values assigned to each Smart Dimension as indicated from Table 55 to Table 58. The resulting weight system utilized in the expert-based assessment approach is the following:

Mobility	21,56 %
Governance	16,86 %
Economy	17,34 %
Environment	18,94 %
Living	17,15 %
People	10,99 %

Table 67: Weight system for the expert-based assessment approach

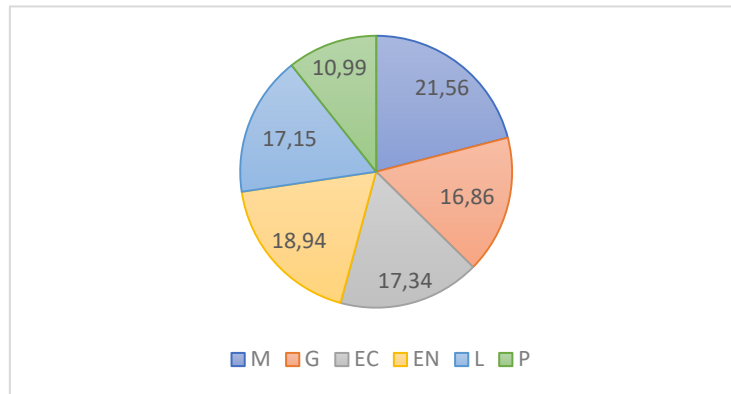


Figure 27: Pie chart showing the final weight system for the expert-based assessment approach

The main Smart Dimension is Smart Mobility, immediately followed by Smart Environment. Smart People is the dimension weighted the lowest when compared to the others. It is obvious that this result is influenced by the presence of two experts with both similar weight system and technical background; in fact, the dimensions that they weighted the most are the same of the final weight system.

4.2.2.2 ELECTRE TRI model

As explained at the end of the 4.2.1.7 paragraph, it was decided to consider the most important indicators, according to the comparison matrix obtained interviewing the Tolmezzo councillor, as a starting point to define the veto thresholds. The following go through each dimension providing the indicators considered the most important compared to the others of the same dimension.

- Smart Mobility: the indicator “offer of public transport” scores the highest weight, precisely 37%.
- Smart Governance: the indicator “Public Administration ways to communicate with citizens” scores the highest weight, precisely 45%.
- Smart Economy: the indicator “approaches used in tourist field” scores the highest weight, precisely 42%.
- Smart Environment: there are two indicators that score the highest weight of 35%: “energy consumption from renewable sources” and “zero waste economy”.
- Smart Living: the indicator “level of health and social care” scores the highest weight, precisely 47%.

- Smart People: the indicator “digital literacy” scores the highest weight, precisely 32%.

Working alongside the experts, it was established to identify only the indicators that count more than 40%, as a result the veto thresholds are fixed for: “approaches used in tourist field” (42%), “Public Administration ways to communicate with citizens” (45%) and “level of health and social care” (47%). Below, the explanation of the veto thresholds is provided:

- “PA ways to communicate with citizens” and “approaches used in the tourist field” possess the same veto: if it is not scored the level “smart but improvable” a downgrade to the immediately previous category is imposed.
- “level of health and social care” is considered a fundamental requirement and so the veto fixed is more restrictive: if it is not scored the level “medium” a downgrade to the lowest category is imposed.

It is worth noticing that the λ -cutting level values for each specific dimension, presented in the table below, are the same for all the TA because we are dealing with a unique weight system. Conversely, as regards to the self-assessment approach, the λ -cutting level values for each specific dimension differs across each TA because the weights system is itself different.

The λ -cutting level values are computed considering the 70 % of each dimension total weight. Therefore, the winning coalition of indicators required to be classified in that specific category is of three indicators indifferently from which they are, as it is with the self-assessment approach.

Mobility	15,09
Governance	11,80
Economy	12,14
Environment	13,26
Living	12,00
People	7,69

Table 68: Dimensions λ -cutting level

The following paragraphs illustrate the results performed by each selected TA with the expert-based assessment approach underlining, if necessary, the differences with respect to those obtained with the self-assessment approach previously discussed. In order to compare more easily the outcomes, the results performed with the self-assessment approach are repeated below. The final category shown in the following tables is without considering the veto threshold. The results obtained applying the veto thresholds are discussed at the end of each paragraph.

4.2.2.3 Valli del Sol, Italy

	Expert-based assessment approach			Self-assessment approach		
	Weights	Dimension λ -cutting level	Dimension final category	Weights	Dimension λ -cutting level	Dimension category
Mobility	21,56 %	15,09	C	22,73 %	15,91	C
Governance	16,86 %	11,80	B	12,98 %	9,09	B
Economy	17,34 %	12,14	B	14,50 %	10,15	B
Environment	18,94 %	13,26	A	15,38 %	10,77	A
Living	17,15 %	12,00	C	20,59 %	14,66	C
People	10,99 %	7,69	B	13,46 %	9,42	B
FINAL CATEGORY: CATEGORY C			FINAL CATEGORY: CATEGORY C			

Table 69: Valli del Sol results obtained with the expert-based assessment approach

Valli del Sol confirms the same situation obtained with the self-assessment approach. The reasons behind this result is covered by the similarity between the weights systems adopted in the two different approaches.

Considering the veto threshold, the veto regarding “innovative approaches used in the touristic field” is not satisfied and so the final category should be category D.

4.2.2.4 Pitztal, Austria

	Expert-based assessment approach			Self-assessment approach		
	Weights	Dimension λ -cutting level	Dimension final category	Weights	Dimension λ -cutting level	Dimension category
Mobility	21,56 %	15,09	C	22,25 %	15,57	C
Governance	16,86 %	11,80	C	12,86 %	9,00	C
Economy	17,34 %	12,14	C	22,10 %	15,47	C
Environment	18,94 %	13,26	A	11,32 %	7,93	A
Living	17,15 %	12,00	C	7,63 %	5,34	C
People	10,99 %	7,69	B	23,84 %	16,69	B
FINAL CATEGORY: CATEGORY C			FINAL CATEGORY: CATEGORY C			

Table 70: Pitztal results obtained with the Expert-based assessment approach

Pitztal confirms the same situation obtained with the self-assessment approach.

Considering the veto threshold, the veto regarding “innovative approaches used in the touristic field” is not satisfied and so the final category should be category D.

4.2.2.5 Bodensee, Germany

	Expert-based assessment approach			Self-assessment approach		
	Weights	Dimension λ -cutting level	Dimension final category	Weights	Dimension λ -cutting level	Dimension category
Mobility	21,56 %	15,09	C	23,65 %	16,56	C
Governance	16,86 %	11,80	B	10,36 %	7,25	B
Economy	17,34 %	12,14	B	19,87 %	13,91	B
Environment	18,94 %	13,26	B	19,87 %	13,91	B
Living	17,15 %	12,00	B	13,11 %	9,18	B
People	10,99 %	7,69	B	13,14 %	9,20	B
	FINAL CATEGORY: CATEGORY B			FINAL CATEGORY: CATEGORY B		

Table 71: Bodensee results obtained with the Expert-based assessment approach

Bodensee confirms the same situation obtained with the self-assessment approach. The reasons behind this result is covered by the similarity between the weights systems adopted in the two different approaches.

All the veto thresholds are satisfied.

4.2.2.6 Pomurje, Slovenia

	Expert-based assessment approach			Self-assessment approach		
	Weights	Dimension λ -cutting level	Dimension final category	Weights	Dimension λ -cutting level	Dimension category
Mobility	21,56 %	15,09	C	6,90 %	4,83	C
Governance	16,86 %	11,80	B	11,40 %	7,98	B
Economy	17,34 %	12,14	B	22,25 %	15,57	B
Environment	18,94 %	13,26	A	25,86 %	18,10	A
Living	17,15 %	12,00	B	18,28 %	12,80	B
People	10,99 %	7,69	B	15,30 %	10,71	B
	FINAL CATEGORY: CATEGORY C			FINAL CATEGORY: CATEGORY B		

Table 72: Pomurje results obtained with the Expert-based assessment approach

Pomurje does not confirm the category obtained with the self-assessment approach. The reasons behind this result is covered by the greatest Mobility's weight assigned by the experts with respect to that used in the self-assessment approach. Therefore, the final category obtained with the expert-based assessment approach is directly influenced by Mobility because it is the dimension weighted the most by the experts.

All the veto thresholds are satisfied.

4.2.2.7 Luzern West, Switzerland

	Expert-based assessment approach			Self-assessment approach		
	Weights	Dimension λ -cutting level	Dimension final category	Weights	Dimension λ -cutting level	Dimension category
Mobility	21,56 %	15,09	B	5,55 %	3,88	B
Governance	16,86 %	11,80	B	6,34 %	4,44	B
Economy	17,34 %	12,14	B	17,75 %	12,42	B
Environment	18,94 %	13,26	A	14,89 %	10,43	A
Living	17,15 %	12,00	C	24,54 %	17,18	C
People	10,99 %	7,69	C	30,93 %	21,65	C
FINAL CATEGORY: CATEGORY B			FINAL CATEGORY: CATEGORY C			

Table 73: Luzern West results obtained with the expert-based assessment approach

Luzern West does not confirm the category obtained with the self-assessment approach. In particular, Luzern West scores a higher category with the expert-based assessment approach because Living and People, that are weighted as the most important by the partners interviewed, are considered less significant by the experts. Therefore, the final category obtained with the expert-based assessment approach is directly influenced by the dimensions weighted the most by the experts, that are completely different with respect to the most important dimensions according to the partner interviewed.

Considering the veto threshold, the veto regarding “innovative approaches used in the touristic field” is not satisfied and so the final category should be category C.

4.2.2.8 Tolmezzo, Italy

	Expert-based assessment approach			Self-assessment approach		
	Weights	Dimension λ -cutting level	Dimension category	Weights	Dimension λ -cutting level	Dimension category
Mobility	21,56 %	15,09	C	4,52 %	3,16	C
Governance	16,86 %	11,80	B	27,88 %	19,51	A
Economy	17,34 %	12,14	C	30,09 %	21,07	C
Environment	18,94 %	13,26	B	14,86 %	10,40	C
Living	17,15 %	12,00	B	15,88 %	11,12	B
People	10,99 %	7,69	B	6,77 %	4,74	B
	FINAL CATEGORY: CATEGORY B			FINAL CATEGORY: CATEGORY B		

Table 74: Tolmezzo results obtained with the expert-based assessment results

Tolmezzo confirms the final category obtained with the self-assessment approach. It is worth highlighting that the dimension categories obtained with the expert-based assessment approach are different with respect to the self-assessment approach. The reason behind this outcome is that the Indicators' weight systems concerning the self-assessment approach is obtained submitting the Indicators' pairwise comparisons to the interviewee (see paragraph 4.2.1.8), therefore the winning coalitions are different.

All the veto thresholds are satisfied.

4.2.3 Sensitivity analysis

In order to evaluate the robustness of the results regarding the final category, a sensitivity analysis considering the λ -cutting level was performed.

One way to define sensitivity analysis is the following: the study of how uncertainty in the output of a model can be apportioned to different sources of uncertainty in the model input (Saltelli, et al. 2008). Sensitivity analysis can be seen as stability or behaviour of the solution to small changes in preferences occurred during the resolution process or to small changes in the values taken for the parameters (Munoz, Romana e Ordònez 2016). Mindful that the λ -cutting level is equal to 70, I decided to base the analysis on twelve values in a range of 35 to 90.

Below, for each selected TA, the sensitivity analysis' results are shown with both the self-assessment approach and the expert-based approach.

4.2.3.1 Valli del Sol, Italy

The sensitivity analysis to evaluate the robustness of results obtained with the self-assessment approach is presented: Table 75 displays an array of different λ -cutting level values and their corresponding final category. In addition, a graph showing the same results is presented.

λ -cutting level	35	40	45	50	55	60	65	70	75	80	85	90
Final category	B	B	B	B	C	C	C	C	C	C	C	C

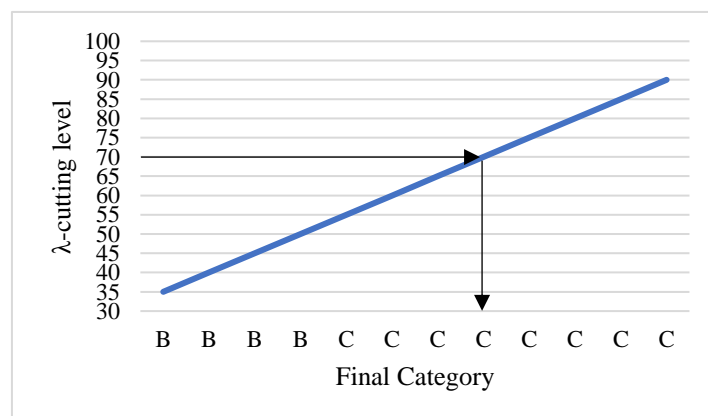


Table 75: Valli del Sol self-assessment approach' sensitivity analysis

It is obvious that with a less demanding λ -cutting level of 50, Valli del Sol would have scored a category B. Meanwhile, even considering a more restrictive value, the final category C is maintained.

As can be seen in Table 76, using the expert-based assessment approach a λ -cutting level of 55 is necessary to obtain the category B.

In conclusion, it is possible to observe that the category C scored by Valli del Sol is very influenced by the λ -cutting level value assumed. In fact, it is sufficient to slightly reduce it to register an upgrade.

λ -cutting level	35	40	45	50	55	60	65	70	75	80	85	90
Final category	B	B	B	B	B	C	C	C	C	C	C	C

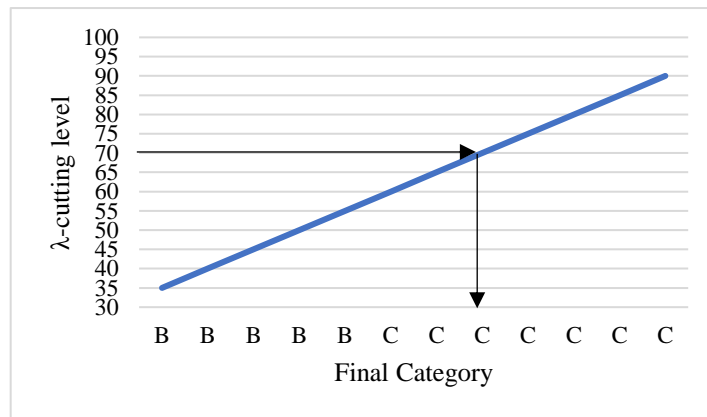


Table 76: Valli del Sol Expert-based assessment approach' sensitivity analysis

4.2.3.2 Pitztal, Austria

The sensitivity analysis to evaluate the robustness of results obtained with the self-assessment approach is presented: Table 77 displays an array of different λ -cutting level values and their corresponding final category. In addition, a graph showing the same results is presented.

λ -cutting level	35	40	45	50	55	60	65	70	75	80	85	90
Final category	B	B	C	C	C	C	C	C	C	C	C	C

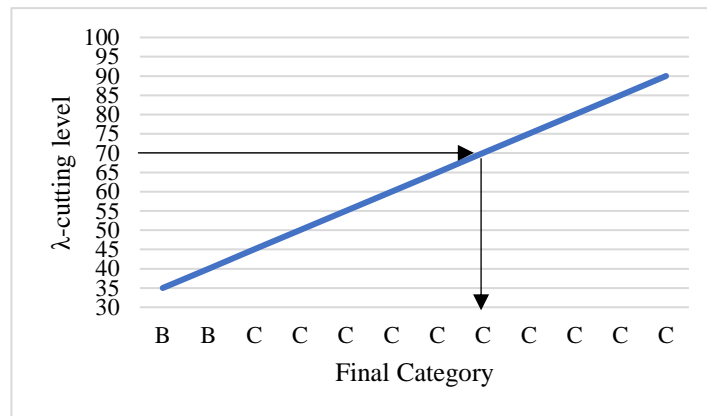


Table 77: Pitztal self-assessment approach' sensitivity analysis

It can be noted from Table 77 that Pitztal would have scored category B with a very low λ -cutting level value of 40 out 100. Meanwhile, even considering a more restrictive value category C is maintained.

λ -cutting level	35	40	45	50	55	60	65	70	75	80	85	90
Final category	B	C	C	C	C	C	C	C	C	C	C	C

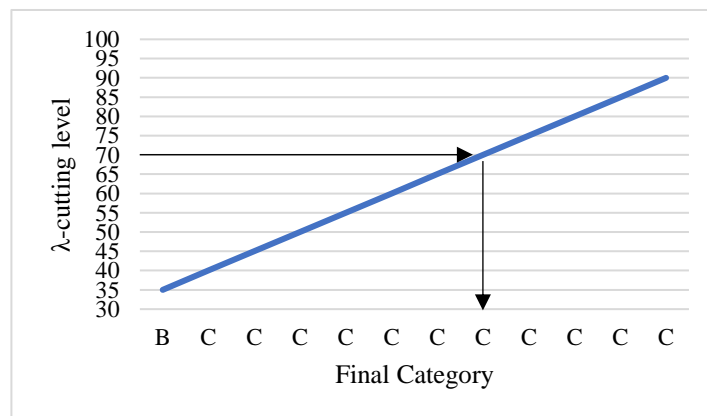


Table 78: Pitztal expert-based assessment approach' sensitivity analysis

As can be seen in Table 78, using the expert-based assessment approach, a λ -cutting level value of 35 is required to obtain category B.

In conclusion, it is possible to observe that the category C scored by Pitztal can be considered sufficiently stable with respect to the λ -cutting level value assumed. Pitztal scored category C as Valli del Sol, but the robustness of their results is completely different.

4.2.3.3 Bodensee, Germany

The sensitivity analysis to evaluate the robustness of results obtained with the self-assessment approach is presented: Table 79 displays an array of different λ -cutting level values and their corresponding final category. In addition, a graph showing the same results is presented.

λ -cutting level	35	40	45	50	55	60	65	70	75	80	85	90
Final category	B	B	B	B	B	B	B	B	B	B	C	C

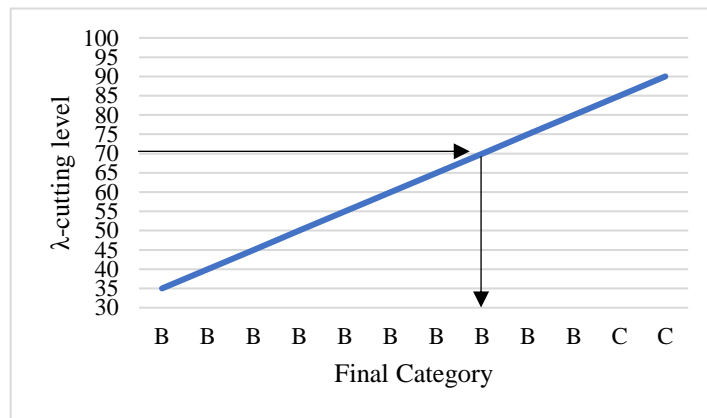


Table 79: Bodensee self-assessment approach' sensitivity analysis

λ -cutting level	35	40	45	50	55	60	65	70	75	80	85	90
Final category	B	B	B	B	B	B	B	B	B	B	B	C

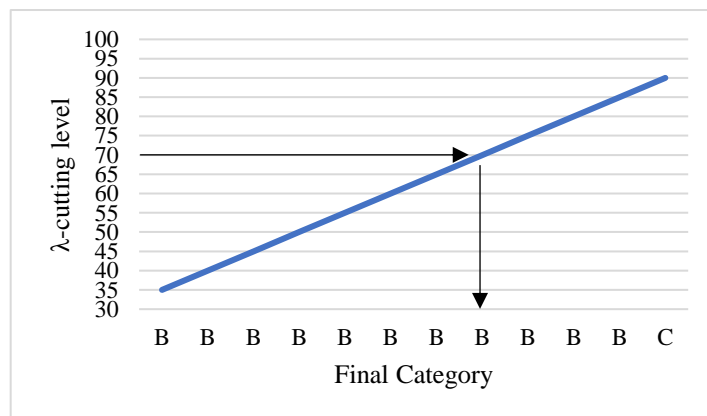


Table 80: Bodensee expert-based assessment approach' sensitivity analysis

It can be noted that category B scored by Bodensee, both with self-assessment approach and expert-based assessment approach, is stable with respect to the λ -cutting level value.

4.2.3.4 Pomurje, Slovenia

The sensitivity analysis to evaluate the robustness of results obtained with the self-assessment approach is presented: Table 81 displays an array of different λ -cutting level values and their corresponding final category. In addition, a graph showing the same results is presented.

λ -cutting level	35	40	45	50	55	60	65	70	75	80	85	90
Final category	A	A	B	B	B	B	B	B	C	C	C	C

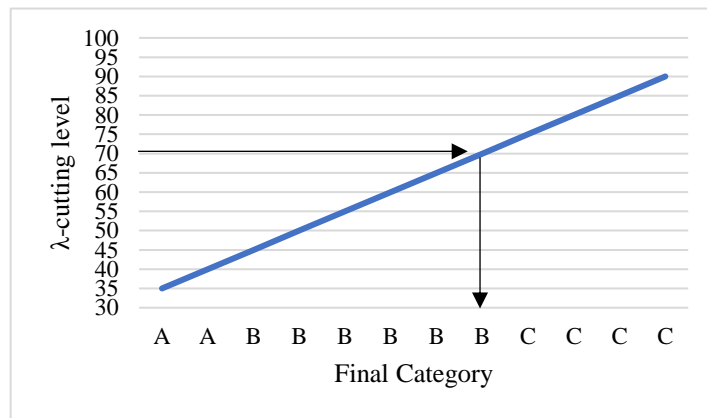


Table 81: Pomurje self-assessment approach' sensitivity analysis

It can be noted from Table 81 that with a more restrictive λ -cutting level value, Pomurje would have scored category C. Meanwhile, considering a λ -cutting level value of 40 out of 100, the final category would be the highest.

λ -cutting level	35	40	45	50	55	60	65	70	75	80	85	90
Final category	B	B	B	B	B	B	B	C	C	C	C	C

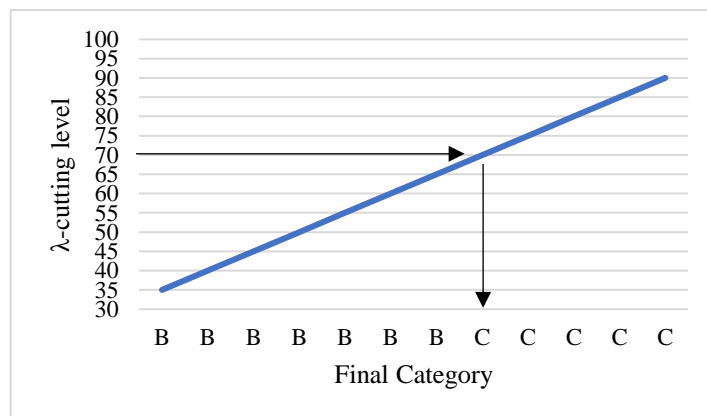


Table 82: Pomurje expert-based assessment approach' sensitivity analysis

Table 82 illustrates that, using the expert-based assessment approach, category A is never scored.

In conclusion, it is possible to observe that results scored by Pomurje are very influenced by the λ -cutting level value assumed. In fact, regarding the self-assessment approach, it is sufficient to slightly increase it to register category C; while, as regards to the expert-based assessment approach, a λ -cutting level value of 65 is enough to score category B.

4.2.3.5 Luzern West, Switzerland

The sensitivity analysis to evaluate the robustness of results obtained with the self-assessment approach is presented: Table 83 displays an array of different λ -cutting level values and their corresponding final category. In addition, a graph showing the same results is presented.

λ -cutting level	35	40	45	50	55	60	65	70	75	80	85	90
Final category	B	B	B	B	B	C	C	C	C	C	C	C

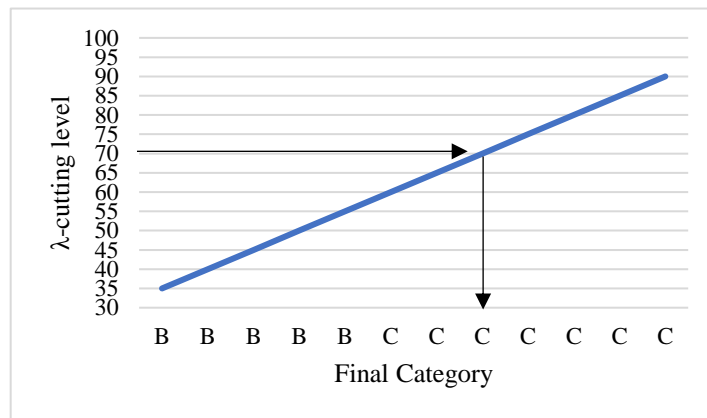


Table 83: Luzern West self-assessment approach' sensitivity analysis

It is obvious from Table 83 that with a less demanding λ -cutting level value of 55, Luzern West would have scored category B. Meanwhile, category C is confirmed even with a more restrictive value.

λ -cutting level	35	40	45	50	55	60	65	70	75	80	85	90
Final category	B	B	B	B	B	B	B	B	B	C	C	C

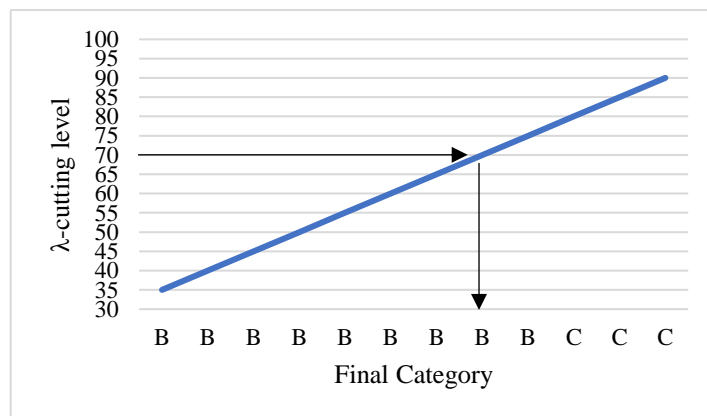


Table 84: Luzern West expert-based assessment approach' sensitivity analysis

Table 84 shows that, considering the results obtained with the expert-based assessment approach, it is sufficient to slightly increase the λ -cutting level value to obtain category C.

In conclusion, it is possible to observe that the results obtained by Luzern West are very influenced by λ -cutting level value assigned. In particular, with the self-assessment approach it is sufficient a λ -cutting level value of 55 to register an upgrade; while considering the expert-based assessment approach a slight increase is enough to score category C.

4.2.3.6 Tolmezzo, Italy

The sensitivity analysis to evaluate the robustness of results obtained with the self-assessment approach is presented: Table 85 displays an array of different λ -cutting level values and their corresponding final category. In addition, a graph showing the same results is presented.

λ -cutting level	35	40	45	50	55	60	65	70	75	80	85	90
Final category	A	B	B	B	B	B	B	B	C	C	C	C

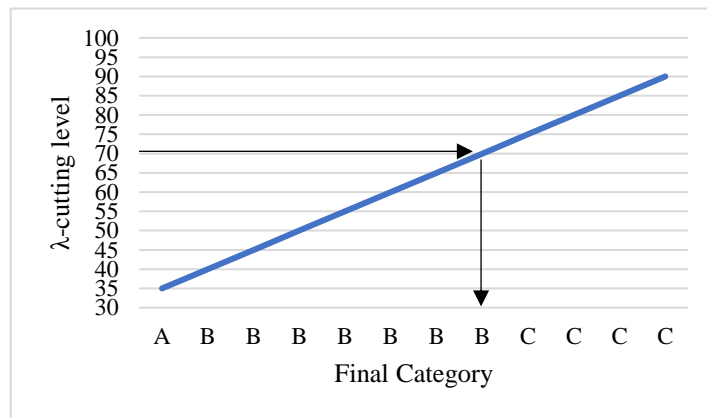


Table 85: Tolmezzo self-assessment approach' sensitivity analysis

It can be noted that category B scored by Tolmezzo is very influenced by λ -cutting level value assumed. It is worth highlighting that it is possible to score category A with a very low λ -cutting level value.

λ -cutting level	35	40	45	50	55	60	65	70	75	80	85	90
Final category	B	B	B	B	B	B	B	B	C	C	C	C

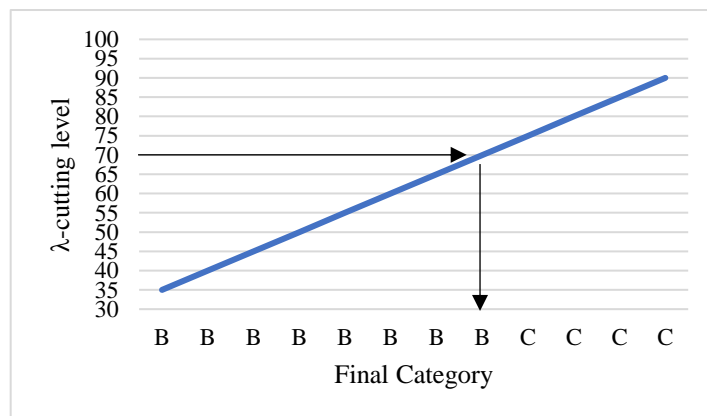


Table 86: Tolmezzo expert-based assessment approach' sensitivity analysis

Table 86 shows that, considering the expert-based assessment approach it is not possible to score category A. It is possible to observe that category B scored by Tolmezzo is influenced by λ -cutting level value assumed because it is sufficient to slightly increase it to register category C.

In conclusion of all these sensitivity analyses, it is necessary specify that the λ -cutting level value considered is very ambitious and so, there are no reasons to increase it. Therefore, the results obtained with a λ -cutting level value reduced with respect to that assumed in the model are more significant than what occurs when λ -cutting level value is further increased.

Chapter 5

Focus on Smart Mobility: how to develop Smart Mobility solutions in rural contexts

Considering that Smart Mobility appears to be the most important dimension according to the experts interviewed, as can be seen in Figure 27, a focus on Smart Mobility has been considered interesting and appropriate. This chapter aims at illustrating some best practices of smart mobility already developed or planned in some of the TA involved in the project “SmartVillages” in order to present some current and possible future activities that can be of inspiration to foster a smart transition in rural mobility systems. A brief introduction regarding the main revolutionary moments of mobility and transportation history is essential to understand the current situation and its challenges.

In the early 21st century, new dynamics transformed cars and consequently the world: mobility is about to experience its second great inflection point. However, in order to fully capture the process, it is important to have a look at its first inflection point. Mobility’s first inflection point is represented by the incredible developments of 1900-20: from steam to internal-combustion engines, from premium automobiles for the few to mass-produced cars for the millions. In addition, entire businesses were altered and new industries and government entities were born, that developed alongside, but distinct from, the automotive industry: repair shops, highway authorities, gas stations, commuter railways, and car washes. This kind of landscape has endured for decades, but nowadays something is changing (Heineke e Kampshoff, *The trends transforming mobility's future* 2019). By 2030, considering also that transport represents almost a quarter of Europe’s greenhouse gas emissions and it is the main cause of air pollution in cities, developments that may be as profound as those of the past are likely to be seen. Radical changes are coming, even faster this time and across multiple dimensions. The characteristics of mobility will be significantly altered and the main innovative issues are: autonomy, connectivity, electrification and sharing (Dhawan, et al. 2019).

5.1 The main innovative issues of Smart Mobility

This paragraph inspired by “Mobility's second great inflection point” by Dhawan, et al. (2019), deals with a more detailed explanation of the four main issues of mobility' second great inflection point: autonomy, connectivity, electrification and sharing.

Autonomy is currently being sought on two fronts. In the private space, we will see the introduction of working level-3 systems, considering a ranging scale from 0 (full driver control) to 5 (the full-time performance by an automated driving system of all aspects of driving under all roadway conditions), in the next one to two years. In the commercial space, level-4 vehicles could cover 60 to 70 percent of all miles driven in markets such as the United States in the first half of the 2020s, however, the actual market adoption will take longer and will depend on further factors, such as regulation, customer preferences, and competitive landscape (Heineke, Kampshoff e Mkrtyan, et al. 2017). The technology for **connectivity** is also ready for a breakthrough. Cutting-edge automobiles today can use a driver's personal profile to access services on external digital platforms. Significant improvements will soon shift the connectivity experience from reactive to predictive. By the early 2020s, connectivity systems will become a “virtual chauffeur,” in which cognitive artificial intelligence can anticipate and fulfil riders' needs. As regard to **electrification**, the significant improvements in battery technologies, the increasing use of RES and the imposition of regional and global carbon limits by global agreements in order to answer to the emission reduction challenge in the transport sector mean the likely end of internal combustion engine's technology predominance. In particular, the United Nations body for assessing the science related to climate change, called Intergovernmental Panel on Climate Change, was created in order to provide policymakers with regular scientific assessments on climate change, its implications and potential future risks, as well as to put forward adaptation and mitigation options (Working Group II 2017). Among the **sharing** topic, one of the main challenges on the European stage is ridesharing with autonomous vehicles in order to make riding more affordable and to have the opportunity to travel much more than a privately-owned vehicle.

5.2 Challenges and needs in a rural context: best practices from the Test Areas involved in “SmartVillages”

The innovative issues detailed in the previous paragraph are considered sound proposals to tackle the challenges and to address the needs characterizing rural areas. In the 1.2 paragraph, it can be noted that many rural areas are locked into a “circle of decline” by two mutually reinforcing trends: firstly, a shortage of jobs and sustainable business activity; and secondly, inadequate and declining services. Among the inadequate and declining services, the transport offer is particularly relevant; in fact, as stated by many of the TA interviewed to test the ELECTRE TRI model (see paragraph 4.2) the traditional concept of mobility is no longer adequate to satisfy the current everyday life problems that rural villages are facing.

In the following, a selection of best practices in Smart Mobility, implemented by some of the TA involved in the project “SmartVillages”, covering almost all the main innovative issues described in paragraph 5.1, are presented.

- **Route 12 and the Swiss Transit Lab, Bodensee, Switzerland** (Lab s.d.)

Route 12 is one of the first examples of **ridesharing with autonomous vehicles** in Europe. The vision of this project was discussed in 2017 when some local transport operators, working alongside Trapeze Switzerland GmbH, decided to undertake trials of driverless shuttle services.

Route 12 is an integrated mobility concept with planned first-mile and last-mile transportation: a driverless bus service, fully integrated into the local public transport schedule, is already available in the Canton of Schaffhausen.

Since March 2018 the shuttle service has been operating on a short route, which connects Industrieplatz with the town centre of Neuhausen am Rheinfall, but soon the route will be extended to take passengers to and from the Rhine Falls Basin. In addition, a first-/last-mile concept is going to be integrated in the project.

- **Bouge tranquille, Royans Express and Collectif part' âge, Royans-Vercors, France**

Bouge tranquille is a **ridesharing service**: volunteer drivers exhibit on their windshield an identifying sticker that also some of the inhabitants possess, in the form of a bracelet. This is a recognizing device that can be shown when asking for or offering a ride. In this way, people can be easily recognized by drivers and benefit from this service, and a working ridesharing service is functional and based on local trust.

The Royans Express is a “**shared bus service**” that travels twice a week following a pre-determined route connecting all the small villages in the area of Royans-Vercors with the main one, St. Jean. There are some strategic locations in which, if planned in the daily schedule, it is possible to take the bus.

Collectif part' âge is a **ridesharing service** especially customized for **elderly and people with reduced mobility**. It is an on-call service and, currently, there are two electric vehicles and one electric bus available. This service is provided voluntarily by the inhabitants of the villages located in the area of Royans-Vercors.

These good practices can be considered examples of “*reverse mobility*”: solution proposed by partner ADRETS during the Capacity Building Seminar (see paragraph 3.5).

- **Ummadum car-sharing service, Pitztal, Austria**

This service is still at its planning stage; however, it could be one of the first examples of **car-sharing in a mountain area** and so, it is worth mentioning and describing it.

The company which is expected to provide the service mainly focuses on commuters: it is however still necessary to analyse if there are enough people commuting in the area and their journeys. In order to successfully implement the service, it is important to find communities and companies which will invite their employees to use the app.

Furthermore, a system based on a reward logic is behind the service: users can pay the ride with “special coins” that can be obtained utilizing the service. In addition, some shops, members of this sustainable initiative, will accept these “special coins”: as a result, the beginning of a virtuous circle is created. If the project accepted by the Public Administrations, the test phase could start in September 2019.

- **SUMP of Città Metropolitana di Genova, Valli del Sol, Italy** (Genova s.d.)

The TA Valli del Sol is directly involved in the initiatives included in the SUMP of Città Metropolitana di Genova; in fact, many of the SUMP activities concern the rural inland.

Plenty of smart activities have started in August 2018, immediately after the Morandi bridge collapse, in order to tackle the emergency; although the majority of road traffic is currently re-established, they are still present and working.

Concerning **on call services**, there is a service similar to the Collectif part'âge implemented in Royans-Vercors, and it is called “Chiama il Bus”. In addition, there is an App related to **car-pooling** that registers a very positive trend with respect to the number of users.

In addition, one of the main smart activities provided by the SUMP regards a service supplied by local transport operators which gives the opportunity to citizens or tourists to reach theatres or other cultural facilities and to move back home without using private means of transport.

Finally, it is worth mentioning the idea of relocating some educational and health facilities, currently located in Genoa and along the coast, to the mountain area of Genoese inland in order to limit commuting and indeed counter depopulation of rural areas.

The best practices in Smart Mobility described above are only few examples that, thanks to the project “Alpine Space SmartVillages”, the partners are able to share

reciprocally. It is indeed hopeful that smart practices in mobility become increasingly frequent within the rural areas involved in the project.

Furthermore, it is expected that other villages all over Europe can and will be inspired by these initiatives and consider them as starting point to develop their own smart transition, since mobility can be considered, as it is shown in this thesis, as a pivotal tool to tackle the circle of decline that rural areas are currently experiencing.

Conclusions

This thesis has focused on a very new and current issue that is the smart transition of rural and mountain areas to counter depopulation and decline. In particular, this thesis has developed an innovative methodology, the first of its kind, that can support rural and mountain areas in fostering their smart transformation much like what has occurred with the concept of “Smart Cities”.

Over the last few years, alongside the increasing interest towards the problematic issues affecting European rural and mountain areas, the necessity to define and implement an analytic procedure to counter the circle of decline, that is mainly characterized by depopulation of rural areas and ageing, has been widely recognised, inspiring the idea to propose a **smart transition** as a solution to keep rural and mountain areas liveable and attractive. In 2018 the European Commission has started to promote projects and initiatives aiming at bringing out rural areas’ potentials with an approach similar to the one adopted for the concept of “Smart City”; the project “Alpine Space SmartVillages” is among those very initiatives. This lively and innovative context is the framework in which this thesis and the collaboration with the European project “Alpine Space SmartVillages” are set. This collaboration has provided me with the opportunity to participate at project meetings as a speaker and, more in general, to interact with international partners and to work alongside them on the vast majority of the analyses developed in this thesis.

One of the first results of this thesis is the outline of a list of **indicators of smartness** for villages, in a first version mostly quantitative, that are essential to provide information about both the current status and the future targets of rural areas in terms of smart transition. In this way, the Test Areas involved in the project and organised in Regional Stakeholder Groups (RSG) can reflect on and are directed towards local smart transition targets. The ninety indicators collected have been grouped according to the six classical dimensions of smartness (Mobility, Governance, Economy, Environment, Living and People), consolidated thanks to the concept of Smart City. While this can be considered a reasonable initial working

assumption, in a dedicated paragraph some reflections about whether and to which extent these dimensions are appropriate to describe the rural and mountain context are provided. Subsequently, it was considered essential to define a clear and structured guide to support the RSG in providing the most suitable values to complete each indicator of the list. Hence, the **Indicator Card** was developed: this was the main topic of my session with the partners during a dedicated project meeting. Following the work with the partners, it became evident that the Indicator Card, while useful for those who wanted to go more in detail in defining needs and setting objectives for their Test Areas, was deemed too detailed for some other partners.

The ensuing research process took into account all the aforementioned issues and defined a **sub-set of twenty-four core indicators**, mainly qualitative in nature, that were included in a survey form and submitted to some selected TA in dedicated interviews. The TA were selected in order to represent all the countries involved in the project “Alpine Space SmartVillages”, as well as a reasonably wide range of issues and needs. In this phase, we decided to involve also my own town of Tolmezzo. Thanks to the survey, it was possible to obtain from local stakeholders the input data that proved to be necessary to test the model that assesses and rates the level of smartness of rural areas.

This thesis’ core result is, in fact, **the development of a model, the first in this field, that use the ELECTRE Tri multi-criteria-analysis method, to rate and assess the level of smartness of rural areas**. Considering that we are dealing with a rating model, the definition of some categories with the corresponding profiles, in which each area can be classified, is required. In particular, four categories and three profiles were defined: CATEGORY A “high level or new goals level”, CATEGORY B “good level or satisfactory level”, CATEGORY C “medium level or work in progress level” and CATEGORY D “low level or traditional concept”. It is worth highlighting that to provide more details about the specific situation of each area, the single dimensions were also rated. Subsequently, two approaches were developed, the self-assessment approach and the expert-based assessment approach, as they were both considered essential to provide a complete evaluation as regards the specific situation of that area.

The **Self-assessment approach** is entirely based, as its name suggest, on a self-assessment process by local stakeholders. In fact, the local stakeholders have provided the answers to the survey, that are the model's inputs, as well as the weight system, that represents how much important is one dimension, and consequently each indicator when compared to the others. The weight system is obtained submitting the fifteen pairwise comparisons between dimensions and following the procedure detailed in the **Analytic Hierarchy Process (AHP)** by Thomas L. Saaty. This approach allows for a weighted evaluation of the level of smartness perceived by the local stakeholders interviewed. In particular, following the self-assessment phase Valli del Sol, Pitztal and Luzern West score CATEGORY C, while Bodensee, Pomurje and Tolmezzo CATEGORY B; even though the TA are differently graded within the categories.

The Expert-based assessment approach provides a more objective and external point of view to assign the final categories of smartness with respect to the previous model. The weight system is defined as a linear combination of the weight systems provided by experts, four in our case, whose technical backgrounds can be associated to the six Smart Dimensions. Concerning the results, these are mainly confirmed, except from Luzern West that scores CATEGORY B: it is obvious that the level of smartness perceived by the local stakeholders is worse than the one resulting from the experts.

Considering that in the model there are numerous parameters that are prone to subjectivity, it was considered appropriate to perform a **sensitivity analysis** in order to assess the robustness of the results obtained. The analysis was conducted on the λ -cutting level value (this value is fundamental to define the final category, because the final category obtained is the one for which the total weight of the indicators reaches at least this threshold value) that was defined as very ambitious and equal to 70 out 100. It was found that two TA rated in CATEGORY C, Valli del Sol and Luzern West, would have scored CATEGORY B with a less demanding λ -cutting level value.

This model is considered as an effective tool that allows each TA to assess its current level of smartness, to identify the crucial point that should be taken into

account to plan initiatives and activities aiming at improving the situation in terms of smart transition, to define future targets and their corresponding expected results and also to re-assess its level of smartness in order to evaluate whether the situation has improved thanks to any activities implemented.

More, the cooperation with the project “Alpine Space SmartVillages” guarantees the opportunity to **disseminate** the outcomes of this thesis to all the rural areas involved in the project. Furthermore, it is expected that other rural areas all over Europe can and will be inspired by these initiatives and can consider them as a starting point to develop their own smart transition.

It is also worth mentioning that this dissertation has provided an effective contribution to the activities of the European project “Alpine Space SmartVillages”, including **three of the project’s reports and deliverables**, and that ELECTRE Tri model outlined in this thesis is the focus of an **abstract** entitled “*Assessing and rating the level of smartness of mountain areas by the use of Electre Tri: the pilot case of the ongoing Alpine Space project SmartVillages*” accepted for the 89th meeting of the EURO Working Group in Multi Criteria Decision Aiding.

As regards the future developments, the main proposal is to analyse the results registered by each Test Area in correlation with their specific geographical, demographic and economic characteristics and consequently, to identify, if possible, some **reference profiles**. This process could provide significant results concerning the importance assigned to each dimension by specific profiles of rural areas and therefore it could define whether and to which extent the six dimensions of smartness are suitable for rural and mountainous areas of different types. Moreover, it could be also relevant to refine the indicators currently implemented in the model, considering for example the first more quantitative list: this would provide with a more numerical and detailed management of results. Finally, taken into account that the model presented in this thesis is the first model based on the ELECTRE Tri multi-criteria-analysis method with the aim of assessing and rating the level of smartness of rural and mountain areas, it is appropriate and expected that will be further debates as regard to the parameters, the assumptions and the structure itself of the model.

Appendix A: Complete List of Indicators

DIMENSIONS	CATEGORIES	INDICATORS
SMART MOBILITY	<i>Accessibility</i>	Linkages with regional hubs
	<i>Accessibility</i>	Commuters' estimated % w/r to the active populations
	<i>Transports</i>	Presence of/Access to train/bus station
	<i>Transports</i>	Presence of/Access to Car-Pooling services
	<i>Transports</i>	Presence of/Access to Car-sharing services
	<i>Transports</i>	Presence of/Access to E-Bike services
	<i>Transports</i>	Presence of/Access to Integrated traffic platform
	<i>Transports</i>	Presence of rail infrastructure for freight
	<i>Transports</i>	Presence of rail infrastructure for people
	<i>Transports</i>	Type of Road infrastructures
	<i>Transports</i>	Presence of limited traffic zones
	<i>Transports</i>	Bike lanes
	<i>Transports</i>	People with annual transport ticket
	<i>Transports</i>	Index of motorisation
	<i>Flow distribution</i>	Rail transport flows
<i>Flow distribution</i>	Road transport flows	
SMART GOVERNANCE	<i>Access to e-SGI</i>	Presence of E-government administrative/fiscal services
	<i>Access to e-SGI</i>	Presence of E-health services
	<i>Access to e-SGI</i>	Access to E-government services
	<i>Access to e-SGI</i>	Access to E-health services
	<i>Methods of participation</i>	Presence of participation events organised by PA
	<i>Action plan for the tertiary sector</i>	Re-orientation of tourist offer
	<i>Communication Tools</i>	Information/communication events for activities of the PA
SMART ECONOMY	<i>Household income and expenses</i>	Mean or median household income per year
	<i>Household income and expenses</i>	Low income household
	<i>Household income and expenses</i>	Population receiving social assistance
	<i>Communication Tools</i>	Presence of/Access to Brand, Logo for the region
	<i>Employment</i>	Travel-to-work areas
	<i>Employment</i>	Job creation for all sectors combined
	<i>Employment</i>	Unemployment rate
	<i>Agriculture</i>	Presence of digital farming
	<i>Agriculture</i>	Changes in the number of farms
	<i>Agriculture</i>	Self-sufficiency in the agricultural industry
	<i>Businesses</i>	Types of businesses (micro, small, medium)
	<i>Businesses</i>	Appealing companies within the radius of 5 km
	<i>Businesses</i>	Businesses with environmental certification
	<i>Businesses</i>	Presence of Platforms for producers
	<i>Businesses</i>	Young-led enterprises
	<i>Businesses</i>	Women-led enterprises
	<i>Businesses</i>	Economic-growth
	<i>Tourism</i>	Tourism intensity
	<i>Tourism</i>	Average length of stay
<i>Tourism</i>	Tourist facilities annual occupancy	
<i>Tourism</i>	Presence of/Access to tourist-related apps	
<i>Tourism</i>	Tourist Trails (ICT, apps, e-trails...)	
SMART ENVIRONMENT	<i>Energy</i>	Energy produced from renewable resources
	<i>Energy</i>	Annual energy consumption from renewable sources
	<i>Waste</i>	Differentiated waste collection
	<i>Waste</i>	Quantity of waste recycled
	<i>Housing conditions</i>	Energy performance certification for building
	<i>Greenspaces, ecosystems and heritage</i>	Land Cover
	<i>Greenspaces, ecosystems and heritage</i>	World Heritage Sites
<i>Greenspaces, ecosystems and heritage</i>	Protected areas	

SMART LIVING	<i>Demographics</i>	Population density
	<i>Demographics</i>	Population density in the residential area
	<i>Demographics</i>	Population ageing rate
	<i>Demographics</i>	Population growth
	<i>Demographics</i>	Suicide rate
	<i>Education</i>	Kindergarten
	<i>Education</i>	Average capacity of primary and secondary school classes
	<i>Education</i>	Provision of high school education
	<i>Education</i>	Universities
	<i>Social and community services</i>	Banks
	<i>Social and community services</i>	Post offices
	<i>Social and community services</i>	Supermarkets
	<i>Social and community services</i>	Cultural performance and events
	<i>Social and community services</i>	Type of internet connection
	<i>Social and community services</i>	Kind of internet connection
	<i>Social and community services</i>	Coworking spaces
	<i>Social and community services</i>	Playgrounds
	<i>Social and community services</i>	Libraries or spaces for under 16
	<i>Social and community services</i>	Delivery services for older people
	<i>Social and community services</i>	Sport facilities
	<i>Social and community services</i>	Restaurants & Bars
	<i>Health</i>	Telemedicine solution
	<i>Health</i>	Accessibility to the closest hospital
	<i>Health</i>	Healthcare
	<i>Health</i>	Maternity ward in the closest hospital
	<i>Health</i>	Pharmacy
	<i>Health</i>	Medical specialists
	<i>Health</i>	Emergency doctor/medical ward
	<i>Health</i>	Retirement community/House assistance for disabled people
	<i>Work</i>	Smart working
SMART PEOPLE	<i>Participation in public life</i>	Citizen participation in meetings/assemblies of public interest
	<i>Participation in public life</i>	Citizen participation in municipal elections
	<i>Participation in public life</i>	Citizens associations or organizations
	<i>Open to innovation</i>	Familiarity with Internet
	<i>Level of qualification</i>	Population aged 16 and over with less than a high school diploma
	<i>Level of qualification</i>	NEET (not in education, employment or training)
	<i>Level of qualification</i>	People living with bachelor working in companies in the radius of 5 km

Appendix B: Indicator Card

INDICATOR:		
DIMENSION:		CATEGORY:
DESCRIPTION:		
DRIVING QUESTION(S):		
1	Does this indicator represent a meaningful issue you might want to consider?	<ul style="list-style-type: none"> • No -> Go to 11 • Yes -> Go to 2
2	What kind of indicator is it (qualitative or quantitative)?	<ul style="list-style-type: none"> • Qualitative -> Go to 3 • Quantitative -> Go to 4
WHERE ARE WE NOW?		
3	<p>If the indicator is qualitative, describe it and then go to ONLINE SURVEY (WPT2) *!</p> <p><i>*The surveys are not available yet. However, Wpt-1 and Wpt-2 are considering the idea of joining forces and create surveys for qualitative indicators to be hosted on Wpt-2 platform.</i></p>	Please provide here a brief outline of the status of the qualitative indicator in your Test Area (TA):
4	<p>If the indicator is a service or item (i.e. a logo, a platform, a car sharing service, ...): is the service/item already available in your TA?</p> <p>If the indicator is not a service or item (i.e. renewable energy production, energy performance certification for buildings, ...): how would you describe its current status in the TA?</p>	<ol style="list-style-type: none"> 1. No -> Go to the section WHERE DO WE WANT TO BE? /HOW DO WE GET THERE? (Next page) 2. Yes -> If possible, provide here some relevant information of the status:
5	<p>Which data would you use to measure this indicator?</p> <p>You can indicate one or more possible data sets.</p>	Please list here one (or more) possible data sets to measure this indicator:
6	<p>Data sources</p> <p>Please provide information on the possible data sources for the data sets listed in question 5.</p> <p>Data can be already available (if so, please indicate possible data sources), or the indicator might be estimable by using information from official data sources, or the indicator might not be quantitatively or numerically estimable.</p>	<ul style="list-style-type: none"> • The data are already available -> What are the data sources? How often are they updated? • The indicator can be estimated quantitatively by using information from official data sources. How would you do so? • The indicator cannot be estimated quantitatively -> Go to 10
7	<p>Data accessibility and estimated costs</p> <p>Provide a brief description of how easy is to access data (are they immediately accessible online or are there, perhaps, several mandatory procedures to be completed to access data?) and, if applicable, how expensive is to access/purchase the data.</p>	Please provide a brief outline of the accessibility of the data and the possible estimated costs:

8	<p>What is the spatial level at which the data are available (national/regional/cantonal/municipal/...)?</p> <p>If the data are not available at the village/TA spatial level, are they easily scalable?</p>	<p>Please provide a brief outline of the spatial level at which the data are available for your TA, and of their scalability:</p>
9	<p>Time expected for data estimation</p> <p>Please indicate an estimation of the time to access the data and to submit it to WPTI.</p>	<p>Please tick as relevant:</p> <ul style="list-style-type: none"> • More than one month • Up to one month • Up to one week
10	<p>Indicate the CURRENT VALUE* or write a qualitative description if the data is not numerically estimable.</p> <p><i>*We do not expect you to have the precise current value as of today, but possibly to have a first estimation of the value to kick-start the discussion.</i></p>	
11	<p>Proposed modifications to the indicator (calculation method, indicator, unit of measure, ...)</p>	<p>Please outline briefly possible modifications:</p>
WHERE DO WE WANT TO BE?		
12	<p>Indicate your FUTURE TARGET* for this indicator, in the context of the smart transition of your TA.</p> <p><i>*The future target can be either quantitative (e.g., from 10% to 50%, from zero logos to one brand, ...) or qualitative (from low familiarity with internet to high familiarity, ...)</i></p>	<p>Please provide here your future target:</p>
HOW DO WE GET THERE?		
13	<p>Are there any policies which take this target into account? If so, indicate the policy/ies.</p>	<p>Please list here any relevant policy/ies that include the declared future target:</p>
14	<p>Are there any private/public funds already allocated or that will be allocated in the nearest future for this target?</p>	<p>Please list here any relevant funds, current or foreseeable:</p>
15	<p>Implementation time (time estimated to get to the declared target)</p>	<p>Please indicate a possible time span to complete the fulfilment of the declared target:</p>
16	<p>How is it possible to monitor if the implementation proceeds as expected?</p>	<p>Please provide some ideas on how to monitor the activities to reach the declared target:</p>

Appendix C: Survey for smartness assessment



SmartVillages Survey Indicators

T1 Regional analysis of readiness and
needs for a Smart Transition in the
Test Areas



SMART MOBILITY

1. Do you consider the offer of public transport adequate in your TA?

- Not at all
- Not at the moment, but progress is being made. Elaborate below:
- Yes, but the TA is at risk of losing some vital public transport services
- Yes, public transport is adequate and covers all needs

2. Are there solutions to share means of transport in your TA?

- No.
- Yes, people share on a private basis with no 'official' sharing service.
- Yes, car sharing. **Number** of available services:
- Yes, car-pooling. **Number** of available services:

3. Is there an integrated transport platform for citizens/visitors in your TA to use?

- No, and there are no plans to build one
- No, but it is planned to build one.
- Yes, only for consultation of transport timetables. Indicate **number** of accesses
- Yes, both for consultation and for buying tickets. Indicate **number** of accesses

4. Is there any multimodal transport infrastructure available in your TA (train/bus and car sharing; train/bus and bike sharing; ...)?

- No, and there are no plans multimodal infrastructures
- No, but there are plan to build multimodal infrastructure(s)
- Yes. Indicate **the type**
- Yes. Reverse mobility (services moves towards people)

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SMART GOVERNANCE

5. Are there e-government administrative and fiscal services, organised and managed by Public Authorities?

- No, and the PA does not have plans for administrative and/or fiscal services on line
- No, but the PA have plans for implementing administrative and/or fiscal services on line
- Yes, but a low percentage of citizens use them. Indicate the **web site** and an approximate **percentage**
- Yes, and a high percentage of citizens use them. Indicate the **web site** and an approximate **percentage**

6. Do Public Authorities involve citizens in decision making? (top-down approach to participation)

- No, decision-making does not involve citizen participation.
- No, but PA plans some activities to involve citizens in decision making
- Yes, but not on the topic of innovation or smart transition
- Yes, PA involves citizens on the topic of innovation and smart transition.

7. Do Public Authorities facilitate partnerships with private enterprises?

- No
- No, but there are some plans to facilitate networks and contacts with private enterprises
- Yes, PA and private enterprises cooperate on some topics but not on innovation or smart transition
- Yes, public and private work together for smart transition. Indicate an approximate **number** of partnerships

8. Do Public Authorities communicate (news, decisions, information) in smart ways to the citizens or visitors?

- No. Indicate the preferred information channel used by the PA
- No, but PA plans to change the way to communicate
- Yes, but PA communication strategy does not cover all the possible social, web or IT channels. Indicate the channels used

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- Yes, the PA communicates decisions, meetings and information using smart (including social) platforms. Indicate the channels used

SMART ECONOMY

9. Are there any tourist-dedicated apps/platforms in your TA, to present and inform about tourist attractions?

- No, and they are not planned
- No, but they are planned
- Yes, there are app(s). Indicate **number** of accesses
- Yes, there are websites/platforms. Indicate **number** of accesses

10. Do tourist activities in your TA use innovative and/or smart approaches?

- No, just traditional ones.
- No, but some innovation is starting to appear in traditional sectors
- Yes, the TA uses some innovative approaches to tourism, elaborated below:
- Yes, the TA offers smart experiences all around

11. Does your TA ensure that tourism does not have a negative impact on the environment?

- No, no specific measures are taken
- No, only general measures are taken
- Yes, some information is provided to protect soil/air/water/environment.
- Yes, the TA specifically markets itself as a zero impact tourism destination.

12. Do economic activities (other than tourism) have new and innovative approaches (i.e. digital technologies in farming, animal husbandry, ...)?

- No.
- Yes, in the agricultural and/or animal husbandry sector. Elaborate below:
- Yes, in the forestry sector. Elaborate below:
- Yes, in other productive sectors. Elaborate below:

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SMART ENVIRONMENT

13. Does your TA produce energy from RES?

- No, and production of energy from RES is not planned
- No, but production of energy from RES is planned
- Yes, but in the TA there is only one RES plant. Indicate the **type** of plant (solar, wind, biomass, hydro, ...) and its **capacity [MW]**
- Yes, and in the TA there are more RES plants. Indicate the **type** of plants (solar, wind, biomass, hydro, ...) and their **capacity [MW]**

14. Does your TA use energy from RES?

- No, the TA sells all the energy from its own RES
- No, but the TA plans to use some of the energy produced
- Yes, the TA buys energy produced by RES in other areas
- Yes, the TA consumes the energy from RES produced in the TA

15. Is your TA working towards a zero waste economy?

- No
- No, but the TA has a working recycling policy.
- Yes, the TA is working towards a zero-waste economy thanks to some local initiatives. Indicate the **number** and the **kind** of activities for this target
- Yes, and there are public policies for a zero-waste economy. Indicate the **policy/ies**

16. Are citizens in your TA aware of natural risks?

- No, and no raising awareness activities are planned
- No, but there are raising awareness activities for natural risks
- Yes, but the awareness is not high.
- Yes, and the awareness of natural risks in the TA is satisfyingly high.

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SMART LIVING

17. What would you say is the level of health and social care in your TA?

- Low, the TA lacks basic health and social care services
- Medium, the hospital is not located in the TA, but the TA is served by doctors/social services on call
- Good level, there is an hospital with all basic medical services in the TA and health and social care services are granted for all age groups
- Very good level, the TA has access to the most advanced medical techniques (e-healthcare)

18. What is the coverage of the internet connection in your TA?

- Low. Indicate **the type** of internet connection
- Medium. Indicate **the type** of internet connection
- High. Indicate **the type** of internet connection
- Very high. Indicate **the type** of internet connection

19. How attractive is your TA, from the point of view of basic services to the population (banks, post-offices, basic-good shops, bars & restaurants, pharmacies, educational services)?

- Low
- Medium
- High
- Very high

20. Is smart working already possible in your TA?

- No, and it is not planned
- No, but it is planned by some PA/enterprises
- Yes, but a low percentage of citizens use it. Indicate an approximate **percentage**
- Yes, a high percentage of citizens use it. Indicate an approximate **percentage**

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SMART PEOPLE

21. Would you say that your TA is subject to depopulation and ageing?

- Yes, the TA is only inhabited and “lived” by elderly people
- Yes, young people (under 30) come back occasionally (for holidays and occasional work)
- Yes, young people (under 30) study and work away but still live here (e.g., daily commuters)
- No, young people (under 30) are staying in the area

22. What is the level of digital literacy in your TA?

- Low, and educational activities to foster digital literacy are not planned
- Low, but educational activities to foster digital literacy are in place or planned
- Medium-to-high, but not for all the age groups
- High, all people can be defined as digital literates.

23. Do citizens in your TA participate in meetings or assemblies of public interest? (bottom-up approach to decision making)

- No, there is not much interest (or not many opportunities) in participating in decision making
- Yes, there are some opportunities but only a low percentage of people participate. Indicate an approximate **percentage**
- Yes, there are some opportunities and a medium-to-high percentage of people participate. Indicate an approximate **percentage**
- Yes, there are some opportunities and a very high percentage of people participate. Indicate an approximate **percentage**

24. Are there active citizens associations and organisations in your TA?

- No, or there were but they are not active any more.
- No, but there are plans for some new associations/organisations to form
- Yes, but they are not focused on innovation. Indicate an **approximate number**
- Yes, and they are focused on innovation. Indicate an **approximate number**

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Appendix D: Project deliverables



GUIDELINES FOR THE WORK OF THE REGIONAL STAKEHOLDER GROUPS FOR SMART TRANSITION and INTERNAL CAPACITY BUILDING SEMINAR

Deliverable D.T1.1.1 – Work Package T1

Gianluca Lentini, Giuliana Gemini, Alessandra Cappiello, Francesca Poletti

Poliedra – Politecnico di Milano





Report on the RSG, their role and potential

**Deliverable D.T1.1.2
WPT-1**

Gianluca Lentini, Francesca Poletti
Poliedra – Politecnico di Milano



Appendix E: Abstract accepted for the 89th meeting of the EURO Working Group in Multi Criteria Decision Aiding

*Assessing and rating the level of smartness of mountain areas by the
use of Electre Tri: the pilot case of the ongoing Alpine Space project
SmartVillages*

Gianluca Lentini¹, Francesca Polettini¹, Alessandro Luè¹, Alberto Colorni Vitale¹

¹ Poliedra-Politecnico di Milano

Abstract:

Several sources, especially at EU policy level, highlight that (rural and) mountain areas are locked in a “circle of decline” by two mutually reinforcing trends: a shortage of attractiveness in terms of jobs and sustainable business activities, and inadequate and declining services, that reinforce depopulation and aging. Alpine Space project SmartVillages (2018-2021) addresses this very topic in six European countries in 12 dedicated Test Areas (1 in Austria, 1 in France, 2 in Germany, 2 in Italy, 5 in Slovenia, 1 in Switzerland), and proposes that a smart transformation of mountain areas can help countering the circle of decline and keep those areas livable and attractive.

‘Smart villages’ have been defined at European level in 2018 as “*communities in rural areas that develop smart solutions to deal with challenges in their local context. They build on existing local strengths and opportunities to engage in a process of sustainable development of their territories. They rely on a participatory approach to develop and implement their strategies to improve their economic, social and environmental conditions, in particular by promoting innovation and mobilizing solutions offered by digital technologies. [...]*” However, no indicator set or rating or ranking method to capture, describe and/or predict ‘smartness’ in mountain areas has been so far proposed.

The Authors propose a methodology to assess and rate ‘smartness’ in mountain areas by means of the creation a specific set of *indicators of smartness for villages*, classified in the six classical *dimensions* of smartness: Economy, Environment, Governance, Living, Mobility and People; the *dimensions* have been derived by literature on the more consolidated concept of ‘Smart City’, and their use for the assessment and rating of smartness in mountain area has been considered as a reasonable working hypothesis.

The methodology proposed consists in the use of ELECTRE Tri multi-criteria-analysis method, aiming to rate the smartness of the SmartVillages’ Test Areas with the direct involvement, via surveys and interviews, of experts and local stakeholders. They, specifically organised in ad-hoc regional stakeholder groups in the 12 Test Areas, are at present responding to surveys aiming to fill in the *indicator of smartness* survey and are providing the binary outranking (including incomparability) conditions among the dimensions of smartness for villages. Surveys and interviews are ongoing, and will cover the Test Areas by mid-March 2019.

The Authors expect to provide, by mid-April 2019, a first rating of smartness of the Test Areas included in the Alpine Space project SmartVillages, to identify specific reference profiles, and to try and draft first conclusions on whether and to which extent the six classical *dimensions* of smartness, as well as the specifically dedicated set of *indicators of smartness for villages*, are suitable descriptors and predictors of smartness for mountain areas.

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