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RURAL DEMAND RESPONSIVE TRANSPORT

An overview of the Italian scenario and analysis of Antola-Tigullio inner area case study

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ABSTRACT

Over time, a car-centred mobility system has contributed to the negative externalities that can be observed today in both urban and rural areas: congestion of transport infrastructures, air and noise pollution, reduced urban space for pedestrians and cyclists, lack of parks, etc. All this has led policy makers to find solutions to shift citizens from cars to public transport and other sustainable modes (walking and cycling). While in urban areas traditional public transport is often an already widespread and effective service that only needs to be transformed to build user confidence, in rural and mountainous areas, where low transport demand and long distances make it economically unviable, it needs to be integrated or completely replaced by innovative forms of mobility. One of the most valid solutions in this regard is on-demand transport technology, which allows transport providers to reduce their costs by rationalizing the supply (e.g. higher vehicles' load factor) and population of these areas to improve their accessibility to public transport and abandon the use of the car. Over time, research has been done extensively in academic literature on the application of this technology in urban areas, but little has been undertaken in rural contexts: this PhD thesis aims to contribute to research in this field by studying the technical characteristics of these services in the Italian scenario, in order to provide decision-makers with useful information to counter the phenomena of depopulation and economic and social isolation of these territories.

First, this paper provides a comprehensive literature review aimed at understanding the strengths and weaknesses of the DRT service in general and in its application in rural areas: from the description of its historical development, the close relationship between the diffusion of this tool and the phases of technological progress emerges. The central chapters of this thesis deal with an in-depth analysis of all rural DRT cases in operation in Italy in the last decade (both temporary and permanent), carried out through a web search, an analysis of the Program Framework Agreements of the Italian regions and sector agencies' websites, as well as with the planning of some DRT services in the inner area of Antola-Tigullio (Liguria Region): this last work, carried out after an analysis of the socio-demographic data and the travel behavior of the population, helped to identify the best routes, time slots and target user groups to experiment with the DRT service. After 5 months of experimentation, it was possible to carry out an ex-post analysis of the

initial results thanks to the data provided by the local Public Transport Authority (PTA), commissioner of the study.

The results of this PhD thesis, obtained from the study of the literature and the analysis both at national level and of a single case study, are multiple and provide useful indications to policy makers and transport providers for the implementation of DRT services in hard-to-reach areas with low transport demand, capable of truly satisfying the mobility needs of the inhabitants by favoring the use of public transport and slowing down the processes of depopulation and economic marginalization affecting these contexts.

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CHAPTER I

INTRODUCTION

1. Introduction

Even before Covid-19 pandemic the transport sector, and in particular urban mobility, was facing some complicated challenges: traffic in constant increase, few green spaces available to citizens, massive use of private vehicles preferred to public and sustainable modes of transport. The advent of aforementioned contagion has in fact prompted local administrations to rethink their urban public transport system: negative externalities of this contingency are known to all but, during this historical period, many growth opportunities have also arisen that policymakers and institutions should seize.

The main mobility trends in place, developed as a result of the pandemic period and the related restrictions, are mainly attributable to phenomena such as the affirmation of e-commerce and tele-work and to the repopulation of rural areas in cities' surroundings.

The repopulation of the so-called low-demand areas, portions of territory (urban or interurban) with "low or medium-low demand for transport and characterized by a considerable spatial and temporal dispersion" (Campisi et al., 2021), as a result of the need of people to pursue a greater quality of life, occurs after decades of progressive depopulation of the same contexts mainly due to scarce and infrequent transport links: here service lines are often neglected by public transport authorities (PTAs) because of the lack of economic sustainability resulting from low transport demand in these territories. Due to an unsatisfactory transport service, many people have been forced in recent years to commute with their own means of transport or to move directly to live in city centres in order to avoid social exclusion, marginalization from essential activities and economic impoverishment (König and Grippenkoven, 2020).

1.1 Overview of the PhD Thesis

Although Demand Responsive Transport (DRT) has already existed for several years, a large part of the academic literature has focused on its application in urban contexts: at a rural and mountain level, territories characterized by a scarce population and low transport demand, little attention has been paid. At the Italian level, as well as in the European Union, there is the firm will of countering the phenomenon of depopulation

of rural areas and guaranteeing the resident population an efficient public transport service as an alternative to the use of cars: to this end, specific political measures have been promoted aimed at identifying the territories most in need of intervention. This PhD thesis intends to provide an analysis of a specific inner area (Antola-Tigullio Valleys, in Liguria Region), through the description of its socio-demographic characteristics and travel behaviour of citizens: on the basis of this information, obtained through questionnaire submitted to the mayors of the municipalities involved, it was possible to formulate some hypothesis of DRT services, which were subsequently brought to attention of the PTA commissioning this study. Based on the ex-post data provided by PTA regarding the first DRT pilot launched (Ne, Val Graveglia), an analysis of the service's performance was then carried out highlighting strengths and weaknesses.

This PhD thesis consists of eight chapters. The first chapter introduces on-demand transport, remarking on the urgency of finding alternative solutions to traditional public transport for social, economic and environmental reasons. Additionally, it provides an overview of the thesis, the methodology used for the research and the key theory about transport justice. The second chapter ("Demand Responsive Transport: characteristics and historic evolution") describes briefly the alternative forms of mobility available nowadays globally and then it focuses on the technical characteristics of demand transport by providing a series of definitions attributed in the literature, by illustrating the technological functioning and by stating the types and business models of DRT service. Furthermore, chapter II describes the historical evolution of on-demand transport starting from the early 1900s up to the present day (many European projects are presented): for this purpose, it is interesting to observe the strong link between the diffusion of this service and technological progress over time.

The third chapter reports on a substantial literature review of DRT, also stating the successes and failures of the service at a global level and the costs associated with this technology. In the fourth chapter, the analysis of all rural DRT cases present in Italy since 2010 is provided, illustrating their main structures and analysing the results. The fifth chapter intends to describe the characteristics of inner areas and how the Italian Government intends to address, as mentioned, the problem of depopulation of these territories and social isolation of people residing there through the National Strategy for Inner Areas (SNAI). In addition, this section describes socio-demographic and mobility

characteristics of inhabitants of the Antola-Tigullio inner area: this study was preparatory to the planning of three DRT services in this area proposed in the following chapter ("*Hyphotesis of DRT services in Antola-Tigullio inner area*"). Chapter VI reports the analysis of the mayors' answers: based on these, it was possible to propose three different DRT cases in as many rural contexts. This chapter also presents the inspection carried out on the field and a SWOT analysis aimed at highlighting the strengths and weaknesses and threats and opportunities of the hypothesized DRT services.

Chapter VII proposes an ex-post analysis of the performance of the first DRT service implemented in the area (Ne, Val Graveglia) thanks to the data provided by PTA: from this study, it was possible to evaluate the efficiency of the service and formulate any corrections. Finally, chapter VIII concerns the conclusions of this PhD thesis, reporting research limitations and future agenda.

The questionnaire submitted to the mayors of the municipalities is in the appendix at the end of the elaborate.

1.2 Thesis research methodology

In this section it is important to present the research methodology adopted in this thesis to address the following research questions identified:

- RQ1: *"What are the main strengths and weaknesses of DRT in rural areas?"*
- RQ2: *"What is the current layout of the on-call service offer in Italy's rural areas?"*
- *RQ3: "What is the level of technological maturity used in DRT technology nationwide?"*
- RQ4: "*What are the perceptions of Mayors of inner areas concerning the characteristics of the territory and the residents' travel behaviour with regard to the implementation of DRT services?"*
- RQ5: *"How did the DRT service perform when tested in Antola-Tigullio Valley?"*

In order to address above research questions, four different methods were used in this elaborate depending on the data needed:

1. Research Method (RQ1) - International literature review;
2. Research Method (RQ2/3) - Cataloguing of Italian rural DRT services;
3. Research Method (RQ4) - Survey of Mayors;
4. Research Method (RQ5) - Data analysis of a specific DRT pilot project.

To answer RQ1, an international literature review was conducted (chapter III) aimed at identifying the success and failure factors of some of the most important DRT case studies at a global level. From this analysis it was possible to clearly outline the strengths and weaknesses of this technology.

In response to RQ2 and RQ3, chapter IV shows the state of the art of rural DRT services in Italy: for this purpose, an analysis was carried out aimed at identifying all the on-call services operating in the national context and consequently evaluating their main technical and strategic characteristics. This study was carried out by looking at the Project Framework Agreements of Italian Regions[1], consulting the websites of industry organizations, and conducting a keyword search on Google Scholar and Web of Science using the search terms "Rural DRT cases," "On-Demand Transport Low Demand Areas," and "Demand Responsive Transport in Rural Areas" along with the words "Italy" and the names of all the Regions.

Identifying rural DRT services provided in Italy starting in 2010 was the task at hand (this includes both still active and already expired services): the research began in 2010 in order to examine DRT cases within the same historical and technological development context because of their heavy reliance on technology. 35 cases of rural DRT were found after the analysis.

Furthermore, the work proceeded by comparing, for each DRT service taken into consideration, the key traits important for comprehending the vast array of options that

[1] The Framework Program Agreements represent the implementation tool through which Regions undertake to achieve the objectives contained in the SNAI document.

this technology can provide (service name, area, manager, period of activity, time slot, booking system, cost of the service, flexibility of the service, availability of dedicated App).

The selected DRT cases were then divided into 4 separate categories based on how far away from major centres they were, along with a group of DRT services specifically for tourists. In order to provide an overview of the solutions most frequently adopted by PTAs, each rural DRT service is assessed based on how flexible it is. For this purpose, an evaluation system is proposed assigning a score on a scale of one to six depending on the DRT flexibility degree.

RQ4 is addressed in chapter VI of this work: in the design phase of the DRT services of Antola-Tigullio valley it was crucial to thoroughly analyse the travel habits of citizens and the demographic, orographic and technical characteristics of the territory. In this regard, a questionnaire of nine questions was submitted to the mayors of all the municipalities involved in the project, requesting the following information:

- current situation of the municipality (population, accessibility, essential services);
- categories of users most in need of the DRT service and time slots not covered by the currently existing traditional transport;
- interventions relating to the current traditional transport considered a priority;
- origins and destinations where DRT service would be more useful;
- possible collaborations with private subjects;
- need to transport additional items such as food, medicine and mail;
- involvement of the tourism sector in the DRT service project;
- judgment on the availability/propensity of the inhabitants to use info-telematic technologies;
- further suggestions.

Since the goal of the research was to gather the most impartial and accurate information about the area, it was decided to only interview the Mayors of the municipalities involved and exclude the general public. As representatives of the communities they are a part of, the Mayors were the best choice of available options.

Furthermore, it should be noted that this choice also presents limitations: although the Mayors have excellent local knowledge of transit service provision and gaps in their jurisdictions, they are not necessarily transport experts, nor are they likely users of the DRT services.

Additionally, the questionnaire approach was employed to collect responses that were as uniform and comparable as possible: a long-form questionnaire was preferred to other data collection techniques as it was more convenient for both the study team and the participants, and it allowed for collection of further issues and information if the respondent wished.

For the purposes of this research, a GIS investigation was not conducted on the territory: in-depth spatial analysis and accessibility analyses of the DRT services was considered as a possible research approach. But it was rejected given: the lack of consistency in the literature about DRT accessibility measures; the diverse aims and objectives, and coverage areas, of each of the DRT schemes included in the study; and, the very different operational arrangement for these services. This is an area for further research and development in the research field, and then for application in the Italian context.

The first DRT service launched in the reference area was analysed in chapter VII to address RQ5 and evaluate the efficiency and attractiveness of the service. Based on the operational data collected and kindly provided by the transport manager (AMT S.p.a.), the following service performances were evaluated:

- Booking method;
- Ride duration;
- Stops frequency of use;
- Booking requests;
- Ride requests;
- Service time;
- Users transported.

The analysis of this data helped to clarify the benefits and drawbacks of the service under test.

Figure 1 graphically shows the structure of this work indicating the link between each research question identified, the method chosen to address the issue and the chapter of the thesis in which the results can be found.

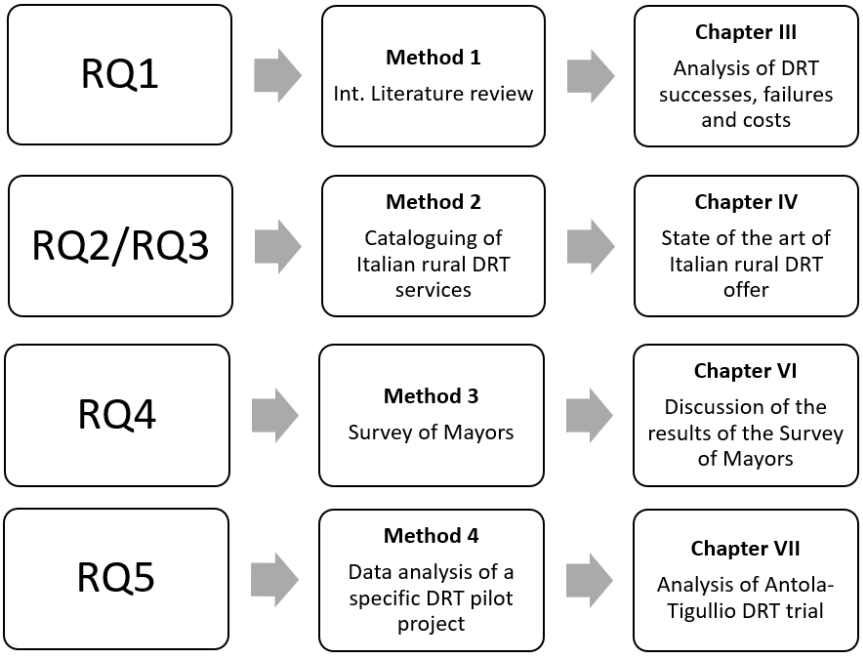

Figure 1.1 Layout of PhD thesis

Further information on research methods 1- 4 are provided in each of the relevant chapters.

1.3 Key theory on transport justice

This section of the thesis intends to shed light on a key aspect underlying the decision-makers' decisions to implement the DRT service: the concept of transport justice.

1.3.1 Social justice theories affecting transport scholars

Scholars have adapted main theories of social justice to the transportation industry; the most influential of these are the "Theory of a Justice" (1971) by American philosopher

John Rawls, "Spheres of Justice" (1983) by political philosopher Michael Walzer, and the "capability approach" (1980s), the product of the collaboration between economist Amartya Sen and philosopher Martha Nussbaum.

A fair society, in the opinion of Rawls (1971), is one in which everyone has access to the same fundamental liberties and opportunities and in which social and economic inequalities are intended to benefit the defenseless members of society. In Rawls' theory, which has been influential in political philosophy, a wide variety of social issues are addressed, such as healthcare, education, and international justice. The theory is criticized for being overly utopian and for failing to fully address the problem of dominance and power in society. However, Rawls' theory continues to make a significant contribution to the discussion of social justice and the function of the state in fostering a fair society.

As stated by Walzer (1983), distributive justice should be viewed as an elaborate concept, with various resources and commodities being distributed in accordance with different principles of justice. He distinguishes many "spheres" of social existence, each with its own set of resources and benefits. The first category of justice, referring to goods and resources traded on the market (e.g. money, property, and labor), is the sphere of market goods: according to the author, the distribution rule in this area should be based on merit and effort, such that those who put in more effort and make more contributions to society are entitled to a larger portion of these benefits. Secondly, the sphere of social goods covers goods and resources distributed through social institutions (e.g. education, healthcare, and welfare): the distribution principle should be based on need, so that individuals who need these resources and things the most receive the largest part. Thirdly, the sphere of political power includes the distribution of political influence and power in society: participation and representation should serve as the foundation in this context so that every member of society has an equal voice in choices that have an impact on them. Lastly, the sphere of culture covers the distribution of cultural products and resources like music, books, and artwork: the distributional ratio ought to be founded on pluralism and variety, allowing various ethnic groups to preserve their own traditions and beliefs.

In political philosophy, Walzer's theory of spheres of justice has been important and has been used to address a wide range of social challenges, including transport, education and sustainability. His approach has been criticized for lacking a clear framework for

resolving disputes between the many spheres of justice, and for failing to adequately address the problem of allocating resources between them. Nevertheless, Walzer's theory continues to make an important contribution to the current debate on distributive justice.

The 'capability approach' is a conceptual framework developed by philosopher Martha Nussbaum and economist Amartya Sen to promote a deeper understanding of social justice and human flourishing. It focuses on people's capacities rather than their access to resources and emphasizes the value of their ability to achieve their goals and live satisfying lives. Put simply, the capacity approach emphasizes the opportunities and possibilities that people have to pursue their own goals and lead fulfilling lives.

According to this method, people's well-being should be measured in terms of their ability to engage in certain 'capabilities' or 'functionings' that are necessary for a fulfilling life. Capabilities refer to the actual opportunities that people need to take advantage of in order to achieve worthwhile outcomes, such as being healthy, having access to education and participating in political life. On the other hand, 'functionings' are the actual outcomes or states of being, such as being educated or healthy, that result from using these capabilities.

The capability approach emphasizes the importance of considering a wide range of elements, including social, economic and political circumstances that contribute to people's capabilities. It also emphasizes the value of recognizing the diversity of human beliefs and aspirations, and the need to foster a diverse society in which everyone is free to pursue their own goals.

Several social concerns, including poverty, gender inequality and the rights of people with disabilities, have been addressed through the capacity approach. It has been used to argue against standard economic development indicators that only include GDP and income, and to support policies that provide social and economic opportunities for neglected people.

The approach's emphasis on people's autonomy and its understanding of the importance of social, economic and political factors in promoting wellbeing are some of its key strengths. According to its critics, the approach can be difficult to put into practice and may not provide a clear direction for policy formulation. Nevertheless, the theory

continues to make an important contribution to the contemporary debate on social justice and human flourishing.

1.3.2 Transport justice

Transport justice refers to the fair and equitable distribution of the benefits and disadvantages of transport across populations, regions and times. Infrastructure and transport networks can either improve or limit people's access to essential services, employment opportunities and social activities. As we have seen, this has significant implications for social justice.

Transport justice can be understood along several dimensions: first of all, the distributional justice, which is the fair distribution of resources, benefits and liabilities among various people and regions and includes access to transportation services, cost, and the geographic distribution of transportation infrastructure. Secondly, the procedural justice, which investigates the fairness and openness of decision-making procedures pertaining to planning and policy for transportation and covers topics such as accountability, representation, and public engagement. Thirdly, the recognition justice, which is concerned with the respect and acknowledgement of many cultural identities, ways of living, and preferences, and might affect how accessible and popular transportation alternatives are. Furthermore, the environmental justice refers to the equitable distribution of environmental advantages and liabilities related to transportation, including problems with air and noise pollution, climate change, and resource consumption.

As a complex and multidimensional concept, transport equity often involves trade-offs and conflicts between its various aspects. For example, promoting accessibility and distributive justice through transport infrastructure development could have negative environmental or social impacts. Achieving transport justice therefore requires a comprehensive and integrated strategy that considers the links between many aspects of justice and the complex trade-offs that exist between them. Achieving transport justice is difficult for a number of reasons: For instance, the distribution of transport services and infrastructure is often unfairly biased in favor of some communities or groups, leaving

others with little or no access to vital opportunities and services (perpetuating current social and economic inequalities). Many transport policies and plans are developed without sufficient feedback from citizens, especially disadvantaged and marginalized groups. As a result, policies may be implemented that are insufficiently responsive to the wishes and needs of these groups. Transport planning involves a number of parties with different and often conflicting interests and values. Promoting social equity may conflict with promoting economic growth or increasing accessibility may conflict with promoting environmental sustainability. For many communities and governments, especially those with limited resources, transport projects often require significant financial and human resources. In addition, it can be difficult to secure the institutional support and political will necessary to achieve equity in transport: political factors or bureaucratic constraints can influence transport policies and plans, thus hampering attempts to promote equity and fairness. Finally, particularly for poor and marginalized populations, detailed and disaggregated data on transport patterns and impacts are often lacking, making it difficult to identify and address transport equity problems.

Addressing these issues requires a collaborative and multidisciplinary strategy involving a wide range of actors from the public and private sectors, civil society and academia. It also requires a commitment to openness, accountability and public participation in the development of transport policies and plans.

In recent years, many authors have contributed to the research in this field by providing different definitions of the concept of "transport justice" (Table 1.1).

Table 1.1 Definitions of "transport justice" identified in the literature

DEFINITION	SOURCE
"Equity (also called justice and fairness) refers to the distribution of impacts (benefits and costs) and whether that distribution is considered fair and appropriate. Transportation planning decisions have large and diverse equity impacts. For example: • *Transport expenditures are a major share of household, business and government spending.*	Litman (2002)

• *The quality of transportation options available affects people's quality of life, and economic and social opportunities.* • *Transport facilities and activities impose various external costs including infrastructure subsidies, congestion delay, crash risk and pollution damages imposed on other people.* • *Transport planning decisions can affect development location and type, and therefore accessibility, land values and local economic activity."*	
"in current transportation planning practice, distributional goals are either not stated at all, are implied but unclear, or, when stated explicitly, are not based on a well-developed moral argument."	Martens et al. (2012)
"a more fair, equitable distribution of the benefits and disadvantages of transportation interventions."	Jennings (2015)
"Recent efforts to emphasize social equity in transportation are emerging as local, regional, and national governments have required agencies to identify and avoid impacts (disproportionately) to low-income and minority population. The U.S. DOT has identified three strategies to address environmental justice: • *Reduce adverse human health and environmental effects on minority and low-income populations.* • *Include all potentially affected communities in the transportation decision-making process.* • *Ensure that minority and low-income populations receive equitable benefits.* *Some agencies have expanded the concept of EJ (environmental justice) areas to encompass transportation constrained populations, such as households without vehicles, disabled persons, and seniors (age 65+), referred to as transportation justice (TJ) areas. Transportation justice can be referred to as the expansion of environmental justice principles to transportation through investigating mobility, access, and modal opportunity."*	Beiler and Mohammed (2016)
"Transport justice in this paper refers to a political ideal primarily concerned with distributional equality, treating people as equals when resources are transferred or distributed among them. This refers to fairness in the distribution of burdens, risks, access, or valuation of assets between different traffic participants. Transport justice thus refers to an achievement of greater equality or the abolishment of injustices."	Gössling (2016)
"Justice considerations stress disadvantaged populations, with the intent to improve equality with respect to accessibility and mobility."	Hananel and Berechman. (2016)

"a transportation system is fair if, and only if, it provides a sufficient level of accessibility to all under most circumstances."	Martens (2016)
"Whether people can get to key services at reasonable cost, in reasonable time and with reasonable ease"	Banister (2018)
"Transportation justice describes a normative condition in which no person or group is disadvantaged by a lack of access to the opportunities they need to lead a meaningful and dignified life. It involves transforming the structures and processes that lead to the inequitable distribution of transportation's multiple externalities (e.g., noise, pollution, visual intrusion, risk of bodily harm, and exposure to law enforcement, among others) across populations and space. Also essential to this notion of transportation justice is that residents and other stakeholders should be able to actively participate in and influence the decisions that affect their lives."	Karner et al. (2020)
"Our working definition of transport justice builds on (…) notion of "transport injustice" as a multi-dimensional construct where space distribution is one of three key dimensions that play a determining role in the fair distribution of accessibility. The cost of urban mobility infrastructures is essential in transport justice because transport infrastructure development is a capital-intensive activity. The development of long-term and efficient financing for transport systems is essential for citizens' well-being."	Guzman et al. (2021)
"Transportation planning and infrastructure decisions often ignore the needs of transportation-disadvantaged populations. This creates inequitable outcomes and results in situations where many cannot meet basic needs for mobility and access. In general, drivers enjoy shorter travel times, greater accessibility, and better employment outcomes than those who use other modes. Cyclists of color are more likely to be killed or injured in crashes and subject to law enforcement than white cyclists, and wealthier populations are more likely to have access to high-quality public transit than low-income residents. Furthermore, transportation's dependence on fossil fuels results in substantial greenhouse gas emissions, driving global climate change. It is well documented that the harms of climate change will fall on society's most vulnerable. Our transportation systems, travel behaviors, and policies are therefore critical sites for advancing and implementing equity and justice ideals—creating a world where people have true access to the transportation resources, they need to lead meaningful, joyful, fulfilling, and dignified lives."	Karner et al. (2023)

"Transportation justice is an important ethical issue of our time and includes reforming and transforming systems, approaches and processes that lead to inequitable distribution of transportation externalities while providing beneficial access to systems and services through procedural engagement in transportation planning across populations and space"	Panikkar et al. (2023)

Source: Author's elaboration

In order to promote fairness, equity and sustainability in transport systems, a growing field of study called 'transport justice' has emerged. Scholars have approached the idea of transport justice from a variety of perspectives, including mobility justice, transport justice and equity. They have also explored a range of issues and themes relevant to transport justice, such as politics and power, innovation and technology, climate change and resilience, collaboration, and co-creation methods. One of the most important scholars in this field is without a doubt Karel Martens, who wrote *Transport Justice* (2017).

Martens, taking advantage of Michael Walzer's "Spheres of Justice" theory, states that "transport good", "defined as accessibility, should be distributed in a so-called separate sphere, i.e. independent from the way in which other key goods, like money or power, are allocated." (Martens, 2012)

According to Martens, transport systems have significant effects on social justice since they may make it either easier or harder for individuals to access essential services, employment opportunities, and social activities. Further discrepancies may come from different transportation policies and practices' impacts on underprivileged and marginalized populations.

Martens delves deeper into the myriad facets of transport justice, examining the potential effects that various infrastructure and modes of transport may have on the distribution of opportunities and resources among populations, regions, and times. Geographic disparities, social exclusion, environmental degradation, and health inequities are just a few of the several sorts of transport injustice the author looks at.

Three crucial dimensions (distribution, recognition, and participation) are included in the normative framework for transport justice proposed by Martens. The equal distribution of resources, benefits and burdens among different people and regions is referred to as 'distribution'. The recognition of different cultural identities, habits and preferences is referred to as 'recognition', which can affect how accessible and palatable different transport alternatives are. To ensure that their opinions and needs are heard and taken into account, 'participation' refers to the involvement and empowerment of stakeholders in the decision-making processes that affect their lives.

In order to demonstrate how transport equity issues manifest themselves in practice and how they can be addressed through policy and planning interventions, Martens also offers case studies and examples from different contexts and regions. The importance of a holistic and integrated approach to transport equity is emphasized, recognizing the links between different dimensions of equity and the complex trade-offs that exist between them.

Additionally, further scholars contribute to the discussion on transport justice.

Karner et al. (2020) state that a switch from transportation equality to justice is required. They draw attention to the necessity of tackling past injustices, present-day power disparities, and laws and institutions that affect transportation. In their study on the connection between transport justice and the allocation of urban space in the Colombian city of Bogotá, Guzman et al. (2021) place a strong emphasis on the value of taking into account the various requirements and interests of multiple stakeholders: the authors focus more on, what Martens called, the 'participation' dimension.

While Gössling (2016) investigates urban transport justice, combining three areas where inequities are clear, namely exposure to dangers and pollution from traffic, allocation of space, and time spent in transit, Jennings (2015), exploring the “recognition” and “distribution” dimensions, reviews the literature and policies pertaining to transport justice in South Africa concluding that different assessments used throughout both the planning and impact evaluation stages (such as quality of life, equity and social cohesion), may result in a more in-depth comprehension of any advantages realized. Banister (2018) analyzes transportation inequity in the UK, whereas Karner et al. (2023) present new viewpoints on transportation justice: the authors were able to summarize the state of the

art in 2022 of transport justice in terms of theories, evaluation techniques, and research questions thanks to the review of 20 articles. Panikkar et al. (2023) investigate distribution dimension of transportation justice in Vermont areas with high environmental risk and the findings of their research show that low-income populations and people of color face greater difficulty in accessing transportation services, which makes it harder for them to find nutritious meals. A "capability approach" to justice and transportation decision-making is set out by Hananel and Berechman (2016), showing the real-world case study of King County (USA), while paternalism and production difficulties are covered by Vanoutrive and Cooper (2019) in their discussion of transportation justice theory, citing the examples of the Transportation Justice movement (California, USA) and the discussion of “basic accessibility” in Belgium.

Other researchers, studying distribution dimension, have looked at the connections between transport justice and walking, public transportation, and accessible networks for those with intellectual disabilities (Sagaris and Tiznado-Aitken, 2018; Adli et al., 2019; van Holstein et al., 2022). Verlinghieri and Schwanen (2020) examine the developing debates surrounding mobility justice and transportation, while in challenging times of global warming and fierce urbanization, mobility justice is a topic Sheller (2018) addresses.

In general, the literature on transport justice emphasises the importance of promoting fairness, equity and sustainability in transport systems, and the need for multidisciplinary and collaborative approaches to achieve these goals. It emphasises the need to understand the power dynamics that influence transport policies and practices, and the need for participatory and co-creative approaches that prioritize the diverse demands and interests of all stakeholders.

It should be noted that the most recent studies on DRT are strongly influenced by the work of Martens, focusing on the three dimensions of the Martens structure.

Demand-Responsive Transport is among the best options for improving transportation accessibility for underserved communities and ensuring equal opportunities for all citizens, particularly for those who lack access to a vehicle of their own and run the risk of becoming economically and socially isolated.

This study aims to address the three Martens-identified dimensions of transport justice at the distribution level, allowing fair access to public transportation for residents of rural areas, at the recognition level, considering the differences in mobility needs of locals in various contexts, and at the participatory level, involving all interested parties.

The next chapter focuses specifically on DRT by emphasizing the positive and negative aspects that have been noted in the academic literature and outlining the main causes of both successes and failures.

CHAPTER II

DEMAND RESPONSIVE TRANSPORT: CHARACTERISTICS AND HISTORIC EVOLUTION

2. Demand Responsive Transport: characteristics and historic evolution

The object of this inquiry, as specified in the introduction, is the study of the characteristics of on-demand transport service in rural areas: before delving into its dynamics, however, it is first necessary to describe all alternative options to fixed transit operating worldwide in order to better understand their potential and operating mechanisms.

2.1 Forms of mobility alternative to Fixed Transit

For years, new forms of public mobility other than traditional transport have been experimented at both urban and rural levels. The main purpose of these experiments is twofold: policymakers aim at avoiding economic and social isolation of some peripheral and poorly served areas and, at the same time, transit providers want to reach financial sustainability and service efficiency. In addition to this, PTAs, as a result of the development of this type of alternative forms of mobility, can become leader in the field of innovation and improve their corporate image and reputation in the eyes of customers.

Having to compete with private vehicles, in order to discourage their possession and use, new alternative services must represent an economic opportunity for users to be used: these forms of mobility thus represent a compromise between the characteristics of convenience and flexibility typical of cars and taxis and the economic convenience of public transport (Mageean and Nelson, 2003).

The aforementioned types of mobility, developed over time, are adaptable to different contexts thanks to their flexibility characteristics: they are generally used in cities (especially in hilly or peripheral areas characterized by a high rate of motorization) in order to integrate traditional public transport or in rural areas with a very low population density, especially mountainous territory, and a high aging rate of the resident population.

Before we turn to contemporary DRT, different technologies of this kind of service have long been in use.

The most relevant are collected in Table 2.1.

Table 2.1 Examples of flexible mobility services (FMSs)

SERVICE	CHARACTERISTICS	SERVICE MODEL[2]	USERS	SUBSIDY
Dial-a-Ride	- On demand service - Stops on request - Non predetermined route - Booking required	Many-to- Many (from a plurality of origins to a plurality of destinations)	Low income, elderly or disabled residents	Often state subsidized
Collective taxi	- On demand service - Stops on request - Predetermined route - Booking required	Many-to- Many (from a plurality of origins to a plurality of destinations)	Residents, workers	Often state subsidized
Shuttle	- On demand service - Stops on request - Predetermined route	Few-to-Many (from a few points of origin to a plurality of destinations)	Tourists	Often state subsidized
Jitneys	- Stops on request - Predetermined route - Private operators - Minimal regulation	One-to-Many (from a single point of origin to a plurality of destinations)	Low income, elderly or disabled residents, workers	Usually no state subsidy
Rental vehicles	- Stops on request - Non predetermined route - Booking required	One-to-Many (from a single point of origin to a plurality of destinations)	Residents, workers, tourists	Usually no state subsidy

Source: Author's elaboration based on (Lunardon, 2011)

[2] Service models are dealt with in the continuation of this thesis.

2.1.1 Dial-a-Ride

Dial-a-Ride services, the object of study of this thesis, are briefly introduced here to be then fully described in the course of the whole paper.

A Dial-a-Ride service (Figure 2.1), also known as Demand Responsive Transport or Paratransit, is a transport service model, which provides for the use of small vehicles by the transit provider (typically 8 or 14-seater minibuses). This service does not present a predetermined time schedule but PTA can activate it only in event of user's request: furthermore, in the most flexible forms, it perfectly adapts its route and stops to the needs of passengers ("Door-to-door" service).

Figure 2.1 Dial-a-ride service

Source: Motacilla, Wikimedia.org

2.1.2 Collective taxi

Collective taxi is also a compromise between public and private transport with its own characteristics very similar to those of Dial-a-ride (on-demand transport service, stop bookable on request, seat on board bookable compulsory in advance). The substantial difference is relative to the definition of the route: in Dial-a-ride services, it varies from

time to time based on users' requests, while in collective taxis it is established in advance during the service-planning phase.

Collective taxi is a transport carried out by minibuses or taxis, normally managed by private companies: it differs from a common taxi for the possibility of sharing the ride with other passengers at discounted prices. Once the operations centre receives user's reservation with basic data (e.g. origin, destination, time, and place of departure), an algorithm matches all passengers 'needs in order to make a single trip.

Collective taxis represent one of the most widespread forms of mobility alternative to traditional transport in the world, especially in developing countries where they often replace it entirely (being cheaper and faster). Below are some globally known examples.

An example of Collective taxi in Tunisia is in Figure 2.2

Figure 2.2 Collective taxi

Source: Wael Ghabara, Wikimedia.org

Marshrutka

The term "Marshrutka" identifies a traditional collective taxi service typically carried out by 15-seat minibuses and widely spread in Russia, Ukraine and in the former Soviet Republics, especially among students and seniors (Figure 2.3). Widespread in the Soviet Union since the 1930s, it remains today one of the most popular modes of transport

in these countries, representing a valid integration to traditional public transport (Weicker, 2020).

A fundamental feature of this service is the possibility for users to stop the bus at any time along the predetermined route of the vehicle, simply by notifying the driver (Gallo, 2020): in fact, there is no call booking system on board the vehicle but it is necessary to communicate to the driver “At the next stop, Please!".

Figure 2.3 Marshrutkas in Ukraine

Source: Alex Shhhh, Wikimedia.org

Daladala, Mabasi, Matatu

There are also several examples of collective taxis currently active on the African continent. In Tanzania, in particular in the most populous city Dar es Salaam is active the so-called service “Daladala”, or “Dalla-dalla”: it became increasingly popular especially from the 1980s, as a result of the collapse of the local public transport system (Citizen, 2014). Unlike what happens in the West countries where on-demand service integrates fixed transport (FT) or acts as subsidiary, in a lot of African countries it represents the main form of public transport: the stops are not often predetermined but adapt to the needs of customers in real time (Mfinanga and Madinda, 2016).

In Zanzibar, the collective taxi service is carried out by two different means of transport: the aforementioned Daladala (for shorter journeys) in urban areas, and the so-called “Mabasi” for longer journeys between different cities.

In Kenya, the so-called “Matatu” carries out the same transport service: 14-seater minibuses travelling on pre-established routes and serving about 87% of passenger market share in Nairobi, the capital (Behrens et al., 2017).

An example of Daladala in Dar es Salaam is in Figure 2.4.

Figure 2.4 Daladala in Dar es Saalam

Source: Muhammad Mahdi Karim, Wikimedia.org

Peseros

Examples of Central American collective taxis are so-called “*Peseros”* (the name derives from the cost of the original ticket of 1 pesos) of Mexico City which every day serve millions of passengers (Figure 2.5): they have developed more and more during the second half of the last century thanks to the flexibility of the service they offer and the possibility for users to stop vehicles at any point on the road, regardless of the location of the fixed stops. The owners of these vehicles, earning based on the number of passengers transported and having mild vehicle capacity limits, tend to get as many users on board as possible to overload the vehicle and move much faster than their competitor's traditional buses (Roschlau, 1981).

Figure 2.5 Pesero in Mexico City

Source: Javisbg618, Wikimedia.org

Songthaews, Dua baris, Lain ka

In Southeast Asia, similar vehicles as above provide on-call transport in the form of collective taxis. In Thailand, for example, the “Songthaews” (literally “two rows”) circulate on the streets of the main cities (pick-up covered with two rows of wooden benches at the ends). They are very popular among the less affluent population as they represent the cheapest and at the same time most flexible form of mobility (Phun and Yai, 2016): the price of transport and the route are predetermined by the transport company and users can stop the vehicle with a wave of the hand, get on board, settle on the benches, book desired stop by pressing a buzzer and pay directly to the driver (Figure 2.6).

The main difference with traditional transport concerns the absence of fixed stops: passengers can get on and off the vehicle, wherever they are.

The same service takes different names depending on the country in which it is provided: Songthaews in Thailand and Laos, "Dua baris” in Malaysia and “Lain Ka” in Myanmar. In Southeast Asia, these paratransit services represent an important component of local public transport, integrating and sometimes replacing the lines of FT.

Figure 2.6 Songthaew in Thailand

Source: Mattes, Wikimedia.org

2.1.3 Other forms of mobility

As per Table 1.1, the forms of mobility of shuttle, jitneys and rental vehicles are briefly described below.

Shuttles are an on-call service in which the route is predefined, and users can book stops on board the vehicle. It is a one/few-to-many type of service where the shuttle connects a single origin (e.g. the main city station) or a few origins (e.g. the main city station and central market) with a plurality of destinations (e.g. the addresses of each individual passenger).

The jitney ("jitney" was the original slang name for the $5 ticket price) is a transport service where route is predefined, but time schedule is flexible: jitneys' routes are usually circular and move around large commercial hubs, airports and wide residential areas. This service is aimed mainly at workers and poor people.

Finally, for a specific transport (e.g. a group of workers of a company), people can directly rent means of transport such as a minibus capable of fully meeting travel requests.

2.1.4 The role of state in flexible mobility services

Depending on the specific setting, the political and institutional frameworks in place, and the type of flexible mobility supply being provided, such as DRT, shared taxis, jitneys, shuttles, or rent vehicles, the role of the state might change. However, the government may assist in the provision of flexible mobility supply in a number of ways:

- FMSs can be regulated by the state to guarantee user safety, credibility, and affordability. In doing so, it may be necessary to create fare structures, service zones, and emission and safety regulations for vehicles;
- The expense of providing services in socially essential but financially unproductive places, such as rural or low-density metropolitan areas, might be mitigated by the state by giving subsidies or financial aid to operators of FMSs;
- The state can encourage the integration of flexible mobility services with other forms of transportation, such as public transportation, walking, and cycling, by using land use planning regulations. Designing transportation hubs or interchanges that enable transfers between various types of transportation might be one way to achieve this;
- For the purpose of delivering FMSs, the state could establish alliances with businesses in the private sector. For instance, the state may enter into agreements with private operators to offer DRT services in places where there is no access to public transportation or collaborate with community organizations to set up shared-transportation programs for certain populations, such as the elderly or the disabled.

When developing FMSs, fares must be taken into account since they might affect consumers' access to and usability of the service. Setting prices for FMSs might provide the state with a number of difficulties (Table 2.2):

Table 2.2 State challenges in setting FMSs fares

Main goal	Issue	Possible solution
Economic sustainability	FMSs need a substantial investment in equipment, vehicles, and technology.	It may be necessary for the state to set tariffs that support cost recovery and guarantee the service's long-term viability.
Users' affordability	FMSs are frequently intended for underprivileged groups of people who would have trouble accessing cheaper transportation choices.	The government may have to set prices that are reasonable for these customers and make sure that everyone may utilize the service.
Competition	FMSs compete with already-existing transportation services like taxi or public transportation.	In order to ensure the service's long-term viability, the state may need to establish prices that are similar with those of other suppliers.
Incentives	To encourage consumers to utilize the service, FMSs may provide incentives like discounts or awards.	It may be necessary for the state to set prices which achieve a balance between these incentives and the demands of cost recovery and long-term viability.
Fairness	Different user groups, particularly low-income or disadvantaged people, may be affected by FMSs differently.	The government may have to set fair prices and make sure that everyone in society may use the service.

Source: Author's elaboration

As a whole, implementing FMSs may be difficult for the government, and it necessitates careful planning, organization, and regulation to guarantee the service's sustainability, usability and safety.

Afterwards a description of the main alternative mobility options utilized across the world (collective taxis, shuttles, jitneys, and rental cars), the thesis's focus shifts to on-demand transportation in the next chapters, as mentioned before.

2.2 Demand Responsive Transport

On-demand transport allows local PTAs to make their services more efficient by optimizing vehicles' load-factor: a DRT system well integrated with FT on one side discourages the use of private vehicles in favour of public transport, resulting in pollution and land-use reduction, and at the same time incentives citizens to repopulate some residential areas further away from the city centre but with a higher quality of living.

Table 2.3 shows the main definitions of Demand Responsive Transport over time in the academic literature, in chronological order.

Table 2.3 Definitions of DRT in academic literature

DEFINITION	SOURCE
"TTDC's (Tidewater Transportation District Commission) dial-a-ride paratransit service is a shared-ride taxi service; it is offered to low-density residential areas as a feeder service to motorbus routes and as a substitute for evening and weekend motorbus services. Dial-a-ride paratransit service is generally defined as a shared-vehicle service, which provides door-to door service on demand to a number of travellers with different origins and destinations. Dial-a-ride service is a type of demand-responsive paratransit service, since it is flexible in time and non-scheduled. The request for TTDC's dial-a-ride service is made by telephone."	Talley and Anderson (1986)
"transportation options that fall between private car and conventional public bus services. It is usually considered to be an option only for less developed countries and for niches like elderly and disabled people"	Bakker and Van der MaaS (1999)
"A wide range of local transport which is complementary to conventional, scheduled passenger transport based on large buses, trams and regional trains. This is usually provided by smaller buses, minibuses, vans, taxis and cars and serves dispersed mobility needs, either during hours of low demand, in areas of low population, or where the target users are dispersed among the general population. These services normally act at a very local level, and are either for the general public, or for specific groups (e.g. disabled and elderly). They provide local mobility, as well as	Ambrosino et al. (2000)

connections to other conventional forms of transportation (e.g. from regular bus network to railway service).	
"Demand Responsive Transport (DRT) services provide transport ''on demand'' from passengers using fleets of vehicles scheduled to pick up and drop off people in accordance with their needs. DRT is an intermediate form of transport, somewhere between bus and taxi which covers a wide range of transport services ranging from less formal community transport through to area-wide service networks."	Mageean and Nelson (2003)
"Public Transport systems between conventional public transport systems with fixed routes, stops and timetables, and personal transport systems are usually called "Paratransit systems"or "Demand Responsive Transport systems"…" Generally, because Paratransit or DRTs provides flexible services responding to each user's demand, timetable and route is not fixed." *"Public transport systems are operated with fixed stops, routes, and timetables determined by public or private companies, who own vehicles and systems. In addition, these systems are available for public use. Most common modes are bus and railway systems. Personal transport systems are operated with route and schedule determined by each user, whose vehicles are owned by each user. Private auto is common case. DRTs, however, consist of systems and vehicles owned by public or private company, and flexible stops, routes and timetables responding to each user's reservation. Because of it, DRT systems have characteristics of both public transport and personal transport. Therefore, when we classify DRTs among transport systems, more categories are needed."*	Takeuchi et al. (2003)
"The term Demand Responsive Transport has been increasingly applied in the last 10 years to a niche market that replaces and feeds into conventional transport where demand is low and often spread over a large area. A typical working definition of DRT is an intermediate form of public transport, somewhere between a regular service route that uses small low floor buses and variably routed, highly personalised transport services offered by taxis."	Brake et al. (2004)
"Increasingly, conventional bus services do not meet the needs of a large section of the population due to increasing incomes and car ownership levels and the resulting dispersal of activity centres and trip patterns. One solution is public transport systems that can operate effectively with lower and more dispersed patterns of demand than the bus, i.e. paratransit…"	Enoch et al. (2006)
"Demand-response is a transit mode comprised of passenger cars, vans or small busses operating in response to calls from passengers or their agents to the transit operator, who then dispatches a vehicle to pick up the passengers and transport them to their destinations. A demand-response (DR) operation is characterized by the following: (i) the vehicles do not operate over a fixed route or on a fixed schedule except, perhaps, on a temporary basis to satisfy a special need, and (ii) typically, the vehicle may be dispatched to pick up several passengers at different pickup points before taking them to their respective destinations and may even be interrupted in route to these destinations to pick up other passengers. *DRT is also known by other terms, particularly in references and publications from earlier years: dial-a-ride, demand-activated transportation, demand-responsive transportation, dial-a-bus, shared-ride paratransit, flexible-route service, and flexible-transport services."*	KFH (2008)

"Essentially, DRT can be defined as an intermediate and highly flexible mode of transportation giving rise to a wide variety of uses."	Laws et al. (2009)
"Historically, the term Demand Responsive Transport (DRT) services has predominantly related to door-to-door Dial-a-Ride services (sometimes referred to as Special Transport Services e STS or "paratransit") provided by statutory authorities and community groups for restricted usage (usually the disabled and elderly). *Interested users would telephone in their requests some days before they intended to travel and the operator would plan the service manually the day before the trip."*	Nelson et al. (2010)
"Demand-Responsive Transport (DRT) is often referred to as a form of public transport between bus and taxi services involving flexible routing and scheduling of small or medium sized vehicles. This means that the vehicle routes are updated daily or in real time by incorporating information on the demand for transportation. Usually, the customers of a DRT service are required to request and book their trips in advance by placing trip requests including information on the origin and destination of the trip as well as the desired pick-up or drop-off time. The vehicle operator uses this information to provide service that satisfies the passenger needs."	Häme (2013)
"Demand Responsive Transport systems provide flexible transport services in which individual passengers request door-to-door rides by specifying their desired start and end locations. Multiple shuttles (or vans or small buses) service these ride requests in shared-ride mode without fixed routes and schedules. DRT services are more flexible and convenient for passengers than buses since they do not operate on fixed routes and schedules, but are cheaper than taxis due to the higher utilization of transport capacity."	Furuhata et al. (2014)
"Demand Responsive Transport (DRT) or Flexible Transit Services (FTS) are considered to be hybrid transit services that combine characteristics of fixed-route services with those of demand responsive ones. In many cases, the implementation of flexible services in urban and suburban areas has led to several benefits, including increased ridership; more cost effective and integrated service for people with disabilities; flexibility in accommodating demand in combination with fixed route traditional services; ability to serve areas with relatively low density to sustain fixed route services."	Papanikolaou et al. (2017)

Source: Author's elaboration

From the definitions of DRT reported in Table 2.1, it is possible to summarize the following key aspects that characterize this technology:

- shared vehicle service providing on-demand door-to-door transport;
- service is flexible in time and routes;
- important especially for elderly and disabled user categories;
- usually provided by minibuses or vans;

- service useful during hours/seasons of low transport demand;
- service useful in low transport demand areas;
- intermediate form of public transport between a bus and a taxi;
- flexible service responsive to users' needs.

2.3 How DRT technology works

Traditional on-call transport services are managed directly by an operations centre (also known as "Travel Dispatch Centre", TDC) capable of planning flexible routes based on users' requests: customers communicate their booking directly online or by telephone (e.g. places of departure and arrival, number of seats, etc.) to PTA's personnel located at TDC and after that, a terminal on board the bus (so-called "Automated Vehicle Locationing" - AVL or "On-Board Unit" - OBU) allows the exchange of information in real time between the Operations Centre and the driver. In this way, the driver is constantly updated on the itineraries and stops they must make.

The service can be planned in two alternative modalities (Mageean and Nelson, 2003): traditional, defined as "centralized" and managed by physical operators, and computer-based, not requiring human intervention. In the first case, the offer is negotiated between PTA's staff and passengers and is particularly suitable in peak times, the elderly or other specific categories of users. Automated system manages DRT service directly via computer, and is particularly suitable during soft hours and seasonal or night services: this type of planning involves a lower cost due to the absence of physical operators.

2.4 Typologies of DRT

Enoch et al. (2004) published a report on the potential of DRT technology as a possible solution to the traditional mobility problems of British transport.

They define four typologies of DRT:

1. *Interchange DRT*: this type of service provides feeder links to fixed transport;

2. *Network DRT*: this type of service provides both additional connections to existing service lines or replacement connections for some lines considered not performing in specific areas or time slots;
3. *Destination-specific DRT*: this type of service provides connections for specific destinations (e.g. airports);
4. *Substitute DRT*: this type of service completely replaces the traditional fixed transport sometimes only in periods of lower demand.

Table 2.4 shows, reporting excerpts from Enoch et al. (2004), abovementioned DRT typologies providing general description and concrete examples from the past and present.

Table 2.4 Typologies of DRT

	DESCRIPTION	EXAMPLES
INTERCHANGE	"The first main category is where DRT is additional capacity in order to provide feeder links to conventional public transport. Typically this would be a DRT service providing an interchange at a rail station or into a bus route. This is interchange DRT."	- InterConnect, Lincolnshire, UK (still active) - Direct Access Response Transit (DART), Bay Area, San Francisco, California, USA (no more active) - Treintaxi, the Netherlands (active until 2014)
NETWORK	"The second category is where DRT enhances public transport either by providing additional services, or by replacing uneconomic services in a particular place or at certain times. Rather than simply being a feeder into conventional public transport, DRT services can be used to provide additional capacity to conventional public transport by serving new markets or to expanding an existing market."	- Wigglybus, Wiltshire, UK (still active but upgraded) - Public Light Bus, Hong Kong, China (still active) - The Belbus midibus, Flanders, Belgium (still active but extended)

		- Public Vanpool, King County Metro, Washington State, USA (still active)
DESTINATION-SPECIFIC	"Here, DRT modes have been developed to serve particular destinations such as airports or employment locations. Once again, in many cases providing conventional public transport would not be economically feasible. A key element of many of these schemes is the presence of a partnership between a local authority and the 'destination' (e.g. a company, airport operator or whatever)."	- Allobus Roissy, Charles de Gaulle Airport, Paris, France (still active) - Supershuttle, Los Angeles International Airport, California, USA (shut down at the end of 2019)
SUBSTITUTE	"Substitute DRT occurs where a DRT system totally (or substantially) replaces conventional public transport services."	- TAXIBUS, Rimouski, Quebec, Canada (still active) - Community Shuttle, Vancouver, British Columbia, Canada (still active)

Source: Author's elaboration based on Enoch et al. (2004).

For a better understanding, an image for each DRT typology mentioned in Table 2.2 is provided below.

Figure 2.7 shows the InterConnect interchange DRT service active in Lincolnshire, UK.

Figure 2.7 InterConnect interchange DRT service in UK

Source: Hullian OneEleven, Wikimedia.org

Figure 2.8 shows the upgraded version of Wigglybus network DRT active in Wiltshire, UK.

Figure 2.8 Upgraded version of Wigglybus network DRT service in UK

Source: Ed Webster, Wikimedia.org

Figure 2.9 shows the destination-specific Vanpool DRT service active in King County Metro, Washington DC, USA.

Figure 2.9 Destination-specific DRT service in King County, USA

Source: kingcounty.gov

Figure 2.10 shows the Community Shuttle active in Vancouver as a substitute DRT service.

Figure 2.10 Subsitute DRT service in Vancouver, Canada

Source: Stephenrees, Wikimedia.org

2.5 DRT service models

After having carried out a careful analysis of the transport demand by studying its characteristics, flows and preferences, PTAs should define DRT service models in order to establish how to perform the transport service: this depends on the morphological structure of the territory and on the category of users to be served (students, elderly, occasional, commuters, etc.).

The service models can be different and differ according to the degree of flexibility that the PTA intends to provide based on potential requests and budget at its disposal: DRT service models, as identified in literature (Nelson et al., 2004; Papanikolaou et al., 2017; Mageean and Nelson, 2003), are presented below in descending order of service rigidity.

Predetermined route with bookable fixed stops

Among the service models in examination, the one represented in Figure 2.11 is the least flexible and consequently the most convenient from an economic point of view for the transport company. As for traditional public transport, the route and stops are predetermined, the differences are essentially two: first, this transport service, being "on demand" and not traditional, takes place only in the presence of reservations by customers and this allows the transport company not to make empty trips, incurring in unnecessary costs. Secondly, vehicles stop only near the stops booked by users on board or by passengers at bus stops: if there are no reservations, minibuses continue their ride without stopping unnecessarily.

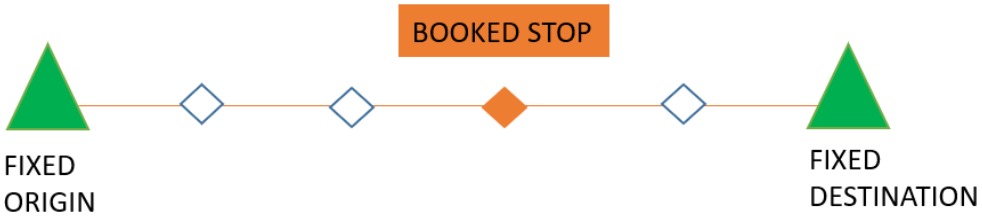

Figure 2.11 Predetermined route with bookable fixed stops

Source: Author's elaboration

Predetermined route with possible detours from nominal line

This service model (Figure 2.12) presents a slightly lower degree of rigidity: here the route is predetermined as well and some stops are located on so-called *nominal line*, but the driver has the possibility of deviating from this line if a reservation arrives from a geographical point outside the predetermined route. This type of service model is applicable above all in rural and mountain contexts where the nominal line is often identified with the main road and reservations can come from secondary roads, even distant ones.

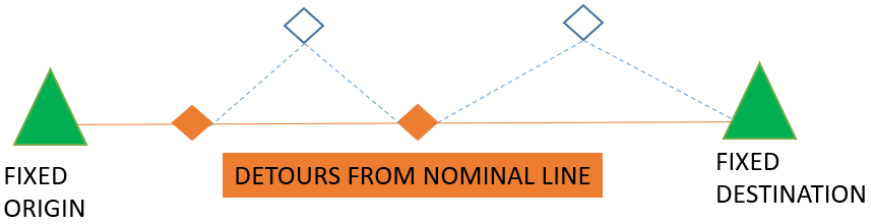

Figure 2.12 Predetermined route with possible detours from nominal line

Source: Author's elaboration

Flexible route with fixed stops

With this service model the degree of flexibility increases, and the transport company determines in advance some fixed stops at which the vehicle stops, if there are reservations, located at some strategic points along the route (school, market, gym, swimming pool, station, etc.). What is flexible in this model is instead the route that varies from time to time, modifying itself based on users' requests. Due to the increased flexibility of the service, costs for PTAs begin to rise (Figure 2.13).

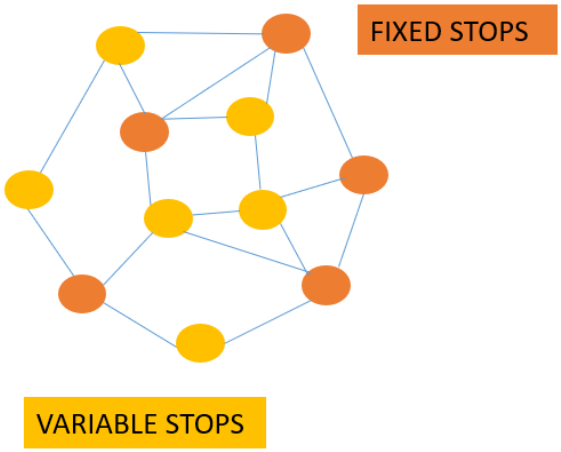

Figure 2.13 Flexible route with fixed stops

Source: Author's elaboration

Flexible route

These service models are more flexible and more expensive for the transport company.

The model defined as "One-to-many" and its complementary "Many-to-one" (or "Few-to-many" and "Many-to-few") represent two service models typically applicable in rural or mountains contexts that gravitate around larger attractive poles capable of generating the commuting phenomenon: as regards the "Many-to-one" model (Figure 2.14), the classic application case is linked to the home - place of study/work trip where users are transported from a plurality of origins to a single destination (e.g. the main square of the city or the central station), or to a few destinations in the "Many-to-few" case.

On the contrary, the opposite "One-to-many" service model is typically applicable to the return journey from work/study to home in the late afternoon (Figure 2.15): minibus picks up commuters at one or a few origins (in the "Few-to-many" case) and allows them to reach a plurality of destinations.

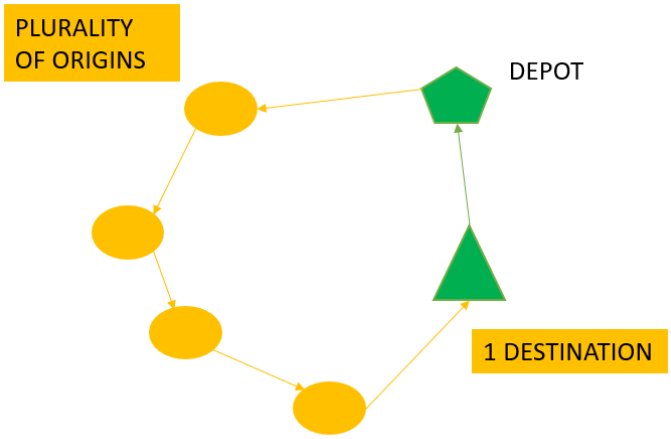

Figure 2.14 "Many-to-one" model

Source: Author's elaboration.

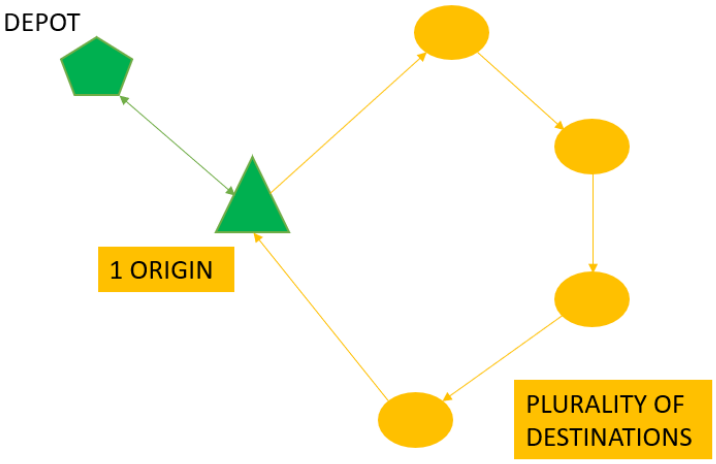

Figure 2.15 "One-to-many" model

Source: Author's elaboration.

Finally, the "Many-to-many" service model (from a plurality of origins to a plurality of destinations), typically used for door-to-door transport of elderly or disabled people, represents the most flexible model ever and consequently the one with the highest operating cost for the transport company (Figure 2.16).

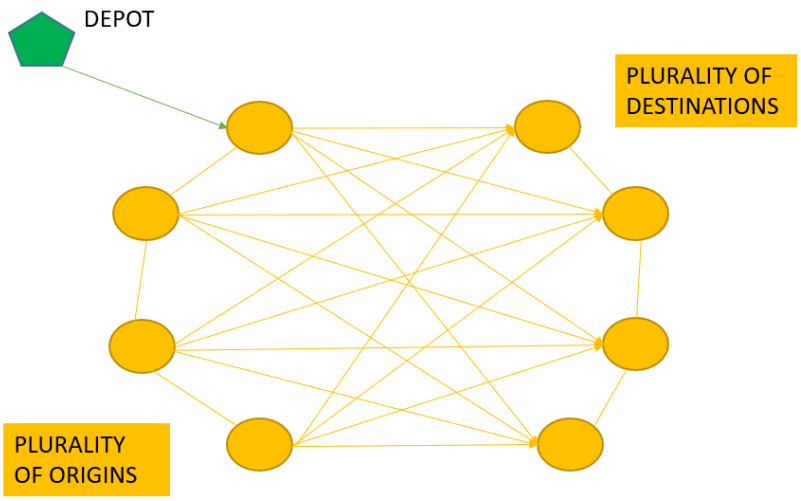

Figure 2.16 "Many-to-many" model

Source: Author's elaboration.

2.6 Historic evolution of DRT

2.6.1 1910 – 1989

The DRT service, become increasingly popular in recent years to remedy some structural problems of urban and rural mobility around the world, presents actually a rather long history that dates back to the early twentieth century (Lave and Mathias, 2009). The first examples of on-call transport spread in the United States with the aforementioned *jitneys* during the 1910s (the first documented examples date back to 1916 in Atlantic City) (Coutinho et al., 2020): these pioneering DRT services travelled on fixed itineraries and consisted of a series of vans or pick-ups in which people could get on and off at desired stops.

Due to the willingness of these vehicles' owners to earn as much money as possible, drivers were forced to race at very high speeds to make their service convenient for users compared to conventional transport: due to this, many accidents were recorded at that time on the streets of many American cities (Higgins, 1976).

As reported by the study of (Coutinho et al., 2020) the thirty-year period following the appearance of these first examples of prototype DRT (at least until the 1960s) does not record concrete cases of application of this technology except for some sporadic experimental attempts.

During the 1960s, following the post-II World War economic boom, in the United States, as in much of the world, many people began to move more and more to large urban centres to seize job opportunities never existed before: this phenomenon, known as *urbanisation*, involved large masses of population migrating to cities. People living in the countryside decreased in number and found themselves living in houses very distant from each other and poorly connected at the infrastructural level: these factors represented a problem for the management of public transport in these contexts. It is in such a scenario that the need to think to a different modality of transport, alternative to the traditional system and capable of satisfying the mobility needs of rural citizens, arose: therefore, a cheap on-call transport suitable for particular low-demand transport areas becomes an alternative or a supplement to fixed public transport (Cole, 1968).

It is in this period that some researchers begin to conduct studies on algorithms capable of planning the routes of vehicles in order to manage transport based on "many-to-many" service models, being able to move people according to a prototype *door-to-door* logic. The most important of these studies is attributable to the CARS (Computer Aided Routing System) project developed by researchers at the Massachusetts Institute of Technology: (Wilson et al., 1969) reported the results of the first study of this kind called "Simulation of a Computer Aided Routing System", in 1969. The authors stated how the CARS project, which involved about 80 researchers, was first sponsored by the U.S. Department of Housing and Urban Environment and later supported by the U.S. Department of Transportation. The main goal of this on-call transport project was immediately clear: to offer a comfortable, flexible and widespread service like taxis at an affordable cost to anyone (like public buses). To do this, the authors understood that the main cost items of traditional transport were represented by number of vehicles and salary of drivers: as a consequence of this analysis, in order to contain costs as much as possible and be able to offer trips at low cost, the natural solution was the reduction both of the number of vehicles employed and of the related number of drivers.

Researchers argued that, through the algorithms developed, they would have been able to allocate more effectively each vehicle to travel demands than a human could ever do. The CARS project was one of the first scientific efforts aimed at studying valid alternatives to traditional transport: although the algorithms developed were not yet fully capable of handling a very large amount of requests, and this required waiting for technological progress for at least another decade, it was still a small step forward in the search for *door-to-door* transport.

The first attempts to remedy the distortions of traditional public transport with forms of on-demand mobility, as mentioned, arose in North America and arrived only in the 1970s in Europe, where some not very successful experiments were recorded.

Starting from the 1980s, on the other hand, with the advancement of technological progress (in particular the development of the first GPS and GIS systems), the first concrete applications of DRT systems began to be registered in Europe as well.

In Italy, the first DRT service experiment was implemented in the province of Piacenza (Val Nure) at the end of the 1980s (Ferrari, 2018): developed by the Politecnico di Milano, the service was committed to solving the problems of social and economic marginalization of the residents of the mountain valleys. The DRT service made use of 15-20 seater minibuses and was configured as a real Dial-a-ride service (without a fixed route). Thanks to the success of the trial, the project was confirmed and is still active today, albeit in an updated and expanded form.

2.6.2 1990s

During the 1990s, DRT services spread more and more in Europe also thanks to important evolutions in the IT field such as new softwares, better data collection, more advanced algorithms and a wide diffusion of telephones among the population.

Also at institutional level this type of sustainable and inclusive mobility solution gained increasing attention and the European Commission in 1996, in the context of the fourth EU framework program, decided to invest in the experimentation of telematics technologies applied to transport: for this reason the SAMPO (System for Advanced

Management of Public Transport Operations) project and its continuation SAMPLUS (System for Advanced Management of Public Transport Operations Plus) were founded.

The SAMPO project

Table 2.5 The SAMPO project

Name of the project	SAMPO
Countries involved	Finland, Sweden, Italy, Belgium and Ireland
Years of experimentation	1996 - 1997
Means of transport	Buses, coaches, taxis, mini-buses, maxi-taxis, etc.
Booking system	Call to the Call Centre
FT Integration/Substitution	Integration
Service Model	Different depending on the test site

Source: Author's elaboration

The SAMPO project, which took place from the beginning of 1996 to the end of 1997, consisted in the evaluation analysis of some test sites located in different locations of the European Union (Finland, Sweden, Italy, Belgium and Ireland) in order to study the fields of application of telematics processes to Demand Responsive Transport: once categories of users have been defined, a step further was to carefully analyse their needs to develop successful on-call services.

The test sites took place in the five EU countries abovementioned. Belgium, Finland and Ireland tested the service in more than one location. One of the main objectives of the SAMPO project was to identify all the stakeholders involved in the development of the on-call service: it should be noted that for all test-sites selected by the project, DRT service integrated the existing offer of public transport, thus not providing for forms of substitution but only of addition and integration of FT.

Identifying potential stakeholders is of central importance if aiming at developing a type of service capable of meeting the needs of different actors, each with their own

needs and characteristics: in Deliverable D3, important report written by Finn (1996), was conducted an in-depth analysis of users' needs after their identification and categorization.

This document expressed the importance of a correct identification of the users involved. First, it asserted that a careful study of the potential demand of end-users allows identifying the so-called "weak" categories (such as the elderly and disabled) who most need this type of service due to the mobility problems they suffer.

Deliverable D3 stated the need to create, at a European and global level, support technologies for DRT service that are as universal and generic as possible, avoiding individual transport companies having to equip themselves with customized and more expensive technological tools. Furthermore, the list of users identified by this study can be of help to operators and transport authorities around the world: the list provided represented a valid "check list" with categories of users and their needs to refer to.

After having identified the general categories, the SAMPO project researchers decided to investigate the individual categories of users contained here within: for this purpose, the same iterative process described above was used.

This study was conducted by interviewing the main stakeholders involved in the SAMPO test-sites asking them, based on their experience, to rate the degree of relevance of each "User category" in relation to DRT service both in general (purely at theoretical level) and for the specific test-site.

As regards the evaluations of DRT service in general, users had to express their opinion by choosing between "low", "moderate", "high" and "very high".

In relation to the SAMPO sites, each interviewee was asked to assign value "1" if the reference "User Category" were considered “significant” for their context, "2" if it was considered “core”. From the sum of these values between all five test-sites, it was obtained a value included on a scale from 0-10 and it was thus possible to compare different "User categories".

From the data obtained, some categories of users have proved to be absolutely prone (for example "healthcare patients") to the use of DRT, while other categories such as "Foreign Operators" revealed very little inclined to the use of this technology.

Based on these data, the SAMPO project researchers selected the categories of users most in need of DRT services (those with the best scores) to conduct an even more in-depth analysis of their necessities (part of the successive SAMPLUS project).

Based on the study conducted by Ambrosino and Romanazzo (2002) for ENEA (Body for New Technologies, Energy and the Environment), Table 2.6 shows the main results obtained by the SAMPO project, one of the first studies in Europe on user attitudes related to DRT service.

Table 2.6 Results of SAMPO project

CATEGORY OF RESULTS	DESCRIPTION
TRANSPORT POLICY	At the Community level, the main need is to convert private transport to public transport as much as possible, obtaining important results in terms of reducing polluting emissions, reducing traffic and reducing social costs. At national and regional level, the transport authorities must take care of offering an efficient, ecological and inclusive transport service. At the local level, individual municipalities and transport operators must take care of guaranteeing a public transport service to the entire population without marginalizing any category of users.
USERS NEEDS	To be attractive to *passengers*, DRT service should present the following characteristics: • ease of access • quick and easy reservations • last-minute bookings • reliability of the service • guaranteed return path • space on board for luggage • guaranteed inter-modality with soft mobility • wide spatial and temporal coverage • low ticket fares • etc. To be attractive to *operators*, the DRT service should present the following: • maximized load factor • opening to new markets • economically convenient service • technical support systems available • efficient operations centre • ability to accept users without reservation

	• etc.
CONFLICTS	Traditional public transport passengers are usually used to a service that is not very reliable in terms of punctuality of vehicles and this negative perception of public transport can also be transferred to the new one on call (at least in the early days). Sometimes booking the service can be difficult, especially for categories of users less accustomed to the use of technology. Conflicts may arise between the transport operator and users as the former prefer a booking method managed automatically by the computer while the latter often prefer to speak directly with an operator who represents a cost for the company. The use of the DRT transport service in rural areas can entice many people to go shopping in larger hubs, in fact, no longer going to the small local shops, which thus see their business decrease.
KEY POINTS	Key points before launching the project: • careful analysis of the market and of the categories of users to be served • understand and meet the user's needs • important service marketing to make the product known • simple booking procedures • collaboration between all parties involved Key points when the project is active: • financial coverage for the whole project period • advanced communication technologies • constant support service to the user

Source: Author's elaboration based on Ambrosino e Romanazzo (2002)

The results of SAMPO project demonstrate that people, regardless of the category of users they belong to, are willing to experiment with new forms of mobility and DRT service, better meeting their mobility needs. Furthermore, the analysis shows how despite on-call service vehicles are smaller than the ones used in traditional transport, thanks to a greater optimization of rides and of space on board, DRT service can be economically advantageous both for transport operators (higher load-factor) and for passengers (low ticket fares) (Eloranta, 1998).

The SAMPLUS project

Table 2.7 The SAMPLUS project

Name of the project	SAMPLUS
Countries involved	Finland, Sweden, Italy, Belgium
Years of experimentation	1998 - 1999
Means of transport	Buses, coaches, taxis, mini-buses, maxi-taxis, etc.
Booking system	Call to the Call Centre
FT Integration/Substitution	Integration
Service Model	Different depending on the test site

Source: Author's elaboration

Immediately following the SAMPO project, the so-called "next step" of the process was launched, again thanks to European funds: the SAMPLUS project.

The latter had, like its predecessor, the primary objective of evaluating the on-call transport service and the "readiness to adopt" of some European contexts involved in the project. SAMPLUS included five demonstration sites (of which only one new, the others were already part of SAMPO) and a further four "feasibility studies" conducted in as many locations with structural mobility problems and functional to the study of costs, benefits, problems, advantages and disadvantages of the implementation of a DRT service (Table 2.8).

Table 2.8 Demonstration and feasibility sites of SAMPLUS project

	Country/Location
Demonstration sites	Belgium/West and East Flanders Finland/Tuusula, Kerava, Järvenpää Italy/ Campi Bisenzio, Porta Romana, Florence Sweden/Gothenburg Sweden/Stockholm
Feasibility sites	Finland/ Nurmijärvi Ireland/Cavan, Leitrim UK/Surrey UK/West Sussex

Source: Author's elaboration based on Mageean and Nelson (2003)

As stated in the SAMPLUS final report "Systems for the advanced management of public transport", drawn up in March 2000, at the end of the project (1998-1999), by Nick Ayland, the main goals of this initiative were:

- to allow technological transfer between different countries in order to obtain a wide application of DRT;
- to conduct feasibility studies in 4 additional test sites in order to allow more countries to implement this service;
- to draw up guidelines to allow all stakeholders involved in the project to implement a DRT service in their own context;
- to spread the results of this project worldwide to make stakeholders become aware of it.

In order to achieve the aforementioned objectives, the SAMPLUS project followed a well-defined methodology, already tested for the previous project SAMPO, which provided for a process divided into five subsequent steps, starting from the analysis of user needs (step 1) and construction of technical specifications of the service in response to these needs (step 2), build a demonstrator and test it in real cases with passengers (steps

3 and 4) and finally use the results obtained to spread knowledge about DRT to all the stakeholders involved (step 5). The demonstration sites involved all went through these five phases, while the feasibility sites only went through steps one and two.

One of the main *lessons learned* from the SAMPLUS project is the necessary cooperation of all stakeholders in order to overcome institutional, legal, organizational and operational obstacles: often the main barrier to the implementation of concrete cases of DRT services does not concern technological progress, but obsolete and non-open to change transport policies.

2.6.3 2000s

Between the end of the 90s and the first decade of the 2000s (EC-funded projects such FAMS), the evolution of DRT changed with the boom of internet and smartphones that found ever greater field of application, not only in Europe but also throughout the world.

The FAMS project

Table 2.9 The FAMS project

Name of the project	FAMS
Countries involved	Italy and Scotland
Years of experimentation	2003 - 2004
Means of transport	Buses, coaches, taxis, mini-buses, maxi-taxis, etc.
Booking system	Call to the Call Centre, FAMS web portal
FT Integration/Substitution	Integration
Service model	Different depending on the test site

Source: Author's elaboration

At the beginning of the new millennium, on the basis of the previous experiences of the late 1990s with the SAMPO project and its successor SAMPLUS, the European Union decided to continue investing in the experimentation of this form of collective transport: so, in March 2002, within the EU-IST (Information Society Technology) Program, European Commission launched the so-called FAMS (Flexible Agency for Collective Demand Responsive Transport Services) project with a dual goal, on the one hand to implement DRT service in two tests-sites and evaluate their characteristics (as for the SAMPO and SAMPLUS projects) and on the other hand to propose the innovative concept of a "Flexible Agency" to enable a common management for DRT services all around Europe. Most of the information available about the FAMS project originated in the FAMS final report entitled "The agency for flexible mobility services "on the move"", drawn up at the end of the project by Ambrosino et al. (2004).

The PTA of Florence (ATAF) was chosen as the coordinator of the entire working group, which included eight partners in total, of which one sub-contractor.

At the beginning of the 2000s, and largely still today, DRT services applied in real contexts were managed by transport authorities in an uncoordinated way with other stakeholders. Compared to the previous European projects SAMPO and SAMPLUS, the FAMS project set itself the primary objective of taking a step further: that is experimenting in two profoundly different contexts such as Florence (Italy), at an urban level, and the Angus region (Scotland), at a rural level, an innovative form of coordinated management of the on-call service. In this regard, the so-called "Flexible Agency" was conceived, capable of planning and managing the DRT transport of different transport operators, with different fleets, different booking systems and different types of service.

The service provided by this agency can be divided into two categories of recipients: end-users in the case of B2C service (Business-to-Consumer) and transport operators in the case of B2B service (Business-to-Business).

The purpose of the agency is therefore to deal with DRT transport managed by many transport operators in different places and times through the provision of an all-inclusive service to make the management of the DRT service as homogeneous as possible despite the presence of many players.

The Flexible Agency conceived by the FAMS project was thus applied in the two selected test-sites: in the metropolitan area of Florence the transport operator ATAF, leader of the whole project, introduced the aforementioned agency in order to coordinate the seven existing DRT services of the area, while in Scotland, in the Angus Region, the Angus Transport Forum tested DRT service for the first time. Table 2.10 reports the main characteristics of the two sites.

Table 2.10 FAMS project test-sites

TEST-SITE	DRT SERVICE PROVIDERS	TOTAL AREA KM^2	TOTAL AREA INHAB.
FLORENCE (Metropolitan)	VOLAINBUS CAMPI DRT SCANDICCI DRT SESTO DRT CALENZANO DRT PORTA ROMANA DRT DISABLED	481,89	586.000
ANGUS REG. (Rural)	GLEN ESK SERVICES GLEN ISLA SERVICES GLEN CLOVA SERVICES ANGUS DISABLED AND ELDERLY SERVICES ANGUS REGULAR AND SPECIAL EVENTS ANGUS GROUP HIRE	2.181	116.040

Source: Author's elaboration based on Ambrosino et al. (2004)

The FAMS trial was launched in May 2003 and lasted until February 2004: although the two test sites had different characteristics and levels of preparation, the staff was trained uniformly so trials could be carried out without major problems.

In the final report of the FAMS project, the main outputs obtained were divided into seven categories: "Innovative transport services", "Innovative organizational platform", "Successful Take-up and Deployment", "Acceptance by Personnel and Intermediate Users", "Acceptance by end-users", "Achieve cost effectiveness and efficiency" and finally "Achieve revenue increases".

As regards the main results achieved in terms of implementation of new services, in general it can be noted that at the end of the FAMS trial in the metropolitan area of Florence DRT services had achieved, thanks to the Flexible Agency experienced, a greater degree of cooperation and integration. Even in Scotland, where on-call services were implemented from zero, the results obtained allowed the Angus Transport Forum to keep DRT services active even after the FAMS trial (moreover, the degree of involvement of the population was such that around 80% of residents were in favor of maintaining the service).

At an organizational level, the results obtained are the most important for the promoters of the FAMS project as the implementation of a Flexible Agency represented the innovative and central aspect of this initiative. In Florence, structural and organizational changes were made to the various existing TDCs in order to make them converge into a single larger one (the FAMS portal introduced, through which passengers could have access to book rides, could now manage up to 300 users per hour, compared to just 20-30 in the past).

In Angus Region, a TDC was introduced where it did not exist before and it received a high degree of appreciation from transport operators both at an operational and organizational level.

As regards the "Successful Take-up and Deployment", reference is made to the degree of reliability and usability of the technologies applied to the new FAMS concept of a single and coordinated TDC: both in Florence and in Scotland TDC staff greatly appreciated new technologies judging them successful (however, problems could arise in

rural contexts with low telephone coverage that can affect the use of the entire system). The use of the FAMS portal for passenger reservations made it possible to reduce a long-lasting problem: “unanswered calls” due to the telephone line blocked by too many calls from users. The FAMS portal has thus made it possible to lighten the number of calls on the telephone line and allow TDC operators to answer more calls than before (“unanswered calls” decreased in Campi Bisenzio).

For example, in Campi Bisenzio, in terms of greater ease of communication between end users and TDC operators, new technologies (such as the FAMS portal) allowed a greater number of connections (360 compared to 30) and a smaller sum of unanswered calls.

As regards the level of acceptance of the FAMS concept introduced in the two test-sites, it received high evaluation scores from all the parties involved: operational staff in the TDC, drivers on board the vehicles and transport provider managers. While in Angus Region all stakeholders assigned very high scores to the degree of acceptance of the new technologies, in Florence the scores were high but slightly lower than the pre-trial values due to some problems resulting from lack of familiarity with the new tools.

The passengers involved in the surveys on the evaluation of the on-call service were all particularly enthusiastic about the innovations introduced both in Italy and in Scotland: in Florence almost half of the passengers (and a greater share of disabled people) decided to use the service 5 days a week and in particular for home-work trips demonstrating loyalty and reliability to the service.

In Angus Region, although about half of the people own a driving license, more than half of the residents decided to use the on-call transport proposed in the FAMS project: this is particularly significant information as in rural areas private vehicle is preferred to the use of public transport, especially in contexts characterized by large gaps in FT network.

The comparison of the costs incurred for the DRT transport can only be studied in the Florence test-site, as data were available for the DRT services already existing before the trial: this was not possible in the Angus Region due to the lack of past data.

Therefore, considering the Florentine context, thanks to the technologies applied by the FAMS project, the booking and dispatch cost per passenger decreased by almost 70%. In the same way, both the "operating costs per revenue hour" and the "operating costs/km" reduced.

One of the main criticalities relating to DRT transport service has always been linked to revenues: many cases of application in the past have shown how this type of service guarantees low revenues not able to cover entirely the operative costs and thus DRT has been adopted in regulated market contexts (thanks to state subsidies) rather than in deregulated scenarios where single transport providers were unable economically to meet the costs. The two test-sites under examination also showed good participation of stakeholders, a high degree of acceptance by users, but at the same time rather low revenues at least in the first months of experimentation. The FAMS project has shown how crucial it is to invest in marketing and make the new modes of transport known to the widest possible catchment area: users are often slow to change their transport habits and for this reason, it takes a long time before DRT service becomes the main form of travel for many people. If in Florence some DRT services had already been active for years and this meant that passengers were already accustomed to the use of this technology, in the Angus Region citizens had to learn about the characteristics of the service from scratch and this, despite the good results achieved, slowed down the spread of DRT.

To conclude, the FAMS project demonstrated how DRT service began to grow in the early 2000s, with more and more users preferring to use public transport over private vehicles.

2.6.4 2010s

Over the last decade, DRT has become a concrete solution for transport providers in order to optimize the load factor of their vehicles and consequently reduce the operating cost of their business. Following the global economic-financial crisis that occurred from 2008, Governments have begun to reduce subsidies to traditional transport and, thanks to the simultaneous global spread of smartphones and internet, the attention of transport

authorities towards DRT service increased exponentially: in fact, it allowed PTAs to replace unsustainable traditional transport lines with on-call services designated ad hoc on the needs of passengers.

In the 2010s, there were several projects conducted at international level to evaluate the feasibility and applicability of DRT services: the most important conducted in Europe are presented below.

The LIMIT4WEDA project

Table 2.11 The LIMIT4WEDA project

Name of the project	LIMIT4WEDA
Countries involved	Italy, France, Greece, Malta, Cyprus and Spain
Years of experimentation	2010 - 2013
Means of transport	Mini-buses
Booking system	Call to the Call Centre
FT Integration/Substitution	Integration
Service model (DRT Perugia)	Many-to-many

Source: Author's elaboration

As aforementioned, the European Commission intervened again to financially support some sustainable public transport projects aimed at offering an alternative to the use of private cars in some low demand areas in Europe: for this purpose, within the framework of the MED Interreg program (2007-2013), the EC allocated € 1.288.180,00 to the LIMIT4WEDA project (Light Mobility and Information Technologies FOR Weak Demand Areas), for the period 2010-2013.

EC proposed four different categories of actions for these areas (integrated ticketing, info-mobility, on-call transport and development of sharing mobility services) and several partners from all over the Mediterranean Region took part in the project (Italy, France, Greece, Malta, Cyprus and Spain) (Campagna and Ambrosi, 2013).

For a better understanding of the text, it is considered necessary to briefly describe the innovative solutions proposed by the LIMIT4WEDA project (except for DRT service), all suitable for solving the low demand areas mobility problems.

Integrated ticketing is the possibility granted to passengers to use "one or more modes of transport provided by one or more operators" (Maffii et al., 2012) of a given city / region / country by purchasing a single ticket. In Italy, the cases of BIP (Integrated Piedmont Ticket) should be mentioned in which users, through a contactless smart card, can access to all urban and extra-urban public transport and to the regional and metropolitan railway services of Piedmont Region. In Lombardy, the integrated ticket "Io viaggio ovunque", has been active since 2011 and allows passengers to use all local public transport services: bus, tram, metro, on-demand services (not managed by private companies), regional trains, boats and vertical systems. Other integrated regional ticketing systems in Italy to mention are UnicoCampania (in Campania Region), Unica Veneto (Veneto Region), Metrebus (Lazio Region), Mi Muovo (Emilia-Romagna Region). At international level, the most important cases are related to metropolis such as London (Oyster system), Paris (RATP / SNFC system), Melbourne (myki card), Sydney (Opal card) and Brisbane (Go card).

Infomobility allows users to always be updated on discounts, lines and timetables of traditional transport and of new and alternative forms of mobility. Technological development allows infomobility systems to evolve over time and to exploit the platforms most used by users: in North America, for example, Zimride takes advantage of the popularity of Facebook to reach as many people as possible. Zimride is a ridesharing platform that connects students or colleagues allowing them to organize a more efficient transport to the desired destination by sharing the vehicle. Likewise, the Roadsharing platform allows users to share their vehicle in order to optimize travel and parking costs (Dicuonzo, 2020).

Sharing services can assume different nuances (car-sharing, car-pooling, ride-sharing) but all modalities have in common the goal of reducing congestion and air pollution in urban centres through vehicles sharing: passengers can thus enjoy the benefits of the private car (flexibility, capillarity and economic convenience) not having to own a vehicle.

The LIMIT4WEDA project consisted in the implementation of four trials in selected locations, experimenting the abovementioned innovations (Figure 2.17).

Figure 2.17 Pilots of LIMIT4WEDA project

Source: Author's elaboration on Google Maps based on (Campagna and Ambrosi, 2013)

Regarding DRT, in Perugia, the local municipality, partner of the LIMIT4WEDA project, decided to experiment an on-call service that could satisfy the need to move of people in low demand areas around the city in central Italy. The test-site was particularly suitable for a trial of this kind: part of the catchment area was not fully satisfied of FT mainly due to the lack of accessibility (large distance between houses and stops) and the scarce temporal coverage of the service, this led many people to prefer using their own car rather than public transport. For this reason, the municipality of Perugia decided to introduce a completely flexible DRT service (no fixed routes and no fixed timetables) capable of responding to the movement needs of the residents of these areas. Users could call the toll-free number 800099661 and speak directly with a TDC operator to reserve their seat on board in advance or book in real-time (Campagna and Ambrosi, 2013).

The "ProntoBus" service of Perugia attracted more and more passengers thanks to the greater flexibility of the service in terms of both time and space.

Furthermore, to testify the success of the experiment, from March 2012 (launch of the service) to April 2013 the number of passengers/km for the DRT service doubled

(from 1.76 to 2.93), the km/day travelled by minibuses decreased (from 518 km to 350 km), with obvious advantages in terms of cost savings for PTAs. In addition, the cost/km decreased allowing the service to become permanent even after the end of the trial (from 2.03 to 1.59) (Interreg Europe; Regione Lazio, 2013; Campagna and Ambrosi, 2013).

Currently the "ProntoBus" service of the municipality of Perugia can be booked by users through weekly bookings, real-time directly with driver or up to 30 minutes before the ride. Nowadays areas served by "ProntoBus" service, almost 10 years after the trial, are the following:

- San Marco
- Cenerente Alta (via Gessara)
- Canneto Alto (Strada della Torraccia, via Macerino, via Piantoni, via Cisternino)
- Canneto Chiesa (Poggio delle Trappole, Str. Canneto)
- Compresso
- Colle Umberto, via Sambuca
- Colle del Cardinale
- Pian di Nese and San Giovanni del Pantano

The Kutsuplus project

Table 2.12 The Kutsuplus project

Name of the project	Kutsuplus
Countries involved	Finland
Years of experimentation	2012 - 2015
Means of transport	Mini-buses
Booking system	Call to the Call Centre
FT Integration/Substitution	Integration
Service model	Fixed stops, flexible routes

Source: Author's elaboration

At European level, in addition to the projects financed by the European Commission, a series of experiments have been launched in the last decade by city administrations with a view to reducing road congestion and air pollution through the optimization of public transport.

One of the main experiments of DRT service in the European context concerns "Kutsuplus", "apparently the world's first fully automated, real-time demand-responsive public transport service" (Rissanen, 2016).

The Kutsuplus project, jointly conducted by the Regional Transport Authority of Helsinki (HSL) and Split Finland Ltd. and planned for the period 2012-2015, was carried out with 15 8-seater minibuses (Jokinen et al., 2019), achieving a great appreciation from the passengers along the whole duration of the trial.

As with all DRT service trials, numerous travel behaviour surveys were conducted before the project to fully understand the travel needs of the local population: in the specific case of Helsinki, the local public transport authority began to conduct this type of analysis since 1966.

Since then, the population of the metropolitan area of the Finnish capital (known as Greater Helsinki) grew from just over 600,000 people to about 1,1 million (in 2012, the year of the start of the trial): due to a growing population numerous trip by private car and by public transport have also increased, albeit at different rates. For example, trips/weekdays by car grew dramatically from 300,000 in the mid-60s to 1,1 million in 2012 while the use of public transport increased slightly from just under 600,000 trips/weekday to little more than 800,000 (as of 2012) (Rissanen, 2016).

Based on this scenario, it immediately became clear to the Helsinki public transport authority that an intervention aimed at fixing the problems of urban mobility was necessary. For this reason, the authority considered it urgent to implement an on-call public transport service on an experimental basis able to cope with this issue: HSL occupied the role of project leader and was responsible for the entire trial, planning the service transport and the relationship with all stakeholders. The real on-call transport service was carried out by three different transport operators who took care of making their vehicles, drivers and communication systems available (Rapiditaxi, Taksikuljetus,

and Andersson). The task of the technology provider, Split Finland Ltd., was to supply and manage the software needed to control the entire transport service.

Based on Kutsuplus final report (Rissanen, 2016), the cost of the ticket assumed for this type of trial was made up of two parts: a fixed base rate to which a kilometre cost was added. The average cost for using the service, after an initial test phase with a very attractive price of € 1.5 + € 0.15 / km, following the launch of the service on 3 April 2013, it was increased to € 3.5 + € 0.45 / km: thereafter it has always grown until the end of the project (corresponding to the increase in service quality).

The success of DRT service implemented in Helsinki by HSL can also be quantified by observing the number of trips made by vehicles used in the on-call service from 2012 to 2015: with progressive increase in the number of annual passengers, since the start of the project the amount of annual trips has grown exponentially as well (100,000 trips in 2015 compared to almost 20,000 in the first year of the trial). The small fleet of 15 minibuses almost saturated their capacity because of the increasing demand for transport: this was a problem for HSL as municipal financial resources to extend the fleet were not enough (Rissanen, 2016).

It is important to observe the costs incurred by the partners of the Kutsuplus trial during the entire project period. Very often supporting an on-demand transport service involves very high costs for the transport company due to the low demand areas where transport is needed. The case of Helsinki is no exception and in fact, at the end of the experimentation period in 2015, due to the lack of public finances, the DRT service was suspended.

From the analysis of the financial situation of Kutsuplus project, at the end of each year and in total, what explained above emerges clear: implementing a DRT service can involve a loss of money for the transport authority providing it. This is the reason why often, in the absence of public funding, it becomes unsustainable for PTAs to maintain a service of this type after the end of the test phase.

Observing the data reported in Kutsuplus final report, it should be noted that revenues for each year of service refer to the price of tickets, naturally following the trend of transport demand: improving the quality-of-service year after year (temporal and

spatial coverage), increases the demand for transport and consequently the revenue from tickets. The ticket revenues, in the Kutsuplus trial, have grown exponentially, rising from €2,600 in 2012 to €507,700 in 2015 (in 2012-2015 operating revenues amounted to €895,400 in total including payment of tickets and some minor revenues).

The main cost item of an on-call transport service is represented by the purchase of the transport service from transit providers: this cost follows the annual trend in transport demand as well (the higher the demand, the higher the cost for provision of the DRT service). The so-called "operating costs" therefore include all the costs necessary to carry out the on-demand transport service: vehicles, drivers, insurance, etc. Other expenses include the purchase and maintenance costs of ICT software and equipment, consultancy from experts and research centres and marketing to make the service known to an ever-increasing number of users. In the case of Helsinki it is observed that the purchase of the transport service (including "operating costs" and "other expenses") has grown over time as service demand increased: in 2012 the costs for the purchase of service amounted to €316,800 and grew to €3,233,000 in just three years of experimentation (the total cost for the 2012-2015 three-year trial period was €7,821,400).

The salaries of the TDC staff represent other cost items. These costs are more rigid than the aforementioned ones as the number of staff varies little with respect to the increase in transport demand: however, the staff recorded a moderate growth that follows the trend of the service request (personnel costs passed from €119,600 in 2012 to €256,000 in 2015).

To these costs are added a series of minor costs and an annual depreciation (total depreciation €39,100 in the three-year period 2012-2015). From the final analysis of the financial situation of the project, it is possible to note the constant increase of the net cost, which raised from €450,000 in the first year of testing to €2,995,800 in 2015. The net cost of the entire project was €7,913,200 (Weckström et al., 2018): it thus required a substantial intervention from Government to cover the costs and return the investment (transport subsidies raised from €200,000 to €2,100,000).

As the demand for transport steadily increased, as mentioned earlier, the capacity of the small fleet of 15 8-seater minibuses began to saturate and then HSL, the leader of the project, asked for additional public funds to extend the transport offer to 45 vehicles

starting from May 2014 but the relevant authority, in a bad economic situation, refused and, despite the high level of appreciation by stakeholders, Kutsuplus pilot was terminated in 2015.

2.6.5 Summary of successes and failures of DRT European projects

It is useful in this paragraph of the PhD thesis to summarize the main objectives, barriers, case studies of success and failure of each European project presented above (Table 2.13).

The first European initiative described in this chapter (SAMPO project) had the objective of analysing citizens' travel habits and studying the most important requirements for the implementation of a DRT service in different geographical areas (Finland, Sweden, Italy, Belgium and Ireland). The researchers thoroughly investigated the main travel needs of citizens as the analysis of their travel preferences represents a key element in the service design phase.

The SAMPLUS project, launched immediately after SAMPO (1998-1999), continued to deepen the study of users' travel habits and the evaluation of DRT pilots in various European test sites (Belgium, Finland, Italy, Sweden). These two projects have contributed together to broaden knowledge on DRT services and on the state of the art of available technologies at the time: results produced by these initiatives have made it possible to draw up guidelines useful for implementing DRT services in other contexts as well. The FAMS project had the main objective of testing (in Italy and Scotland) a Flexible Agency capable of coordinating all DRT operators involved in a given area, in order to integrate the whole transport network. The initiative involved the city of Florence, which already had several operational DRT services, and the Angus Scottish region, which was instead launching its own project from scratch: in both cases the test was positive, and the flexible agency was accepted by local stakeholders who understood its importance. This initiative has also shown how often the main barriers to the implementation of innovative public transport organization tools are not technological but legislative, institutional and operational. The LIMIT4WEDA project wanted to test innovative mobility solutions in different countries of the Mediterranean area (Italy,

France, Greece, Malta, Cyprus and Spain): sharing services, info-mobility, car-pooling and DRT. In relation to the latter, a fully flexible ("many-to-many") DRT service was funded in Perugia, Italy. The DRT service showed absolutely positive results, deserving confirmation even after the pilot. Finally, the Kutsuplus project tested the validity of a new DRT service in the city of Helsinki: despite the excellent results obtained during the trial in terms of attracted users, the service was suspended at the end of the pilot due to lack of funds. This initiative shows how often DRT services, without the help of *ad hoc* public funding, can be economically unsustainable.

Table 2.13 Comparison of European projects

Project	Area	Years	Results
SAMPO	Finland, Sweden, Italy, Belgium and Ireland	1996-1997	Good results useful for extending knowledge on citizens' travel habits and on the state of the art of available technologies: from these outputs guidelines have been created to implement DRT also elsewhere.
SAMPLUS	Belgium, Finland, Italy, Sweden	1998-1999	
FAMS	Italy and Scotland	2003-2004	The Flexible Agency was accepted by all stakeholders in both test sites. The project has shown some problems of a legal, operational and institutional nature in the adoption of innovative organizational concepts in the public transport sector.
LIMIT4WEDA	Italy, France, Greece, Malta, Cyprus and Spain	2010-2013	The DRT service showed absolutely positive results, deserving confirmation even after the pilot.

KUTSUPLUS	Finland	2012-2015	The pilot had excellent operational results but was suspended at the end of the trial due to lack of funds.

Source: Author’s elaboration

The aforementioned European projects have over time raised several issues of the DRT service. The reasons for the success and failure of DRT technology in rural areas, as well as its primary costs, are highlighted in the next chapter's brief international review.

CHAPTER III

DEMAND RESPONSIVE TRANSPORT: A SHORT REVIEW

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3. Demand Responsive Transport: a short review

This chapter intends to answer the following research question:

RQ1: *"What are the main strengths and weaknesses of DRT in rural areas?"*

The paragraphs of this section aim to address this question: first of all, it was conducted on Google Scholar, Web of Science and Scopus a succinct summary of the primary scientific study on the use of DRT technology in low-demand areas; after that an examination of the major success and failure cases and the identification of major costs in the literature was carried out.

3.1 Background research

Despite the numerous advantages that DRT entails both for the community and for the transport companies adopting this technology, it still remains underutilized: König and Grippenkoven (2020) have analysed the reasons behind this trend by studying the case of two rural areas in Germany: they conducted a survey, involving 205 families residing in the areas under study, in order to identify the psychological factors that induce users to adopt this technology.

The results of the model developed by the authors demonstrate that the psychological factors most impacting on passenger behaviour choices are above all "Performance Expectancy*"* (highest score), i.e. the level of how much an individual believes the use of a given system can be useful for realizing his own purposes (Venkatesh et al., 2003), "Facilitating Conditions*"*, "the degree to which an individual believes that an organizational and technical infrastructure exists to support the use of the system" (Venkatesh et al., 2003) and "Attitude towards Car", a natural propensity towards using and owning a private car.

The aforementioned results indicate how "Performance Expectancy*"* represents the decisive factor behind users' usage choices: if consumers are clear about the advantages and possibilities that DRT technology offers, they will be inclined to use it. This demonstrates the importance of marketing policies: PTAs willing to exploit DRT systems

must be able to better advertise their service and make it known to as many citizens as possible in order to achieve a good rate of use.

Wang et al. (2015), conducting a similar study for DRT implementation in Lincolnshire, England, stated that the categories of people most likely to change their mode of transport and use DRT services are disabled people, work commuters and people who live in sparsely populated areas. Furthermore, outputs of the work conducted by these authors, resulting from the application of an ordered logit model to a survey conducted in the Region, showed that males tend to use DRT more in the retirement phase than in working years.

Some studies apply mathematical models to predict DRT transport demand and optimization routes.

In order to identify the metropolitan areas of the city of Melbourne most prone to the implementation of a DRT service, Jain et al. (2017) decided to estimate the so-called "susceptibility" for DRT in the urban environment: the model used by authors, which is an alternative to the more expensive "user preference survey", studies DRT demand patterns on the basis of demographic characteristics and current population movements. The results of this analysis showed that at an urban level there are areas that are different from others in terms of their predisposition for the implementation of on-call services: therefore, a model of this type is useful for better understanding in which areas of the city it is necessary to integrate or replace FT with DRT.

Another case of application of a mathematical/statistical model can be found in the industrial area of North Bristol, England: this part of the city, in particular the neighbourhoods of Filton, Avonmouth and Severnside, presented numerous industrial sites, few parking spaces, it was home to low-income residents and public transport was unable to meet the mobility demand of commuters to the area. As a consequence of this mobility disconnection, the MODLE (Mobility on Demand Laboratory Environment) project was funded to introduce new and innovative mobility systems. The objective of the work of Franco et al. (2020) was, through the use of an Agent Based Model (ABM) built on MatSim (Mutli-Agent Transport Simulation) platform, to build a model capable of predicting the transport demand of two new solutions of experimental mobility: the aforementioned ABM model was able to trace the movements of users through the use of

anonymous data extracted from people's mobile phones and provided by Telefonica company. This process was useful in order to trace the best routes of two new on-call services, predict their demand for mobility and measure the advantages that this type of DRT services entail if correctly integrated with traditional public transport and private mobility. The results obtained by the authors demonstrate the validity of the tool used: it can also be very useful for policy-makers and PTAs who intend to implement an economically sustainable DRT service.

Dytckov et al. (2020) believed it is of central importance the correct analysis of DRT transport demand and to be able to correctly estimate the potential DRT requests: the authors proposed thus a model for predicting transport demand and proved its validity by applying it to the real cases of two small towns in rural southern Sweden facing public transport problems (Sjobo and Tomelilla). The results, although promising, did not yet allow for a correct estimate of the feasibility or efficiency of a DRT service, necessitating further research.

Calabrò et al. (2020) used an agent-based model in order to optimize the routes of a last/first mile service that aims to improve the accessibility of the San Nullo metro station in Catania, Italy. To achieve their goal, the authors used the Ant Colony Optimization (ACO) algorithm, subsequently developed on the NetLogo software: this made it possible to obtain two different routes of 30 minutes of travel time each able to fill the gap in the transportation network.

Other studies seek to help PTAs management and municipal administrations by providing them with valuable evaluation tools that can influence the investments decision: Papanikolaou et al. (2017) developed a methodological framework in an attempt to highlight the key factors determining success or failure of a DRT service. The main question that the authors intended to answer was: how does a PTA evaluate the implementation of a DRT service to supplement or replace FT? The authors then developed a framework composed of four successive questions that public transport authorities must ask themselves: each question can be answered by retrieving different data and inputs. Table 3.1 illustrates this framework.

Table 3.1 Research questions and related data

	Research question	Input and data
Step 1	In which part of the network should FT be replaced with DRT?	Low frequency/demand/gain service lines or areas with no transport service at all.
Step 2	What is the investment required for this intervention?	Choose between full replacement of FT with DRT and integration of existing service.
Step 3	In this phase, select the valuation method and define the costs and benefits of the investment.	Choose between cost-benefit analysis and multi-criteria analysis.
Step 4	In last step, define the success or failure criteria of the investment: compare DRT case with the zero scenario.	Definition of the criteria by which the investment is considered successful or not.

Source: Author's elaboration based on Papanikolaou et al. (2017)

3.2 DRT successes

In the literature, there are several comparisons showing better performances of DRT than Fixed Transport (FT) (Papanikolaou and Basbas, 2021): Coutinho et al. (2020) examined parameters such as travelled distance, number of passengers, overall costs, greenhouse gas emissions and user perception in order to demonstrate the advantages of the DRT service compared to traditional public transport. After describing the historical evolution of DRT technology and having collected some examples worthy of mention at a global level, the authors focused on an urban mobility project of the city of Amsterdam: started in December 2017 and for the duration of one year, it consisted of the replacement of FT in some areas of the city with an on-demand service calibrated to the real needs of inhabitants. Based on the characteristics of poor accessibility and connection with the rest

of the city, two areas were identified in which to launch the pilot called Mokumflex: in the Amsterdam Zuidoost and Weesp districts, the DRT service was only added to line 49 that was already serving those areas, while in Amsterdam Noord the innovative service (lasted from February 2018 to December 2018) completely replaced the two previously active traditional transport lines.

After a careful comparison between traditional fixed transport and DRT characteristics, results of the analysis showed that ridership of DRT vehicles had decreased compared to the levels of traditional transport (78.1 passengers/day to 15.9 passengers/day), however at the same time the passenger-km driven had decreased even more (from 1,252.8 km/day to 136.6 km/day) as a result of a service created specifically for users' travel needs. Therefore, despite a reduced ridership of vehicles, DRT service allows PTAs, thanks to a lower passenger-km rate, to obtain lower costs. This DRT service was then confirmed for the years to come.

Alonso-González et al. (2018) conducted a performance comparison based on the calculation of general travel times of DRT service and public transport: they suggest that DRT is almost never considered and evaluated as a stand-alone service but always jointly with fixed transport. For this reason, the authors decided to build an assessment framework, exclusively dedicated to DRT, able to provide to PTAs the useful KPIs for understanding the degree of success of a possible implementation of a DRT service within their own network.

The assessment framework proposed consisted of three distinct sections: the first concerned the characteristics of DRT system and included aspects such as the coverage of the service (operational area and degree of flexibility of the service). This section also included data on operating hours of service, on the technical characteristics of the vehicles, on the technological booking system adopted and, lastly, on the passengers request acceptance criteria. The section relating to the operational characteristics of the service mainly consisted of two indicators: “usage of DRT” and “performance of DRT”. The first concerned travel demand and specifically included indicators such as “journey distance”, “spatial usage” and “temporal usage”, while the second related to “generalized journey time” (GJT) and “share of declined trips” (trips refused by the operator). The third section presented accessibility indicators by comparing DRT service with active

transport modes such as walking and cycling, with long-distance transport and traditional transport.

The aforementioned assessment framework was then applied to the Dutch case study of the Arnhem-Nijmegen Region (an area of about 200,000 inhabitants): the pilot, called “Breng Flex”, was launched in December 2016 by local PTA Breng and included a fleet of five minibuses and four electric cars.

Results of this work showed that DRT lines provided a reduced GJT compared to FT: outputs also indicated areas with a greater reduction showing PTAs where to invest in DRT. This analysis allowed policy makers to decide whether to implement DRT service as a support to FT or directly as a replacement in some non-economic lines.

Attard et al. (2020) analysed the needs of students’ mobility of the University of Malta. In Malta, a small country in the centre of Mediterranean Sea divided into 3 islands (Malta, Comino and Gozo), the problem of mobility is quite significant as it is one of the countries with the highest motorization rate in Europe. To suffer particularly from this critical situation is the only public university present: the University of Malta, located in Msida town. Every day it attracts about 15,000 people including students and staff who go there with different modes of transport: the problem lies in the fact that 76% of people travel to and from the University by their own vehicle with only 1,500 parking slots available. Surveys conducted in the area over the last decade have shown that most of the students live near the University and would gladly use public transport if service was of good quality. The authors therefore decided to plan and implement a DRT service that would allow reducing the number of cars reaching University every day, contracting road congestion and environmental pollution: they conducted nine trials in just 3 days (using real vehicles but simulating transport demand) in order to evaluate the performance of DRT service through some selected KPIs. The results of the analysis showed that State intervention was necessary as the cost of DRT service approximately doubled the FT one. At the same time, however, the innovative transport service tested proved to be applicable to the real context from a technological point of view, furthermore the degree of appreciation of the service by the students revealed a good chance of success.

3.3 DRT failures

Although DRT brings numerous benefits for users and PTAs in terms of greater efficiency, economic savings and flexibility, the list of failures in the world is long.

In the UK, the problems related to traditional transport led PTAs to reflect on possible solutions in order to make transport service more customer-oriented. As a result, DRT technology was chosen as the most appropriate and Department of Transport and the Greater Manchester Passenger Transport Executive decided in 2002 to commission some British universities to study the best cases of DRT operating globally. This work ended into the so-called "INTERMODE: innovations in Demand Responsive Transport" report produced by Enoch et al. (2006). Authors analysed in detail 72 DRT cases globally and the most important failures were reported together with *lessons learned* in order to clearly understand the crucial factors determining success or failure of DRT.

The barriers that hinder the full diffusion of the DRT service can be related to three different areas:

- Internal - inside the company (workers, vehicles, service planning, financial management, etc.);
- Micro - everything related to the market in which the company operates (its customers, competitors, suppliers, etc.);
- Macro - relating to what is outside company's own reference market and cannot be directly controlled (global economic and geopolitical situation, social, legal and cultural changes, etc.) (Enoch et al., 2006)

The authors concluded that DRT trials very often fail due to an incorrect or not in-depth a priori investigation of the potential transport demand: sometimes, having not sufficiently studied or predicted the residents transport needs of a selected reference area, PTAs carry the risk of providing an excessively flexible (and therefore quite expensive) transport service or to equip their vehicles with very expensive and unnecessary technological equipment. Furthermore, researchers argued that marketing aspect of the transport service is also very important for the success of DRT experimentation, in addition to necessary in-house training of new skills, which can be very different from

those of traditional transport. Finally, good communication between all the stakeholders involved in the project is essential.

Currie and Fournier (2020) stated that cases of failed DRT implementation experiments in the world are higher than those that become permanent: they argue that the academic literature never focused on DRT failures because supporters' will was to fuel enthusiasm for this innovative form of transport by focusing exclusively on the positive aspects of the service. This in fact allowed the failed DRT projects to be little considered or in any case soon forgotten by the media and public opinion.

To conduct their analysis on DRT failure cases, the researchers looked for information on some specific DRT dedicated reports, always double-checking results to assess whether services were still active or not: from this long work they extracted and reported on a single database a total of 120 DRT cases from 19 different countries.

They divided the life cycle of on-call transport into three main phases starting from 1970: the first stage (1970-1984), defined "Early DRT Dial-a-Bus Development", included the first cases of DRT trials characterized by high failure rates. During the second phase of the service history (1985-2009), called "Paratransit/Community Transport DRT Era", in which public subsidies have greatly helped the financial stability of services around the world, the number of trial failures has been quite low and many DRT services have since become permanent. The third phase of the life cycle of DRT, "ICT Tech Micro-Transit DRTs" from 2010 to the present day, despite availability of increasingly advanced technologies, presents a higher failure rate than the previous era (Currie and Fournier, 2020).

From this analysis, the largest number of DRT trials still active in 2019 (reference year) were launched between 1997 and 2004 (therefore within the so-called "Paratransit/Community Transport DRT Era"): 58% of DRT trials launched during the second era are still active to this day (updated to 2019) making this period the most successful in DRT history.

From the analysis of the 120 DRT systems collected by the authors, the results showed that in general, regardless of the historical launch period of the trial, DRT services

tend more to fail than to become permanent: about half of the cases observed lasted less than 7 years and 40% of them had a maximum lifespan of 3 years.

The authors' aim was to understand reasons behind this phenomenon: the main cause identified is attributable to the relation between high costs of service and high failure rate. The ultimate phase, "ICT Tech Micro-Transit DRTs", revealed to be the least successful due to the use of expensive vehicles and very flexible lines, whereas "Paratransit/Community Transport DRT Era" presented the lowest costs because many times the service was carried out as a voluntary activity and drivers were not paid. This naturally implies that complex and very flexible types of services ("many-to-many" models) are also the most expensive for the transport company.

3.4 DRT costs

In Florida, USA, the authorities also decided to analyse DRT service in order to use it as a possible alternative to the traditional transport service. In 2008, the Department of Transportation of the State of Florida commissioned the Centre for Urban Transportation Research of the University of South Florida (Tampa) to produce a report that could identify the main categories of expenses related to DRT service, collecting some best practices to contain costs. In July 2008, Goodwill and Carapella (2008) delivered the final report "Creative Ways to Manage Paratransit Costs" in which the above was treated.

When it comes to on-call service in the United States, a due premise is necessary: the introduction of the *Americans with Disabilities Act* (ADA) of 1990 revolutionized the transport sector in the country. This law prohibits discrimination against people with disabilities and guarantees them equal rights in all contexts of public life such as school, transport, work, areas of public use (libraries, parks, swimming pools, etc.).

In the transport sector, this law forced each fixed-route service provider to introduce in parallel an ADA complementary paratransit service for people with disabilities compliant with ADA requirements: for example, *"ADA complementary paratransit service must be provided during the same service hours as fixed-route service and within a three-fourths mile corridor of the fixed route."* Furthermore, *"each provider must have*

an established eligibility process to determine whether a customer who requests use of the ADA complementary paratransit is eligible for such a ride" (NADTC, 2014).

This law led to profound changes in the corporate structure of American transport companies, forcing them to enter suddenly a business whose dynamics they did not know.

The researchers, in order to identify the main categories of costs associated with the Paratransit service provided in Florida, conducted a search in the National Transit Database (NTD) and in the Florida Commission for the Transportation Disadvantaged Annual Operating Reports (AOR): thanks to this multitude of data they were able to identify the major cost items and their evolution over time.

The 12 main cost categories identified in 67 different Florida counties (related to the fiscal years from 2002 - 2003 to 2005 – 2006) are listed below (each cost category includes many cost items within it):

- Personnel costs;
- Fringe benefits;
- Services;
- Materials and supplies consumed;
- Utilities;
- Casualty and liability;
- Taxes;
- Purchased transportation services;
- Leases and rentals;
- Annual depreciation;
- Contributed services;
- Other.

Annual Reports provide information on the composition of the total expenditure of transit providers: the 12 main cost categories have been calculated individually in order to understand how much each of them contributes to the total expenditure. The main cost item is represented by the cost of labour (36%), followed by the purchase cost of the transport service (22%), after which, to a lesser extent, the expenses for materials and supplies (9%), fringe benefits (8%), services (7%), insurance expenses (5%), other

expenses (4%), equal annual depreciation and leases/rental (3%) and finally taxes, contributed services and utilities (1 %). The evolution of these expenses has been studied during the period 2003-2006: due to stringent financial possibilities by transport providers, each expense item has remained more or less stable over the period of time considered (a slight increase is noted only for the two main cost items, namely "labour" and "purchased transport").

The analysis of NTD Reports is important in order to understand the evolution over time of operating costs and maintenance costs of the service. These reports look at 25 public transport providers in the state of Florida for fiscal years from 1999-2000 to 2004-2005. In general, operating costs are much higher than maintenance costs and represent almost all expenses incurred by transport companies: the "Total Operating Expenses" raised from $ 66,301 in 2000 to $ 165,524 in 2005, while the total costs of maintenance grew significantly less (from $ 11,293 in 2000 to $ 22,392 in 2005).

The above testifies, in the 6-year period considered (1999-2005), a lesser growth for service maintenance costs (98.3%) and very high for operating costs (149.7%). The hourly cost of the service also grew exponentially from 2000 to 2005 from $ 23.31/h to $ 36.52/h (57% increase).

Table 3.2 shows the main strategies implemented by transport providers in order to keep total costs of DRT service low. These measures were identified by researchers based on the best practices observed.

Table 3.2 Strategies to keep DRT total costs low

AREA OF INTEREST	DESCRIPTION
SERVICE AREAS	USA transport providers, since they must comply with ADA requirements, must try to offer a transport service able to meet the needs of any passenger in order to optimize business costs and avoid having two separate services: fixed route on the one hand and DRT on the other. Another strategy to contain costs concerns the possibility of meeting the ADA requirements at the minimum allowable: for example, limiting the service area of DRT services exclusively to the area within 3/4 mile of the already existing fixed-route service. For DRT services that exceed this

	space, transport providers must charge higher rates in order to increase revenues.
ELIGIBILITY PROCESS	Another way to keep costs down concerns the possibility of controlling the demand of transport: this can be done through the eligibility process (it defines whether passengers are able to use the fixed-route service or based on their degree of disability are entitled to DRT service). In order to better identify people who need DRT service, proposed strategy is to define eligibility application forms that are as precise as possible and that include a medical verification of the passenger's doctor.
RECERTIFICATION	After having carried out the analysis for the eligibility process and having accurately identified their potential demand, transport provider must constantly certify the conditions of their DRT passengers on a regular basis (this allows them to be constantly updated on changes in policies and on the conditions of users about their status, relocations and deaths). The frequency of recertification depends on each individual company, although the report shows 3 years as the average.
RESERVATION PROCESS	After defining the operational area of the service and identifying transport demand, next step is to obtain an efficient reservation / scheduling / dispatch process. Each transport provider must have an efficient reservation process: the company must communicate as clear as possible the booking window created to customers. It is useful for containing costs to negotiate the exact pick-up time directly with passengers so that the company can spread the demand over a wider time slot and users benefit from great flexibility. In order to communicate clearly with passengers, it may be important to provide users with guides on the reservation processes and use of DRT services. Subscriptions to the service allow transport agencies to manage better reservations: this is because subscribed passengers are often commuters who always have the same travel times and the same origin and destination.
SCHEDULING PROCESS	The scheduling process is now completely automated but the physical presence of the operators is still very important: a double check by the staff is always useful to avoid system errors. It is important for operators to set up a system that contacts users before the time of their ride: this reduces so-called "no-shows" and confirms the present passengers.
DISPATCHING PROCESS	Some transport providers have systems that provide for direct communication between dispatchers and drivers at each pick-up and drop-off location: this allows the dispatch centre to be constantly updated on changes in the schedule which, in the event of delays or no-shows of passengers, must be modified (this can only happen in contexts with few operators present, in larger contexts the driver contacts the dispatch centre only in case of problems).
USE OF TECHNOLOGY	Investments in technology represent a cost containment solution. The digitization of the booking system, both via app and web, allows the PTAs to save on TDC personnel costs. Furthermore, DRT service is based

	on the use of so-called Automatic Vehicle Location (AVL) terminals on board vehicles: the greater the technological advancement of these systems, the better the degree of real-time response of the TDC to any problems encountered by the driver. Together with the AVLs, the drivers are also equipped with Mobile Data Terminals (MDTs), which are terminals with which the driver can record the exact times and locations of passengers' pick-up and drop-off.
NO-SHOWS AND LATE CANCELLATION POLICIES	Some of the main problems related to the planning of DRT services are attributable to the so-called "no-shows" (passengers who simply do not show up at the agreed time and stop without giving any notice) and to "late cancellations" (passengers who decide to contact the customer care of the transport agency to cancel their ride but with insufficient advance to allow TDC to reformulate a new route for the DRT vehicle). Since practices such as no-shows and late cancellations involve heavy losses, the transport operator must impose strict policies on passengers who intend to abuse the system. One solution could be to record the behaviour of individual passengers and provide bonuses to those who behave flawlessly and penalties to those with high rate of no-shows and late cancellations (e.g. Citifare, in Reno, USA).
CONTRACTING	A possible strategy to contain costs and cope with fluctuations in transport demand lies in the possibility of dividing the management of PTA's own transport service: some services are carried out by their own vehicles and with PTA's own personnel, while contractors are used in other lines.
SERVICE MONITORING	PTAs must be equipped with service monitoring systems as this ensures that the quality of the service is always high, prevents any fraud and protects the rights of passengers: these monitoring systems use KPIs to evaluate the performance of the service from all points of view (including user feedback).
USE OF FIXED ROUTES	As previously mentioned, a key aspect for containing costs is linked to the in-depth study of transport demand: the main objective of transport agencies is to convey as many users as possible to fixed-route services. This can be done in several ways such as better accessibility of information and bus stops.
FIXED ROUTE TRAVEL TRAINING	In order to shift regular users of DRT to fixed-route service, PTAs can use different strategies including offering reduced or free rates as an incentive or providing individual or group training.
USE OF VOLUNTEERS	The simplest strategy to contain costs lies in the availability of volunteers able to perform certain roles within the PTA for DRT service: for example, carrying out training sessions for passengers, information services, etc.

Source: Author's elaboration based on Goodwill and Carapella (2008)

3.5 Concluding remarks

In order to answer the first research question of this thesis, a careful analysis of the international literature has been done in order to pinpoint the key traits of the DRT service in rural regions, the driving forces behind success and failure cases, and the key costs related to it.

Although the fundamental elements of this technology are universal, it should be highlighted that any regional, cultural, and governmental environment can have a different impact on DRT performances. The Italy case study is covered in the next chapter.

CHAPTER IV

ITALIAN RURAL DRT CASES: STATE OF THE ART

4. Italian rural DRT Cases: state of the art

This chapter reports on the case studies of rural on-demand transport services implemented in Italy. Research questions that this chapter intends to address are the following, on the basis of what conducted by Bellini et al. (2003) at the urban level:

RQ2: *"What is the current layout of the on-call service offer in Italy's rural areas?"*

RQ3: "What is the level of technological maturity used in DRT technology nationwide?"

In order to address above issues, a research was conducted through the consultation of the Project Framework Agreements of Italian Regions, by a review of sector agency websites and by a keywords web search. In the latter case, the analysis was carried out by typing, on Google and Microsoft Edge search engines, the inputs "Rural DRT cases", "on-demand transport low demand areas" and "Demand Responsive Transport in rural areas" associated with the word "Italy" and the name of every single Region. This research was conducted in Italian as this is the language of all material relating to DRT services implemented in Italy. The work involved identifying rural DRT services implemented in Italy from 2010 (both active and already expired services).

Since DRT services are strongly technology-based, the research started in 2010 in order to compare DRT cases within the same historical and technological development context. At the end of the analysis, 35 rural DRT cases[3] were identified.

The overview in this section compares, for every DRT case taken into consideration, the main characteristics useful for understanding the wide range of possibilities that this technology offers (Dycktov et al., 2022):

- Service name;
- Service area;
- Service manager;
- Period of service activity;
- Service time slot;

[3] TSonDemand DRT service of Trieste is split in two different service models.

- Booking system;
- Cost of service;
- Route;
- Stops;
- App availability;
- Score of flexibility.

The case studies reported in this section are divided into four different categories: three refer to the SNAI classification[4] related to distance from the closest service provision centre (“outlying”, “intermediate” and “peripheral/ultra-peripheral" areas) and in addition, a fourth category of rural DRT cases dedicated to tourists is proposed.

Each rural DRT service is evaluated based on its degree of flexibility in order to provide an overview of the strategies most adopted by PTAs: an evaluation method assigning a score from one to six depending on the degree of flexibility implemented is here proposed. Table 4.1 shows the scoring criteria based on the different service degree of flexibility.

Table 4.1 Scoring criteria

Service model	Score of flexibility
Predetermined route with bookable fixed stops	1
Predetermined route with possible detours from nominal line	2
Flexible route with fixed stops	3
Flexible route with some fixed stops and some variable stops	4
One-to-many (Few-to-many) Many-to-one (Many-to-few)	5
Many-to-many	6

Source: Author’s elaboration

In Table 4.2 is initially presented the list of DRT cases selected for this overview divided according to the categories they belong to (in alphabetical order). Afterwards

[4] The SNAI classification criteria are described in detail in chapter 5.

every case study is individually analysed by examining common characteristics and differences.

Table 4.2 List of DRT cases selected

SNAI classification	DRT service
Outlying areas	Alessandria – ECCOBUS
	Bologna – ProntoBus di Pianura
	Casarza Ligure (GE) - Chiama il Bus
	Casina (RE) – TeleBus
	Castiglione del Lago (PG) – "L' auto…bus frazioni"
	Central Piedmont - Provibus
	Cogorno (GE) – Chiama il Bus
	Crema (CR) – MioBus
	Cremona - Stradibus
	Plaine d'Aoste – Allô Bus
	Plaine d'Aoste - Allô Nuit
	Reggio Calabria – ChiamaBus
	Sarzana (SP) – Prontobus
	Torino – MeBus
	Trentino e Alto Garda - Bus&Go
	Trieste – SmartBus
	Trieste - TSonDemand
	Val Graveglia (GE) - Chiama il Bus
	Valmarecchia (RN) – Valma Bass
Intermediate areas	Bargagli and Davagna (GE) – Chiama il Bus
	Borzonasca (GE) - Chiama il Bus
	Mondovì (CN) – Grandabus
	Oltrepò Pavese (PV) – MioBus
	Sondrio – Chiamabus
Peripheral and ultra-peripheral areas	Bormio, Valdidentro, Valdisotto (SO) – Chiamabus
	Courmayeur (AO) – Allô Bus Courmayeur

	Grand Paradis (AO) - Allô Bus Grand Paradis South Salento – "Bus a chiamata Sud Salento" Val Degano (UD) – UDonDemand Val di Zoldo (BL) – Navetta Comunale Valbrevenna (GE) - Chiama il Bus
Turistic DRT services in rural contexts	Bolognese Appennine – ColBus Gran Paradis (AO) – Trekbus Valle Gesso (CN) – InMarittime

Source: Author's elaboration

4.1 Outlying areas

- *Alessandria – ECCOBUS*

The ECCOBUS service is managed by AMAG Mobility Spa and is carried out in the province of Alessandria, Piedmont. The service was tested starting from 2006 when it consisted of only four vehicles and aimed at substituting traditional transport: currently only one vehicle is used and this sometimes creates inconvenience to users due to a mobility demand higher than the offer (Table 4.3).

Table 4.3 Alessandria - Eccobus

Service Name	ECCOBUS
Service Area	Province of Alessandria, in the areas between via Vecchia dei Bagliani, Cittadella, San Michele, Cornaglie, Giardinetto, Valle San Bartolomeo, Pecetto, Valmadonna, Alessandria (Ospedale, Piazza Libertà, Stazione F.S.).
Service Manager	AMAG MOBILITA' Spa
Period of service activity	All year round

Service time slot	active every weekday from 6.00 – 10.00 / 11.00 – 15.00 / 16.00 - 20.00
Booking system	Via telephone
Cost of service	1 €/day must be added to the ordinary ticket for traditional transport. There are also forms of monthly or annual passes that vary according to kilometre range and age of passengers.
Route	Flexible
Stops	Fixed
App availability	No
Score of flexibility	3

Source: Author's elaboration

- *Bologna – ProntoBus di Pianura (Plain ProntoBus)*

The DRT service active in the Bologna plain and involving 13 municipalities is called "ProntoBus di Pianura" (Plain ProntoBus) and was launched in 2001 to connect these locations with the Bentivoglio hospital, which is the hub of the entire network (Table 4.4).

Table 4.4 Bologna - ProntoBus di Pianura (Plain ProntoBus)

Service Name	ProntoBus di Pianura (Plain ProntoBus)
Service Area	The DRT service connects 13 municipalities in the Northern area of the city of Bologna: Argelato, Baricella, Bentivoglio, Castello D'Argile, Castel Maggiore, Galliera, Granarolo dell'Emilia, Malalbergo, Minerbio, Molinella, Pieve di Cento, San Giorgio di Piano, San Pietro in Casale.
Service Manager	TPER Trasporto Passeggeri Emilia Romagna
Period of service activity	All year round
Service time slot	Monday to Saturday 6:50 - 20:00; public holidays 7:00 -20:00

Booking system	Via web or telephone up to 35 minutes before the ride
Cost of service	The cost of the service varies according to the zones to cross (one zone at € 1.30 up to five zones at € 4.50). There are also discounts on monthly and annual passes based on the age of the passengers.
Route	Fixed (also timetables are fixed)
Stops	Fixed
App availability	No
Score of flexibility	1

Source: Author's elaboration

- *Casarza Ligure (GE) – Chiama il Bus (Table 4.5)*

Table 4.5 Casarza Ligure (GE) – Chiama il Bus

Service Name	Chiama il Bus
Service Area	Municipalities of Massasco, Campegli, S. Pietro Di Frascati, Masso, Novano, Cardini, Tassani, Rovereto, 1° Maggio Street, Bruschi, Verici, Olivella Caminata Street, Barletti Street, Nicolò Sottanis Street, Giuseppe Stagnaro Street.
Service Manager	AMT SPA
Period of service activity	All year round (Pilot)
Service time slot	Mon – Sat from 06.00 – 19.30, no holidays
Booking system	Via telephone and via App, up to 12.00 of day before
Cost of service	Ordinary ticket
Route	Flexible
Stops	Fixed
App availability	Yes
Score of flexibility	3

Source: Author's elaboration

- *Casina (RE) – TeleBus*

The DRT service of Casina (RE) is part of an initiative involving two other DRT services, those of Reggio Emilia and Correggio, managed by Local Mobility Agency of Reggio Emilia and aimed at allowing the inhabitants of the Emilian rural areas to have access to the essential services offered in the close major centres (Table 4.6).

Table 4.6 Casina (RE) – TeleBus

Service Name	TeleBus
Service Area	Service divided into three areas around Casina (RE): first area (Banzola - Costaferrata - Cortogno - Sarzano), second area (Leguigno - Migliara - Canala), third area (Giandeto - Canicchia)
Service Manager	TIL Trasporti Integrati e Logistica Srl
Period of service activity	All year round
Service time slot	Only Tuesday, Thursday and Saturday 09.00 – 12.30
Booking system	If the user's stop is located along the main route, he must not book, otherwise he must call the call centre within 23.00 the previous day to book the ride.
Cost of service	2€ per ride
Route	The itinerary is partly fixed (main route) with the possibility of deviating from the nominal line according to user needs.
Stops	Stops are predetermined along the main route and variable outside.
App availability	No

Score of flexibility	2

Source: Author's elaboration

- *Castiglione del Lago (PG) – "Auto…bus frazioni"*

The DRT service in Castiglione del Lago (PG) was launched, on an experimental basis, in 2017 (July - December), immediately achieving a high degree of satisfaction from passengers. The project, called "L' auto...bus a chiamata" ("on-demand bus"), was active only in urban areas: the service used a 6-seater methane minibus and connected over 100 stops within the Umbrian municipality. Based on the success of this service, from 28 February 2022 the local administration decided to extend the coverage of DRT service also to the hamlets around Castiglione del Lago (PG): the service thus took the name of "Auto...bus frazioni" ("Hamlets bus"). A 9-seater minibus carries it out on weekdays (excluding holidays) for the hamlets and from Monday to Saturday (excluding holidays) in the capital with another 9-seater minibus (Table 4.7).

Table 4.7 Castiglione del Lago (PG) – "Auto…bus frazioni"

Service Name	*"Auto…bus frazioni"*
Service Area	Castiglione del Lago (PG) and neighbouring hamlets
Service Manager	ISHTAR Soc. Consortile Srl tramite Gervasoni Autotrasporti
Period of service activity	All year round (service started on 28 February 2022)
Service time slot	For the hamlets active from Mon to Fri (except holidays) 7:30 - 13:30; In Castiglione del Lago (PG) active from 8.30 to 12.30 and from 15.30 to 19.00 from Mon to Sat (except holidays).

Booking system	Only via telephone, the day before the ride
Cost of service	In Castiglione del Lago (PG) the cost of the ticket is 1,50 €/ride while in the hamlets it varies depending on the length: within 6 kms from the capital the cost is 2€/ride, over 6 kms the cost is 2,50€ (the second member of the family pays 2€ only).
Route	The itinerary is partly fixed (main route) with the possibility of deviating from the nominal line according to user needs.
Stops	Stops are predetermined along the main route and variable outside.
App availability	No
Score of flexibility	2

Source: Author's elaboration

- *Central Piedmont – Provibus*

The Provibus DRT service, one of the longest running in Italy, has been active in the central part of Piedmont since 2006 and currently covers an area of approximately 900 sq. km.

DRT lines serve the residents of numerous municipalities belonging to three different Piedmont's provinces such as Turin, Vercelli and Alessandria and refer to eight main attractive poles (Table 4.8). The network of DRT lines of Provibus service is constantly expanding: thanks to the European funds of the ALCOTRA project (Alpi Latine COoperazione TRAnsfrontaliera), a cross-border cooperation program between Italy and France, lines and hours of service activity are gradually extended in more and more municipalities of the area.

Table 4.8 Central Piedmont – Provibus

Service Name	Provibus
Service Area	The service area covers many municipalities belonging to three provinces in the heart of the Piedmont region (Torino, Alessandria and Vercelli). All the municipalities covered by the service refer to 8 different attraction poles: - Crescentino (VC) - Chivasso (TO) - Cerrina Monferrato (AL) - Gassino Torinese (TO) - Caluso (TO) - Perosa Argentina (TO) - Ciriè (TO) - Pont Canavese e Cuorgnè (TO)[5]
Service Manager	Various
Period of service activity	All year round
Service time slot	Active on weekdays 9.00 – 12.00 / 14.00 – 16.00[6] and for special events on holidays.
Booking system	Via telephone, up to the day before
Cost of service	The same as regional public transport (from 1,60 € to 2,80€).
Route	Flexible
Stops	Fixed
App availability	No

[5] In the municipalities of Pont Canavese and Cuorgnè, in the province of Turin, an experimental service called "Provibus +" is active: it is a semi-flexible on demand transport service that replaces the traditional low transport demand lines and maintains the main features (stops and fixed times).

[6] In some municipalities covered by the Provibus on-demand transport service is currently active an experiment to extend the service hours: Mon - Fri 08.15 - 12.15 and Sat 08.15 - 12.15.

Score of flexibility	3

Source: Author's elaboration

- *Cogorno (GE) – Chiama il Bus (Table 4.9)*

Table 4.9 Cogorno (GE) – Chiama il Bus

Service Name	Chiama il Bus
Service Area	Municipalities of Breccanecca, Monticelli and Galle
Service Manager	AMT SPA
Period of service activity	All year round (Pilot)
Service time slot	Mon – Sat from 06.00 – 19.30, no holidays
Booking system	Via telephone and via App, up to 12.00 of day before
Cost of service	Ordinary ticket
Route	Flexible
Stops	Fixed
App availability	Yes
Score of flexibility	3

Source: Author's elaboration

- *Crema (CR) – MioBus*

MioBus DRT service is carried out in two areas to the west and east of the town of Crema, in the province of Cremona (Table 4.10). This service takes up the characteristics of the virtuous example of the on-call service active in the province of Cremona ("Stradibus") for the areas of Piadena and Soresina / Castelleone. Users can book by e-mail or speak directly with an operator of the operating centre by telephone: the latter asks the passenger for their user code (attributed to the first trip booked), desired departure and arrival stop and departure and arrival time. Due to problems related to booking procedures and excessive waiting times, in September 2021 the DRT service was partially replaced by a

traditional service with fixed routes and stops (30). In any case, the on-call service remains active for stops not covered by scheduled transport.

Table 4.10 Crema (CR) – MioBus

Service Name	MioBus
Service Area	Municipalities east of Crema (CR): Crema, Camisano, Casaletto di Sopra, Casale Cremasco-Vidolasco, Castel Gabbiano, Mozzanica, Offanengo, Pianengo, Ricengo, Romanengo, Sergnano, Soncino, Ticengo. Municipalities west of Crema (CR): Crema, Campagnola Cremasca, Cremosano, Bagnolo Cremasco, Trescore Cremasco.
Service Manager	Province of Cremona and Auto Guidovie Italiane Spa
Period of service activity	All year round Every day at the following times:
Service time slot	from Monday to Saturday, 08:45 - 12:30 / 14:30 - 18:30
Booking system	Via telephone or mail, before 17:00 (from Monday to Friday) and 11:00 (on Saturday) of the day of the ride.
Cost of service	Ordinary ticket for fixed transport
Route	Flexible
Stops	Fixed
App availability	No
Score of flexibility	3

Source: Author's elaboration

- *Cremona – Stradibus*

The DRT service of the province of Cremona, "Stradibus", articulates its transport offer on two services: the Piadena and the Soresina - Castelleone area (Table 4.11). The reservation can be made directly on the official website of the transport company or by telephone at the call centre. The cost of service depends on the number of zones crossed on board the vehicle: the entire area covered by the on-call service has been divided into 4 zones and the journey within a single zone requires a ticket cost of 1 €, while the crossing of all 4 zones costs a maximum of 2.25 €.

Table 4.11 Cremona - Stradibus

Service Name	Stradibus
Service Area	Province of Cremona. The Piadena area (municipalities of Bozzolo, Cà d'Andrea, Calvatone, Picenardi Chapel, Casteldidone, Cicognolo, Cingia de 'Botti, Derovere, Drizzona, Isola Dovarese, Pessina Cremonese, Piadena, Pieve San Giacomo, Rivarolo del Re, Rivarolo Mantovano, San Giovanni in Croce, San Martino del Lago, Solarolo Rainerio, Spineda, Tornata, Torre de 'Picenardi, Vescovato and Voltido). The Soresina / Castelleone area (municipalities of Annicco, Azzanello, Bordolano, Cappella Cantone, Casalbuttano, Casalmorano, Castelleone, Castelvisconti, Corte dè Cortesi with Cignone, Formigara, Gombito, Montodine, Paderno Ponchielli, San Bassano, Soresina and Ossolaro).
Service Manager	Arriva Italia Srl
Period of service activity	All year round
Service time slot	The Piadena area service: active on weekdays 06.30 – 19.30.

	The Soresina / Castelleone area service: active on weekdays 08.00 – 12.00 / 15.00 – 19.30
Booking system	Via web or telephone, up to 19.00 of the day before
Cost of service	The cost of service depends on the number of zones (4 in total) crossed during trip: - trip within 1 zone costs 1€; trip between all 4 zones costs 2,25€
Route	Flexible
Stops	Fixed
App availability	No
Score of flexibility	3

Source: Author's elaboration

- *Plaine d' Aoste (AO) – Allô Bus*

The DRT Allô Bus service has been active for several years (starting from 2006) in the so-called Plaine d'Aoste, the plain surrounding the city of Aosta. It was from the beginning integrated by the evening and night DRT service Allô Nuit (still active and presented in Table 4.13) and operative in the same areas (Table 4.12).

Table 4.12 Plaine d' Aoste (AO) – Allô Bus

Service Name	Allô Bus
Service Area	Aosta and some municipalities of the plaine d'Aoste such as Gignod, Roisan, Saint-Christophe and Sarre.
Service Manager	SVAP Società Valdostana Autoservizi Pubblici
Period of service activity	All year round (not active anymore)
Service time slot	On weekdays 9.00 – 13.00 / 15.00 – 20.00
Booking system	Via telephone
Cost of service	

	Supplement of 0,20€/ride and in some lines supplement of 1€/ride compared to FT.
Route	Flexible
Stops	Fixed, the same of traditional transport
App availability	No
Score of flexibility	3

Source: Author's elaboration

- *Plaine d'Aoste (AO) – Allô Nuit*

The Allô Nuit service has been active since 2008 in Aosta and in the neighbouring municipalities that are part of the so-called Plaine d'Aoste (Table 4.13). This service is very particular compared to the other case studies analysed as it is the only night on-demand transport service in rural areas. Another peculiarity is given by the fact that users cannot contact the call centre or reserve their seat on board in advance, but they must call the drivers directly during the hours of service activity (from 21.00 to 05.30). SVAP Società Valdostana Autoservizi Pubblici won the public tender for the provision of the service but sub-licensed the service to a group of taxi drivers of Aosta. The service provides for the use of only one vehicle on weekdays (until Thursday), while three vehicles are used on Fridays, Saturdays and pre-holidays. The cost of the service is divided based on three different categories: urban area (Aosta), within 15 km and over 15 km of ride. As for the DRT service of Reggio Calabria, also here the ticket price varies according to the degree of filling of the vehicle.

Table 4.13 Plaine d'Aoste (AO) – Allô Nuit

Service Name	Allô Nuit
Service Area	Aosta and some municipalities of the plaine d'Aoste such as Aymavilles, Brissogne, Charvensod, Gignod, Gressan, Jovençan, Pollein, Quart, Roisan, Saint-Christophe, Sarre, Nus, Fénis and Saint-Marcel, Saint Pierre, Villeneuve.

Service Manager	SVAP Società Valdostana Autoservizi Pubblici
Period of service activity	All year round
Service time slot	Every night (except Sunday) 21.00 – 05.30
Booking system	It is not possible to book or contact the call centre. Users need to call the vehicle driver directly.
Cost of service	Up to 15 km 1 user on board pays € 9, 2 users on board pay € 6.50 each, 3 users on board pay € 5 each. Over 15 km 1 user on board pays € 13, 2 users on board pay € 7.50 each, 3 users on board pay € 6 each.
Route	Flexible
Stops	Fixed, the same of traditional transport
App availability	No
Score of flexibility	3

Source: Author's elaboration

- *Reggio Calabria – ChiamaBus*

As part of the "Meglio Muoversi" project promoted by the province of Reggio Calabria in 2017 in order to achieve goals of green and inclusive mobility, two types of innovative transport services were launched involving the entire metropolitan area: a car sharing, and a DRT service called "ChiamaBus" (Table 4.14).

As for the "ChiamaBus" on-call service, after an experimental phase in 2017, it was definitively re-proposed starting from May 2018. This service is carried out by 9 and 14-seater minibuses and 54-seater buses. The cost of the service, as per Allô Nuit, is quite peculiar: there is no standard rate but the cost of transport depends on the number of passengers on board (one user on board pays 13.80 € while eight users on board pay 1.70 € each).

Table 4.14 Reggio Calabria – ChiamaBus

Service Name	ChiamaBus
Service Area	Province of Reggio Calabria, 97 municipalities covered
Service Manager	Svi.Pro.Re. Spa
Period of service activity	All year round
Service time slot	All days h. 24/24
Booking system	Via mail, telephone or totem placed at stops
Cost of service	The cost is determined according to the degree of filling of the vehicle. The more passengers use the service, the lower the cost for everyone. Concessions are provided for families, under 18, over 65, users who must undergo treatment and / or visits to provincial health facilities. Free transport for people with physical disabilities or reduced mobility.
Route	Flexible
Stops	Fixed
App availability	No
Score of flexibility	3

Source: Author's elaboration

- *Sarzana (SP) – Prontobus*

The DRT Prontobus service has been active in Sarzana (SP) and in the hamlets of Val di Magra since 2009 (Table 4.15). ATC La Spezia, service provider, in 2019 extended DRT daily trips: nine trips a day for the hamlet of Bradia and four for Battifollo and Crociata.

Table 4.15 Sarzana (SP) – Prontobus

Service Name	Prontobus
Service Area	The DRT service connects Sarzana (SP) to the inland hamlets of Bradia, Battifollo, Crociata and Camponesto (Val di Magra).
Service Manager	ATC La Spezia
Period of service activity	All year round
Service time slot	On weekdays 08.00 – 20.00
Booking system	Via telephone, up to 30 minutes before the ride
Cost of service	Same as regional fixed transport (1,50€)
Route	Flexible
Stops	Fixed
App availability	No
Score of flexibility	3

Source: Author's elaboration

- *Torino – MeBus*

The MeBus service has been active in the Turin metropolitan area since 2008, thanks to funds from the Metropolitan Mobility Agency and the Piedmont Region (Table 4.16). As reported by the official site of the MeBus project[7], the DRT service has grown a lot since it was launched both in terms of kilometres travelled and passengers served (annually about 22,000 passengers use the on-demand service and more than 160,000 km/year are travelled by vehicles). The service has expanded year after year and currently covers four different areas of the province of Turin (each served by a different operator): North East, North West, South West and Collina Chierese. In addition to MeBus, there is also another on-call transport service ("ProviBus") which is particularly widespread throughout the central area of the Piedmont Region.

[7] http://www.mebus.it/il-progetto

Table 4.16 Torino – MeBus

Service Name	MeBus
Service Area	Municipalities of Borgaro Torinese, Brandizzo, Caselle Torinese, Chivasso, Leinì, Mappano, San Benigno Canavese, Malanghero (hamlet of San Maurizio Canavese), San Mauro Torinese, Settimo Torinese and Volpiano with extension to Turin Stura.
Service Manager	MeBus NordEst (Demarchi Srl) MeBus SudOvest (GTT Spa) MeBus NordOvest (Gherra Srl) MeBus Collina Chierese (Cavourese Spa)
Period of service activity	All year round (except August)
Service time slot	MeBus Nord Est is active on weekdays Mon - Fri 9.00 - 19.00 and Saturday 9.00 - 13.00; MeBus Sud Ovest is active on weekdays Mon - Fri 9.00 - 19.00 and Saturday 9.00 - 14.00; MeBus Nord Ovest is active on weekdays Mon - Fri 8.30 - 19.00 and Saturday 8.30 - 12.00; MeBus Collina Chierese is active on weekdays Mon - Fri 8.30 - 19.30 and Saturday 8.30 - 12.30.
Booking system	All services via telephone the day before
Cost of service	Tickets of all DRT services cost like other suburban buses.
Route	Fixed
Stops	Fixed
App availability	No
Score of flexibility	1

Source: Author's elaboration

- *Trentino e Alto Garda - Bus&Go*

Bus&Go is an on-call transport service active in the summer period in the Alto Garda Trentino Region service carried out with a 19-seater minibus. Trentino Trasporti Spa manages this service in collaboration with three municipalities (Arco, Riva del Garda and Nago-Torbole) and the tourist office of the area. The peculiarity of this DRT service is the possibility given to users to book their rides through the dedicated Bus&Go app (available for Ios and Android, as per Figure 4.1). Furthermore, Trentino is one of the most technologically advanced realities in terms of integrated service offer: people staying in Trentino hotels are entitled to obtain the so-called *Trentino Guest Card* (guests can receive it via SMS or email at the time of the booking). This card, usable directly from a smartphone, offers various benefits to holders including free use of public transport in Trentino (also the on-demand Bus&Go service), access to museums, exhibitions, tastings and other activities at discounted prices (Table 4.17).

Table 4.17 Trentino e Alto Garda - Bus&Go

Service Name	Bus&Go
Service Area	Trentino and Alto Garda Region
Service Manager	Trentino Trasporti Spa
Period of service activity	Every day from 16 July to 30 September 2022
Service time slot	8.00 – 12.30 / 13.30 – 17.00 / 18.00 – 24.00
Booking system	Via Bus&Go app, bookings up to midnight
Cost of service	2€ per ride or free with Trentino Guest Card
Route	Flexible
Stops	Fixed, the same of traditional transport
App availability	Yes
Score of flexibility	3

Source: Author's elaboration

Figure 4.1 "Bus&Go" app.

Source: Author's screenshots on Google Play

➢ *Trieste – SmartBus*

SmartBus is an on-call transport service launched on an experimental basis by Trieste Trasporti Spa for 4 months in 2019 (from July to October) which connected the municipalities and localities of the Trieste Plateau (Table 4.18). The pilot was co-financed by a Central European Interreg project[8] and authorized by the Infrastructure and Transport Department of the Friuli Venezia Giulia Region. It was a service structured in two parts and carried out by two buses: the karst area to the west and the one to the east with respect to the polarity of Trieste. The model was flexible from a timetable point of view, while the service used the same stops of traditional transport, even if the route was flexible according to the requests of users.

The service has been suspended for a few years due to Covid-19 pandemic and now some attempts to strengthen the service and relaunch it are in progress.

[8] "Peripheral Access" is the name of this project aimed at realize concrete actions in order to increase level of accessibility of people residing in remote areas.

Table 4.18 Trentino e Alto Garda - Bus&Go

Service Name	SmartBus
Service Area	Plateau of Trieste
Service Manager	Trieste Trasporti Spa
Period of service activity	01/07/2019 - 31/10/2019 (Pilot)
Service time slot	Every day 9.00 - 21.00
Booking system	Via web at smartbus.triestetrasporti.it or telephone, up to two hours before the ride
Cost of service	Free until 11/08/2019, then 2€/ride
Route	Flexible
Stops	Fixed, the same of traditional transport
App availability	No
Score of flexibility	3

Source: Author's elaboration

- *Trieste – TSonDemand*

The line 51 of the extra-urban transport of Trieste in some time slots was replaced by the experimentation of an on-call transport service (started 23 May 2022). The service carried out by the traditional line 51 is now divided into two: a DRT service is responsible for connecting Piazza della Libertà in Trieste with its eastern plateau, while another line of DRT service transports passengers only within the plateau without connection to Trieste (Table 4.19). This second service allows people living in the more peripheral hamlets of the Karst (such as Fernetti, Grozzana, Pesek, etc.) to have an easy connection with the two major poles of Basovizza and Opicina and from there to use the traditional line to reach Trieste. The service can be booked calling to the Operative centre or using the special TSonDEMAND app (Figure 4.2) developed by ViaVan, a leading company in DRT sector. This type of DRT service is in continuity with the previously described experience of the trial in the east and west plateau of Trieste in 2019 ("SmartBus"), which was then suspended due to the outbreak of the Covid 19 pandemic.

A similar service, UDonDemand, for the mountain area of Udine, is described below (Table 39).

Table 4.19 Trieste – TSonDemand

Service Name	TSonDemand
Service Area	Line 51 of the traditional extra-urban transport is replaced by a double service. The first service operates exclusively on the eastern plateau (no connection with Trieste city center). It allows users to connect Opicina or Basovizza with the more peripheral and less connected localities of the Karst (Fernetti, Grozzana, Pesek, Draga Sant'Elia and San Lorenzo). The second service instead connects Villa Carsia with Piazza della Libertà (center of Trieste), following the fixed route of line 51.
Service Manager	Trieste Trasporti Spa and TPL FVG
Period of service activity	All year round (pilot started 23/05/2022)
Service time slot	Mon – Sat from 9.15 – 12.15 / 13.45 – 17.15
Booking system	Via TSonDEMAND app or telephone, up to 45 minutes before the ride
Cost of service	The same of fixed extra-urban transport, first ride is free for those who have no subscription.
Route	The first service, operating only in the eastern plateau area of Trieste, provides a flexible route. The second service, which connects the eastern plateau with the centre of Trieste, involves the use of the same route as traditional transport: in the absence of reservations, the buses will only connect Opicina with the city centre, without detours. In the presence of reservations, however, the rides will be able to pass through Banne, Gropada, Area Science

	Park (Padriciano campus) and Sincrotrone Elettra (Basovizza).
Stops	Fixed, the same of traditional transport
App availability	Yes
Score of flexibility service 1	3
Score of flexibility service 2	1

Source: Author's elaboration

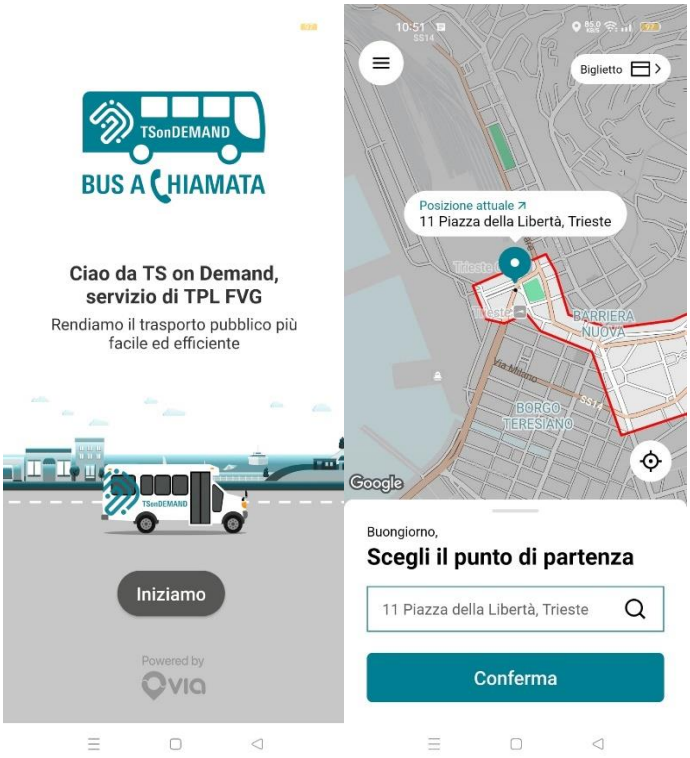


Figure 4.2 "TSonDEMAND" app.

Source: Author's screenshots of "TSonDEMAND" app.

- *Val Graveglia (GE) – Chiama il Bus*

The Genoa-based transit provider AMT launched this on-call transport pilot service in February 2022, thanks to the funds of the SNAI project (Table 4.20). This specific case study will be analysed in detail in the next chapter of the thesis.

Table 4.20 Val Graveglia (GE) – Chiama il Bus

Service Name	Chiama il Bus
Service Area	Municipalities of Conscenti, Caminata, Frisolino, Piandifieno, Botasi, Chiesanuova, Casedogana, Pontori, Campo di Nè, Iscioli, Castagnola, Zerli, Statale, Reppia e Arzeno.
Service Manager	AMT SPA
Period of service activity	All year round (Pilot)
Service time slot	Mon – Sat from 06.00 – 19.30, no holidays
Booking system	Via telephone and via App, up to 12.00 of day before
Cost of service	Ordinary ticket
Route	Flexible
Stops	Fixed
App availability	Yes
Score of flexibility	3

Source: Author's elaboration

- *Valmarecchia (RN) – Valma Bass*

The Valma Bass service was launched prior to the SNAI initiative (in 2012) but still covers one of the inner areas identified by the project: Alta Valmarecchia. The Valma Bass on-call transport service consists of two lines afferent to two different areas: the red line in the Verucchio and Poggio Torriana area, the blue in Santarcangelo and Poggio Torriana. Agenzia Mobilità entrusted the management and provision of the transport service to the Cooperative "La Romagnola" of Rimini, through a public tender (Table 4.21).

Table 4.21 Valmarecchia (RN) – Valma Bass

Service Name	Valma Bass
Service Area	Areas of the municipalities of Santarcangelo di Romagna/Poggio Torriana (blue line) and Verucchio/Poggio Torriana (red line).
Service Manager	Social cooperative La Romagnola onlus
Period of service activity	All year round
Service time slot	From Monday to Saturday 8.30-12.00/14.30-16.30
Booking system	Via WhatsApp message or telephone the day before from 7.30 – 18.30
Cost of service	Free with Start Romagna subscription, otherwise cost of ordinary ticket for local fixed transport
Route	Flexible
Stops	Fixed, the same of traditional transport and school bus service
App availability	No
Score of flexibility	3

Source: Author's elaboration

4.2 Intermediate areas

- *Bargagli and Davagna (GE) – Chiama il Bus*

The Genoa-based transit provider AMT launched this on-call transport service in June 2022 thanks to the funds of the SNAI project (Table 4.22).

Table 4.22 Bargagli and Davagna (GE) – Chiama il Bus

Service Name	Chiama il Bus
Service Area	Municipalities of Bargagli, La Presa, Preli, Viganego, Terrusso, Cavassolo, Maggiolo, Capenardo.
Service Manager	AMT SPA
Period of service activity	All year round
Service time slot	Mon – Sat from 06.00 to 19.30, no holidays
Booking system	Via telephone and "App Servizi a Chiamata", up to 12.00 of the day before
Cost of service	Ordinary ticket
Route	Flexible
Stops	Fixed
App availability	Yes
Score of flexibility	3

Source: Author's elaboration

- *Borzonasca (GE) – Chiama il Bus (Table 4.23)*

Table 4.23 Borzonasca (GE) – Chiama il Bus

Service Name	Chiama il Bus
Service Area	Municipalities of Acero, Belpiano, Levaggi, Temossi, Caregli, Caroso, Borzone.
Service Manager	AMT SPA
Period of service activity	All year round (Pilot)
Service time slot	Mon – Sat from 06.00 – 19.30, no holidays
Booking system	Via telephone and "App Servizi a Chiamata", up to 12.00 of the day before
Cost of service	Ordinary ticket
Route	Flexible
Stops	Fixed

App availability	Yes
Score of flexibility	3

Source: Author's elaboration

- *Mondovì (CN) – Grandabus*

In August 2020, on-demand transport for the hamlets around Mondovì (CN) definitively entered in service (Table 4.24). The service is managed by the Granda Bus consortium, which gathers the main public transport companies in the province of Cuneo. The peculiarity of this DRT service is that it is active only on weekdays when city markets are open and it is structured in order to let people get to these markets and go back home. The service is indeed active in the morning of Tuesday, Wednesday and Saturday only for a few minutes (from 8.00 to 9.10 maximum depending on the hamlet) and provides a single time window for the return trip (11.10 - 12.10). The Granda Bus consortium also provides the DRT service for the cities of Cuneo, Levaldigi and Cupole.

Table 4.24 Mondovì (CN) – Grandabus

Service Name	Grandabus
Service Area	Municipalities of Rifreddo, Gratteria, San Giovanni, Merlo, Borgato, Pascomonti.
Service Manager	The Granda Bus Consortium (2004) collects the main PTAs of the Province of Cuneo
Period of service activity	All year round
Service time slot	The service is active on Tuesday, Wednesday and Saturday (excluding holidays): - Rifreddo, Gratteria and San Giovanni area 8.00 - 8.40 - Merlo area 8.00 - 8.30

	- Borgato area 8.40 - 8.50 - Pascomonti area 8.30 - 9.10 The service also includes return trips between 11.10 - 12.10 for all areas.
Booking system	Via telephone, up to 12.00 of the day before
Cost of service	The ordinary ticket uploaded on the BIP card (Piedmont Integrated Ticket) costs € 1,50, while the ticket purchased on board costs € 2,50.
Route	Flexible
Stops	Fixed
App availability	No
Score of flexibility	3

Source: Author's elaboration

- *Oltrepò Pavese (PV) – MioBus*

MioBus, the DRT service present in the Oltrepò Pavese area, was designed to integrate the extra-urban line service (Table 4.25). The areas of reference are two: Varzi and Stradella - S.Maria della Versa. It is a completely flexible service, both in terms of timetables and in terms of routes: stops are, however, predetermined and indicated both on the Miobus App (Figure 4.3) and in the digital and paper brochure. The service is active every day of the year except Sundays and holidays such as January 1st, May 1st, August 15th and December 25th.

Table 4.25 Oltrepò Pavese (PV) – MioBus

Service Name	MioBus
Service Area	Oltrepò Pavese (PV) with reference areas Stradella - Santa Maria della Versa and Varzi.
Service Manager	Autoguidovie Spa

Period of service activity	All year round
Service time slot	In the Varzi area from Mon to Sat 9:30 - 11:30 and 16:30 - 18:30; In the Stradella - S. M. della Versa area Mon to Sat 9:30 - 11:30 and 16:30 - 18:30; on Fridays also 8:30 - 12:30 for the Broni market.
Booking system	Via Miobus app and telephone
Cost of service	Not specified
Route	Flexible
Stops	Fixed
App availability	Yes
Score of flexibility	3

Source: Author's elaboration

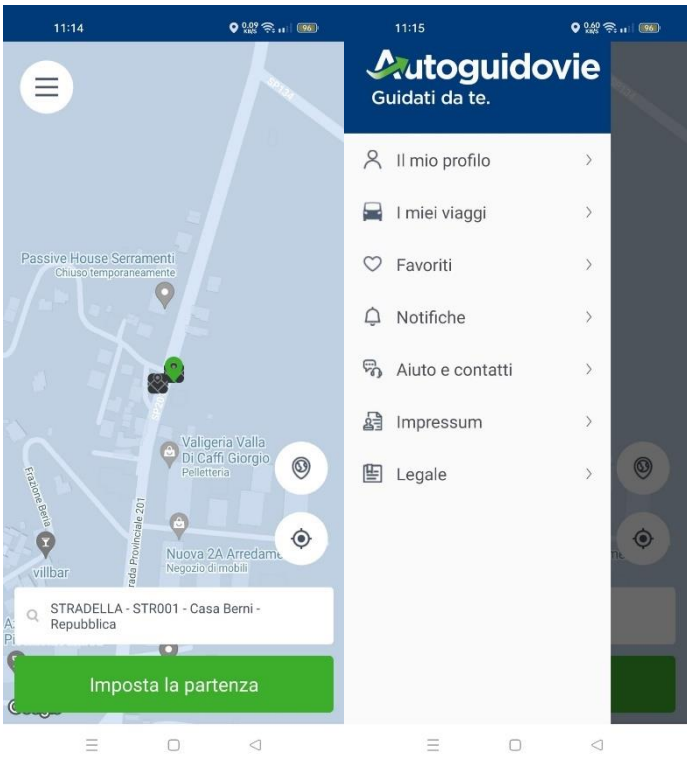


Figure 4.3 "Miobus" app.

Source: Author's screenshots of "Miobus" app.

- *Sondrio – Chiamabus*

In the municipal area of Sondrio, the transit company “Gianolini Servizi e Trasporti Srl” provides the local public transport service. The service consists of five different lines (three in the urban area and two connecting the hamlets) and is provided on all weekdays: transport on holidays is covered by an additional FT line, specifically dedicated to low mobility demand days, and integrated by the on-call transport service (Table 4.26). In addition, in Sondrio there is another on-call transport service dedicated to people who have a certification demonstrating mobility problems, disabilities, etc. (this service is active every day, including holidays).

Table 4.26 Sondrio – Chiamabus

Service Name	Chiamabus
Service Area	Municipal area of Sondrio
Service Manager	Gianolini Servizi e Trasporti Srl
Period of service activity	All year round (active on Sundays and holidays)
Service time slot	Sundays and holidays from 8.30 to 12.30 and from 14.30 to 19.00.
Booking system	Via telephone, up to 1 hour before the ride
Cost of service	The same of ordinary ticket transport
Route	Flexible
Stops	Fixed, the same for traditional transport
App availability	No
Score of flexibility	3

Source: Author’s elaboration

4.3 Peripheral and ultra-peripheral areas

- *Bormio, Valdidentro, Valdisotto (SO) – Chiamabus*

During the last month of 2017, the experimentation of a DRT service was started in the area surrounding the municipality of Bormio (SO), the so-called "ChiamaBus" (Table

4.27). This service was designed to integrate FT coverage in areas not served due to impervious territory and low transport demand. This pilot focused on the areas of Valfurva, Valdisotto and Valdidentro, characterized by sparsely populated hamlets with low transport demand. The pilot was covered for about € 800,000 by the municipality of Bormio and for an additional € 100,000 by the Comunità Montana Alta Valtellina (local mountain community). Since December 2018, the service has been reconfirmed.

Table 4.27 Bormio, Valdidentro, Valdisotto (SO) – Chiamabus

Service Name	Chiamabus
Service Area	Valleys around Bormio: Valdidentro, Valdisotto and Valfurva with reference areas of Bormio and Isolaccia.
Service Manager	Automobilistica Perego Spa
Period of service activity	20/11/2017-31/12/2017 (Pilot) From 27/12/2018 onwards
Service time slot	every day 08.30 - 12.30 / 14.00 - 20.00
Booking system	Via telephone
Cost of service	The same for traditional transport
Route	Flexible
Stops	Fixed
App availability	No
Score of flexibility	3

Source: Author's elaboration

- *Courmayeur (AO) – Allô Bus Courmayeur*

On 01/09/2015, this DRT service was launched throughout the Courmayeur area (until 24/12/2015): it replaced entirely FT during trial period, except for school bus lines (Table 4.28).

Table 4.28 Courmayeur (AO) – Allô Bus Courmayeur

Service Name	Allô Bus Courmayeur
Service Area	Courmayeur area (from Verrand to Val Ferret and Val Veny).
Service Manager	SAVDA (from 2016 part of Arriva Group)
Period of service activity	01/09/2015 – 24/12/2015 (Pilot)
Service time slot	Mon – Fri 9.00-12.00 / 14.30-16.30 / 17.30-19.30 Sat – Sun – holidays 9.00-12.00 / 14.30-19.30
Booking system	Via telephone
Cost of service	In Courmayeur area supplement of 0,50€ In Val Ferret and Val Veny supplement of 1€
Route	Fixed
Stops	Fixed
App availability	No
Score of flexibility	1

Source: Author's elaboration

- *Grand Paradis (AO) – Allô Bus Grand Paradis*

The DRT service of Val di Rhemes and Valsavarenche (Val d'Aosta), between March and June 2022 replaced the traditional transport lines in the morning time slot 8.30 - 11.30. After this trial, the administration decided to restore the traditional service for the summer months: in September, with the beginning of the new academic year, the on-call service has been proposed again (Table 4.29).

The transport company Arriva Italia Srl, which has sub-conceded the provision of the service to some "NCCs" (cars with driver), manages this pilot in the area.

Table 4.29 Grand Paradis (AO) – Allô Bus Grand Paradis

Service Name	Allô Bus Grand Paradis
Service Area	30 stops between Villeneuve, Introd and the Rhêmes and Valsavarenche Valleys.
Service Manager	Arriva Italia Srl
Period of service activity	01/03/2022 – 15/06/2022 (Pilot)
Service time slot	Weekdays 8.30 – 11.30
Booking system	Via telephone, up to 9.00 of the day of departure
Cost of service	The same of fixed transport
Route	Flexible
Stops	Fixed
App availability	No
Score of flexibility	3

Source: Author's elaboration

- *South Salento (LE) – "Bus a chiamata Sud Salento"*

The DRT service, funded under the SNAI initiative for the South-Salento Inner Area, currently consisted in one-month pilot, carried out in collaboration with "Ferrovie del Sud Est" (FSI[9] Group) and based on the European HiReach project[10]. This pilot offered an extremely flexible service: there were some fixed stops but the routes were completely customizable. Collaboration with Ferrovie dello Stato Italiane underlines the desire to integrate on-demand transport with the existing service by promoting greater intermodality: this area presents a rather widespread railway network, while FT is unable to respond to the mobility needs of citizens, which in fact prefer to use their car (Table 4.30).

[9] Ferrovie dello Stato Italiane (FSI) – Italian State Railways.
[10] European Commission project aimed at guaranteeing mobility to vulnerable and fragile user groups.

Table 4.30 South Salento (LE) – "Bus a chiamata Sud Salento"

Service Name	"Bus a chiamata Sud Salento"
Service Area	South Salento Region: line 1: areas of Tricase, Tiggiano, Corsano and Gagliano del Capo; line 2: Gagliano, Leuca, the coastal towns up to Pescoluse and the inland towns up to Salve.
Service Manager	Ferrovie del Sud Est (part of Ferrovie dello Stato Italiane, Italian railways manager) within the European HiReach project
Period of service activity	15/09/2020 – 15/10/2020 (Pilot)
Service time slot	Line 1: 7.20 - 20.00 Mon – Sun Line 2: 8.30 - 20.15 Mon – Sun
Booking system	Only via NE-MI app, from 3 days to 2 hours before departure
Cost of service	Not specified
Route	Flexible
Stops	Some stops are fixed while others depend on users requests
App availability	Yes
Score of flexibility	4

Source: Author's elaboration

- *Val Degano (UD) – UDonDemand*

The DRT UDonDemand service was launched on an experimental basis for 12 months on 20 June 2022 (Table 4.31): the purpose was to better connect five municipalities in Val Degano (UD) with characteristics of scattered population and poor fixed transport connections. Users can book the rides through call centre via telephone or with the innovative UDonDEMAND app (available on both Ios and Android systems). If successful, the service will be extended to other Carnic areas adjacent to Val Degano at the end of the trial.

Table 4.31 Val Degano (UD) – UDonDemand

Service Name	UDonDemand
Service Area	Five municipalities of the Val Degano (UD) (Comeglians, Prato Carnico, Ovaro, Rigolato and Forni Avoltri).
Service Manager	TPL FVG scarl
Period of service activity	20/06/2022 – 20/06/2023 (pilot)
Service time slot	Forni Avoltri - Comeglians 9.00 - 12.00 / 15.00 - 17.00 (Mon - Wed - Fri); Comeglians - Rigolato 8.30 - 12.00 / 15.00 - 17.00 (Tue - Thu - Sat); Prato Carnico - Ovaro 8.30 - 12.00 / 15.00 - 17.00 (from Mon to Sat).
Booking system	Via UD on DEMAND app and telephone up to 3 hours before the departure.
Cost of service	1,35€/ride
Route	Flexible
Stops	Fixed, the same of traditional transport + 34 new stops

App availability	Yes
Score of flexibility	3

Source: Author's elaboration

- *Val di Zoldo (BL) – Navetta Comunale*

The DRT service of Val di Zoldo (province of Belluno) was launched in December 2021 thanks to the "Interreg Italia Austria MMM (Meglio Muoversi in Montagna) BBB (Sich Besser in Bergregionen Bewegen)" project[11] funded by the European Regional Development Fund. The service was realized to connect the populations of the scattered hamlets of the Val di Zoldo following three different routes that lead to Goima, Coi and Fornesighe. It is interesting that the service was for free for the entire duration of the trial and, although fixed stops have been identified, the municipal will was to carry out *door-to-door* service as much as possible (Table 4.32).

Table 4.32 Val di Zoldo (BL) – Navetta Comunale

Service Name	Navetta Comunale (Municipal Shuttle)
Service Area	Val di Zoldo (BL)
Service Manager	Easy Project Srl
Period of service activity	From 20/12/2021 to 30/06/2022 (Pilot)
Service time slot	Mon – Fri 8.00 – 12.30 / 13.30 – 17.00
Booking system	Via telephone, up to 60 minutes before departure
Cost of service	Free during trial
Route	Flexible
Stops	Fixed, moreover where possible the service will be door-to-door
App availability	No
Score of flexibility	4

Source: Author's elaboration

[11] The project intends to improve the local transport service by minimizing the conditions of social marginality of the citizens of Val di Zoldo (BL).

- *Valbrevenna (GE) – Chiama il Bus (Table 4.33)*

Table 4.33 Valbrevenna (GE) – Chiama il Bus

Service Name	Chiama il Bus
Service Area	Municipalities of Ternano, Sorrivi, Nenno, Mulino Vecchio, Penola and Fullo.
Service Manager	AMT SPA
Period of service activity	All year round (Pilot)
Service time slot	Mon – Sat from 06.00 to 19.30, no holidays
Booking system	Via telephone, up to 12.00 of the day before
Cost of service	Ordinary ticket
Route	Flexible
Stops	Fixed
App availability	Yes
Score of flexibility	3

Source: Author's elaboration

4.4 Touristic DRT services in rural contexts

- *Bolognese Apennine – ColBus*

The ColBus service of the Bolognese Apennine is divided into two lines for the 2021-2022 winter season (Table 4.34): "Porretta Terme Corno alle Scale" line, which broadly connects the railway station of Porretta Terme with the ski resorts of Mount Corno alle Scale, and "San Benedetto Val di Sambro" line, which instead connects the town of San Benedetto with all its hamlets and with the village of Castiglione dei Pepoli. This DRT service is, among all cases examined, the one offering the widest booking options: it provides four different ways to book a ride (telephone, website, "ColBus" app and mail).

An experimentation was also conducted from 06/06/2021 to 12/09/2021, only on Saturdays, Sundays and holidays: 5 on-call transport lines were established in favor of tourists. This trial allowed passengers to reach by train some stations along the Porrettana

and Direttissima lines and from there, thanks to 7 minibuses, to reach the main tourist attractions of the Bolognese Apennine. All three ColBus services mentioned above were financed with funds from the "European Interreg Central Europe" project[12] within the SMACKER[13] (*Soft Measures & Actions for Behavioral Change and Knowledge to Embrace peripheral and Rural areas*) initiative.

Table 4.34 Bolognese Apennine – ColBus

Service Name	ColBus
Service Area	Bolognese Appennine: the ColBus line "Colbus - Porretta Terme Corno alle Scale" connects the railway station of Porretta Terme with the ski resorts of the main mountain area of the region (Corno alle Scale). The "San Benedetto Val di Sambro" line connects the town with its hamlets and with the village of Castiglione dei Pepoli.
Service Manager	TPER Trasporti Passeggeri Emilia-Romagna
Period of service activity	ColBus "San Benedetto Val di Sambro" from 01/12/2021 to 04/06/2022 ColBus "Porretta Terme Corno alle Scale" from 08/12/2021 to 07/01/2022 and from 01/02/2022 to 31/03/2022.
Service time slot	ColBus "San Benedetto Val di Sambro" active on weekdays 9.00 – 12.00 / 15.00 – 19.00. ColBus "Porretta Terme Corno alle Scale" active on Saturdays, Sundays and holidays 08.00 – 19.00
Booking system	

[12] "Interreg CENTRAL EUROPE Program 2021-27" is a European program aimed at developing and supporting transnational cooperation with a view to greater resilience of European regions.

[13] The SMACKER project lasted three years (01/04/2019 - 30/03/2022), led by the PTA of Bologna, and aimed at reducing the social and economic disparities of citizens through the introduction of on-demand transport.

	ColBus “San Benedetto Val di Sambro” via ColBus app, telephone, web site or mail, up to 2 hours before the ride. ColBus “Porretta Terme Corno alle Scale” via ColBus app, telephone, web site or mail, up to 18.00 before the day of ride.
Cost of service	The cost of the service is equal to the cost of an ordinary extra-urban ticket for both lines.
Route	Flexible
Stops	Fixed
App availability	Yes
Score of flexibility	3

Source: Author’s elaboration

Figure 4.4 shows all the stops from Porretta Terme railway station (right) to Corno alle Scale (left), indicated by red arrows.

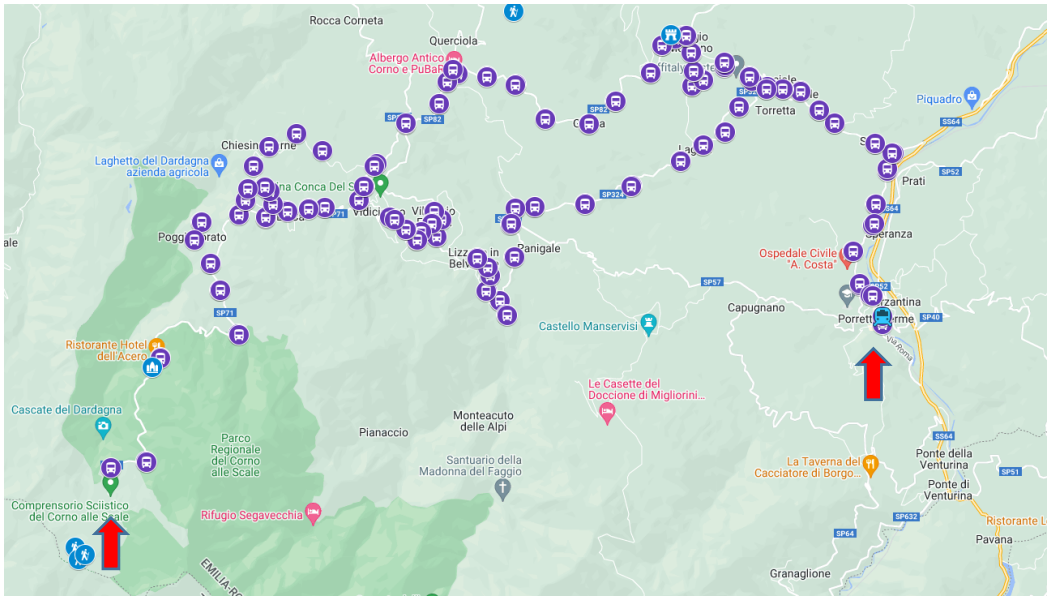


Figure 4.4 "Porretta Terme Corno alle Scale" DRT line

Source: Author’s screenshot of "Porretta Terme Corno alle Scale" DRT line on Google Maps

Figure 4.5 shows all the stops from San Benedetto Val di Sambro (right) to its hamlets and to Castiglione dei Pepoli (left), indicated by red arrows.

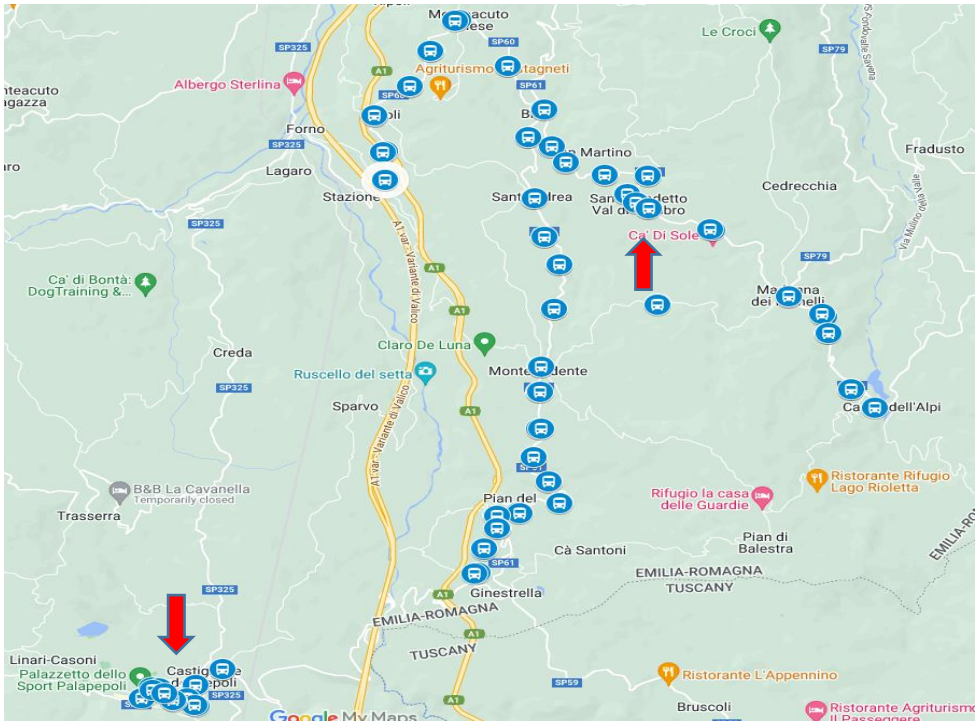


Figure 4.5 "San Benedetto Val di Sambro" DRT line

Source: Author's screenshot of "San Benedetto Val di Sambro" DRT line on Google Maps.

- *Grand Paradis (AO) – TrekBus*

The service offered within the Grand Paradis area consists of an integration of the traditional service for the summer period, designed to facilitate tourists who decide to go trekking (Table 4.35). The purely integrative purpose of DRT service is further confirmed by the choice not to accept bookings that overlap the scheduled service (of which DRT uses the stops).

Flexibility is guaranteed from the temporal (extended time window to address the typical attitudes of mountain hikers), and spatial standpoint. The service uses the stops of the local public transport but with a little supplement it is possible to request a customized

stop (2 €/km). The DRT TrekBus service was created as part of the "MobiLab project"[14] thanks to funds of the "Interreg Italy - France ALCOTRA program".

Table 4.35 Grand Paradis (AO) – TrekBus

Service Name	TrekBus
Service Area	The DRT service allows the connection between the municipalities of the valley floor (Aymavilles, Villeneuve, Introd and Arvier) and the municipalities of the Gran Paradiso valley (Cogne, Valsavarenche, Rhêmes-Saint-Georges, Rhêmes-Notre-Dame and Valgrisenche).
Service Manager	Fondation Grand Paradis
Period of service activity	Summer (in 2022 from 01/07 – 11/09)
Service time slot	06.00 – 20.00 every day
Booking system	Via telephone, up to 19.00 of the day before
Cost of service	The fare is 5€ for a ride between towns in the valley floor, 12€ for valley floor – valley villages and 29€ for a ride from valley to valley.
Route	Flexible
Stops	Fixed (the same of traditional transit), but users have the possibility to request a stop outside the predetermined stops at a cost of 2 €/km.
App availability	No
Score of flexibility	4

Source: Author's elaboration

[14] The objective of the MobiLab project is to provide a more accessible transport service to all categories of users.

- *Valle Gesso (CN) – InMarittime*

This service was proposed in summer 2019 to connect the municipalities of Valle Gesso, in the province of Cuneo, with the main tourist attractions in the area (Entracque, Valdieri, Lago Rovina, etc.). This service represents an integration of the traditional service, of which it uses the same stops. Telephone reservations can be made within 24-36 hours prior to the trip, indicating the required stops, time and number of passengers: in case of a single user, a supplement is required to make the offer of this service in any case sustainable (Table 4.36).

Table 4.36 Valle Gesso (CN) – InMarittime

Service Name	InMarittime
Service Area	Valle Gesso (CN) and its hamlets
Service Manager	Local Car with Driver company
Period of service activity	22/06/2019 – 15/09/2019
Service time slot	Every day from 08.00 to 18.00
Booking system	Via telephone, 24h-36h before the ride
Cost of service	The cost of ticket varies from € 6 to € 12 depending on the length of the route. The single passenger on board pays double the price.
Route	Flexible
Stops	Fixed
App availability	No
Score of flexibility	3

Source: Author's elaboration

4.5 Considerations on rural DRT cases in Italy

Table 4.37 summarizes the 35 rural DRT cases described in this section for an immediate understanding of similarities and differences, taking into consideration only the comparable parameters of each service: booking system, cost of service, flexibility of routes and stops, availability of a dedicated DRT app and score of service flexibility.

Table 4.37 35 rural DRT services identified

Service area	Service name	Booking system	Cost of service	Route	Stops	App availability	Score of flexibility
			Outlying areas				
Alessandria (AL) Province	*ECCOBUS*	Telephone	Supplement to Fixed Transport (FT) ticket	Flexible	Fixed	No	3
Bologna (BO) Province	*ProntoBus di Pianura*	Web or telephone	Km/fare	Fixed	Fixed	No	1
Casarza Ligure (GE) area	*Chiama il Bus*	APP Servizi a chiamata or telephone	Ordinary ticket	Flexible	Fixed	Yes	3
Casina (RE) area	*TeleBus*	Telephone	Flat fare	Fixed with deviation	Mix	No	2
Castiglione del Lago (PG)	*"Auto…bus frazioni"*	Telephone	Km/fare	Fixed with deviation	Mix	No	2
Central Piedmont	*Provibus*	Telephone	Ordinary ticket	Flexible	Fixed	No	3
Cogorno (GE) area	*Chiama il Bus*	APP Servizi a chiamata or telephone	Ordinary ticket	Flexible	Fixed	Yes	3
Crema (CR) area	*MioBus*	Telephone or mail	Ordinary ticket	Flexible	Fixed	No	3
Cremona (CR) Province	*Stradibus*	Web or telephone	Km/fare	Flexible	Fixed	No	3
Plaine d'Aoste (AO)	*Allô Bus*	Telephone	Supplement to FT ticket	Flexible	Fixed	No	3
Plaine d'Aoste (AO)	*Allô Nuit*	Call drivers	Combo Km/fare - No. Passengers/fare	Flexible	Fixed	No	3
Reggio Calabria (RC) Province	*ChiamaBus*	Mail or telephone	No. Passengers/fare	Flexible	Fixed	No	3
Sarzana (SP) area	*Prontobus*	Telephone	Ordinary ticket	Flexible	Fixed	No	3

Torino (TO) Province	*MeBus*	Telephone	Ordinary ticket	Fixed	Fixed	No	1
Trentino and Alto Garda Region	*Bus&Go*	Bus&Go app	Flat fare	Flexible	Fixed	Yes	3
Trieste (TS) Province	*SmartBus*	Web or telephone	Flat fare	Flexible	Fixed	No	3
Trieste (TS) Province	*TSonDemand 1*	TSonDEMAND app or telephone	Ordinary ticket	Flexible	Fixed	Yes	3
Trieste (TS) Province	*TSonDemand 2*	TSonDEMAND app or telephone	Ordinary ticket	Fixed	Fixed	Yes	1
Val Graveglia (GE)	*Chiama il Bus*	APP Servizi a chiamata or telephone	Ordinary ticket	Flexible	Fixed	Yes	3
Valmarecchia (RN)	*Valma Bass*	Whatsapp message or telephone	Ordinary ticket	Flexible	Fixed	No	3
Intermediate areas							
Bargagli and Davagna (GE) areas	*Chiamabus*	Telephone	Ordinary ticket	Flexible	Fixed	Yes	3
Borzonasca (GE) area	*Chiamabus*	Telephone	Ordinary ticket	Flexible	Fixed	Yes	3
Mondovì (CN) area	*Grandabus*	Telephone	Flat fare	Flexible	Fixed	No	3
Oltrepò Pavese (PV)	*MioBus*	Miobus app or telephone	/	Flexible	Fixed	Yes	3
Sondrio (SO) Province	*Chiamabus*	Telephone	Ordinary ticket	Flexible	Fixed	No	3
Peripheral and ultra-peripheral areas							
Bormio, Valdidentro, Valdisotto (SO)	*Chiamabus*	Telephone	Ordinary ticket	Flexible	Fixed	No	3

Courmanyeur (AO) area	*Allô Bus*	Telephone	Supplement to FT ticket	Fixed	Fixed	No	1
Grand Paradis (AO)	*Allô Bus*	Telephone	Ordinary ticket	Flexible	Fixed	No	3
South Salento (LE) Region	*"Bus a chiamata Sud Salento"*	NE-MI app	/	Flexible	Mix	Yes	4
Val Degano (UD)	*UDonDemand*	UDonDEMAND app or telephone	Flat fare	Flexible	Fixed	Yes	3
Val di Zoldo (BL)	*Navetta Comunale*	Telephone	Free trial	Flexible	Mix	No	4
Valbrevenna (GE)	*Chiama il Bus*	Telephone	Ordinary ticket	Flexible	Fixed	Yes	3
Rural touristic DRT services							
Bolognese Apennine (BO)	*ColBus*	App, telephone, web or mail	Ordinary ticket	Flexible	Fixed	Yes	3
Grand Paradis (AO)	*TrekBus*	Telephone	Km/fare	Flexible	Fixed, variable stops at 2€/km	No	4
Valle Gesso (CN)	*InMarittime*	Telephone	Km/fare	Flexible	Fixed	No	3

Source: Author's elaboration

After having identified the 35 DRT case studies object of the analysis and having reported the main technical characteristics above, the results of this study, divided by category, are stated below.

4.5.1 Booking options

The booking options provided to passengers show the degree of technological advancement of DRT services.

The booking possibilities are various: the telephone call to the call center is the most widespread option among the DRT cases analyzed (it is provided, singularly or combined with other tools, in 94% of the booking methods examined). This demonstrates how the spread of smartphone among the population, which makes the use of this tool immediate and simple, convinces the transport authorities to offer this booking method in most cases. After the telephone, the booking option of the DRT service most proposed to passengers are dedicated apps (34%): PTAs that have developed and implemented the use of an app are often those which, through a careful analysis of the potential transport demand, have decided to attract the young segment of the population more than other categories.

The booking options via web (11%) or email (9%) are not as common.

Finally, some booking methods chosen in a residual manner by PTAs: the DRT "Valma Bass" service in Valmarecchia (RN) is the only one bookable via WhatsApp, the “Allô Nuit” night on-demand service (active in the Plaine d'Aoste) allows users to contact directly the vehicle driver by telephone. In addition, the DRT service of the metropolitan city of Reggio Calabria offers users the possibility to book the ride also through electronic totems located at the stops.

As can be seen from Figure 4.6, on 35 DRT cases examined, in 16 cases users must book a ride exclusively calling the call center (46%). The second booking method mostly adopted in the Italian context concerns the "Telephone/App" combination: it was offered to passengers in 9 cases (26%). “Telephone/web” option was offered 3 times (9%), “Only-app” 2 (6%), while in residual form (3%) are the options "Call to driver", "Telephone/WhatsApp", “Telephone/mail”, “Telephone/mail/totem” and the ColBus all-inclusive offer of the Bolognese Apennine (“Telephone/mail/web/app”), proposed only once.

Figure 4.6 Booking options

4.5.1.1 Dedicated App availability

As regards the use of DRT dedicated apps (useful for information on timetables and rides, reservations, payments, etc.), it is evident from the analysis that this technology is still little used by transport companies: it is offered only by 13 PTAs (37%), as shown in Figure 4.7.

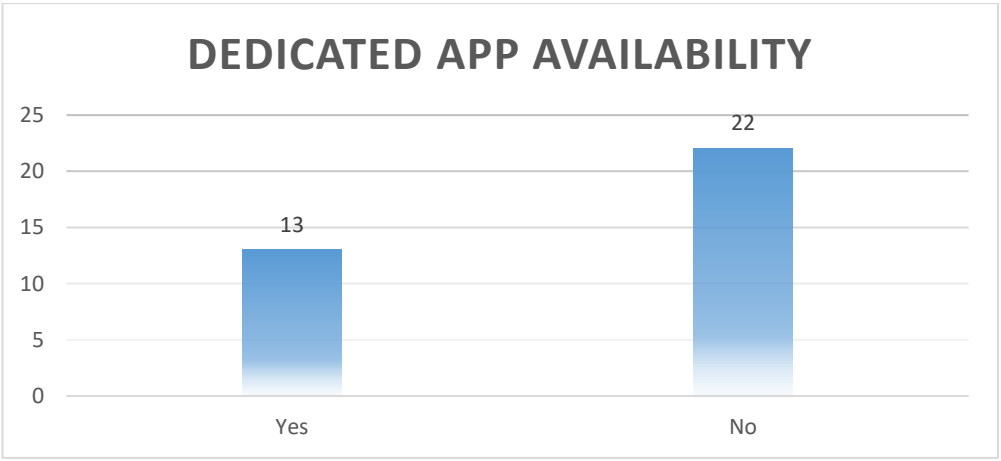


Figure 4.7 Dedicated App availability

Taking into account only PTAs that have developed a DRT dedicated app, Figure 4.8 shows that just 2 of them (“Bus & Go” and the "Bus a chiamata Sud Salento" trials) make the app available as the only booking method (17%): this strategy is possibly due to the fact that having invested money in the development and implementation of the app, PTAs aim to cut the costs of the Operations centre.

75% of DRT services that use an app offer passengers the possibility to book through this technology as alternative to the telephone, while only one case (“ColBus” in the Bolognese Apennine) offers four different booking options (telephone, web, app or mail).

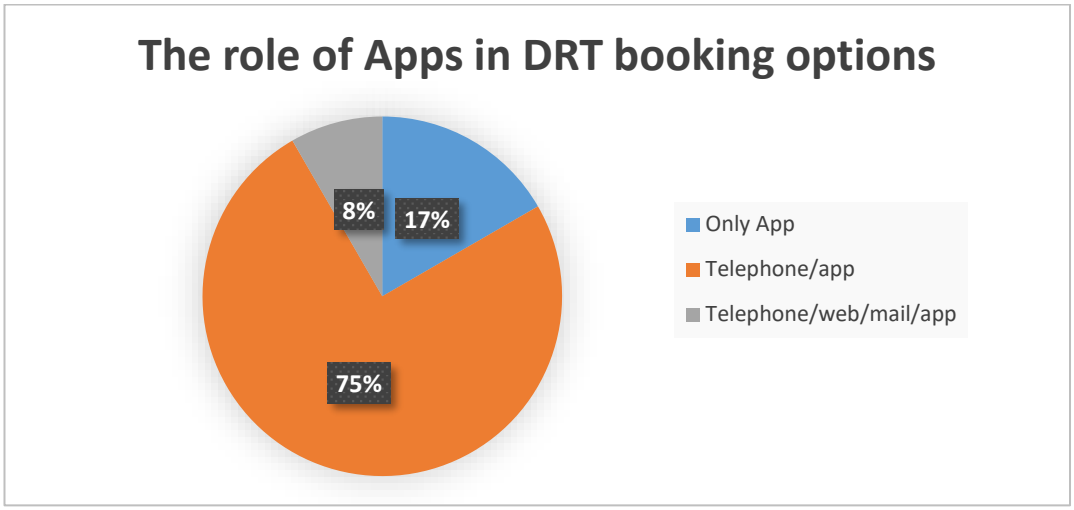


Figure 4.8 The role of Apps in DRT booking options

4.5.2 Cost of service

As regards the cost of service of the examined DRT cases, the price strategies implemented by PTAs differ (Figure 4.9): in 17 cases (the most widespread pricing strategy), PTAs decided to keep the cost of on-demand service ticket unchanged compared to a FT ordinary ticket (49%).

In five initiatives (14%) it was adopted a so-called *flat fare*: that is, the possibility for users to pay a standard ticket price regardless of areas crossed, kilometers traveled or number of passengers on board. The *flat fare* was equal to 2€/ride in 3 of the cases

examined (60%), 1.35€/ride for “UDonDemand” in Val Degano (UD) and 1.50€/ride in Mondovì (CN) with “Grandabus”.

Five (14%) cases priced travel by the zones crossed as kilometers traveled by the vehicle. “ProntoBus di Pianura” in Bologna provides for a rate based on the zones crossed (from 1,30€ to 4,50€) as well as “Stradibus” in Cremona (from 1€ to 2,25€). "Auto ... bus frazioni" in Castiglione del Lago (PG) splits the cost of the ticket into two on the basis of the distance traveled (within 6 kms the cost is 2€/ride, over 6 kms the cost is 2,50€/ride). “InMarittime” in Valle Gesso (CN) and “TrekBus” in Grand Paradis (AO) present fare ranges corresponding to the kilometers traveled.

Three cases (9%) required the payment of a supplement to the standard FT ticket. This pricing strategy was applied by “ECCOBUS” in Alessandria (1 €/day as an extra-charge), “Allô Bus” in the Plaine d'Aoste (0.20 €/ride as supplement in general and 1 €/ride in some remote lines) and “Allô Bus Courmayeur” (0.50€/ride as supplement in Courmayeur area and 1€/ride in Val Veny and Val Ferret).

Two DRT cases analyzed did not specify the cost of the service (6%), while some residual cases present interesting characteristics: the payment of the “ChiamaBus” DRT service ticket in Reggio Calabria depends on the degree of filling of the vehicle (that is on the number of passengers on board). The “Allô Nuit” service in Plaine d’Aoste is peculiar as it combines the Km/fare with the No. Passengers/fare (up to 15 km one user on board pays 9€, two users pay 6.50€ each, three users pay 5€ each; over 15 km one user on board pays 13€, two users pay 7.50€ each, three users pay 6€ each).

Finally, the “Navetta Comunale” of Val di Zoldo (BL) offered a free service during the trial.

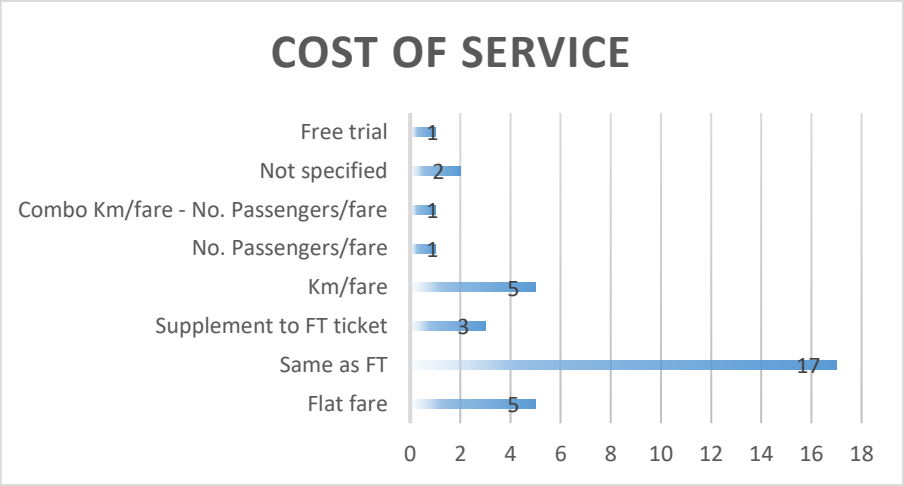


Figure 4.9 Cost of service

4.5.3 Flexibility of routes

DRT services differ from each other in terms of service model adopted. A completely flexible typology of on-demand service (in terms of routes and stops) maximizes user's convenience but represents a very high cost for the provider, vice versa more rigid DRT structures lead to PTAs economic savings but passengers' greater discomfort. On that basis, transport companies must find a compromise between the different needs involved.

The 35 DRT cases analysed provide some indications on PTAs choices also in terms of service flexibility.

As regards the route, as shown in Figure 4.10, in 29 cases observed (83%) were revealed to be flexible: this result demonstrates the willingness of the Italian PTAs to attract a large number of users offering to residents of rural areas a totally taylor-made transport service.

In the remaining cases (17%), DRT services were characterized by a fixed route. This result is split in two depending on the degree of service rigidity: 4 DRT cases (11%) offered a traditional transport fixed route, while to a lesser extent 2 cases (6%) provided the possibility for users to deviate from the nominal line depending on the their needs (such as DRT cases of "TeleBus" in Casina, province of Reggio Emilia, and "Auto ... bus frazioni" in Castiglione del Lago, close to Perugia).

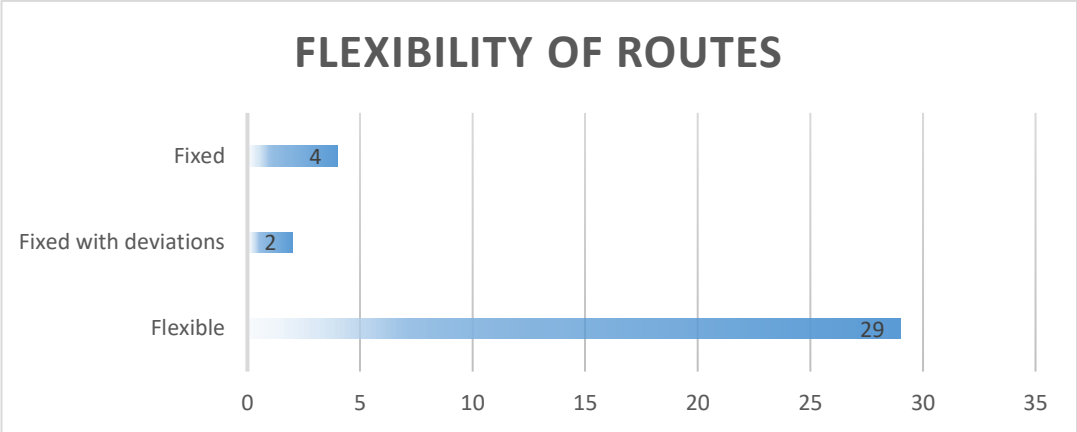


Figure 4.10 Flexibility of routes

4.5.4 Flexibility of stops

As regards the degree of flexibility offered in terms of on-call transport stops, Figure 4.11 shows that in 86% of cases stops are predetermined by the transport company (often using the same as for traditional transport).

In a residual manner (4 cases, 11%) the stops are "partly fixed and partly flexible", while only one case of DRT examined (the “TrekBus” tourist service in the Grand Paradis area in Valle d'Aosta) allows passengers, in addition to the use of predetermined stops, also to get off or on at further stops upon payment of a kilometre rate (2 €/km).

No completely flexible stop services were found in the analysis.

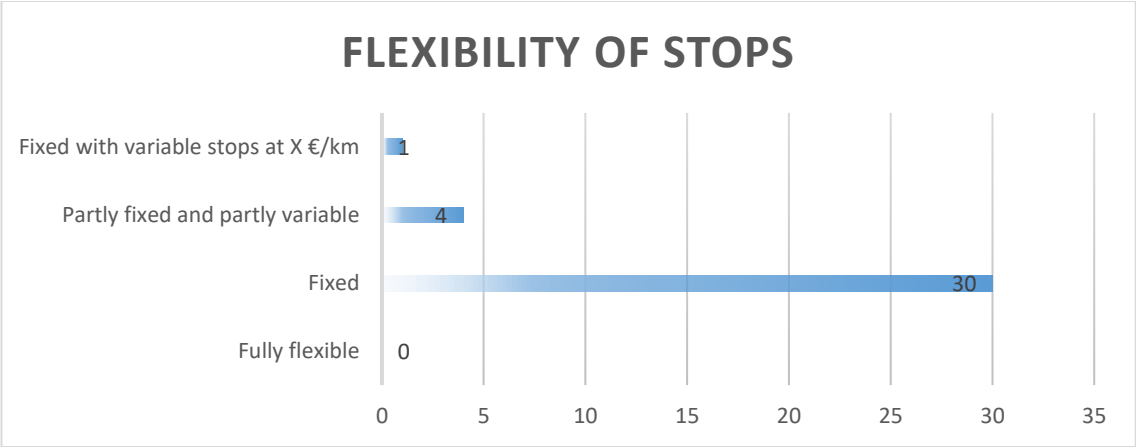


Figure 4.11 Flexibility of stops

4.5.5 Service models

The combination of routes and stops with different degrees of flexibility generates the abovementioned service models.

Figure 4.12 shows that the most widespread service model adopted in Italian rural contexts is characterized by flexible route and fixed stops (26 cases, 74%). This kind of service model fits perfectly to contexts with a predominantly rural or mountain morphology and characterized by a small and scattered population.

In such a scenario, it is crucial to define the service coverage area and the so-called "hinge points" (typically fixed stops corresponding to the same of FT) around which to develop customizable and flexible routes.

11% of the cases observed (4 DRT cases) present the most rigid structure consisting of predetermined routes and fixed stops while only 2 services (6%) offer a fixed route with possible deviation from nominal line.

Three DRT cases (9%) present a service model consisting of a flexible route and a combination of fixed and variable stops: specifically, the DRT “TrekBus” tourist service active in the Grand Paradis area (AO) provides for some fixed stops and the possibility for users to reach some variable stops upon payment of a 2 €/Km fee.

From the analysis conducted, it emerges that the most flexible service models "One/few-to-many", "Many-to-one/few" and “Many-to-many”, characterized by increasing degrees of flexibility in terms of both routes and stops, have not been implemented in any context. This data is very important: it indicates how the PTAs try to find the right compromise between sustainability, social inclusion and economic savings. The very flexible service models entail great advantages for users but at the same time high costs for the transit provider: without many public subsidies in favour of PTAs, it becomes very difficult to realize such flexible DRT services.

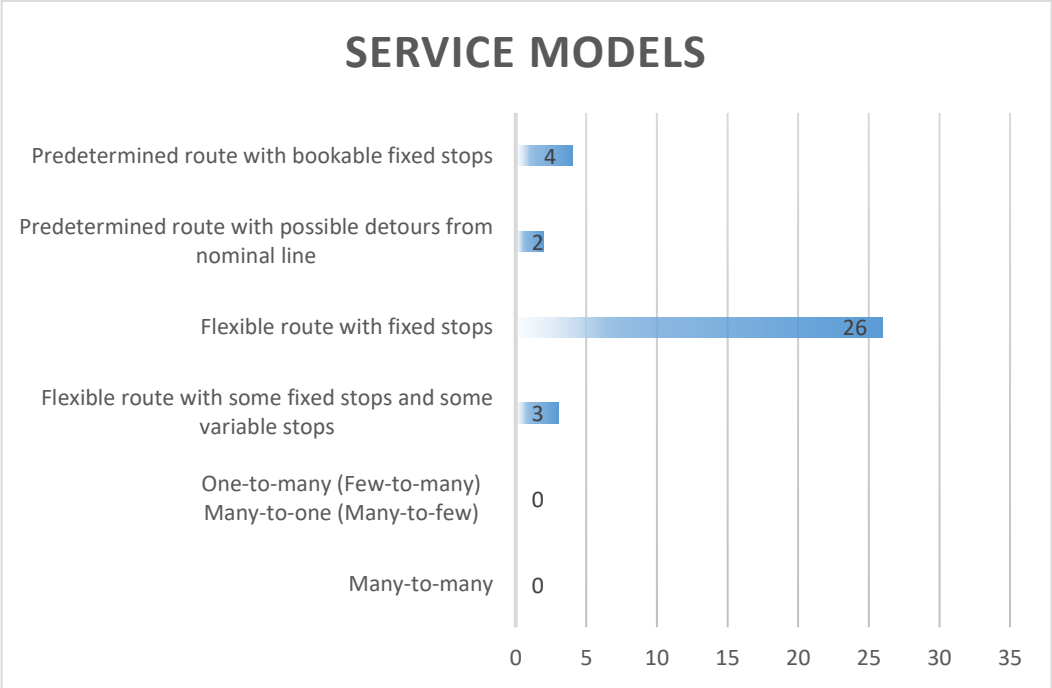


Figure 4.12 Service models

The proposed evaluation method (score from 1-6 points based on the flexibility of the service model) makes it possible to investigate the types of service models most implemented at national level and the strategic vision of the individual PTAs, those that have invested more and less in the flexibility of the service (Figure 4.13).

Three PTAs obtained the highest score (4) in this analysis: "Trekbus" in the Grand Paradis area (AO), "Bus a chiamata Sud Salento" in South Salento (LE) Region and "Navetta Comunale" in Val di Zoldo (BL). These three DRT services presented an above average level of service flexibility. Not having found during the analysis very flexible service models such as "One-to-many / Few-to-many" and "Many-to-many", the score 4 ("flexible route with some fixed stops and some variable stops ") is associated with the maximum degree of flexibility implemented in Italy.

The characteristics of the DRT tourist service "Trekbus" have already been described above. The DRT service trials implemented in South Salento (LE) and in Val di Zoldo (BL), on the other hand, have common characteristics: flexible route with some fixed stops and further variables depending on the users' needs.

As seen above, 26 DRT cases received a score of 3 equivalent to a service model with flexible routes and fixed stops, representing the vast majority of cases studied.

The DRT services implemented in Casina (RE) and Castiglione del Lago (PG) are the only ones to have obtained a score of 2: both services allow the vehicle driver to deviate from the predetermined route and reach originally unscheduled stops.

Finally, the four DRT cases classified with the lowest score (1) corresponding to the maximum rigidity of the service are reported: "Prontobus di Pianura" in the metropolitan area of Bologna, "MeBus" in the province of Turin, "TSonDemand" in the province of Trieste and "Allô Bus" in the Courmayeur (AO) area.

These four DRT cases all offer users a fixed route and fixed stops: PTAs have aimed at containing costs by simply replacing some lines of fixed transport with on-call service.

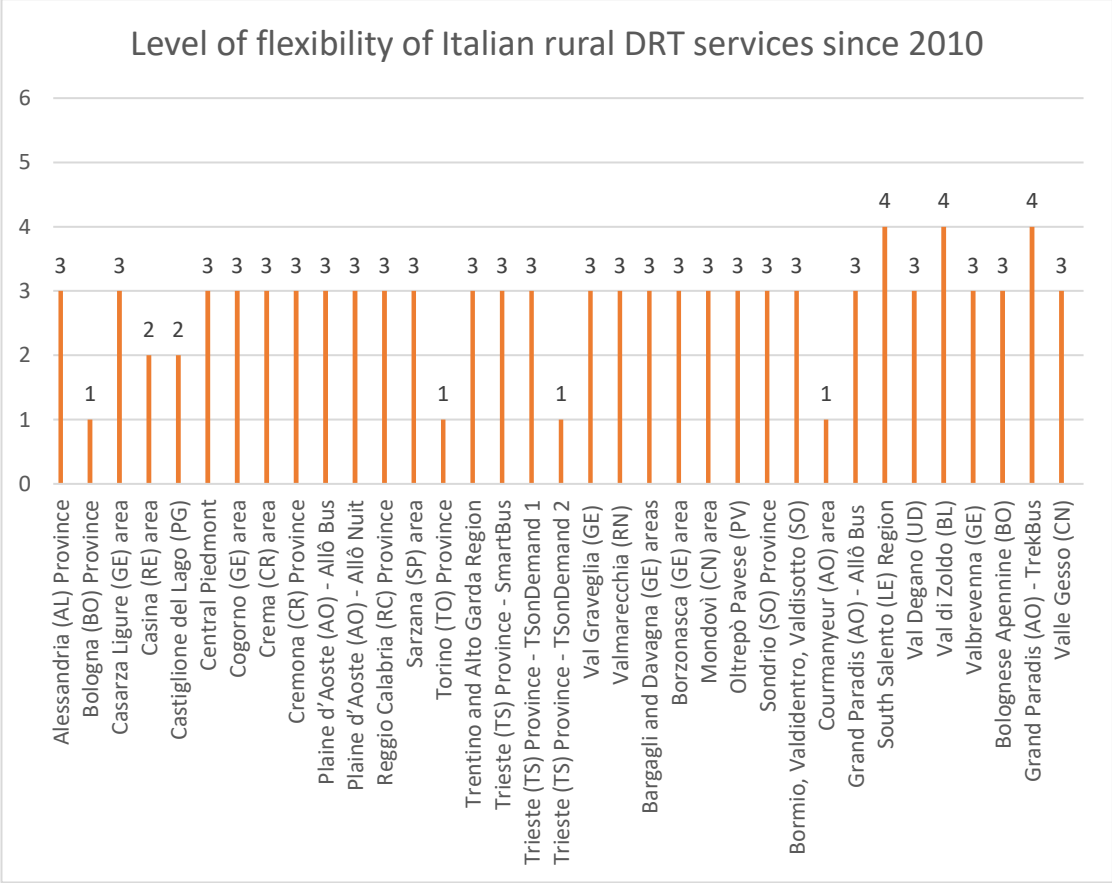


Figure 4.13 Level of flexibility of Italian rural DRT services since 2010

The results obtained in the present study are commented in chapter 9 "*Conclusions, research limitations and future agenda*".

CHAPTER V

ITALIAN "NATIONAL STRATEGY FOR INNER AREAS" AND ANALYSIS OF ANTOLA-TIGULLIO CASE STUDY

5. Italian “National Strategy for Inner Areas” and analysis of Antola-Tigullio case study

5.1 Inner areas description and SNAI initiative

After having introduced and described the characteristics of on-call transport service, having studied its historical evolution from the early 1900s to the present day and having reported the main studies conducted by scientific literature, this part of the doctoral thesis introduces the topic of low transport demand areas and the measures taken to support them. During the three-year doctoral period, my research center (Italian Center of Excellence on Logistics, Transport and Infrastructures, C.I.E.L.I.) of University of Genoa was involved by the regional public transport company ATP Esercizio S.r.l. (from 1st January 2021 acquired by Genoa transit provider AMT S.p.a.) to provide scientific support for the planning and implementation of an experimental DRT service in the Antola and Tigullio Valleys, prototype areas identified by the Liguria Region as part of the National Strategy for Inner Areas (SNAI – Strategia Nazionale Aree Interne). Based on this collaboration, a report called “Introduction of on-call transport service for the Antola-Tigullio area” was thus jointly produced between the University of Genoa / C.I.E.L.I. and local PTA: most of the information in this chapter is taken from that document.

This chapter discusses the distinctive characteristics of inner areas and the National Strategy for Inner Areas (SNAI), the Italian government's plan to address the depopulation issue of these regions and social isolation of residents. The sociodemographic and mobility characteristics of the people living in the Antola-Tigullio inner area are also described in this section.

In order to clarify what are the political measures and concrete actions implemented by the public entity to deal with inner areas, it is useful first of all to refer to the guidelines dictated by Italy’s National Strategy for the Inner Areas to ensure a brief but representative description of the broader framework within this initiative is inserted.

In recent years, Italy (and Europe) are witnessing the phenomenon of the demographic decline of some specific portions of the territory: the so-called "inner areas".

These are characterized by a significant distance that separates them from major centres providing essential services such as education, health and mobility. Given the complicated accessibility to essential services and to employment, people residing in these areas, in particular students and families, have preferred over time to move to neighbouring centres: this migratory trend (started in the 1950s), still evolving, involves the progressive abandonment of inner areas and the natural ageing of the population that decides to remain (Carrosio et al., 2018).

The phenomena of migration and depopulation characterizing inner areas have impacts of different nature: social, environmental and economic. From a social point of view, the progressive abandonment of these territories by the younger age groups of the population and the consequent general ageing of the residents imposes considerable stress on the national welfare and pension system.

Environmentally, this scenario is associated with a state of neglect of the cultivated fields, which can lead to problems of hydrogeological instability of the territory in the medium-long term, and considerable risks of landslides.

From an economic and financial standpoint, this situation determines the closure of local businesses and the lack of interest of private companies in investing in these territories: for residents of working age this entails having to commute several hours to reach their workplace (Mastronardi and Romagnoli, 2020).

Based on the above, the Italian government has decided, in order to stop the phenomenon of depopulation of inner areas (which represent 60% of the territory and affect 23% of the Italian population) (SNAI, 2013), to adopt in 2014 the "National Strategy for Inner Areas". This technical document, part of a broader European project, had the objective of inverting abovementioned trends and creating value for these territories.

The SNAI strategy has selected only 72 inner areas on a national level in order to be able to concentrate resources and energies in a few case studies without the risk of dispersing them. The objective for each inner area is twofold: first of all, promotion of the territory from an economic and productive point of view, then the creation of essential services to prevent the residents of these territories from migrating towards cities. For the

purposes of this initiative, were selected territories with the highest level of criticality but which, at the same time, presented an unexpressed potential.

On 9 December 2013, the draft of Italy's Partnership Agreement on cohesion policy for the period 2014-2020 was sent to the European Commission: this document, which had to be drawn up by each Member State, set out the strategies and procedures with which each State intended to use ESI (European Structural and Investment Funds) resources in order to pursue the common cohesion policy promoted by the European Commission and aimed at sustainable and inclusive community development. A technical document entitled "National strategy for inner areas: definition, objectives, tools and governance" has been attached to the aforementioned draft: it analyzed in depth the situation of Italian inner areas, describing the state of the art and development strategies.

Inner areas are generally characterized by reduced accessibility to essential services and by territories abundant of remarkable cultural and landscape heritage. Furthermore, these areas are strongly distinct from each other, making it virtually impossible to apply generic laws not calibrated on the specific context.

Based on above, it is crucial to understand how inner areas have been identified by the Government and because of which criteria. As part of this project, it was decided to proceed by radially defining the distance of these areas from the nearest "service provision center": each kilometer range is associated with a different degree of accessibility to these poles.

The report "A strategy for inner areas in Italy: definition, objectives, tools and governance "of 2014 gives the exact definition of “service provision center":

"A 'service provision center' is identified as a municipality or group of neighboring municipalities able to provide simultaneously: a full range of secondary education, at

least one grade 1 emergency care hospital (DEA)[15] *and at least one Silver*[16] *category railway station ".* (UVAL, 2014)

From this definition it is clear that the services considered essential, that citizens residing in inner areas must have access to, are a complete school offer and a hospital, in addition to First Aid, able to also provide resuscitation services, brief hospitalization and allowing patients to receive the main diagnostic-therapeutic interventions. Furthermore, the attractive pole must have a railway station capable of offering metropolitan, regional and long-range mobility.

Based on the organization of the Italian territory, defined as "polycentric" as there are numerous medium-large centers with small settlements gravitating around (which often lack of essential services), SNAI thus classified the latter on the basis of their distance from major poles, taking into account the three essential services set out above, namely education, health and rail transport. The so-called "outlying areas" actually represent a continuation of the reference attractive pole being only about 20 minutes away from it. The residents of these areas can reach the essential services they need quite comfortably by exploiting the integration between suburban and urban LPT services. In this context, DRT service can integrate some traditional lines of transport that are not very convenient or cover some little-served time slots. The distance bands identified by SNAI following "outlying areas" are respectively "intermediate areas", "peripheral areas" and "ultra-peripheral areas". For "intermediate areas" (from 20 to 40 minutes), DRT service can still play the role of integrator with FT, serving some lines or some unserved time slots. As the distance from the attractive pole increases, as in the "peripheral areas" and "ultra-peripheral areas", the economic, social and mobility situation for citizens inevitably worsens: in these contexts, 40 - 75 minutes and more than 75 minutes away respectively, DRT service can replace traditional public transport which does not have any kind of economic return from the provision of these services.

[15] "Grade 1 emergency care hospitals (DEA) include a set of operational units that, in addition to Casualty departments, guarantee observation facilities, short stays, resuscitation and diagnostic-therapeutic general medical intervention, general surgery, orthopaedics and traumatology, cardiology intensive care. They are also able to provide chemical, clinical and microbiological laboratory services, medical imaging and carry out transfusions." (UVAL, 2014)

[16] Rete Ferroviaria Italiana (RFI), manager of the Italian railway infrastructure, classifies Italian stations into different categories on the basis of size, average number of passengers who frequent the station per day and average number of trains crossing that station per day: the SILVER category identifies small-medium sized stations that guarantee a metropolitan, regional and long-distance transport.

The supply of the three services designated as essential (education, health, and mobility) is the foundation of this project of economic and social rehabilitation of the inner cities of Italy. To ensure the best use of resources, the current provision of critical services needs to be reconsidered. For these areas, which are characterised by considerable distances between houses and impervious territory, a capillary distribution of such services throughout the area proved to be wholly ineffective.

The above is what happened in recent years for healthcare: in order to rationalize costs and increase the quality of service, the many small clinics distributed throughout the area have been closed and merged into a few larger medical centres. Figure 5.1 illustrates the main measures that SNAI strategy intends to adopt to reorganize healthcare in these territories.

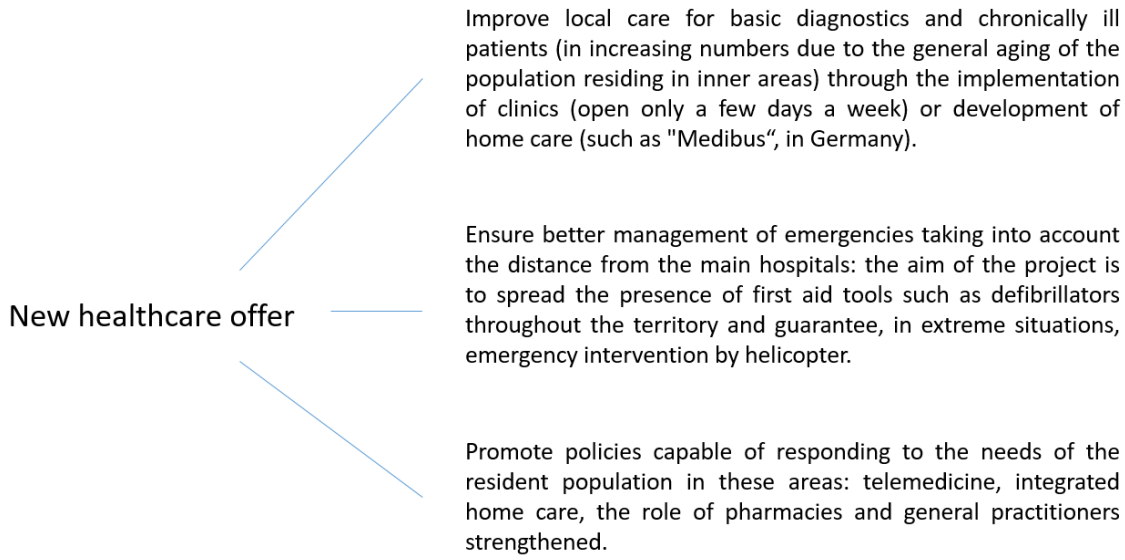


Figure 5.1 New healthcare offer

Source: Author's elaboration based on UVAL (2014)

As per education, the aforementioned phenomenon of ageing of the resident population in these areas has led over time to a declining number of students: often the only schools present in the area create unique classes in which students of different ages are grouped together, resulting in a rather low quality of education service offered and not suited to the needs of individual schoolchildren.

This situation pushes many families to leave inner areas to go live in bigger centres that offer students move. The SNAI project intends to intervene stopping this process of depopulation: the aim of this project related to education is to improve the school service offered to students residing in these areas avoiding them to move and strengthen the link with their territory. In terms of education, the project includes the following measures (Figure 5.2):

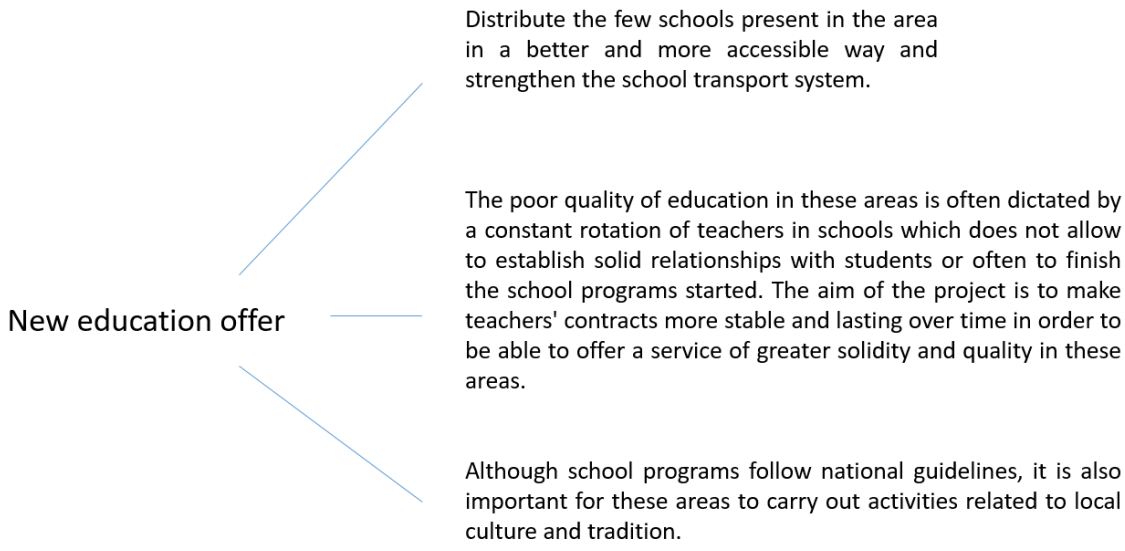


Figure 5.2 New education offer

Source: Author's elaboration based on UVAL (2014)

After the description of the main measures in terms of education and health, SNAI initiative focuses on the improvement and reorganization of the mobility offer (Figure 5.3).

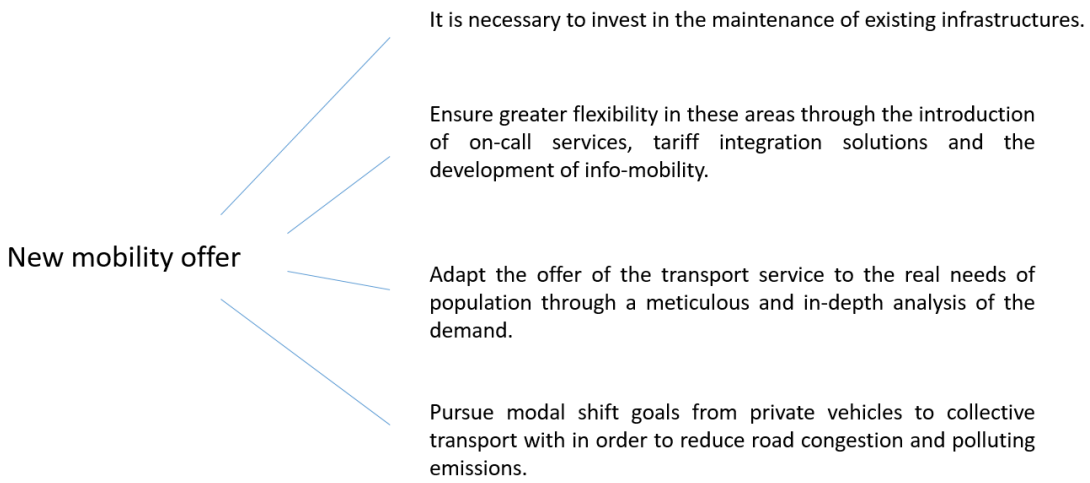


Figure 5.3 New mobility offer

Source: Author's elaboration based on UVAL (2014)

The SNAI project also defines the governance model for the measures needed to relaunch Italian inner areas: although this strategy is of a national nature and involves the whole country, the responsibility for identifying these areas and the implementation of the established measures falls on the Regions (in the initial phase a single inner pilot area is chosen by them).

Central Government, on the other hand, had the task of monitoring actions undertaken by Regions during the process: monitoring activity took place with selected indicators that allowed evaluating the impact of measures taken and the success or failure of these initiatives. Government also created a platform for sharing *lessons learned* during the course of this project: this was the purpose of the so-called "Federation of Project Areas".

The SNAI strategy also provided that each measure converged within a so-called "Area Project": each initiative was implemented through a "Project Framework Agreement" (PFA), undersigned by Government, Regions and Local Bodies and containing the interventions to be realized and the related funds. This agreement allowed communication to all stakeholders involved.

5.2 Other measures supporting inner areas' conservation

The fragile conditions of inner areas remain at the centre of the Italian Government political agenda: in February 2020 the "2030 Plan for the South" was presented in Gioia Tauro (Calabria Region) with the aim of promoting economic and social development in the Regions of Southern Italy. This ten-year vision plan (2020-2030), in order to accelerate the timing of interventions, provided for a short-term reporting for the three-year period 2020-2022. In addition to other measures aimed at relaunching employment, education and industrial production, this act intended to relaunch SNAI policies in the inner areas of these territories: to achieve this, Government decided to allocate more than € 290 million. Furthermore, following the Covid-19 pandemic, each Member State, in order to access Next Generation EU funds and relaunch its economy, had to present its National Recovery and Resilience Plan (NRRP) containing the spending methods of these funding. The Italian Government had thus access to € 191.5 billion to be distributed into four priority areas: justice, public administration, simplification and competitiveness. As part of these measures, resources amounting to € 2.1 billion have been allocated for the SNAI initiative to be invested within 2026.

5.3 Antola – Tigullio inner area: analysis of the context

5.3.1 Socio-demographic and mobility characteristics of Antola-Tigullio Valleys

This chapter deals with the central theme of this doctoral thesis: the study and planning of a DRT service in the Antola-Tigullio Valley, a site optioned by Liguria Region as a prototype inner area on which to concentrate resources in the initial phase of the SNAI project.

Antola-Tigullio area, one of the four Ligurian inner areas included in SNAI, is in the province of Genoa and consists of 16 mountain municipalities (area of about 600 sq. km), described as per Table 5.1 and illustrated in Figure 5.4.

Table 5.1 Municipalities of Antola-Tigullio area

Municipality	Inner Area classification by SNAI	Inhabitants (2022)	Total area in sq. km	Population density (pop/ sq. km)	Altitude (m)
Borzonasca	Outlying	1,798	80.51	22	167
Ne	Outlying	2,099	63.52	33	68
Bargagli	Intermediate	2,538	16.28	156	341
Davagna	Intermediate	1,824	20.53	89	552
Lumarzo	Intermediate	1,412	25.51	55	228
Mezzanego	Intermediate	1,489	28.65	52	83
Torriglia	Intermediate	2,185	60.02	36	769
Fascia	Peripheral	70	11.25	6	900
Fontanigorda	Peripheral	240	16.16	15	819
Gorreto	Peripheral	93	18.88	5	533
Montebruno	Peripheral	210	17.68	12	655
Propata	Peripheral	117	16.93	7	990
Rezzoaglio	Peripheral	867	10.72	8	700
Rondanina	Peripheral	60	12.81	5	981
Rovegno	Peripheral	482	44.09	11	658
Santo Stefano d'Aveto	Ultra – Peripheral	980	54.78	18	1012
Inner Area Antola-Tigullio	/	16.464	592.3	33	/

Source: Author's elaboration based on PFA Regione Liguria (2017)

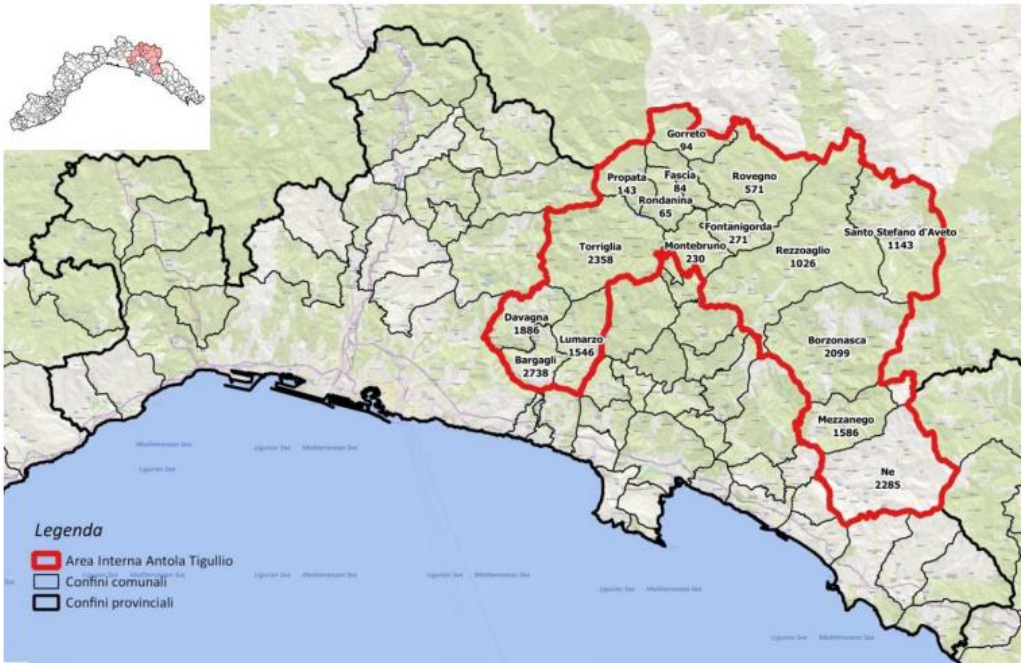


Figure 5.4 Representation of Antola-Tigullio inner area

Source: PFA Regione Liguria (2020)

The morphology of this area is particularly complex evident from the difference in terms of altitude that some municipalities present: Ne, in Val Graveglia, is located 68 m above sea level (the lowest area), Santo Stefano d'Aveto is located at 1,012 m above sea level (more than 900 m higher). The municipalities have been divided according to the SNAI classification criteria in terms of distance from the nearest service provision centre: Borzonasca and Ne are the closest to their reference pole, located near the municipal boundaries of the town of Chiavari (27,335 inhabitants). The areas classified as intermediate are altogether five and four of them gravitate around the pole of Genoa (Bargagli, Davagna, Lumarzo and Torriglia), while Mezzanego refers to Chiavari. The areas classified as peripheral are characterized by a higher average altitude (Propata in Antola Valley reaches 990 m above sea level) and, apart from the exceptions of Rezzoaglio (867 inhabitants) and Rovegno (482 inhabitants), have a population resident not exceeding 240 units (Fontanigorda). The municipality of Santo Stefano d'Aveto, the only one classified as ultra-peripheral, is located at the top of the Valley (1,012 m) but has more residents (980). The table also shows that total number of inhabitants of the inner area is equal to 16,464 while the average population density is 30.60 inhabitants per

sq. km (significantly lower than the average value of the Ligurian inner areas of 50 inhabitants per sq. km).

To fully understand the characteristics of the Antola-Tigullio inner area, it is necessary to frame the socio-economic aspect of the territory, its productive fabric and its offer of essential services such as mobility, education, health and digital divide.

The data on the resident population of the area, as reported in the Project Framework Agreement of 2017, has remained almost unchanged from the mid-1980s to the present day: this is due to the balancing effect between the growing suburbanization of the two referring centres of Chiavari and Genoa and the depopulation of the most remote areas.

Other socio-demographic trends of considerable interest for these territories concern aging of population and old age index: over 65 population residing in Antola-Tigullio inner area (30% in 2015) ranks above the national and regional average. In addition, the old-age index of this area, that is the ratio between over 65 population and under 14 children, is clearly higher than the Italian (157.7) and the Ligurian average (242.7): the Antola-Tigullio area presents an index of 289.3 elderly every 100 children.

In terms of production, the territory is characterized by the presence of a small number of companies and of small size: the sectors most represented in the area are construction (30%) and agriculture, forestry and fishing (21%). The tourism sector in these valleys has profoundly changed in recent years: the typical tourist is attracted today by the countless offers of outdoor activities that this area can offer (trekking, e-bikes, hiking, fishing, etc.). This tourist trend partially replaces the old concept of vacation that characterized citizens of main neighbouring centres who decided to move to these places, mainly in summer, to escape the heat of the city. Based on this, the tourism sector of these territories has also attracted many foreign tourists in recent years (mainly Dutch, Swiss and German).

Table 5.2 shows the main characteristics of essential services offered in these areas.

Table 5.2 Essential services offered in Antola-Tigullio inner area

Type of essential service	Description
Mobility	The resident population in the Antola-Tigullio Valley presents one of the most critical conditions (among the four inner Ligurian areas) in terms of accessibility to the nearest service provision centres: citizens must travel an average of 50.4 minutes by car (the average of the other internal Ligurian areas is equal to 35.7 minutes) to access the essential services they need. Based on these data, it is clear that the public transport system must be entirely redesigned in order to avoid that more and more people move to live in major centres and the process of depopulation of the territory continues. To date, in fact, public transport has a very limited offer of just 6.8 trips/day for every 1,000 inhabitants, against the regional average of 8.7. Another important fact is that in the reference area, no citizen lives within 15 minutes of a railway station or a motorway exit and only a minimum portion of the population is able to reach them within 30 minutes.
Education	The education offer consists of the presence of 25 schools in the area, all included between kindergarten and first grade secondary school (no presence of second grade secondary school/high schools), which provide for the presence of 1,131 students, divided into 74 classrooms (of which 8 are multi-age classes). The data mentioned show a particularly complex situation that involve aforementioned issues.
Health	The municipalities belonging to the Antola-Tigullio refer to two different local health authorities, in Italy known as "Aziende Sanitarie Locali" (ASL): 11 municipalities close to the Genoa pole belong to ASL 3 while 5 municipalities close to Chiavari are part of ASL 4. A very important data for understanding the quality of medical care offered in the area concerns the rate of hospital admissions: this data is an indication of how the medical facilities in these areas are not qualitatively or quantitatively able to meet demand and therefore oblige patients to be admitted to hospitals located in the attractive poles of Chiavari and Genoa (even several kilometres away). Based on the above, the rate of hospitalizations for acute cases (number of hospitalizations / total number of residents of the area) in the Antola-Tigullio area is equal to 10.4% (the city of Genoa is at 10.00%), while if considering only the hospitalization rate for the population over 65 it reaches 20.2% (higher than 18.9% in Genoa).
Internet connection	The provision of infrastructures and technological services in the area represents a key element for the relaunch of inner areas: in fact, technology allows the development of innovative services such as telemedicine, remote education services, home working (increasingly widespread in Italy after the outbreak of the Coronavirus pandemic, etc.). In the Antola-Tigullio area only a very low share of population (21.6%) has access to a medium-power internet connection: the Italian population that has access to this connection is 36.7% of the total, a much higher percentage than in Antola-Tigullio inner area. Moreover, even more critically, about a quarter of the population of this area has no access to internet and is totally excluded from the opportunities that this technology offers. With this in mind, SNAI considers it crucial in order to develop these territories and avoid the depopulation of inner areas, to spread the broadband connection and allow internet access to more and more people: the on-call transport service, highly technological-based, can only benefit from this vision.

Source: Author's elaboration based on PFA (2017).

After having described Antola-Tigullio inner area from a socio-demographic point of view, an overview is needed on the morphological and geographical characteristics of the territory.

The orographic characteristics of a territory greatly affect its degree of accessibility: inner areas, being mainly mountainous territories, present a conformation that it does not adapt well to scheduled transport, paving the way to new and innovative forms of mobility.

Factors having the greatest impact on the accessibility of a territory are its degree of slope ("steepness") and its altitude above sea level ("altitude").

Considering the physical conformation of the Liguria Region, characterized by a coastal strip set between the sea and the Apennines, the Antola-Tigullio area presents very sloping bands near the coast and the city of Genoa (greater than 35% of acclivity) and less steep areas on the north side of the area.

The altitude factor, as previously mentioned, greatly affects the accessibility of a territory: in Antola-Tigullio inner area, moving away from the coast altitude rises up to over 1,000 meters in the municipality of Santo Stefano d'Aveto: the innermost areas exceed 800 meters in height and represent most of the territory falling within the boundaries of the inner area designated by SNAI. The municipalities close to the coast and to the two attracting poles of Genova and Chiavari are indeed located between 400 and 800 meters above sea level.

The hilly-mountainous conformation of this specific inner area has represented over time a challenge also in terms of urbanization due to the difficulties of construction and settlement: woods and crops in fact mainly cover the area, while the inhabited centres are often small and far from each other. The analysis of land use indicates a prevalence of settlements close to the coast and the centre of Genoa (in particular the municipalities of Bargagli and Davagna), while inland only the municipality of Torriglia exceeds 2,000 inhabitants.

Through the Geoportal on the official website of the Liguria Region, it is possible to download the map relating to the settlement structure of Antola-Tigullio inner area (Figure 5.5).

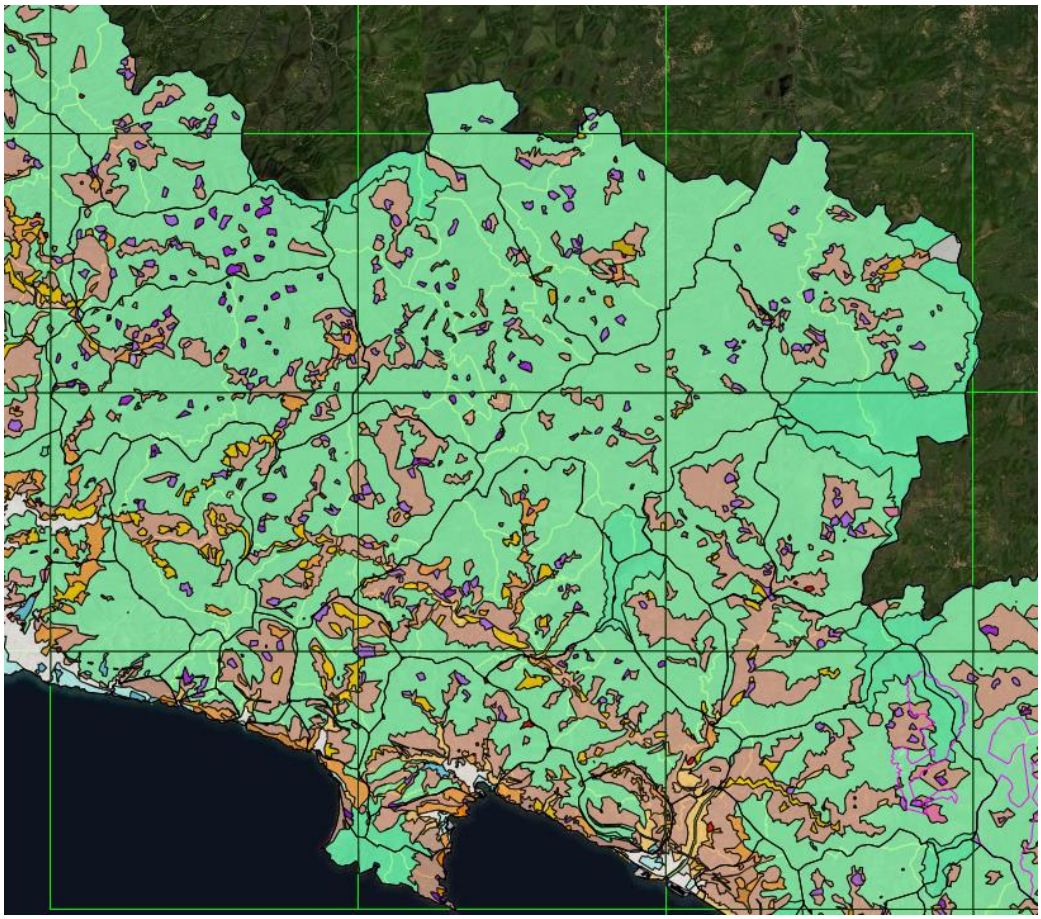


Figure 5.5 Settlement structure of Antola-Tigullio inner area

Source: *regione.liguria.it*

The Geoportal map reproduces the settlement structure of the area, distinguishing areas in different colours, each associated with an abbreviation (explained in the legend):

- ANI – Aree Non Insediate ("Uninhabitated Areas") are represented by various shades of green and represent almost the entire territory;
- IS – Insediamenti Sparsi ("Scattered Settlements") are represented by various shades of pink;
- ID – Insediamenti Diffusi ("Widespread Settlements") are represented by various shades of yellow and orange;
- NI – Nuclei Isolati ("Isolated Centres") are represented by various shades of purple.

Figure 5.6 focuses exclusively on the municipality of Fontanigorda. It is possible to observe the subdivision of the residential settlements up close: all around the small town there are uninhabited areas (ANI, in green) and gradually scattered settlements (IS, in pink), diffuse settlements (ID, in yellow) and finally an isolated centre (NI, in purple).

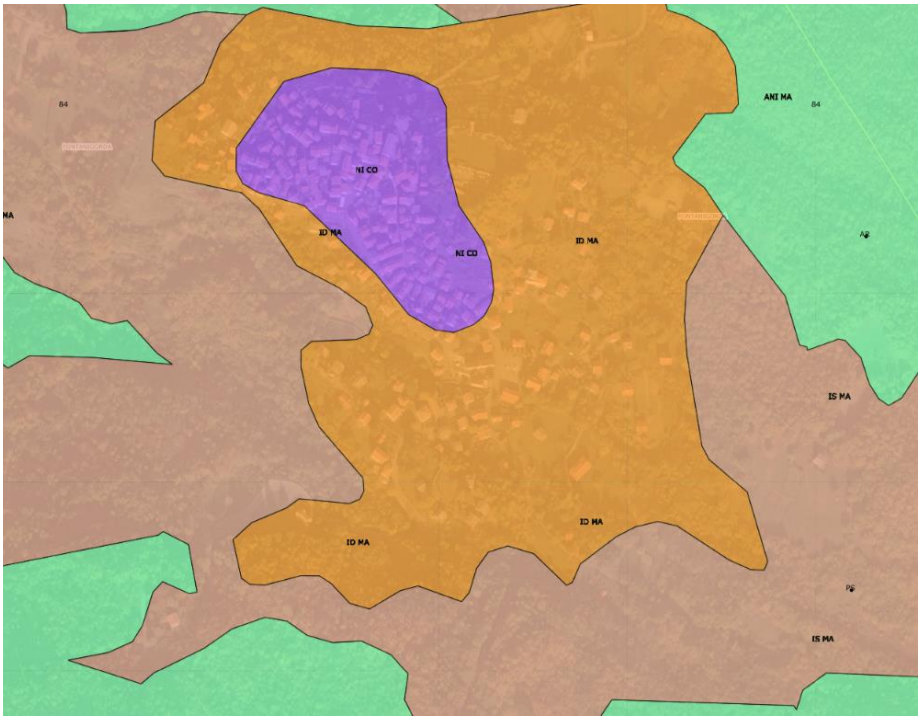


Figure 5.6 Focus on Fontanigorda's settlement structure

Source: *regione.liguria.it*

As for the road network that affects this area, as showed from Figures 5.7 and 5.8, it essentially consists of the state road SS45 (Antola Valley) and the provincial road SP586 (Tigullio Valley) up to the village of Rezzoaglio, after which it takes the name of SP654. SS45 state road, built in 1928, connects the cities of Genoa, located on the Ligurian Sea, with Piacenza, in the Po Valley, crossing the entire Apennines on the border between the Regions of Liguria and Emilia-Romagna. The "provincial road SP586 of the Aveto Valley" also connects the regions of Liguria and Emilia-Romagna, as well as the state road SP654 that reaches the highest point of the Ligurian Apennines.

These roads, which represent the main access to these hilly-mountainous territories, branch off at various points in minor roads (municipal) to reach the more isolated hamlets. The conformation of a road network of this kind entails the need, for implementing a DRT service, to use vehicles of adequate size to travel along winding and very narrow roads in order to reach even the most remote stops.

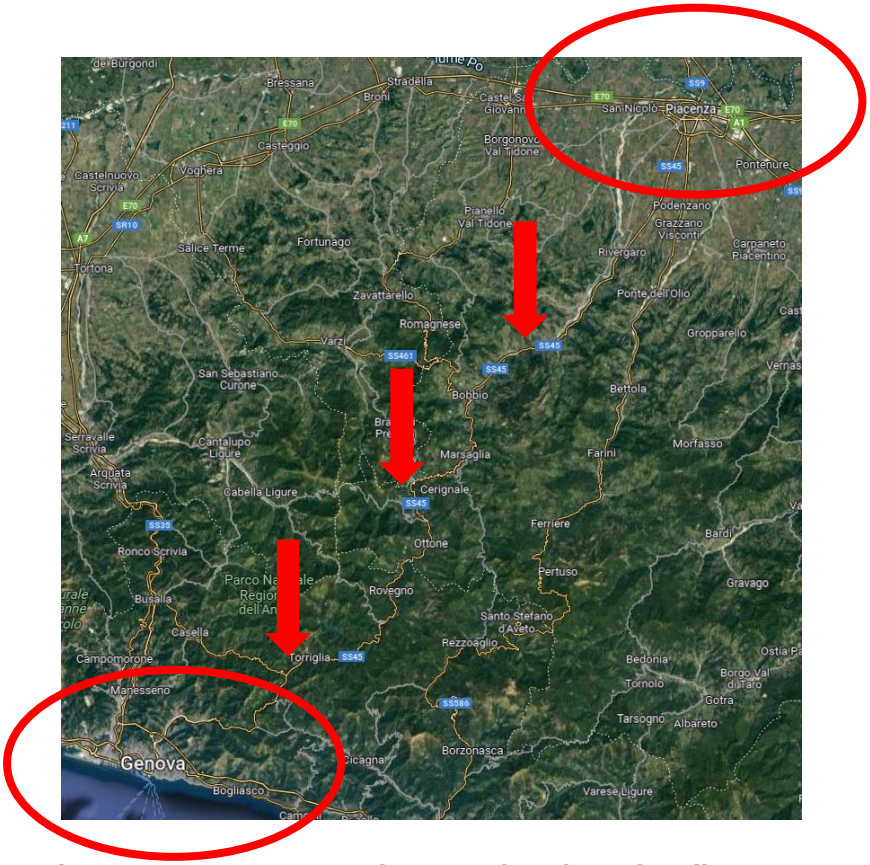


Figure 5.7 State Road SS45 connecting Genova and Piacenza through Antola Valley

Source: Screenshot taken by author on *Google Maps.*

Figure 5.8 SP586 branches off into SP654 at Rezzoaglio, to reach Santo Stefano d'Aveto

Source: Screenshot taken by author on *Google Maps.*

After having analysed the characteristics of the territory in terms of the provision of services and at the morphological level (studying the steepness, altitude, land use and settlement structure of the area), it is crucial to deepen the study of social and economic dynamics that characterize this inner area.

The first factors taken into consideration concern the territorial dimensions of municipalities, number of residents and population density. These values, shown in Table 5.3, provide a concrete picture of the situation affecting this area.

Table 5.3 Main characteristics of Antola-Tigullio municipalities

Municipality	Land area (sq. km)	Resident population (2022)	Population density (inhab./sq. km)	Altitude (m)
Bargagli	16.28	2,538	156	341
Borzonasca	80.51	1,798	22	167
Davagna	20.53	1,824	89	552
Fascia	11.25	70	6	900
Fontanigorda	16.16	240	15	819
Gorreto	18.88	93	5	533
Lumarzo	25.51	1,412	55	228
Mezzanego	28.65	1,489	52	83
Montebruno	17.68	210	12	655
Ne	63.52	2,099	33	68
Propata	16.93	117	7	990
Rezzoaglio	104.72	867	8	700
Rondanina	12.81	60	5	981
Rovegno	44.09	482	11	658
Santo Stefano d'Aveto	54.77	980	18	1,012
Torriglia	60.01	2,185	36	769

Source: Author's elaboration based on ISTAT data

In terms of territorial size, Rezzoaglio (Tigullio Valley) represents the largest municipality (104.72 sq km) with a population of less than 900 units and a very low population density (just 8 inhab./sq km). On the contrary, the municipality of the smallest inland area is Fascia in Antola Valley (11.25 sq. km) with a population of only 70 people and one of the lowest population densities (6 inhab./sq. km) together with Rondanina and Gorreto (5 inhab./sq. km both). For these contexts, an innovative and inclusive transport system is essential to guarantee the population access to essential services and thus counteract the phenomenon of depopulation and abandonment of these areas.

From Table 6.3 it can be observed that municipalities located near the attractive poles of Genoa and Chiavari are the more populous: for example, Bargagli is immediately located outside the municipal boundaries of Genoa and, despite a very low territorial extension (just 16.28 sq. km), has a number of residents in 2022 equal to 2,538 inhabitants

and a population density of 156 inhab./sq. km (the highest data among the municipalities of the inner area in exam). The municipality of Davagna, adjacent to Bargagli, also presents the same characteristics (thanks to its proximity to the city of Genoa it presents 1,824 inhabitants with a land area of 20.53 sq. km).

The Chiavari centre, on the other hand, has a rather high population for the neighbouring municipalities of the inner area such as Ne (2,099 inhabitants), Mezzanego (1,489 inhabitants) and Borzonasca (1,798 inhabitants): while Borzonasca and Ne have a rather large territorial dimension (respectively 80.51 sq. km and 63.52 sq. km) and therefore a low population density (respectively 22 and 33 inhab./sq. km), the municipality of Mezzanego has rather small dimensions (28.68 sq km) and a higher population density (52 inhab./sq. km).

The municipalities of Torriglia and Lumarzo, despite their position being distant from both cities, take advantage of their central position in Antola Valley which determines a rather high population for both contexts (respectively 2,185 and 1,412 inhab.): if Torriglia has large territorial dimensions (60 sq. km) and therefore a low population density (36 inhab./sq. km), Lumarzo has the opposite characteristics (25.51 sq. km and 55 inhab./sq. km). The municipalities of Rezzoaglio and Santo Stefano d'Aveto, located in the deep inland of Antola-Tigullio inner area, present very low population densities (respectively 8 and 18 inhab./sq. km) due to large and sparsely populated territories.

Altitude is a factor inversely proportional to the accessibility of a territory and therefore to its populousness: excluding the exceptions of Santo Stefano d'Aveto, Torriglia and Rezzoaglio, all the most populous municipalities are located at a very low altitude (the most populous municipality, Bargagli, is located at 341 m above sea level).

Another relevant element for understanding the socio-demographic dynamics of the area concerns the depopulation trend of these territories. Table 5.4 compares data on the population surveyed in 2011 and 2019 (ISTAT), providing an overview of the population changes of Antola-Tigullio inner area over time.

Table 5.4 Depopulation trend of Antola-Tigullio municipalities

Municipality	Legal population (2011)	Resident population (2019)	Population lost	Depopulation %
Bargagli	2,810	2,613	- 197	-7%
Borzonasca	2,124	1,946	-178	-8%
Davagna	1,927	1,842	-85	-4%
Fascia	100	65	-35	-35%
Fontanigorda	274	253	-21	-8%
Gorreto	107	85	-22	-21%
Lumarzo	1,594	1,504	-90	-6%
Mezzanego	1,624	1,488	-136	-8%
Montebruno	217	225	+8	+4%
Ne	2,361	2,203	-158	-7%
Propata	161	137	-24	-15%
Rezzoaglio	1,080	949	-131	-12%
Rondanina	69	62	-7	-10%
Rovegno	568	506	-62	-11%
Santo Stefano d'Aveto	1,217	1,097	-160	-13%
Torriglia	2,392	2,219	-173	-7%

Source: Author's elaboration based on ISTAT data.

The analysis of ISTAT data shows a demographic decline that has affected all the municipalities of the inner area in the last decade, with the sole exception of Montebruno that instead recorded a slight increase (+4% residents). The highest percentages of depopulation concern the municipalities of the deep hinterland: the highest numbers in the period 2011/2019 were recorded in Antola Valley in the municipalities of Fascia (-35%), Gorreto (-21%) and Propata (-15%). The municipalities of deep hinterland of Tigullio Valley also report significant demographic drops, in particular Rezzoaglio (-12%) and Santo Stefano d'Aveto (-13%). These data show how the great distance from the coast and from the attractive poles that characterizes the aforementioned municipalities inevitably entails conditions of marginalization, social and economic

exclusion and therefore, in the absence of targeted support initiatives, a progressive depopulation of these areas.

On the contrary, the municipalities closer to the coast recorded a minor demographic decline in the period considered, also due to the effect of new residents who decided to leave the city looking for a higher life quality and more accessible housing market. The municipality of Davagna, adjacent to Genoa, recorded the smallest decline (-4%) while Borzonasca (-8%), Bargagli (-7%) and Ne (-7%) remained almost stable. The municipalities of Torriglia and Lumarzo, due to their centrality in the Antola Valley, have also maintained their population rather stable in the period 2011-2019 (demographic decline of -7% and -6% respectively).

The municipality of Montebruno, on the other hand, is surprisingly the only one to have increased its population over the last decade (growth of +4%).

At this point of the analysis, the phenomenon of the depopulation is observed over a very large period: the 2018 report on inner areas published by ASITA (Geomatics Federation in Italy) provides interesting data on the percentage variation of the population of Antola-Tigullio Valleys in the reference period 1951-2017.

The inner area in exam suffered the greatest depopulation in the post-war period (1951-1971) where it recorded a residents' decline of 28.35%: this negative trend has gradually decreased over time (-17.90% in the period 1971-2001) up to a slight increase of +3.61% in 2001-2011. From 2011 to 2017, the depopulation rate started to decrease again (-4.47%).

The greatest percentage variation in population (from -70% to -30%) happened, confirming what aforementioned, in the most remote and difficult to access municipalities such as Rezzoaglio, Santo Stefano d'Aveto, Gorreto, Fascia, Propata, Rovegno, Fontanigorda, Rondanina, Montebruno and Propata. The municipalities of Borzonasca and Ne recorded a demographic decline of lesser intensity in the period 1971-2011 (from -30% and 0), furthermore, the municipalities close to the coast and to the centres of Genoa and Chiavari are characterized by a slight demographic increase (from 0 to 50%).

Another element to take into consideration in terms of socio-demographic dynamics concerns the phenomenon, relevant in recent years, of foreign immigration in the

municipalities of the area closest to the coast and to the cities. This phenomenon developed because of foreign families (made up of people of working age and minors) willing to move for work reasons from cities to inner areas: this process helped in compensating the demographic decline and in lowering average age of these municipalities.

ASITA reported also data showing the incidence of foreign immigration in the municipalities of the area: in the decade 2001-2011, the foreign population of Antola-Tigullio inner area increased by 383.48% (followed by a slight decrease of 1.80% in the following period 2011-2017). According to 2017 data, it should be noted that the phenomenon of foreign immigration particularly affected the municipalities of Borzonasca, Mezzanego, Rovegno (foreign presence between 10% and 15%) and Propata (foreign presence between 5% and 10%). This has no particular incidence in the other municipalities of the area.

It is crucial now to focus on the population that, instead of leaving, decided to stay and live in these areas. Understanding the population composition in terms of groups of age and travel behaviours is essential in order to organize an ad hoc transport service in this context. Table 5.5 shows data relating to the resident population in 2017, the percentage division by age group, the old age index and average age of each municipality.

Table 5.5 Groups of age, old age index and average age of Antola-Tigullio municipalities

Municipality	Resident population (2017)	% 0-14	% 14 – 64	% > 65	Old age index	Average age
Bargagli	2,697	12	64	24	202.1	46.4
Borzonasca	2,089	9	57	33	356.4	51.4
Davagna	1,895	11	61	29	263.9	49.1
Fascia	75	0	39	61		66.6
Fontanigorda	266	6	46	49	806.3	58.1
Gorreto	97	4	44	52	1,250	64.7
Lumarzo	1,502	11	58	31	296.2	49.6
Mezzanego	1,544	14	61	25	175.1	45.3
Montebruno	238	10	55	35	350	50.6
Ne	2,252	12	62	26	216.5	47.7
Propata	140	6	56	38	588.9	53.8
Rezzoaglio	982	7	49	44	593.1	56.4
Rondanina	64	2	48	50	3,200	59.7
Rovegno	533	8	57	36	475	53.6
Santo Stefano d'Aveto	1,122	7	59	35	505.2	53.1
Torriglia	2,297	9	61	30	316.2	50.5

Source: Author's elaboration based on ISTAT data.

The municipalities with the highest percentages of under 14 are Mezzanego (14%), Bargagli (12%), Ne (12%), Lumarzo (11%), Davagna (11%) and Montebruno (10%). The young people belonging to this age group are characterized by the lack of their own means of transport (as they do not have the necessary age to obtain a driving license) and therefore their demand for a transport service tailored to their needs could be higher (mainly home-school trips). All the other municipalities of the inner area show a presence of young people under 14 below the 10% threshold: the borderline cases are represented by Gorreto (4%), Rondanina (2%) and above all Fascia (0%), all part of the Antola Valley.

The age group 14-64, relative to the active population, represents the largest share of the inhabitants of almost all the municipalities: people between 14 and 64 years show the greatest demand for mobility to reach work, study and leisure places. The

municipalities near the coasts and the cities (Bargagli, Davagna, Mezzanego and Ne) all have a percentage share greater than 60%, as does Torriglia (61%).

Out of 16 municipalities, only 4 show a lower share of the active population (14-64) than the over 65. These municipalities are Fascia (active population 39% compared to 61% of over 65), Fontanigorda (46% compared to 49%), Gorreto (44% compared to 52%) and Rondanina (50% compared to 48%).

Furthermore, the aforementioned municipalities are also those with a more advanced average age of the population (respectively 66.6 years, 58.1 years, 67.7 years and 59.7 years).

Another very important element concerns the so-called "old age index": it measures the number of elderly (over 65) present in a population every 100 young people (under 14). This index provides information on the degree of aging of a population and values over 100 indicate the presence of a majority of elderly compared to young people: for this reason, the municipality of Fascia has an old age index that cannot be measured, as the presence of young people under 14 is zero.

The municipalities with the highest share of population over 65 are also those with a higher old age index: the highest value in absolute corresponds to Rondanina (3,200), followed by Gorreto (1,250) and Fontanigorda (806.3). On the contrary, all the municipalities adjacent to the cities or with a central position in the valley have a rather low old age index (but in any case higher than 100). Bargagli (202.1), Davagna (263.9), Lumarzo (296.2) and above all Mezzanego (175.1) represent the lowest values.

To understand travel behaviours of population residing in these areas it is important to observe the number of private vehicles available in each municipality (both cars and motorbikes): this data provide significant information about the degree of car/motorbike dependence of citizens and therefore their willingness to use any new public transport service.

Table 5.6 shows the number of cars and motorbikes present in each municipality and the number of cars per 1.000 inhabitants in order to provide indications on the dependency rate of the population on the use of private vehicles.

Table 5.6 Number of cars and motorbikes of Antola-Tigullio municipalities

Municipality	Number of cars (2016)	Number of motorbikes (2016)	Total	Cars per 1,000 inhab.
Bargagli	1,617	583	2,200	600
Borzonasca	1,133	364	1,497	542
Davagna	1,123	463	1,586	593
Fascia	37	11	48	493
Fontanigorda	145	51	196	545
Gorreto	54	12	66	557
Lumarzo	1,050	335	1,385	699
Mezzanego	925	322	1,247	599
Montebruno	131	43	174	550
Ne	1,453	533	1,986	645
Propata	72	22	94	514
Rezzoaglio	530	111	641	540
Rondanina	41	16	57	641
Rovegno	332	114	446	623
Santo Stefano d'Aveto	664	160	824	592
Torriglia	1,480	455	1,935	644

Source: Author's elaboration based on ISTAT data.

The municipalities with the highest number of cars (data as of 2016) are also those with the highest resident population: Bargagli, Torriglia, Ne, Borzonasca, Davagna and Lumarzo. On the contrary, the lowest numbers are found in the municipalities with the smallest population such as Fascia, Gorreto, Propata and Rondanina.

The values relating to the availability of motorbikes reflect the data on cars: the greatest number of motorbikes is concentrated in the most populous municipalities.

The data about the number of cars per 1000 inhabitants indicate that Lumarzo has the highest value (699) and therefore the highest car-dependence of its citizens: Lumarzo is followed by the municipalities of Torriglia (644), Rondanina (641) and Bargagli (600).

From the aforementioned analysis, the situation of strong car-dependence of population emerges: the residents of these municipalities prefer using private vehicles

because of the scarcity of public transport service and the convenience and flexibility of cars. Figures 5.9 and 5.10 graphically illustrate the total number of private vehicles (2016) and the data relating to the number of cars per 1,000 inhabitants respectively.

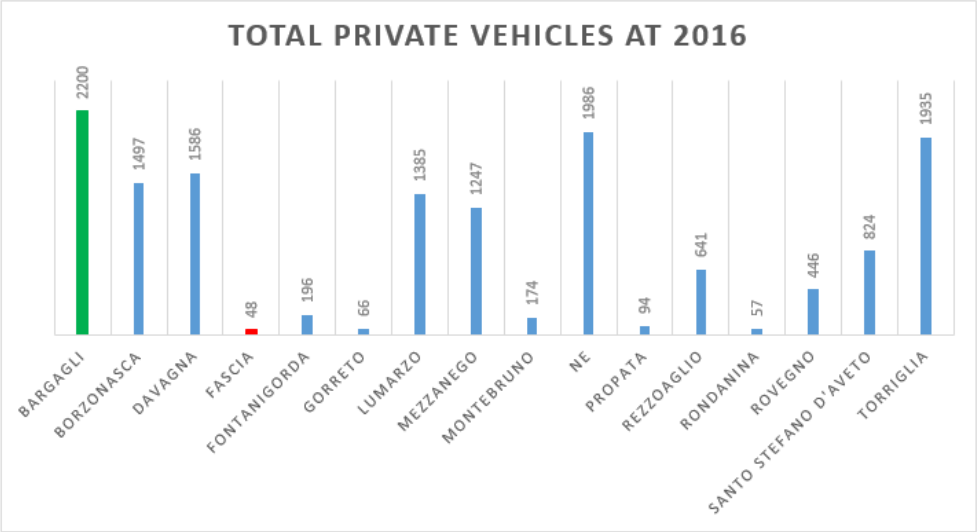


Figure 5.9 Total private vehicles (2016) of Antola-Tigullio municipalities

Source: author's elaboration based on ISTAT data.

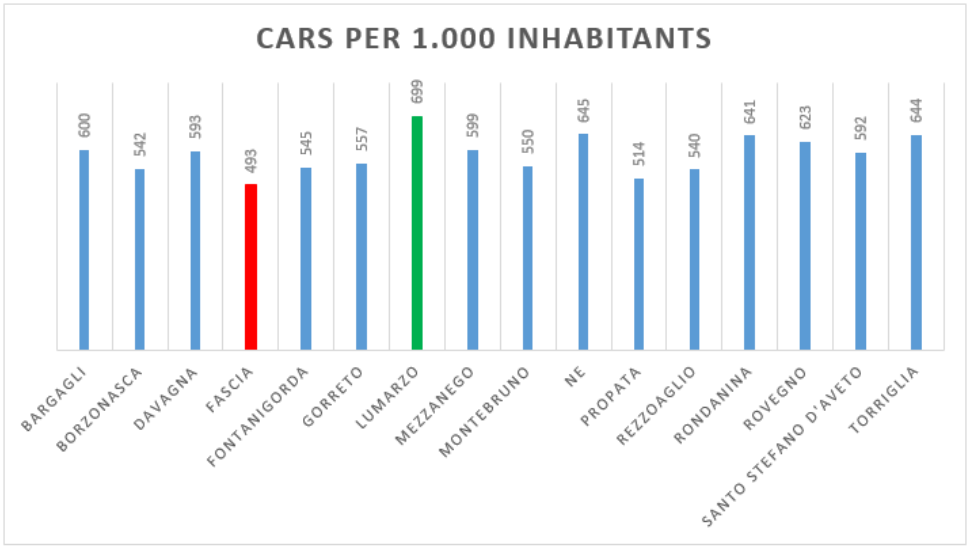


Figure 5.10 Cars per 1.000 inhabitants (2016) of Antola-Tigullio municipalities

Source: author's elaboration based on ISTAT data.

5.3.2 Current transport offer in Antola-Tigullio Valleys

Before one can understand the need of implementing a DRT service, one must examine the traditional public transport offer existing in Antola and Tigullio Valleys.

The municipalities of Antola-Tigullio inner area, based on the subdivision carried out by AMT (transit provider of the entire urban and metropolitan area of Genoa), belong to two different service lines: the municipalities of Antola Valley belong to "Valbisagno and Alta Valtrebbia" (“Group M”) while territories of Tigullio Valley belong to the "Tigullio Centrale" line. The municipality of Lumarzo is the only one to be served by two different lines: the aforementioned "Tigullio Centrale" and the one called "Golfo Paradiso", which includes the areas closer to the coast.

To the “Valbisagno and Alta Valtrebbia” service line belong the following municipalities:

- Genova (not part of Antola-Tigullio inner area project)
- Bargagli
- Davagna
- Fascia
- Fontanigorda
- Gorreto
- Montebruno
- Montoggio (not part of Antola-Tigullio inner area project)
- Propata
- Rondanina
- Rovegno
- Torriglia

The “Valbisagno and Alta Valtrebbia” service consists of the lines contained in Table 5.7 (only lines serving Antola-Tigullio inner area municipalities are reported).

Table 5.7 "Valbisagno and Alta Valtrebbia" service line

Service Line No.	Service Line Name
725	Torriglia – Bargagli - Genova Brignole
829	Buffalora – Torriglia – Laccio - Scoffera
726	Torriglia – Scoffera – Davagna - Prato
824	Traso Ponte - Traso Centro - Traso Alto - S. Alberto - Bargagli
910	Bromia – Laccio - Torriglia
925	Montebruno – Rovegno – Gorreto - Ottone
926	Torriglia – Casoni – Fontanigorda – Casanova – Carchelli - Rovegno
927	Torriglia – Propata - Rondanina
928	Local lines Torriglia
929	Local lines Fascia
930	Local lines Fontanigorda – Rovegno - Montebruno
931	Local lines Gorreto

Source: Author's elaboration

The two traditional public transport lines 831 (Prato-Marsiglia) and 832 (Prato-Terrusso-Cisiano) have been replaced by an on-call transport service active since 13/06/2022. The "Chiama il bus" service, active from Monday to Saturday (06.00 - 19.30) serves the localities of Bargagli, La Presa, Preli, Viganego, Terrusso, Cavassolo,

Maggiolo, Calvari, Marsiglia and Capenardo, all adjacent to the Genoa pole. The seat on the bus can be booked through the call centre or through a dedicated app.

To the “Tigullio Centrale” service line belong the following municipalities:

- Bargagli
- Borzonasca
- Carasco (not part of Antola-Tigullio inner area project)
- Chiavari (not part of Antola-Tigullio inner area project)
- Cicagna (not part of Antola-Tigullio inner area project)
- Cogorno (not part of Antola-Tigullio inner area project)
- Coreglia Ligure (not part of Antola-Tigullio inner area project)
- Favale di Malvaro (not part of Antola-Tigullio inner area project)
- Genova (not part of Antola-Tigullio inner area project)
- Lavagna (not part of Antola-Tigullio inner area project)
- Leivi (not part of Antola-Tigullio inner area project)
- Lorsica (not part of Antola-Tigullio inner area project)
- Lumarzo
- Mezzanego
- Moconesi (not part of Antola-Tigullio inner area project)
- Ne
- Neirone (not part of Antola-Tigullio inner area project)
- Orero (not part of Antola-Tigullio inner area project)
- Rezzoaglio
- S. Colombano Certenoli (not part of Antola-Tigullio inner area project)
- S. Stefano d’Aveto

The “Tigullio Centrale” service consists of the lines contained in Table 5.8, classified by AMT according to the municipality of reference (only lines serving Antola-Tigullio inner area municipalities are reported).

Table 5.8 "Tigullio Centrale" service line

Municipality of reference	Service Line No.	Service Line Name
Bargagli	715	Chiavari FS - Gattorna - Ferriere - Genova
	725	Genova Brignole - Bargagli - Torriglia - Ottone
	824	Traso ponte - Traso centro - Traso alto - S.Alberto - Bargagli
Borzonasca	712	Chiavari - Borzonasca
	711	Chiavari - Borzonasca - Rezzoaglio - S.Stefano d'Aveto
	917	Borzonasca - Levaggi - Belpiano - Acero
	916	Borzonasca - Caregli
	915	Borzonasca - Borzone
	812	Borzonasca - Belvedere
	826	Carasco - Montemoggio - Borzonasca
Lumarzo	715	Chiavari FS - Gattorna - Ferriere - Genova
Mezzanego	712	Chiavari - Borzonasca
	711	Chiavari - Borzonasca - Rezzoaglio - S.Stefano d'Aveto
	826	Carasco - Borgonovo - Montemoggio - Borzonasca
	812	Borzonasca - Belvedere
	814	Chiavari FS - Villagrande di Cichero - Ferreccio
Ne	703	Chiavari FS - Lavagna Osp. - S.Salvatore - Conscenti
Rezzoaglio	911	Rezzoaglio - Alpepiana - Vicomezzano - Vicosoprano
	912	Rezzoaglio - Sbarbari

	711	Chiavari - S.Stefano d'Aveto
	913	Rezzoaglio - Casaleggio
Santo Stefano d'Aveto	994	Rezzoaglio - Torrini - Pareto - Ascona
	711	Chiavari - S.Stefano d'Aveto
	994	Rezzoaglio - Torrini - Pareto - Ascona

Source: Author's elaboration

Many lines of traditional public transport service in the municipality of Ne have been replaced by an on-call transport service: it will be described in detail in the next chapter. To the "Golfo Paradiso" service line belong the following municipalities:

- Genova (not part of Antola-Tigullio inner area project)
- Avegno (not part of Antola-Tigullio inner area project)
- Bogliasco (not part of Antola-Tigullio inner area project)
- Cicagna (not part of Antola-Tigullio inner area project)
- Lumarzo
- Moconesi (not part of Antola-Tigullio inner area project)
- Neirone (not part of Antola-Tigullio inner area project)
- Pieve (not part of Antola-Tigullio inner area project)
- Recco (not part of Antola-Tigullio inner area project)
- Sori (not part of Antola-Tigullio inner area project)
- Tribogna (not part of Antola-Tigullio inner area project)
- Uscio (not part of Antola-Tigullio inner area project)

The only line of the "Golfo Paradiso" service to serve the municipality of Lumarzo is number 870 "Ferriere - Lumarzo - Colle Caprile".

CHAPTER VI

RESULTS OF THE SURVEY OF MAYORS CONDUCTED IN ANTOLA-TIGULLIO INNER AREA

6. Hypothesis of DRT services in Antola-Tigullio inner area

This chapter describes the process that led to the experimental implementation of on-call transport in some selected municipalities of the Antola-Tigullio Valleys. It uses a survey, conducted through a questionnaire addressed to all the municipalities' Mayors, as a first element useful for planning a DRT service as close as possible to the real needs of users.

The decision was made to exclusively interview the Mayors of the communities concerned and exclude the general public in order to get the most impartial and reliable information about the area. The Mayors perfectly suited this goal since they represent the whole community they are a part of. The questionnaire method was used to get responses that were consistent and similar as much as possible. Since the DRT service proposed integrates/replaces existing lines of FT and for which it was believed to already have a solid socio-demographic and mobility data base, a GIS accessibility study of the region was not performed for the objectives of this research.

The answers to this inquiry allowed us to address the following research question, investigating elements considered crucial in literature, as described in paragraph 6.1, for a successful implementation of the service:

> RQ4: "*What are the perceptions of Mayors of inner areas concerning the characteristics of the territory and the residents' travel behaviour with regard to the implementation of DRT services?"*

After understanding, also through the valuable suggestions provided by Mayors, the strengths and weaknesses of public transport offer and the mobility needs of residents, three pilot areas were identified where to initially test the new DRT service. A hypothesis of DRT service was then associated with each selected pilot area: this resulted in the definition of a new on-call transport service to supplement existing FT. Furthermore, in order to test the feasibility of the hypothesized solutions, a field inspection was conducted by CIELI researchers (University of Genoa) and AMT managers. In conclusion, a workshop was organized with all stakeholders involved so as to discuss the findings of this study.

For the purposes of this paper, only one of the three hypothesized services is taken into consideration and analysed as it represents the first that found concrete application: pilot started on 14 February 2022.

6.1 Study of population travel behaviours: the questionnaire

The questionnaire submitted to the mayors of the municipalities of Antola-Tigullio inner area is attached in the appendix of this work (translated in English): it consists of an introduction in which the purpose of this survey and the fundamental characteristics of the new on-call transport service are explained to the mayors. Then, in the central part of the questionnaire, seven open-ended questions aimed at fully understanding the demand characteristics and the users' travel behaviours are expressed. Finally, the mayors are asked to indicate the name of their municipality and to leave their contact details (email and telephone).

The first question aims to collect information about three different characteristics of each municipality: population, accessibility and services.

The mayors are initially asked for some demographic characteristics such as the number of inhabitants, the average age, the average income and the general economic and social conditions in which the population lives: demographic information is crucial in order to implement an *ad hoc* DRT service, as reported by Jain et al. (2017). The accessibility of the territory is useful to understand through which infrastructures the municipality can be reached (both outgoing and incoming) and with which means of transport (whether private or public). As revealed by Laws et al. (2009), the territory accessibility represents a key factor in the implementation of DRT services: their study, conducted on DRT cases in England and Wales, showed that one of the main drivers incentivising local authorities to invest in this technology is represented by the will to increase the area accessibility for citizens.

The mayors are also required to list the essential services present within the municipality and, if necessary, for those absent, to which other municipality the citizens turn to meet their needs.

The second question is aimed at understanding which categories of users encounter the greatest degree of difficulty in terms of mobility within the municipal area and towards the outside. Mayors are also asked to provide information on the time slots less served by traditional public transport: this information allows users to be targeted in order to plan an *ad hoc* DRT service. The importance of user segmentation based on specific characteristics for the success of DRT services has been already demonstrated in academic literature (Vij et al., 2020; Woolf and Joubert, 2013; Nyga et al., 2020).

The third question still intends to obtain information about the existing FT offer: in particular, the mayors are asked for the interventions they consider a priority for improving the transport service (better routes, stops and services). The Mishra et al. (2022) study states how the integration of the new DRT service with the existing traditional transport is strictly necessary to provide users with a complete transport offer.

The fourth question asks mayors to indicate from which origins to which destinations the new DRT service could be more useful: this depends on the presence or absence of essential services in the relevant Municipality. Based on this information, it is possible to outline the correct *ad hoc* DRT service models described in paragraph 2.3 of this elaborate as identified in literature (Nelson et al., 2004; Papanikolaou et al., 2017; Mageean and Nelson, 2003).

The next question aims to understand the possible availability of local private entities to collaborate with the public transport service provider, as is already the case in various parts of the world (Jain et al., 2017): in this way, public-private synergies can be realized and contribute to improving the general offer of the transport service in such areas. The sixth question collects information about the possibility of, using means of transport intended for passengers, offering to the residents of these mountain areas also different services: for example, public transport vehicles can also transport medicines (Hirsch and Fredericks, 2001; Schumacher, 2020; BBC, 2023; Médecins du Monde, 2023), food and mail to the more remote and difficult to access locations.

The seventh question, like the second, aims at obtaining an in-depth targeting of users: specifically, object is to attract more, through the introduction of changes to the current transport system, tourists in these areas. Almost all the municipalities of the Antola-Tigullio inner area present a purely summer type of tourism linked to sports such

as trekking, hiking and biking: the routes and stops that means of transport serve must be rethought with a view to favouring tourists in reaching the main desired destinations. The importance of combining on-call transport with tourism purposes has already been demonstrated by Matsuhita et al. (2022), who tested the "Misato Aiai Taxi" service in the town of Aizumisato (Japanese prefecture of Fukushima).

The eighth question investigates the propensity of residents of the area to use technologies such as smartphones, computers, tablets, applications, etc. This information is useful for creating a DRT transport service with user-friendly booking methods easily accessible even by older users, who show a natural propensity to use technology after appropriate training courses (Burlando and Cusano, 2014).

The last question aims to collect further indications and suggestions from the mayors of the area: in particular, it tries to study the best possible integration between traditional public transport and flexible on-call services.

Except for Torriglia's Mayor, who did not respond , all of the Mayors sent their responses to the questionnaire (response rate of 94%).

6.2 Analysis of questionnaire responses

The answers to the first question are interesting above all in relation to the accessibility of the territory and the presence of essential services. Most of the mayors pointed out how access to their municipalities takes place through municipal, provincial and state roads, allowing connection with larger centres both by car and FT vehicles. Some mayors also complained about the lack of maintenance carried out on the road surface which makes the viability dangerous (Propata, Fontanigorda, Rondanina).

From the observation of the results relating to the presence of essential services (e.g. post office, pharmacy, supermarket, bank, etc.), a rather heterogeneous picture emerges. The 20% of the municipalities (3) have all the essential services on their territory: Bargagli, Borzonasca and Mezzanego, located near the Genoa and Chiavari poles, present a high population and all the essential services that citizens require. Opposite situation for four municipalities of the Antola-Tigullio inner area (26.67%)

whose mayors declared they do not have any essential service on their municipal territory and that therefore their citizens are forced to move to the neighbouring major centres. This data is understandable for the municipalities of Fascia, Gorreto and Propata (presence of a butcher selling also foodstuff) due to the difficult accessibility of their territories and the low resident population. On the contrary, this data is surprising for the municipality of Ne, more populated, where the population must go to the neighbouring Conscienti centre to get access to essential services.

The municipality of Fontanigorda presents essential services on its territory but complains about reduced hours and few days of opening: in addition to the lack of a butcher, the clinic opens only once a week, the pharmacy and the post office on alternate days while the bank service is available only one afternoon a week. Two municipalities in the area (Montebruno and Rezzoaglio) present only some essential services while the residents have to move to neighbouring municipalities for others: in Montebruno there are medical services, pharmacies, post offices, banks and police but not school services. In Rezzoaglio, on the other hand, there are clinics with specialists present once a month, post office, bank and primary school, but for all other services, residents must move to Bedonia (PR), Chiavari, Genoa and Santo Stefano d'Aveto.

It should be noted that five municipalities in the area did not answer this specific question or in any case answered in an irrelevant way.

Figure 6.1 shows responses in terms of essential services for a better and immediate understanding.

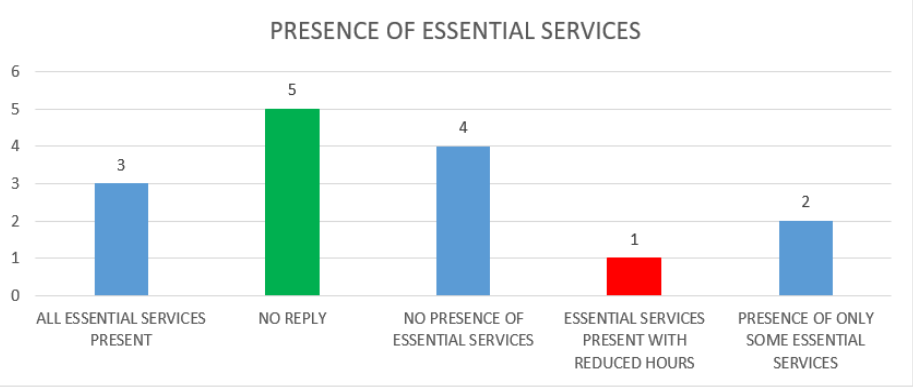


Figure 6.1 Presence of essential services

Source: Author's elaboration

The analysis of the results of the second question makes it possible to target the categories of users who, in the opinion of mayors, find it more difficult to access mobility within the municipality borders and towards the main neighbouring centres.

All the mayors included the elderly among the people who find most obstacles to mobility. This fact is not surprising, as the elderly, who represent the prevalent component of the population of these areas, very often do not have a private vehicle to move and, due to a poor public transport service, consequently face the risks of isolation. Many mayors pointed out that the elderly residing in these areas need an efficient transport service especially in the morning hours (10.00 h-12.00 h), those less served by FT, in order to reach the neighbouring municipalities for services such as the bank, post office, pharmacy, etc. Mayors indicated even evening time slots as critical: the line service is not present and therefore the elderly, and other categories of users that do not own a car, find difficulties in mobility.

Ten mayors indicated the category of young people as a target of users who find difficulties in access to mobility: this is because many children under 14 are not of the age to obtain a moped license and therefore cannot reach the major interchange centres (and under 18 cannot drive a car). Time slots indicated as critical are referred to morning: high school students often have to make very long trips to reach the cities of Bedonia in Emilia-Romagna (especially young people residing in Rezzoaglio) or Chiavari and Genoa. Very often, students are forced to get up very early in the morning and return home in the late afternoon due to the absence of a more suitable transport service for school hours.

Only three municipalities (20%) indicated the category of workers: Borzonasca, Davagna and Ne. The workers residing in these areas, due to the lack of an effective traditional transport service, prefer to use their own car. The mayor of Davagna pointed out that even the category of workers of foreign origin residing in the municipality presents numerous mobility problems, often not owning a private vehicle.

The mayors of Borzonasca and Fontanigorda also indicated the category of tourists: in particular, hikers, trekkers and mountain bikers encounter mobility problems associated with moving from the poles of Genoa/Chiavari to the start of trails and back.

Figure 6.2 illustrates categories of users afflicted by mobility problems for a better and immediate understanding.

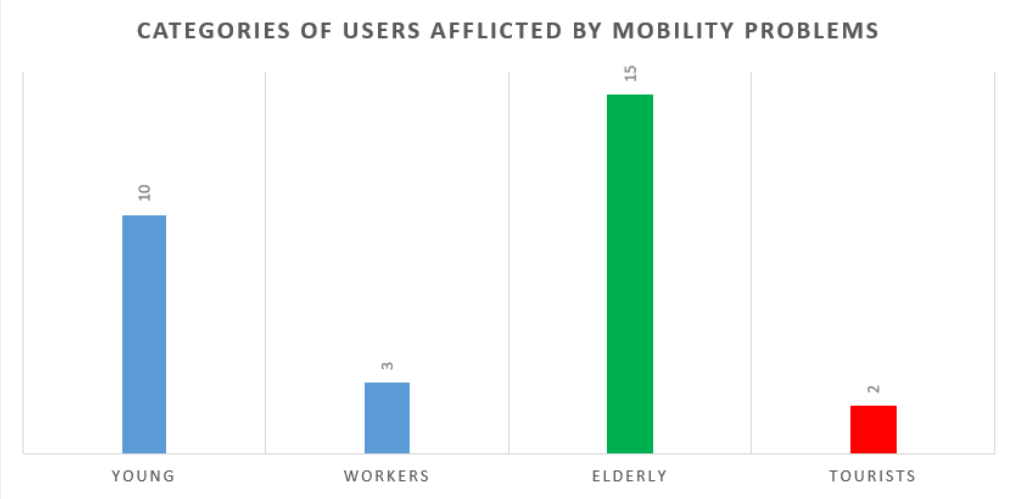


Figure 6.2 Categories of users reported by Mayors as afflicted by mobility problems

The third question asked mayors to indicate the priority interventions required, taking into account the existing public transport offer. 40% of them expressed a desire to strengthen the existing FT system by introducing new routes (Davagna, Mezzanego, Ne, Rezzoaglio, Rovegno) and stops (Rondanina).

The mayors of four municipalities requested a better connection of the existing public transport with the hamlets scattered within the municipal boundaries: together with the municipalities of Rezzoaglio and Rondanina, the mayor of Gorreto asked for connections from the more isolated hamlets to the major centres neighbours such as Gorreto capital, Rovegno, Montebruno and Ottone.

The mayors of Borzonasca, Ne and Mezzanego requested the implementation of an on-call transport service: the municipality of Borzonasca considered crucial the presence of a DRT service exploiting Borzonasca capital as an interchange node between FT and on-call service. The municipality of Ne asked for the introduction of an on-call service capable of transporting people with motor disabilities, Mezzanego instead deemed DRT service necessary for hilly areas within its municipality.

Three municipalities (20%) wanted to define an interchange node between scheduled and on-call transport services in correspondence with their capital: in addition to Borzonasca, the mayors of Propata and Bargagli also expressed this need.

Three mayors (20%) expressed also the need for a better school transport: the municipality of Montebruno considered important to introduce a much faster school bus service to the Genoa hub, Propata required the implementation of a students dedicated line to reach the primary school of Torriglia and Santo Stefano d'Aveto asked for a dedicated line for students going to Bedonia (PR).

Finally, two mayors have expressed two different requests: the municipality of Fascia requested a transport service (not specifying whether FT or DRT) whose trips have the same timetables as the main essential services. The municipality of Rondanina expressed its willingness to adapt public transport timetables to the needs of residents and tourists (and therefore the introduction of a DRT service is considered appropriate).

Figure 6.3 illustrates priority interventions as reported by mayors.

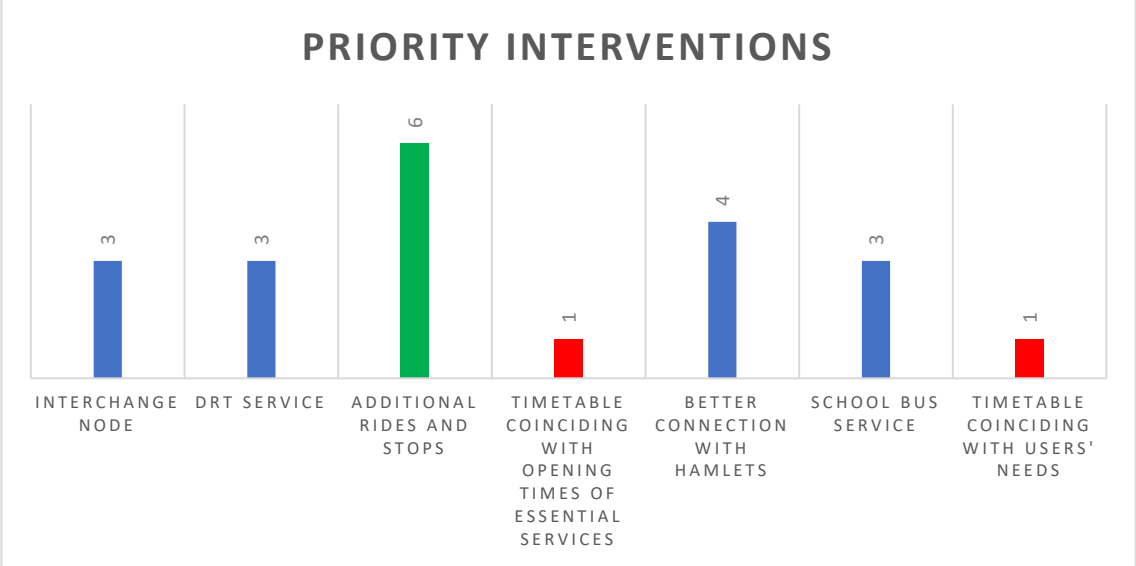


Figure 6.3 Priority interventions

In response to the fourth question, all the mayors expressed their opinion by indicating as a priority the connections from the more peripheral hamlets to the larger

centres offering essential services. The mayor of Rondanina pointed out the lack of a connection to the lake of Brugneto, a well-known tourist and sports resort: he considered necessary to introduce a transport service dedicated to this locality at least in the spring-summer period.

The fifth question, relating to possible collaborations between the public transport provider and private entities, showed 60% of positive opinions: the Mayors replied that collaborative relationships between public and private companies are already active, in particular for school transport and car with driver. Figure 6.4 shows the Mayors' perception of the possibility of establishing partnerships between public and private entities (%).

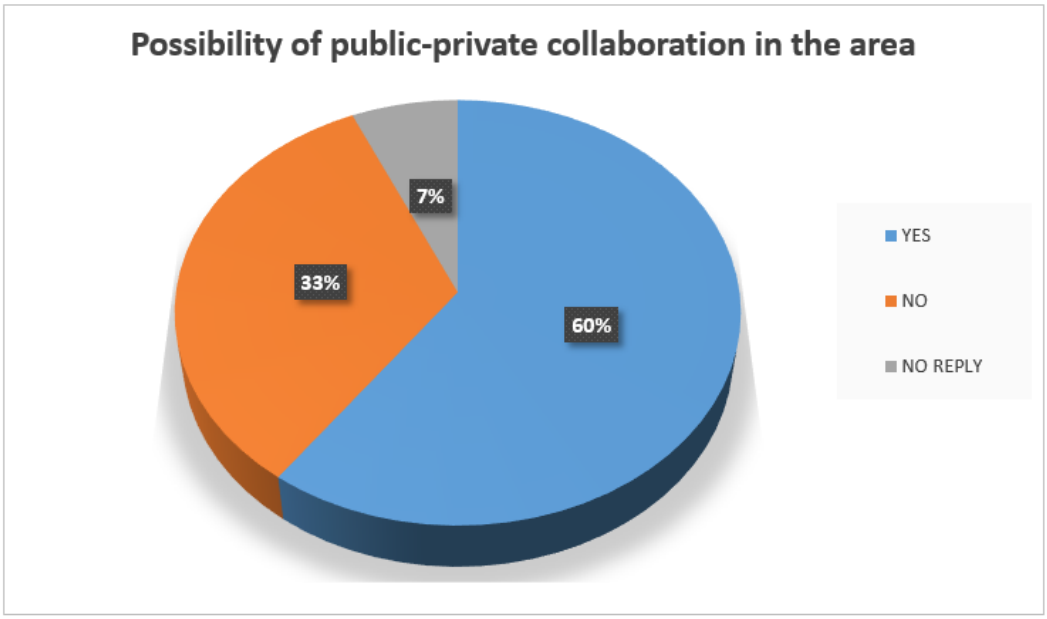


Figure 6.4 Possibility of public-private collaboration in Mayors'perception

The sixth question of the questionnaire investigated the need to transport medicines, mail and foodstuffs to these areas, in addition to people, and asked mayors to indicate locations most in need. Most of the answers indicated the need for the transport of medicinal products: this is the result of the generalized aging process that affected these areas in the last decades. 60% concerned the transport of foodstuffs, while others required transport of mail. In addition, Mayors could propose further transport solutions: the

municipality of Gorreto required the transport of newspapers while Rondanina complaints to the police. The mayor of Santo Stefano d'Aveto supported the need to use vehicles allowing the transport of bicycles for tourists interested in mountain biking in the area. The municipality of Montebruno, on the other hand, did not detect any need to transport other goods besides people. Figure 6.5 summarizes mayors' requests in terms of transporting additional products in DRT vehicles.

Figure 6.5 Additional services

Question number 7 asked mayors to indicate possible changes to be made to the transport service (new routes, stops, shuttles, etc.) in order to attract more tourists in those areas.

Apart from Bargagli, Fontanigorda and Montebruno, the mayors of all the other municipalities (80%) responded positively to the possible extension of the transport service to the more touristic locations. Almost all the mayors promoted the implementation of new rides and stops to meet the demands of tourists, especially in the summer period. Propata also suggested the introduction of specific stops to serve the main tourist destinations also in winter period (such as Monte Antola and Casa del Romano).

The questionnaire investigated (question 8) the availability and propensity of the residents of the inner area in exam to use info-telematic technologies (smartphones, tablets, computers, applications, etc.), which are very important for the booking procedures of an on-demand transport service.

The responses of the mayors showed a heterogeneous picture: many of them indicated at the same time more options due to a propensity for technology, which naturally varies according to the age of residents. Most of the responses indicated a low propensity for technology: not surprising given the average advanced age of the population of these areas. A small share of the Mayors stated a medium level of availability to use technology and only a few considered it high (where the elderly population is not predominant). These data provided important information in relation to the most suitable booking method for the new DRT service to be implemented: it appears logical, with a rather low propensity to use technology in this area, to avoid providing the use of the website or a dedicated app as the only possible booking methods. On the contrary, a booking method based on telephone calls appears more suitable for the context.

Figure 6.6 illustrates the level of population propensity to the use of technology.

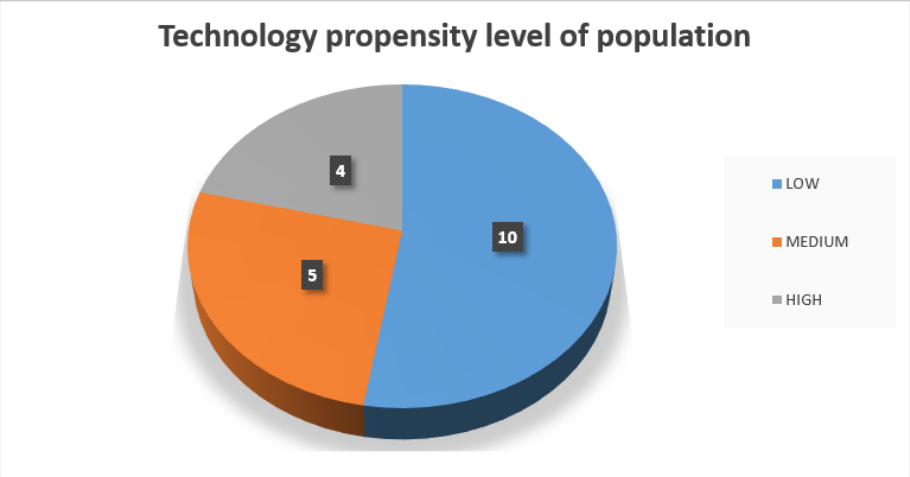


Figure 6.6 Technology propensity level of population

As regards question number 9, asking the Mayors for further suggestions about the services to be implemented in the area, no additional details emerged: they limited to reiterating the importance of strengthening the existing FT and the utility of a good quality DRT service tailored to the local mobility demand.

From the questionnaire submitted to the Mayors of Antola-Tigullio inner area, important information was collected for the design and implementation of a DRT transport service: key factors learnt from this inquiry are stated below.

What emerged from the survey can be summarized in a general attention and priority to the category of the elderly: the mayors requested better connections from the most remote hamlets to the main centres able to offer essential services, booking methods suitable for an advanced age group (possibility to book up to the day before by phone) and times of the rides corresponding to the needs of this user range (mainly in the morning).

The other category of users strongly afflicted by the mobility problems typical of these mountain areas were students: many mayors highlighted how young people, not having their own vehicle, have to spend many hours on board public transport vehicles to reach the nearest schools (even 2 hours in some cases). In order to prevent students from getting up very early in the morning and returning home in the late afternoon, the mayors are calling for the introduction of faster service lines with fewer stops.

For the category of workers, the introduction of an on-call service is less of a priority as people in this range almost all have their own vehicle, which they would hardly abandon in favour of public transport.

Some mayors also expressed the request to create a DRT transport service able to meet the needs of tourists who reach these areas for activities such as hiking, trekking and mountain biking: for this category of users it is considered necessary the introduction of seasonal service lines (mainly in summer) or on holidays.

Finally, almost all of the mayors interviewed considered useful to transport also other goods on the same vehicles intended for people: in particular medicinal products, foodstuffs and mail.

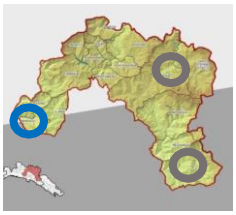
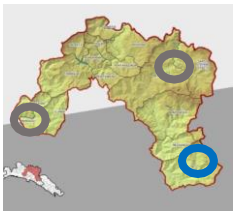
6.3 DRT service hypothesis

The survey conducted made it possible to collect a series of data useful for understanding the mobility dynamics of the categories of users residing in the inner area, to analyse the strengths and weaknesses of the current public transport offer and to design a new, more efficient and flexible DRT service.

At this stage, taking into consideration the Mayors' recommendations regarding the users' needs and the areas' socio-demographics, three pilot municipalities were selected to design as many DRT services: profoundly different areas were thus identified and, based on the SNAI classification, characterized by a different distance from the Genoa and Chiavari poles (main characteristics summarized in Table 6.1).

The analysis led to the selection of the intermediate municipality of Bargagli (small size but highly populated), of the outlying municipality of Ne (larger size and population over 2,000 inhabitants) and the peripheral municipality of Rezzoaglio (large size and very low population density).

Table 6.1 Main characteristics of Bargagli, Ne and Rezzoaglio

	Bargagli	**Ne**	**Rezzoaglio**
Geographical location			
SNAI classification	Intermediate	Outlying	Peripheral
Self-containment	Low	Low	High
Type of settlement	widespread settlement	scattered settlement	Isolated centres
Population	2,613 inhab.	2,252 inhab.	982 inhab.
Population density	Highest in the inner area (165.95 inhab./sq. km)	Low (34.95 inhab./sq. km)	Very low (9.21 inhab./sq. km)
Territorial size	Small (16.28 sq. km)	Medium (64.1 sq. km)	Very large (104.7 sq. km)
Prevailing demographic groups	Under 14 14-64 years	Under 14 14-64 years	Over 65 14-64 years
Motorization rate	High	Very high	Very low

It is decided, for each of the pilot municipalities selected, to start from the recognition of the current transport offer in different time bands (h. 7.00 – h. 11.00 – h. 15.00 – h. 19.00) to be able to capture the variability over time of the service, with particular attention to the "soft" hours for which DRT is actually proposed.

The next step is then represented by the actual proposal of a new on-call service: for each area, the main characteristics are specified in terms of locations reached, timetables and booking systems.

Based on the requests expressed by the Mayors in the surveys, the main objectives that each of the proposed solutions offer are reported.

6.3.1 Bargagli

The existing public transport offer in the municipality of Bargagli consisted of the presence of five different service lines (15, 24, 25, 26, 27) which, in particular in the soft hours, did not sufficiently connect the fractions of the municipality with the capital of Bargagli. In the questionnaire, the mayor of Bargagli expressed the need for a better connection between the hamlets of Viganego, Terrusso, Cisiano and Maxena with the capital Bargagli in late afternoon - evening hours: for this reason, a very rigid service model with fixed routes and fixed stops (score of flexibility 1) was assumed in integration to the FT and active from h. 05.00 - 20.00 from Monday to Saturday.

Taking into account the requests of the Mayors, a proposed DRT service intends to connect the fractions farthest from the SS45 with Bargagli capital and with the pole of Genoa to take advantage of long-distance transport lines. In addition, the service reduces the difficulty of accessing mobility for the elderly, students and the disabled.

6.3.2 Ne

The offer of traditional public transport existing in the municipality of Ne consists of three different lines (3, 31, 34). The mayor's objective was to strengthen the existing offer through a better hourly coverage of the service and the introduction of an on-call service for the elderly category. The request of the mayor of Ne was a better connection with the town of Conscienti, home to the main services of the municipality. The centre of Conscienti was thus assumed the ideal interchange hub for passengers residing in the surrounding hamlets.

Thus, an on-call service was proposed which provides for transit through the hamlets of Conscenti, Camminata, Frisolino, Pian di Fieno, Chiesanuova, Casedogana, Pontori, Ne and Castagnola, active from Monday to Saturday h. 07.00 - 19.00. The proposed service presented flexible timetables and routes, with fixed stops (score of flexibility 3): furthermore, this can replace traditional transport line 34.

The introduction of a DRT transport service of this type entails better service coverage in the second morning and early afternoon time slots, as requested by the Mayor. The service allows students to reach school complexes faster.

6.3.3 Rezzoaglio – S. Stefano d'Aveto

The third proposal concerns the largest municipalities of the inner area, namely Rezzoaglio and Santo Stefano d'Aveto. The existing FT lines in the area were 11, 111, 112 and 113.

The municipal areas of Rezzoaglio and Santo Stefano d'Aveto are among the largest in Liguria. Priority requests of mayors were essentially two: on the one hand, to improve the fraction-capital connections for the elderly in the mid-morning time slots, on the other to guarantee a school service to students allowing them to reach the schools of Chiavari and Bedonia (PR) faster than today. The service hypothesis consisted in the connection of the areas of Gavadi, Amborzasco and Ascona to Santo Stefano d'Aveto and of Villanoce, Alpepiana and Parazzuolo to Rezzoaglio: this service, active 05.00 - 20.00 from Monday to Saturday, was planned with score of flexibility 1 (fixed stops and a predetermined itinerary).

An on-call transport service such as the one proposed above provides a greater territorial extension, greater hourly coverage, increased accessibility for the elderly and disabled. This service is also provided through call centre booking the day before.

6.4 The inspection

In conclusion, to testing feasibility of above proposals, on 15 October 2021 a joint inspection was carried out between researchers of CIELI (University of Genoa) and AMT managers in charge of DRT project for the Antola-Tigullio inner area.

This inspection concerned exclusively the routes of DRT transport service assumed for Bargagli, to which was also added the inspection of the Davagna area: this because AMT managers decided that this service area would have been one of the first to test the trial (started on 13 June 2022). Localities of Prato, Viganego, Terrusso, Cisiano, Bargagli, Sant'Alberto di Bargagli, Davagna, Capenardo and Cavassolo were then inspected.

The route of the inspection was chosen by AMT managers to validate on the field the sections of the route that the future on-call transport vehicles must travel in these areas. The meeting place was at the main square of the municipality of Bargagli where it was decided to continue towards the terminus of the urban line 13 in Prato / Genoa to begin the inspection. The Prato / Pian Martello urban stop represents the terminus of the urban line 13, which from Prato (outskirts of Genoa) transports passengers to Caricamento (centre of Genoa) and indeed, it constitutes an interchange point for the extra-urban lines arriving from Antola Valley.

From the Prato / Pian Martello stop, the route started towards Bargagli capital on state road 45: the first detour made it possible to reach the remote hamlets of Viganego (isolated centre), Terrusso (larger centre) and Cisiano (isolated centre) which must be connected to the SS45 and to the capital Bargagli through DRT service.

Given the limited width of the road travelled to reach these hamlets, it is considered necessary to use a rather small vehicle capable of manoeuvring easily.

Route continued towards S. Alberto di Bargagli: the road necessary to reach this hamlet, the SP82, is different from the previous one in width (it is wider and able to accommodate vehicles of standard size) and in residential fabric (presence of numerous multi-family houses).

Planned itinerary continued towards the hamlets of the municipality of Davagna, west of Bargagli. The road to reach Davagna capital from Bargagli is the SS45 (which

changes its name to "SP62" after Bargagli) that turns off into the SP14 at Scoffera deviation: here, after passing the hamlets of Scoffera, Moranego, Sella and Villa Mezzana, vehicles can reach Davagna, the capital. This stretch of road is characterized by rather large dimensions, suitable for standard buses, and the presence of some shops especially near the junction of Scoffera and the capital itself.

After Davagna, the inspection route continued up to the hamlet of Capenardo, rather remote compared to the main road SP14 and reachable by a particularly narrow and impervious road: it seems logical to use a vehicle of small size and able to drive on steep slopes (presence of snow and ice is typical in winter).

The route then descended towards the city of Genoa through the hamlets of Calvari, Mareggia and Maggiolo (SP14) until the centre of Cavassolo, where road becomes steeper up to the city.

Figure 6.7 shows the itinerary of the inspection.

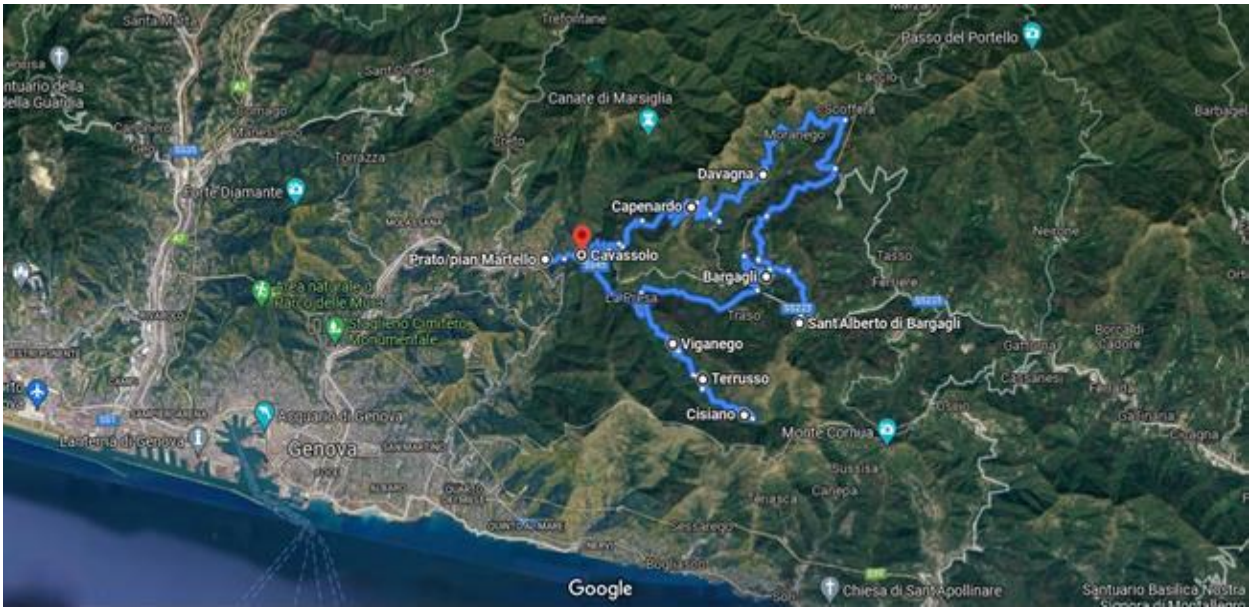


Figure 6.7 Itinerary of inspection conducted

6.5 SWOT analysis

Before the actual experimentation of the on-call service in selected areas of Antola-Tigullio Valley, a workshop was organized between the main project actors: mayors of

the municipalities, AMT, University of Genoa and representatives of ANCI (National Association of Italian Municipalities). Some interesting reflections have arisen from this dialogue.

First, the mayor of Davagna requested the introduction of an additional stop at the hamlet of Paravagna (located along the road that connects the capitals of Bargagli and Davagna): DRT service seems to be the ideal solution to meet the mobility needs of residents of this fraction.

The preliminary meeting also revealed the need, in a subsequent phase to the experimentation and if results would have demonstrated its validity, to extend DRT service to other municipalities in the inner area not taken into consideration in the pilot phase.

Another important issue that emerged during the debate concerned the modelling of an ad hoc DRT service for the tourist category: the satisfaction of the mobility needs of this user group represented one of the main requests for most of the mayors. In the experimentation phase of the project, however, due to the season in which the pilot would have been launched (winter-spring), it was considered a priority to favour the categories of elderly, students and workers residing in the area. A specific DRT service for summer outdoor activities practitioners was postponed to the subsequent stages of implementation of the service.

At the end of the report, it was considered crucial to summarize the main perspectives of the service hypotheses reported using the SWOT analysis tool: to this end, Figure 6.8 shows the main strengths and weaknesses of the proposed DRT services, as well as their opportunities and threats.

INTERNAL FACTORS	
STRENGHTS (+)	**WEAKNESSES (-)**
• Increased accessibility towards the range of "weak" users; • Greater coverage of the territorial and hourly service; • Greater integration of LPT network; • Small size vehicles that travel more easily impervious roads; • Flexibility guaranteed to users entails greater loyalty; • Telephone booking suites elderly users.	• Limited number of municipalities involved; • Quite limited number of vehicles in relation to the extension of the area; • Difficulty in reaching the most remote municipalities connected to the distance of the deposits; • High operative costs of transport; • Long booking times.
EXTERNAL FACTORS	
OPPORTUNITIES (+)	**THREATS (-)**
• The case studies structured allow to have good practices to be replicated also in other contexts; • The vehicles have been funded by the strategy, resources can be dedicated to service management; • The DRT can meet the needs of internal accessibility but also improve connections with the metropolitan network as a whole; • This first trial makes it possible to "calibrate" the service and to make users aware of the new service;	• High marketing and promotion costs to make the service known to as many people as possible, otherwise low adherence to the service; • Poor propensity to change mentality, given the high average age; • Small numbers to support the service, also due to the strong dependence on private cars; • Call Centre mechanism not too user-friendly.

Figure 6.8 SWOT analysis of proposed DRT services

CHAPTER VII

EX-POST EVALUATION OF VAL GRAVEGLIA DRT PILOT RESULTS

7. Ex-post evaluation of Val Graveglia DRT pilot results

AMT has recently launched several on-call transport services ("Chiama il bus") in various territories, some belonging to the inner areas identified by SNAI, such as the one in Val Graveglia (Ne municipality), in the Bargagli and Davagna area and in the territory of Borzonasca (Figure 7.1), and others external to this initiative such as the DRT service operating in Val Brevenna, Recco, Casarza Ligure and Cogorno.

As regards the services of inner areas, this section of the thesis only reports the results of DRT service of Ne (Val Graveglia), representing the first trial launched by AMT in the area (February 14, 2022): data provided by AMT for the reference period 02/14/2022 - 07/19/2022 are studied to carry out an initial analysis of the service performance. For the additional DRT services operating in Bargagli and Davagna area (started on 13 June 2022) and in Borzonasca (started on 3 October 2022), it is still too early to analyse the performance data.

Figure 7.1 Borzonasca DRT's vehicle

Source: photo taken by Author.

This chapter, based on similar studies conducted by Coutinho et al. (2020) and Yen et al. (2023), intends to address the following research question:

RQ5: *"How did the DRT service perform when tested in Antola-Tigullio Valley?"*

7.1 Ne – Val Graveglia (outlying municipality)

The on-call transport service in Ne has been active since 14 February 2022 and presents the characteristics proposed in the previous chapter by report *"Introduction of on-call transport service for the Antola-Tigullio area"* (Table 7.1):

Table 7.1 Ne DRT service characteristics

Service Name	"Chiama il bus"
Service Area	Conscienti, Caminata, Frisolino, Piandifieno, Botasi, Chiesanuova, Casedogana, Pontori, Campo di Ne, Iscioli, Castagnola, Zerli, Statale, Reppia, Arzeno
Service Manager	AMT
Period of service activity	Pilot, from 14 February 2022
Service time slot	Since 22 June from Mon to Sat h. 06.00 – 19.30
Booking system	Via app "SERVIZI A CHIAMATA" or telephone (up to h. 12.00 the day before the ride). It is possible to use "Chiama il bus" also by contacting the driver directly at the Conscenti terminus; every request will be fulfilled compatibly with the reservations previously received.
Cost of service	Same as Fixed Transport

Route	Flexible
Stops	Fixed, same as FT
App availability	Yes

Source: Author's elaboration

Figure 7.2 indicates the Val Graveglia DRT service area, showing the impervious nature of the served context and the proximity to the Chiavari pole.

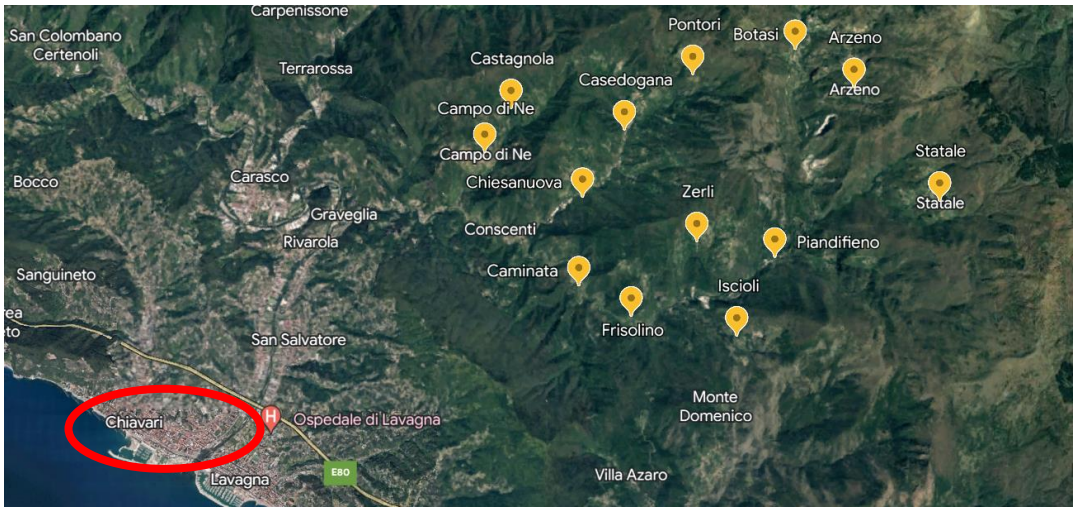


Figure 7.2 Val Graveglia DRT service area

Based on the data provided by AMT (related to the period of reference 02/14/2022 - 07/19/2022), it is possible, as mentioned, to carry out an initial analysis of the operational performance of the service. Below seven parameters are examined one at a time through a brief description and a clarifying graph.

7.1.1 Booking method

Database relating to booked rides distinguishes the origin of the booking (call centre or app) for each day of service activity: the data relating to the period considered (total 499 bookings) show a total use of the telephone booking method (100%) confirming the greater usability of this tool especially for the elderly category.

7.1.2 Ride duration

Data relative to the duration of rides reports for each day of service activity the average duration of each individual trip (min), average length (km) and number of trips carried out.

The average duration and length of trips in the entire reference period are respectively 64 minutes and 24.44 km: these data show the complexity of operating a traditional transport service in rural or mountainous territories. The average duration of the rides (exceeding 1 hour) and the almost 25 km covered each trip testify the need to find an alternative to FT: traditional transport indeed is usually characterized by very shorter trips in terms of time and km travelled.

Data show that vehicles performed 369 trips, covering in total 9,388.46 km.

Figure 7.3 illustrates the number of total trial days where a specific number of trips per day was made: as can be seen from the graph, the number of daily trips with higher frequencies is 1 (23 total days), 2 (25) and 3 (34). These results, at the moment, do not require PTA the purchase of additional vehicles for the execution of the service.

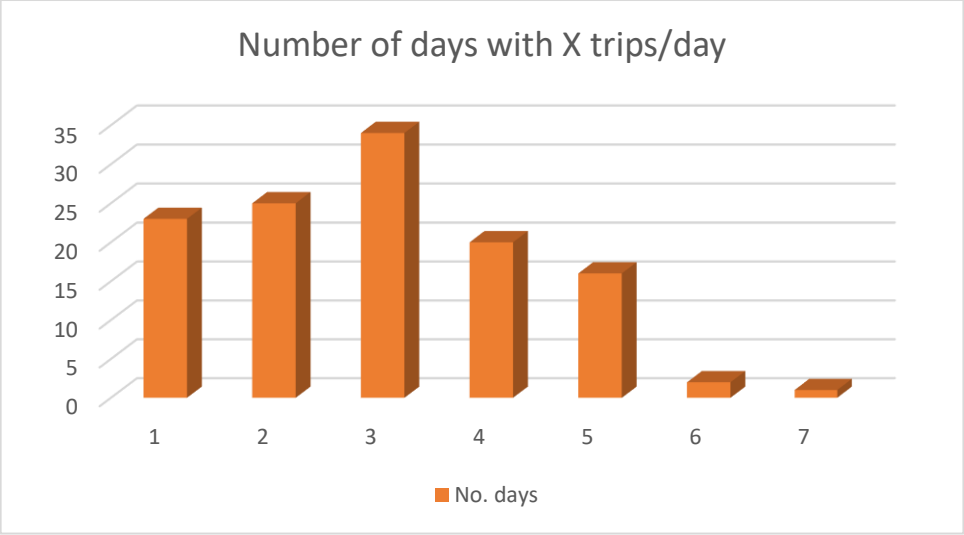


Figure 7.3 Number of days with X trips/day.

Source: author's elaboration based on AMT data (02/14/2022 - 07/19/2022)

7.1.3 Stops frequency of use

The database relating to the stops frequency of use considers the compute of the passengers boarded and disembarked from the vehicle at each single stop every day. In addition, the data relating to the frequency with which each stop is used daily by passengers (both for getting on and off) and the number of passages of the vehicle for that specific stop are reported.

Vehicles stopped at bus stops 948 times in total, boarding 1,114 people (total stops frequency of use).

Figure 7.4 illustrates the frequency of use of each individual stop: "Conscenti Capolinea" is largely the most used stop in the reference period (395 times), amply justifying the mayor's indications to set this location as a strategic interchange point for the whole area.

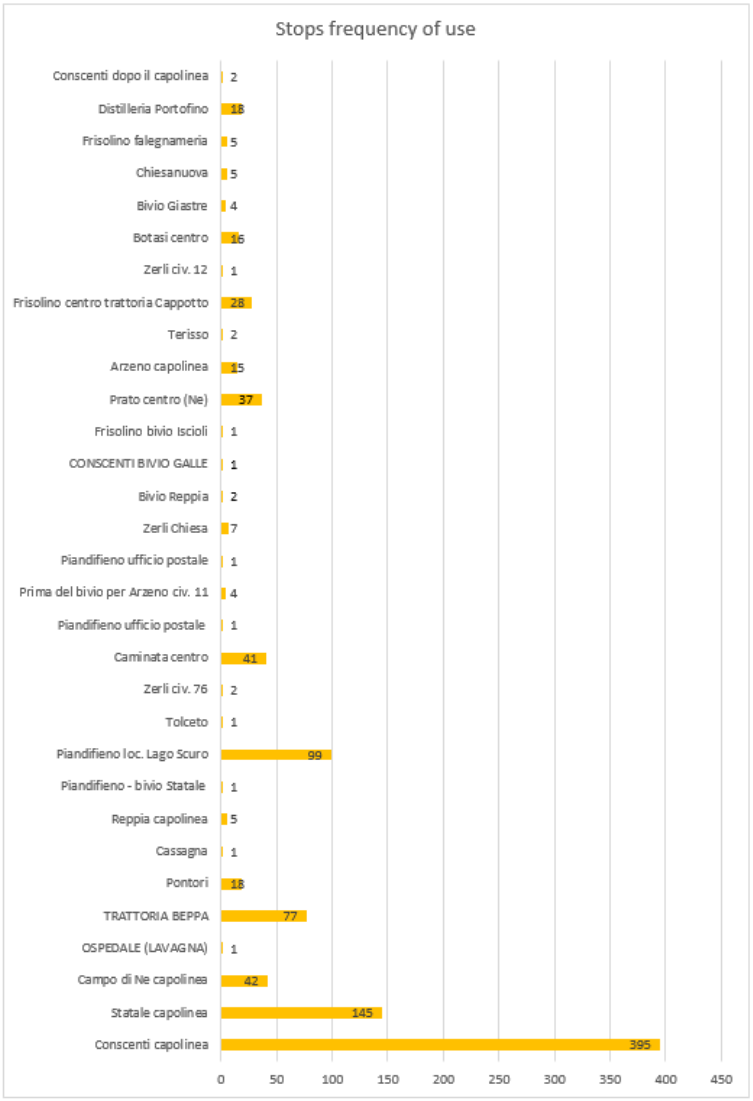


Figure 7.4 Stops frequency of use

Source: author's elaboration based on AMT data (02/14/2022 - 07/19/2022)

7.1.4 Booking requests

The data relating to booking requests received at the call centre (booking method was 100% the telephone) are, in the database provided by AMT, divided for each single day of service activity considering the processing status of the requests and the number of seats booked.

Each booking request can thus be "satisfied" if processed in the system by TDC and accepted by users, "not satisfied" if inserted in the system but not accepted by users and “not elaborated” if not even inserted in the system.

The overall total shows 526 requests received at call centre in the reference period with 540 seats booked: this data indicates that the vast majority of requests were made to reserve a single seat on board.

Figure 7.5 shows that 89% of booking requests received at call centre were correctly processed and accepted by users (“satisfied”). In a residual way, 6% of requests were processed in the system but not accepted by users (“not satisfied”) and 5% were not even elaborated (trip request not operable).

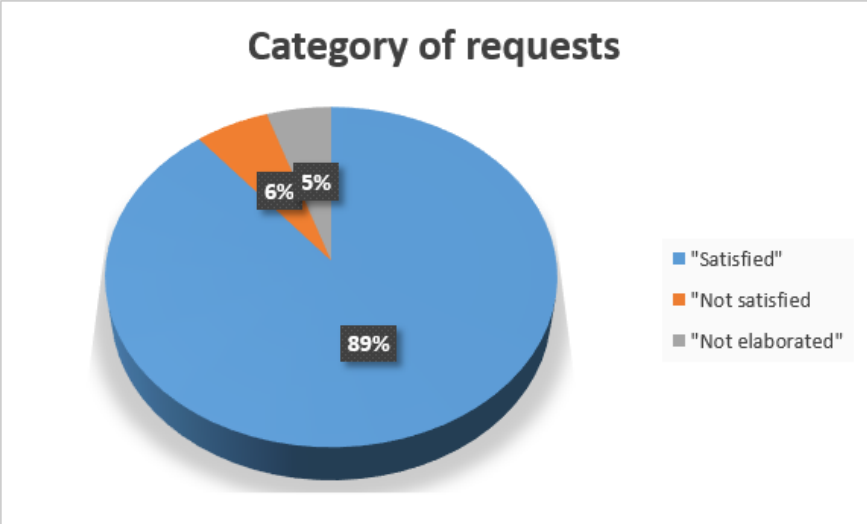


Figure 7.5 Category of requests

Source: author’s elaboration based on AMT data (02/14/2022 - 07/19/2022)

Figure 7.6 shows that three bookings/day was the highest booking frequency (22 service days), followed by 1 booking/day and two bookings/day (18 both). These data demonstrate how call centre, in this scenario, can be efficient even with a few operators able to manage the low amount of bookings/day received.

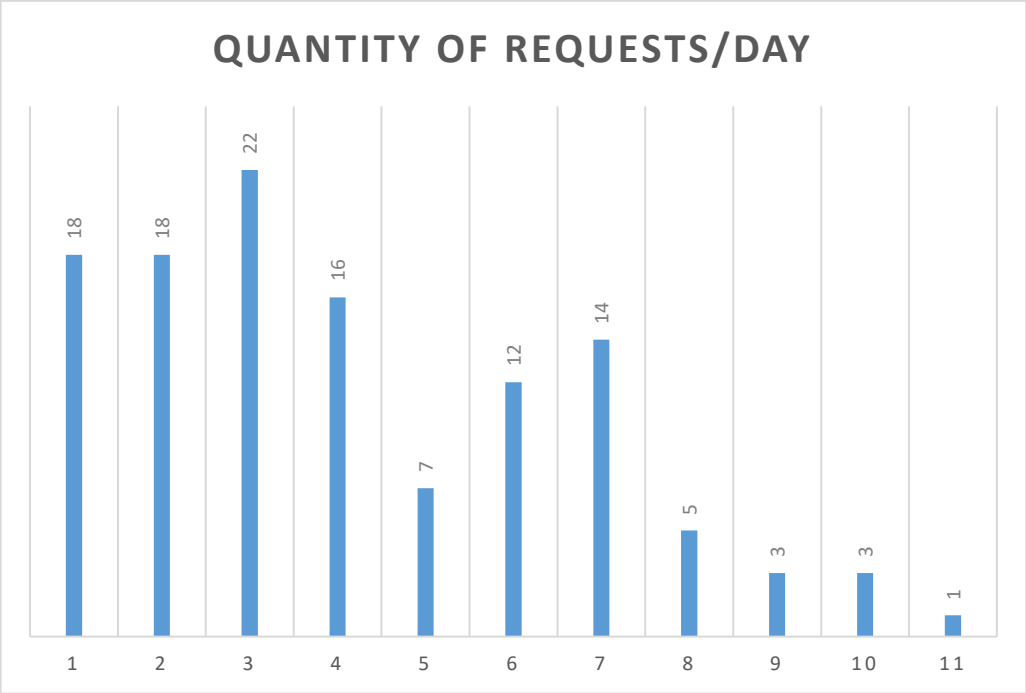


Figure 7.6 Quantity of requests/day

Source: author's elaboration based on AMT data (02/14/2022 - 07/19/2022)

7.1.5 Ride requests

Data relating to travel requests allow to investigate the number of bookings received at the call centre for each day of service and to classify them based on whether they were carried out in advance or on the same day of the ride.

This information is useful for understanding the needs of the population: people who book a ride in advance, typically the categories of elderly, students and workers, have time to plan their regular trips. In most of the cases trips booked on the same day pertain to people who use on-demand transport on an occasional basis. Figure 7.7 indicates that 387 reservations were received at call centre in advance of the day of ride (presumably from the categories of users stated above), while 112 were made on the same day, complicating the service planning process for transit provider.

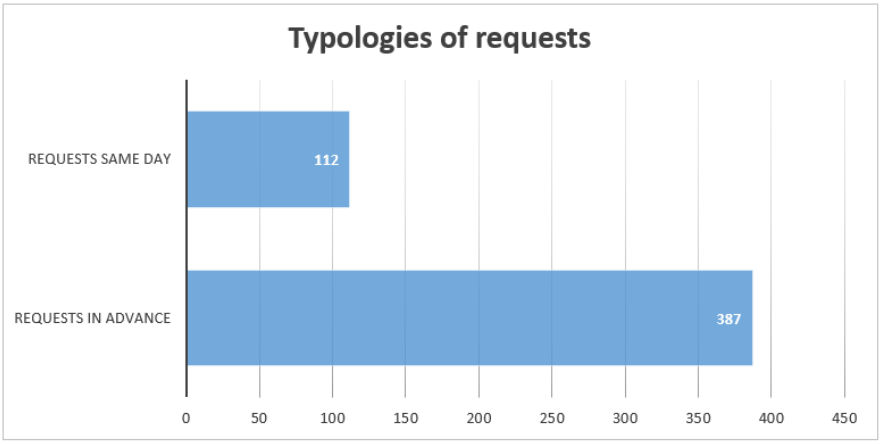


Figure 7.7 Typologies of requests

Source: author's elaboration based on AMT data (02/14/2022 - 07/19/2022)

7.1.6 Service Time

To obtain information about the percentage of use of the vehicles, the availability of the service (number of hours in which the DRT service is operational during the day) is compared with the actual use of the vehicles on that given day.

In addition, daily service time was further divided into service time with passengers on board and total service time (both rides with passengers and rides with no passengers on board to pick them up or to enter/leave the depot). Database shows that service time with passengers on board was 176.19 hours, just over half of the total service time (336.57 hours). Furthermore, total availability of service was equal to 1,552.4 hours with a service utilization rate of 21.7%: such a low utilization rate compared to the total availability of service was due to the AMT decision to create an extended daily service time window (11.40 hours per day until 21 June, then 13.50 hours/day). A time window of this width offers an excellent service to users as it provides maximum flexibility, at the same time it entails a considerable cost for the transport company. In future, based on the data available, the transport provider can reason on the creation of a service time window exclusively tailored to the time slots of highest demand for DRT service. Figure 7.8 illustrates the above.

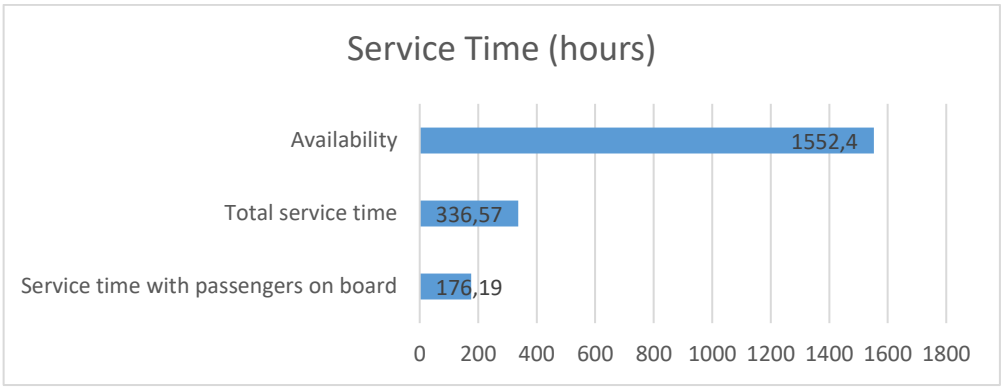


Figure 7.8 Service time

Source: Author's elaboration based on AMT data (02/14/2022 - 07/19/2022)

7.1.7 Users transported

Finally, the data relating to users transported in the period considered indicate 514 passengers in total.

7.2 Concluding remarks

Based on the data provided by local PTA, it was therefore possible to analyse the passengers' travel behaviours and obtain important information about the main performances of the new on-call transport service implemented in Val Graveglia (Ne).

The resulting information framework, observing the operating period 02/14/2022 - 07/19/2022, is that of a DRT service much appreciated by the residents of this area and capable of welcoming 514 passengers since its launch. As expected, given the average age of the population residing in Val Graveglia, one of the key elements of the service was not used at all: people decided to book all their rides through the call centre tool, never using the app made available by AMT. Booking via smartphone application represents an important element for PTAs because it allows them to save personnel costs at the call centre and to manage bookings more efficiently: the fact that no passenger has used this possibility shows decision-makers the great future potential of this service. In this regard, it is necessary to increase the technological knowledge of users and dedicated

training courses, organized at some easily accessible points in Val Graveglia, represent a valid solution: as reported by (Burlando and Cusano, 2014), the elderly of this generation show a natural propensity to use technology that only needs to be stimulated.

The data analysis also indicates that the Conscenti Capolinea stop is the one most used by passengers to get on and off the vehicles of DRT service: the centre of Conscenti owns the main essential services that meet the needs of all residents of the municipal area of Ne and its surroundings. As per the mayor's request, in the report was proposed a DRT service that used the Conscenti centre as an interchange node between the surrounding hamlets and the fixed transport line that connects the municipality of Ne with the poles of the coast (Chiavari, Lavagna, Sestri Levante, etc.). The data show how the questionnaire submitted to the mayors helped in correctly implementing an *ad-hoc* transport service for citizens.

Almost all the bookings received at the call centre (89%) were processed correctly and, after negotiation, accepted by users: given the low number of daily reservations made (3 represents the highest frequency), data justify the presence of a few operators at the call centre, allowing PTA to save on personnel costs, waiting for a total shift, as mentioned, towards the use of app which would eliminate this cost at all.

The data relating to the bookings received in advance of the day of ride show the travel behaviours of passengers: 387 bookings were made in advance and are probably attributable to categories of students, the elderly and workers who have decided to abandon the use of the private vehicle to take advantage of this new service. The relationship between these categories of users and DRT is win-win: on the one hand, passengers can plan their trips in time and on the other, by booking trips in advance, PTA can better organize the rides to make them as efficient as possible. 112 reservations made on the same day of the ride are in any case attributable to a good number of people who decide to use DRT service on an occasional basis: these people have hardly already decided to entrust their trips exclusively to public transport, leaving out car which, as König and Grippenkoven (2020) report, still represents one of the main barriers to the adoption of DRT. Finally, as mentioned, such a low rate of effective use of vehicles (21%) is indicative of an excessively large time window aimed at favouring users by granting them maximum service flexibility: on the basis of the data obtained from this trial, and

from others to come, PTA, in order to save money and energies, can tighten this service window calibrating it perfectly on the travel needs of users.

CHAPTER VIII

CONCLUSIONS, RESEARCH LIMITATIONS AND FUTURE AGENDA

8. Conclusions, research limitations and future agenda

8.1 Statement of contributions

Starting from the assumption that the characteristics of DRT in rural areas have received little attention in the academic literature, this thesis seeks to make multiple contributions to the research in this area by examining the global context, outlining the state of the art in Italy, and analysing the efficiency of a specific local case study. The thesis employed four different methodologies to achieve these goals: international academic literature analysis; cataloguing of rural DRT services in Italy; distribution of a survey to the mayors of the municipalities of two Ligurian inner areas; and data analysis of DRT pilot results in such regions.

Thus, this work contributes first to the enrichment of the scarce literature on the subject. Secondly, the process of cataloguing the rural DRT cases in Italy, based on the collection and comparison of the essential characteristics of the services (booking method, trip duration, frequency of use of stops, booking requests, trip requests, service time, users transported), provides a classification method that can also be exported to other study contexts and is useful for understanding the digital maturity and the degree of flexibility implemented. Finally, the responses of the mayors of the inner areas involved in the DRT project and the analysis of the trial performance provide further information on the strengths and weaknesses of this tool and its potential.

8.2 Concluding remarks and future agenda

As stated in the introduction of the PhD thesis, several critical issues in this era impose deep reflections to policy-makers about the transportation system, both in urban (congestion of roads, climate-changing emissions, noise pollution, most of public soil occupied by cars, minimal space for pedestrians, heat islands, etc.) and rural context (economic marginalization of the population, social isolation, depopulation of entire territories due to a scarce and inefficient transport offer, preference for car use). On-call

transport, as observed in the thesis, seems to be one of the possible valid solutions to the problems affecting mobility today.

This PhD thesis deliberately left out critical issues of the transport system in cities, already widely covered in the academic literature, to focus on DRT service in contexts characterized by low transport demand and scarce population density, still understudied by researchers. The first two chapters of this work have provided useful indications for understanding the need of developing an alternative form of public transport to FT in order to meet mobility needs of population residing in areas difficult to access, sparsely populated and many kilometres away from the main inhabited centres.

Currently, citizens of these areas are forced to use their own cars or motorcycles for daily travel due to a scarce public transport offer unable to satisfy their needs: this happens because of the characteristics of these territories that make the provision of traditional transport service economically unsustainable.

In order to push people to abandon the use of private means of transport in favour of a new form of mobility, with clear environmental and economic benefits, it is for PTAs first of all necessary an in-depth analysis of the transport demand to understand population's segmentation and travel attitudes: this allows to create an on-call transport offer operating in the most requested time slots and addressed to specific user targets.

The analysis of literature review made it possible to study various cases of application of this technology and to understand the reasons behind the numerous failures (RQ1): it was found that although technological progress is strongly linked to the diffusion of DRT service, to greater technological complexity correspond high costs for the PTAs. The will of policy makers to offer citizens the greatest possible service flexibility ("many-to-many" model) collides with the economic unsustainability that this entails for PTAs: for this reason, out of the 35 rural DRT cases studied in chapter IV, none of them presented characteristics of this type. Literature also showed that, in the service-planning phase, an in-depth analysis of transport demand turns out to be a key element to avoid providing excessively onerous services. Furthermore, marketing activity through digital and analogue channels also proves to be of primary importance to allow even the elderly, who typically do not use social networks and represent the predominant share of the population in these territories, to get to know the initiative.

The study of the costs associated with on-call transport provided interesting indications: the main cost item is represented by the cost of labour, followed at a distance by the purchase cost of the transport service. Both of these cost items, based on a careful analysis of the transport demand, can be decreased over time by PTAs: the cost of personnel, as regards the staff of TDC, can be eliminated by encouraging the use of app as a booking tool (removing the need for physical operators at the call centre). Furthermore, in the future the development of driverless vehicles will be able to completely eliminate this cost item which represents the main obstacle to the diffusion of DRT service.

The rationalization of service can instead be obtained through a better adaptation of the time windows of service operation to the travel behaviours of residents. The analysis of data relating to users' travel attitudes is crucial in correcting this element and thus reducing costs.

The study conducted in chapter IV through a web search, the vision of the Framework Program Agreements of the Italian Regions and sector agencies' websites, investigated the main technical characteristics of the 35 DRT case studies identified.

From a purely technical point of view, the DRT services were compared under various aspects: the methods of booking, the cost of the ticket (in most cases it coincided with the fixed transport ticket), the flexibility of routes (with "flexible" prevalence) and stops (with "fixed" prevalence), service models and the availability of DRT dedicated apps.

In terms of innovation, particular attention was paid to three aspects: booking options provided by PTAs, flexibility of the service and availability of DRT dedicated apps.

The results of the analysis showed that the call centre tool remains the most widespread booking option in Italy: moreover, to contain costs, most of the PTAs investigated usually offer one, at most, two booking tools (rare are cases with more than two options).

This result confirms what was already stated in literature several years ago, demonstrating how technological innovations always need time to find full affirmation.

Laws et al. (2009), conducting a study on DRT systems in England and Wales, also found that the telephone tool (call centre) represents by far the booking option most offered by PTAs. In second place was the combination “Telephone/hailing at bus stop” (in Italy replaced today by Telephone/App), while bookings via web and telephone messages was rather low (as is still the case in Italy today). Furthermore, similarities are also recorded in relation to the number of booking methods offered: as in the current Italian rural context, even in the British panorama of more than a decade ago, PTAs tended to offer, in order to contain costs, one or at most two booking tools (mostly "Telephone", "Phone and hail at bus stop", "Phone and internet"). It should also be noted that the combo "Phone, internet, hail" was significantly applied in the British context.

In this regard, it should be highlighted that, thanks to the technological development of recent years, the possibility of booking rides hailing at the stop has been eliminated in almost all of the DRT applications: operative centre must receive reservations in advance of the time of the ride in order to allow the dedicated software to plan and optimize vehicle trips.

In response to RQ2 and RQ3 the following are the most relevant results. Service models most adopted by Italian PTAs revealed to be those characterized by an average degree of flexibility (26 cases with flexible routes and fixed stops), indicating how the more flexible models are too expensive in the absence of high public funding.

The applicability of a totally flexible DRT service in rural context (German Oberharz area) was studied by Sörensen et al. (2021): the results of the analysis confirmed the difficult applicability of a door-to-door service model in low demand areas also from a technical point of view, suggesting in that case the use of the on-call service as only feeder tool for fixed transport.

Finally, the development of dedicated apps is growing, but still concerns a small part of PTAs (37%). Abdullah et al. (2021), who studied the Pakistan case, conducted an analysis confirming the greater worldwide diffusion of app-based for public transport.

Regarding the political vision and the concrete measures adopted by the public entity to address the critical issues of inner areas, chapter V of this work provides some important answers. The Italian government has demonstrated its willingness to remedy to

social and economic isolation affecting residents of inner national areas through the adoption, in 2014, of the "National Strategy for Inner Areas". This political measure, part of a wider European initiative, had the objective of halting the depopulation process and creating value for these areas. From the political plan, concrete actions to be implemented in the context emerge, such as a rationalization of health facilities (merger of many small clinics into a few large ones able to provide basic assistance services, increase the diffusion of first aid tools in the area, develop telemedicine, etc.), a better scholastic offer (better distribution of institutions, more stable contracts for teachers, carrying out school activities related to local culture and traditions, etc.) and a renewed offer of mobility (investments in current transport infrastructure and experimentation with innovative forms of mobility).

RQ4, useful for understanding the main characteristics of the territory and of population in which DRT service trial takes place, is answered in chapter VI of the thesis. The reference context shows a typical scenario for inner areas: majority of the elderly population, generally low digital maturity, difficulty in accessing the more inland municipalities and greater road connections for the municipalities closest to the coast and large inhabited centres, scarce presence of essential services especially in smaller municipalities, highly developed commuting particularly for students and workers, strong need to develop the tourist service and to transport additional items such as food, mail and medicines.

From the analysis of the results of the first months of experimentation of the DRT service operating in Val Graveglia (Ne), conducted in chapter VII, policymakers can learn important information (RQ5): the trial was positive overall, attracting numerous users who decided to abandon the use of cars in favour of the new DRT service, such as to justify the permanence of the service even after the pilot.

Furthermore, population of these areas consists mainly in elderly people not familiar with the use of technology, proposing thus the app as only booking option can represent a major problem for the effectiveness of the service. PTAs should thus insist on the use of the call centre as the main booking tool but, at the same time, stimulate residents to adopt technologically advanced booking methods (app or website) through dedicated training courses.

This PhD thesis inevitably presents some research limitations and future agendas.

The analysis, conducted in chapter IV, of rural DRT cases concerned only the services operated in Italy since 2010: this allowed to clearly understand the main characteristics of DRT services in low demand areas of this country. A broader future study, at European level, could be conducted aimed at comparing, in rural contexts, the strategic decisions of PTAs and the different travel needs of citizens on a larger scale. As regards the study of results of DRT service implemented in Val Graveglia (chapter VII), it was possible to access only partial data referring to the first 5 pilot months: in the future the analysis could expand to the other on-call services implemented by AMT in the province of Genoa and, on the basis of data referring to longer periods of service, it would be possible to obtain more robust and reliable indications on the travel behaviour of the population and on strengths and weaknesses of the service.

In conclusion, having established the viability of on-call service as a substitute for FT in low-demand areas, transit providers must find the ideal compromise between two opposing viewpoints: on the one hand, the provision of an economically sustainable service, which, however, only gathers a small number of users due to the medium-high cost of transportation and the strong rigidity of the service. On the other hand, a transportation service that is unprofitable but aims to meet customer demands by offering inexpensive tickets and the most possible flexibility in terms of service ("many-to-many" model).

Currently, a median solution appears to be the cornerstone for an effective deployment of DRT in rural areas, as the behaviour of PTAs detailed in chapter IV attests: the capacity of technical advancement to significantly reduce transportation and technological equipment costs, enabling more flexible and customized services, will be crucial for the future of this tool.

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APPENDIX

QUESTIONNAIRE OF MAYORS

STRATEGIA NAZIONALE AREE INTERNE
“ANTOLA-TIGULLIO inner area”
"DRT" public transport service

(action 4.5)

SURVEY WITH THE MAYORS OF THE MUNICIPALITIES OF THE AREA

Introduction

As part of the 2014-2020 regional cohesion policy, particular attention - as a tool for the development of the entire country - was paid to the so-called “inner areas”.

The national strategy for the development of inner areas has the dual objective of adapting the quantity and quality of education, health, mobility (citizenship) services and promoting development projects that enhance the natural and cultural heritage of these areas, also focusing on local production chains (market).

With reference to the improvement of mobility services, the Liguria region has envisaged the planning and testing of an "on call" bus service, involving ATP as the operator.

So-called "On call" Collective transport allows to maintain and improve public service obligations, strengthening the distribution network that meets the needs of mobility in the "weak demand" portions of the territory.

The "on call" service therefore makes it possible to strengthen the "Complementary Service" strategy, that is the secondary service that guarantees the widespread transport offer:

✓ improving the territorial "coverage" of LPT (coverage of travel needs in the local area)

✓ maximizing the "social function" of the LPT.

This type of service in rural and low population density areas has a strategic value: it is a service mode defined as "flexible" precisely because of its ability to adapt to the characteristics of demand. Each trip is built based on departure/arrival times and at the points of Origin (O)/Destination (D) as requested by the users served.

Therefore the intervention is aimed at experimenting a transport system on individual demand, that is a transport service on request or Demand Responsive Transport (DRT), which can also constitute a model that can be replicated on several areas of the Liguria region.

In order to better design and implement the service,

We kindly ask you to help us understand better

the characteristics of your territory and of the people who live there

through the following questions.

You are free to detail the answers as you believe, also attaching any documents and figures, if useful.

1. Your municipality represents a rural territorial context with low population density.
   In areas of this kind, it is often difficult to organize a widespread public transport service corresponding to the citizens' needs.
   How would you describe **the current situation of your municipality**?

   Population (number, age, professional and economic conditions, etc.):

   ……

   ……

   ……

   ……

   Accessibility (to and from the outside):

   ……

   ……

   ……

   ……

   Services (offered in the territory of the Municipality; accessibility to other centres where they are offered):

   ……

   ……

   ……

   ……

2. Some categories of users may find it difficult to meet their mobility needs for reasons of location (inhabitants of the hamlets), lack of their own means (elderly and young people), etc.

   In his opinion, what are the categories of users who are most affected by difficulties in mobility in your Municipality and what are the time slots where the lack of a local public transport service is particularly felt?

   ……

   ……

   ……

   ……

3. What are the interventions relating to the LPT offer that within your Municipality could be perceived as a priority (routes / stops / services)?

   ……

   ……

   ……

   ……

4. Could you indicate from/to which origins/destinations (interchange nodes such as other terminus and railway stations, clinics, school centres, sports and shopping centres, etc.) the on-call services could be more useful?

   ……

   ……

   ……

   ……

5. Do you think there are **private entities in the area who could collaborate** with the public transport service, guaranteeing mobility to other citizens as well? (modalities, routes, etc.)

   ……

   ……

   ……

   ……

6. What **other transport services** besides people could the bus guarantee (medicinal products, mail, foodstuffs, etc.)? On which routes?

   ……

   ……

   ……

   ……

7. Are there possible innovations in the service ("shuttles", “stops”, etc.) that could be taken into consideration for a **possibly increased use by tourists**? And why?

   ……

   ……

   ……

   ……

8. How do you judge the availability/propensity of the inhabitants to use info-telematic technologies (smartphones, computers, applications, etc.)?

   ……

   ……

   ……

   ……

9. Do you have **any further indications** that could help to define the type of "flexible" LPT service best suited to your territory?

   ……

   ……

   ……

   ……

Questionnaire completed by the Municipality of …

Please indicate the person to contact for any clarifications:

- Name: ……
- Mail: ……
- Telephone: ……