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Demand Responsive Transport in Italian rural areas: state of the art of technical characteristics and level of innovation of 35 case studies

Transporte a Demanda en las zonas rurales italianas: estado de la cuestión sobre las características técnicas y nivel de innovación en 35 casos de estudio

Tiziano Pavanini
tiziano.pavanini@edu.unige.it 0000-0001-8709-3710

University of Genoa. Via Francesco Vivaldi, 5. 16126 Genova, Italy.

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ABSTRACT

In recent years there has been a gradual depopulation of rural areas due to a limited supply of essential services: consequences of this are general ageing and marginalization of the resident population.
This paper intends to focus attention on Demand Responsive Transport (DRT) as a solution to public transport issues in these territories: for this purpose, through web research by keywords and the analysis of Regions' Project Framework Agreements and sector agency websites, 35 rural DRT services implemented in Italy have been identified to analyse their technical characteristics and status of technological innovation.
In order to compare DRT services within the same historical and technological context, the study focused on case studies implemented from 2010 onwards: the results obtained were then classified based on the distance from major centres (outlying, intermediate and peripheral/ultra-peripheral areas) with the addition of a fourth category pertaining to extra-urban tourist services. Selected DRT services, evaluated on the basis of their main technical characteristics (booking system, service cost, itinerary, stops, app availability), were then assigned a respective flexibility score based on the service model used.
The results show that achievement of the highest service flexibility levels is possible only through huge public funding (74% of the DRT cases analysed show an average degree of flexibility), the ticket cost of DRT services must be limited (in 49% of cases is equal to the cost of traditional public transport) in order to attract users, most of the transit providers offer only one booking option to reduce costs and the use of innovative booking tools is still limited.

PALABRAS CLAVE

Transporte a Demanda (TAD)
Zonas de baja demanda
Zonas rurales
Servicios a demanda
Transporte público

RESUMEN

En los últimos años se ha producido un despoblamiento progresivo de las zonas rurales debido a la escasa oferta de servicios esenciales: las consecuencias de ello son el envejecimiento generalizado y la marginación de la población residente.
Este trabajo pretende centrar la atención en el Transporte a Demanda (TAD) como solución a los problemas de transporte público en estos territorios. Para ello, a través de la investigación en la web y el análisis del Marco de Acuerdos de Proyectos de las Regiones, se han identificado 35 servicios rurales de TAD implantados en Italia con el fin de analizar sus características técnicas y su estado de innovación tecnológica.
Para comparar los servicios de TAD en el mismo contexto histórico y tecnológico, el estudio se centró en estudios de casos realizados a partir de 2010. Los resultados obtenidos se clasificaron en función de la distancia desde los principales centros (zonas d'hinterland, intermedias y periféricas/ultraperiféricas), con la adición de una cuarta categoría relativa a los servicios turísticos extraurbanos. A los servicios TAD seleccionados, evaluados en función de sus principales características técnicas (sistema de reserva, coste del servicio, itinerario, paradas, disponibilidad de la aplicación), se les asignó una puntuación de flexibilidad respectiva basada en el modelo de servicio utilizado.

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Correspondencia autores: tiziano.pavanini@edu.unige.it (Tiziano Pavanini)

Los resultados muestran que la consecución de los niveles más altos de flexibilidad del servicio sólo es posible a través de una enorme financiación pública (el 74% de los casos de TAD analizados tienen un grado medio de flexibilidad), el coste del ticket de los servicios TAD debe ser limitado (en el 49% de los casos es igual al coste del transporte público tradicional) con el fin de atraer a los usuarios, la mayoría de los proveedores de transporte ofrecen solo una opción de reserva para reducir los costes y el uso de herramientas innovadoras a la hora de reservar estos servicios es todavía limitado.

1. INTRODUCTION

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 areas are characterized by a significant distance separating them from major centres where essential services such as education, health and mobility are provided. Given the complicated accessibility to essential services, people residing in these areas, in particular students and families, have preferred over time to move to neighbouring centres: this migratory trend, still evolving, involves the progressive abandonment of inner areas and the natural ageing of the population that decides to remain (Carrosio et al, 2018; Arlotti & Cerea, 2021).

The phenomena of migration and depopulation that characterize inner areas have impacts of different natures: 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 (Acierno, 2015).

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 & 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 the abovementioned trends and creating value for these territories.

Of the three cornerstones of this strategy, namely renewing the supply of healthcare, education and mobility (Punziano, 2019), this article intends to focus attention on the latter element.

The complicated accessibility of these areas, often characterized by narrow streets and steep slopes, makes transport particularly complex from both the point of view of public transport authorities (PTAs) and residents (Bacci et al. 2021).

Inner areas are defined as low-demand areas (LDAs), portions of territory (urban or interurban) with "low or medium-low demand for transport and characterized by a considerable spatial and temporal dispersion" (Campis et al., 2021) the traditional line transport provides for a very low load factor of vehicles, effectively making public transport management in these territories often economically unsustainable.

As a consequence of this, in order to contain costs, the level of public transport service offered by PTAs is often scarce due to the few daily rides in operation: this scenario involves greater use of private vehicles for residents with driving licenses and social marginalization for those who cannot move independently (in particular students and the elderly).

Rationalization of public transport thus becomes urgent and necessary to guarantee social inclusion, fair accessibility to essential services and at the same time to reduce the use of private vehicles with positive effects on the environment.

To cope with the above, new forms of public mobility other than traditional transport have been experimented at both urban and rural levels for years. PTAs, aiming at reducing operating costs through the study and experimentation of different services, lines, vehicles and business models, assume thus the role of leader in the field of innovation, also improving their corporate image in the eyes of customers.

The technology of Demand Responsive Transport (DRT), or on-demand transport, is configured as the most suitable tool to meet all aforementioned needs: unlike traditional public transport, it consists of a very customizable transport service provided only in presence of reservations (Mageean & Nelson, 2003; Burlando et al., 2021).

Having to compete with private vehicles, in order to discourage their possession and use, DRT services must represent an economic opportunity for citizens: this form of mobility is a compromise between the characteristics of comfort and flexibility typical of private vehicles and taxis and the economic convenience of public transport (Brake et al., 2004).

Academic literature analysed urban and peri-urban DRT services in many articles but still little is found at the rural level: this study intends to focus its analysis on this latter area, highlighting the degree of innovation and flexibility of Italian rural DRT services.

Research questions that this paper intends to address are the following:

> "How do transit providers intend to structure their on-call transport service offer in rural areas? What is the level of technological maturity reached by this tool?"

To answer that, this article conducted an in-depth analysis of all rural DRT cases implemented in Italy in the last decade, investigating qualitatively their characteristics: methodologically, each case study has been identified through a web search by keywords and the vision of the Project Framework Agreements[1] (PFAs) of Italian Regions and sector agency websites.

This paper has five sections. The introduction of this analysis frames the challenges afferent to Italy's inner areas and states the importance of the on-demand transport tool as a possible solution to the mobility issues of these territories. The second section, "Theoretical background", provides first a literature review on rural DRT services and then describes the "Italian National Strategy for Inner Areas" tools and objectives. The section "Methodology" states the procedure used in this research to identify rural DRT services implemented in Italy: it describes the main characteristics of services selected and the criteria for assigning the degree of flexibility to different service models. The "Results" section shows the results of this analysis and the final paragraph "Discussion and conclusions" presents the discussion of results and highlights the contribution to the research, suggesting implications for PTA management and reporting the limitations and the future research agenda.

2. THEORETICAL BACKGROUND

2.1. Literature review

Despite the numerous benefits that DRT provides both for the community and for PTAs adopting this technology, it still remains underutilized and (König & Grippenkoven, 2020) have decided to analyse 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.

1. The Framework Program Agreements are instruments of cooperation between Regions, local authorities and government ministries: by signing this document, they are bound to the achievement of the objectives established in the "National Strategy for Inner Areas".

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The results of the model demonstrated that the psychological factor most impacting passenger behaviour choices is first of all "Performance Expectancy", i.e. the level of how much an individual believes that the use of a given system can be useful for realizing his own purposes (Venkatesh et al. 2003). Other two key factors revealed to be "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 demonstrated how "Performance Expectancy" factor represents the decisive element behind users' usage choices: if consumers have clear in mind the advantages and possibilities of DRT technology, they will be incline to use it. This demonstrates the importance of marketing policies: Local Public Transport (LPT) companies that intend to exploit DRT system 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 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, the results of the work conducted by authors, consequence of the application of an ordered logit model to a survey conducted in the region, showed that males tend to use DRT more when they retire than in their working years: this data opens the door to a new segment of potential market.

Dytckov et al. (2020) assumed that a valid analysis of DRT transport demand, aimed at correctly estimating the potential requests, it is of central importance in implementing a service of this kind.

Based on the above, the authors proposed a model for assessing DRT services and proved its validity by applying it to real cases of two small towns in rural southern Sweden characterised by public transport problems (towns of Sjobo and Tomelilla).

Other studies aim at helping PTAs management and Municipal administrations by providing valuable evaluation tools that can influence the decision of whether to invest in DRT technology or not: 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 through this work was the following: how does a public transport authority evaluate the implementation of a DRT service to supplement or replace some traditional transport lines? According to the authors, the answer to this question consisted of four successive steps that PTAs must follow: first, it is necessary to identify the specific area most in need in which to invest resources. After selecting the area of interest, it is necessary to determine the typology of service model and the transport characteristics that want to be offered through DRT service. The next step concerns the identification of the most appropriate evaluation method for the specific case and finally the definition of the success or failure investment threshold in order to assess whether the intervention can be sustainable or not.

To complete each step PTAs must collect inputs and data in order to answer the above question. These four steps have been then grouped, by authors, into a single framework ready to use for every transport authority.

In literature can be found several comparisons between Fixed Transport (FT) and DRT (Papanikolaou & Basba, 2021; (Navidi et al. 2018; Diana et al. 2009b; Diana et al., 2007a)

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 DRT service compared to traditional public transport.

After describing the historical evolution of DRT technology and having collected some notable examples at a global level, the authors focused on a rural case study close to the city of Amsterdam. The object of analysis was in particular an urban mobility project, which included, from December 2017 and for the duration of one year, the replacement of the rural traditional public transport with an on-demand service, calibrated to the real needs of local residents.

Based on the characteristics of poor accessibility and connection with the rest of the city, two rural areas were selected in which to test the pilot project "Mokumflex". In the Amsterdam Zuidoost and Weesp districts, the DRT service integrated line 49, which already served those areas, while in Amsterdam Noord

the innovative service (operative from February 2018 to December 2018), completely replaced the two previously active traditional transport lines.

The authors made a careful comparison between FT and DRT, by analysing the respective characteristics of the fleet, operating frame, headway, stops and fares. Results of this study showed that DRT "ridership of means of transport" decreased compared to the levels of traditional transport (from 78.1 passengers/day to 15.9 passengers/day) but at the same time, the "passenger-km" factor decreased even more (from 1,252.8 km/day to 136.6 km/day) as a result of a taylor made service adaptable to specific users' needs. Therefore, despite a reduced ridership rate, DRT service allows PTAs, thanks to a smaller amount of total km/day travelled, to incur lower costs and produce fewer harmful emissions.

Following the success of the trial in 2018, the 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: authors stated that DRT service is never considered and evaluated as a stand-alone service but always jointly with fixed transport. According to this, they decided to build a dedicated DRT assessment framework able to provide PTAs with the Key Performance Indicators (KPIs) useful for understanding the degree of success of a possible DRT service implementation within their transport network.

The assessment framework proposed consisted of three distinct sections. The first concerned the characteristics of DRT system including key factors such as the coverage and routing of the service, operating hours, technical characteristics of the vehicles, technological booking method adopted and, lastly, passengers' request acceptance criteria.

The second section, relating to the operational characteristics of the service, mainly consisted of two indicators: "usage of DRT" and "performance of DRT". The first is related to travel demand and specifically included indicators such as "journey distance", "spatial usage" and "temporal usage", while the second concerned two aspects such as "generalized journey time" (GJT) and "share of declined trips".

The third section presented three accessibility indicators divided as follows: comparison of DRT service with active transport modes (such as walking and cycling), with long-distance transport and with traditional transit.

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

Results of this work showed that DRT lines present a reduced general journey time compared to FT: the analysis was also able to indicate which areas showed a GJT greater reduction compared to others, thus indicating PTAs where to invest more. This study allowed policymakers to decide whether to implement the 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 at the University of Malta. In Malta, a small country in the centre of the Mediterranean Sea divided into 3 islands (Malta, Comino and Gozo), the problem of mobility is quite significant as, according to (EUROSTAT, 2016), it is the third country in Europe for number of cars per 1000 inhabitants. 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 reach it by 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 the service was good. The authors, therefore, decided to plan a DRT service that would allow reducing the number of cars reaching University every day, contrasting road congestion and environmental pollution. The authors conducted nine trials in just three days (using real vehicles but simulating the transport demand) in order to evaluate the performance of the 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 one of traditional transport. 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 students' appreciation revealed a good chance of success.

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The technology of on-call transport service is not only applicable to the transport of people from an origin to a destination but it can also be experimented in other contexts. For example in rural areas with great distance and isolation from urban centres, some essential services such as medical visits (Sörensen, 2021) can be particularly complex to be satisfied for the resident population.

For this reason, since 2017 in Germany (in prototype form for the first 2 years and then as a real service) is operative an "on-call medicine" service called "Medibus" (Heeser, 2019). Deutsche Bahn group, in collaboration with technology provider Cisco, created this service: based on user requests the vehicle moves around in rural areas of the German Hesse Region to "bring" basic medical visits directly to citizens.

This innovative service is particularly important as in many rural areas around the world, and specifically, in Germany, the elderly residents are forced to travel tens of kilometres to reach the nearest clinic. This happens because of the phenomenon in which many doctors have retired and have not been properly replaced by young generations (Hirsch & Fredericks, 2001).

In 2020, there were a total of 7 "Medibus" vehicles moving around the entire Hesse region (6.2 million inhabitants). Each vehicle is 12.7 m long (supplied by the Dutch coach and bus Company VDL) and it is equipped with all the infrastructures and instruments typical of an ordinary doctor's office: waiting room, consultation room, laboratory with refrigerating cells capable of reaching very frigid temperatures. In terms of energy, each bus uses 16 solar panels placed on the roof capable of supplying energy to the on-board instruments that require it (such as the air conditioning system and refrigerators): this leads vehicles to be energy self-sufficient. In rural areas, internet connection can sometimes be difficult: these vehicles are thus also equipped with integrated dual-sim routers in order to guarantee a stable connection. Good internet is crucial having doctors on-board sometimes to connect directly with remote specialists through so-called "telemedicine" consultancy. Since 2020, "Medibus" has been used above all to deal with Covid-19 cases both for patient visits and for vaccinations (Schumacher, 2020).

Examples of this kind can be found in other rural European contexts where the lack of doctors is becoming a serious problem for local communities: for example, following the German case, also in the French Auvergne-Rhone-Alpes Region an on-demand transport bus equipped with all medical facilities, called "DOK ICI", is active (DOKICI, 2018).

The same is beginning to be glimpsed even outside the old continent: in 2021, a camper was used by the French NGO "Médecins du Monde" with very similar characteristics to "Medibus" in the metropolitan area of Tunis to help especially homeless people (MedicinsDuMonde). The same type of vehicle is often used by the same NGO also in other contexts of war or natural catastrophe (for example in Lombok, Indonesia, during the 2018 earthquake).

2.2. Italian "national strategy for inner areas: definition, objectives, tools and governance"

Inner areas are generally characterized by reduced accessibility to essential services and by territories abundant in remarkable cultural and landscape heritage. Furthermore, these areas are strongly distinct from each other, making it virtually impossible to apply generic laws not calibrated to the specific context (Borghi, 2017).

The condition of inner areas does not concern only Italy but all of Europe (Copus & Hörnström, 2011): for this reason, the European Commission (EC) has promoted a series of common cohesion policies aimed at offering the communities residing in these areas greater social inclusiveness and economic prosperity.

At the basis of the reasons that push EC to these actions is art. 174 of the Treaty of Lisbon which states that, through the development of actions aimed at increasing territorial, economic and social inclusion, the European Union (EU) must commit itself to make homogeneous the levels of development of the various European Regions (Marek & Baun, 2014).

The EC thus introduced the "Cohesion Policy Program 2014-2020" for this purpose: each member state could finance specific projects through the European structural and investments funds (ESIF)[2].

Italy, on 9 December 2013, thus presented to the EC the draft of "Italy's Partnership Agreement on Cohesion Policy for the period 2014-2020", containing the strategies and procedures with which each Member State intended to address the objectives of social, territorial and economic cohesion promoted by the European Union, through the use of ESIF funds.

Together with this draft, Italy also submitted to the EC a technical document entitled "National strategy for inner areas: definition, objectives, tools and governance" (hereinafter "SNAI", from the Italian definition of "Strategia Nazionale Aree Interne"): it analysed in depth the situation of Italian inner areas, describing the state of the art and development strategies (Cotella & Brovarone, 2020).

From the definition of "*service provision centre*" provided by SNAI, 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 provide also 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 (UVAL, 2014).

Based on the organization of the Italian territory, defined as "polycentric" as there are numerous medium-large centres with small settlements gravitating around (which often lack 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 (Pezzi & Punziano, 2017). 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 completely replaces traditional public transport which does not have any kind of economic return from the provision of these services (figure 1).

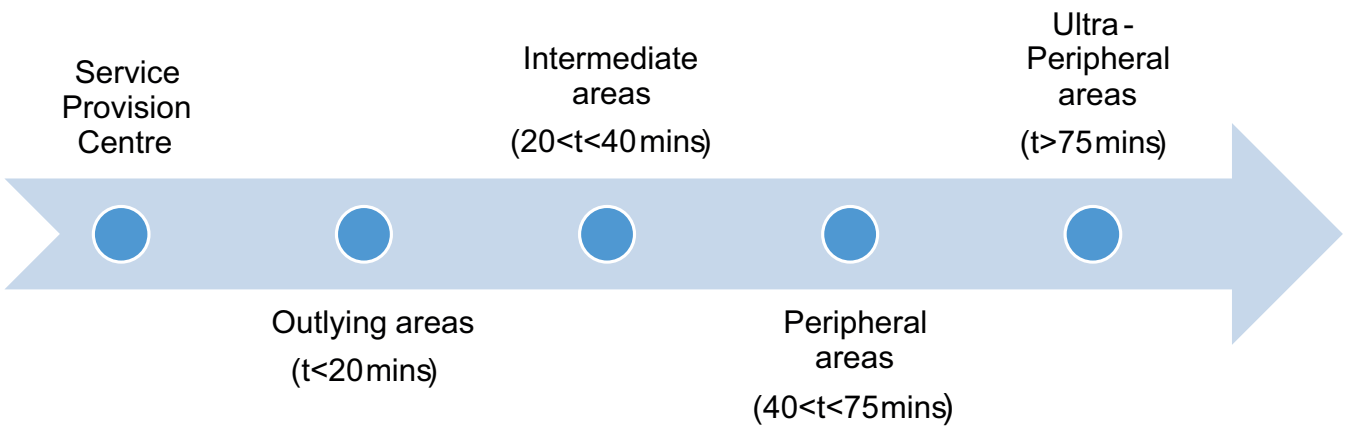

Figure 1. Italian Municipalities. Source: Own elaboration based on (UVAL, 2014).

2. For the 2014-2020 long-term EU budget, the European Union established five different funds jointly managed by EC and member states: the purpose of these funds is investments in job creation, environmental protection and economic development of Europe.

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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 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 this 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.

3. METHODOLOGY

For the purposes of this analysis, research was conducted through the consultation of the Project Framework Agreements of Italian Regions, the vision of sector agency websites and a web search by keywords. 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.

The work involved identifying rural DRT services implemented in Italy from 2010 (this includes both still 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 compares, for every DRT case taken into consideration, the main characteristics useful for understanding the wide range of possibilities that this technology offers (Dytckov, 2022):

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

The case studies observed are divided into four different categories: three categories refer to the SNAI classification 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 the tourism sector is proposed.

Each rural DRT service is assessed based on its degree of flexibility to provide an overview of the strategic visions most adopted: an evaluation method is proposed that assigns a score from 1 to 6 depending on the service model implemented.

The service models can be different and differ according to the degree of flexibility that the transport authority intends to provide based on the potential demand requests and the budget at its disposal (Westerlund, 2000; Kisla, 2016). DRT service models, as identified in literature (Nelson et al., 2004; Papanikolaou et al., 2017; Mageean & Nelson, 2003), are briefly described below in descending order of service rigidity.

3. TSonDemand DRT service of Trieste is split into two different service models.

3.1. Predetermined route with bookable fixed stops

This scenario represents the least flexible mode of transport and consequently the most convenient for PTAs in terms of economic savings. As for traditional public transport, routes and stops are predetermined, but the trip takes place only in case of reservations made by customers allowing PTAs not to make "empty" rides. During a ride, the vehicle stops only at the bus stops (often the same used by traditional transport) booked by passengers on board or by users at home: if there are no reservations, the vehicle continues its journey without stopping unnecessarily.

3.2. Predetermined route with possible detours from nominal line

This service model presents a slightly lower degree of rigidity than the aforementioned one: route is predetermined and some fixed stops are located on the 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 fixed route. This scenario is applicable above all in rural and mountain contexts where the nominal line is often identified with the main road and reservations can arrive from secondary roads, even distant ones.

3.3. Flexible route with fixed stops

With this service model the service degree of flexibility increases. PTAs establish in advance some fixed stops at which the vehicle stops if there are reservations, located at strategic points along the route (school, market, gym, swimming pool, central station, etc.). This model is instead totally flexible; the route varies from time to time, modifying itself based on user requests. Due to the increased flexibility of the service, which provides a completely adaptable route to user bookings, operating costs begin to rise.

3.4. Flexible route with some fixed stops and some variable stops

This service model represents the middle way between the more rigid and the more flexible services. It consists of a completely flexible route and of a part of stops predetermined in advance by the PTA at strategic points (as for the previous service model) and of a part of further variable stops depending on the request of users.

3.5. "One-to-many" ("Few-to-many") and "Many-to-one" ("Many-to-few") service models

The forms defined as "One-to-many" and "Many-to-one" (or "Few-to-many" and "Many-to-few") represent two service models applicable in contexts (typically rural) gravitating around larger attractive poles capable of generating the commuting phenomenon.

As regards the "One-to-many" service model is adapted normally to return trips from work/study to home in the late afternoon: DRT 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.

On the contrary, the opposite "Many-to-one" model, is commonly 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.

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3.6. "Many-to-many" service model

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.

Table 1 shows the scoring criteria proposed based on the different degrees of flexibility that each service model assumes.

Table 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: Own elaboration.

Below is reported the list of DRT cases selected for the analysis grouped according to the categories they belong to (in alphabetical order). Afterwards, table 2 shows the technical characteristics of each case study analysed.

- *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

Table 2. Rural Italian DRT services.

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

Service area	Service name	Booking system	Cost of service	Route	Stops	App availability	Score of flexibility
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: Own elaboration.

4. RESULTS

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

4.1. 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 largely the most widespread option among DRT cases analyzed (it is proposed, 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, convince 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 very considered by transport authorities as simple and effective methods of booking rides.

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 a WhatsApp message, 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 a ride also through electronic totems located at the stops.

The aforementioned booking options are provided to users both singularly and in alternative to other methods.

As shown in figure 2, in 35 DRT cases examined, 16 users have the possibility to book a ride exclusively by 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 examined (26%). "Telephone/web" option has been 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.

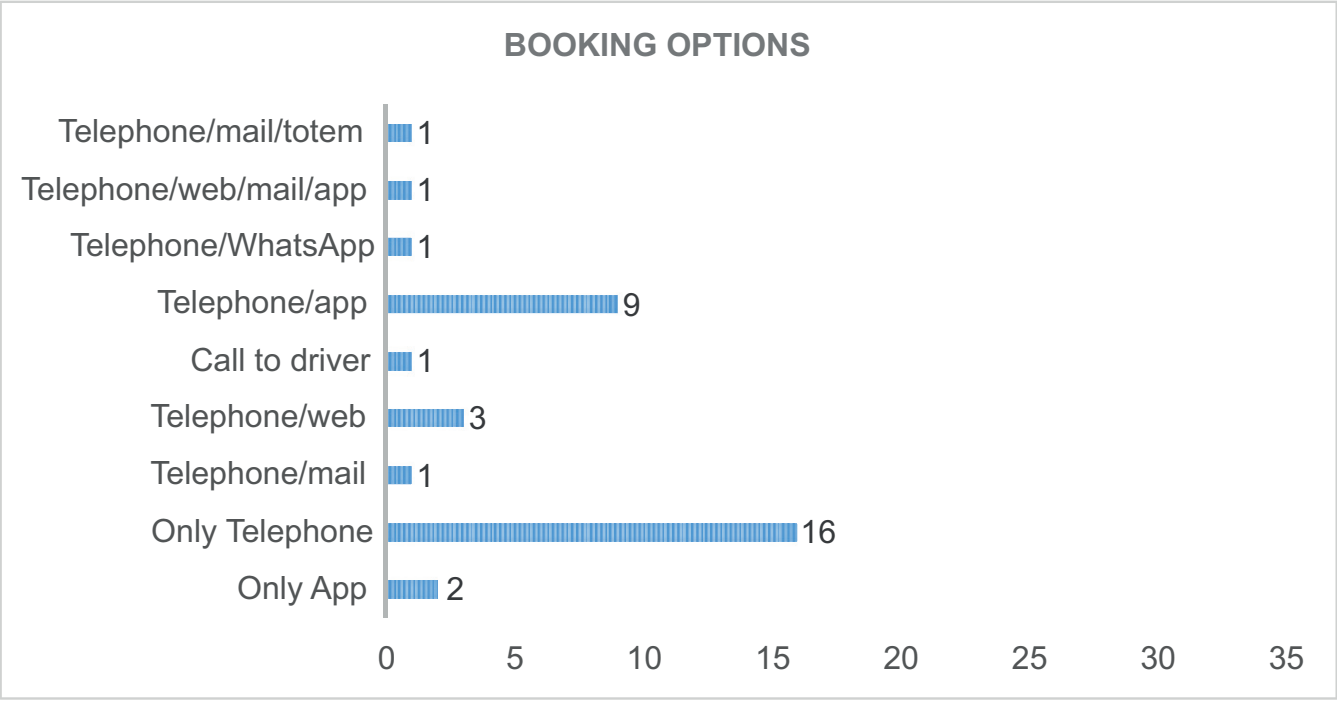

Figure 2. Booking options. Source: Own elaboration.

4.2. Cost of service

As regards the cost of service of examined DRT cases, the price strategies implemented by PTAs revealed to be different (figure 3): in 17 cases (the most widespread pricing strategy), PTAs decided to keep the cost of on-demand service tickets unchanged compared to 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 travelled 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%) are also DRT cases proposing a price ticket depending on kilometers travelled by the vehicle. "ProntoBus di Pianura" in Bologna provides for a rate based on the areas 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 travelled (within 6 km the cost is 2€/ride, over 6 km the cost is 2,50€/ride). "InMarittime" in Valle Gesso (CN) and "TrekBus" in Grand Paradis (AO) present fare ranges corresponding to the kilometers travelled.

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 a 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.

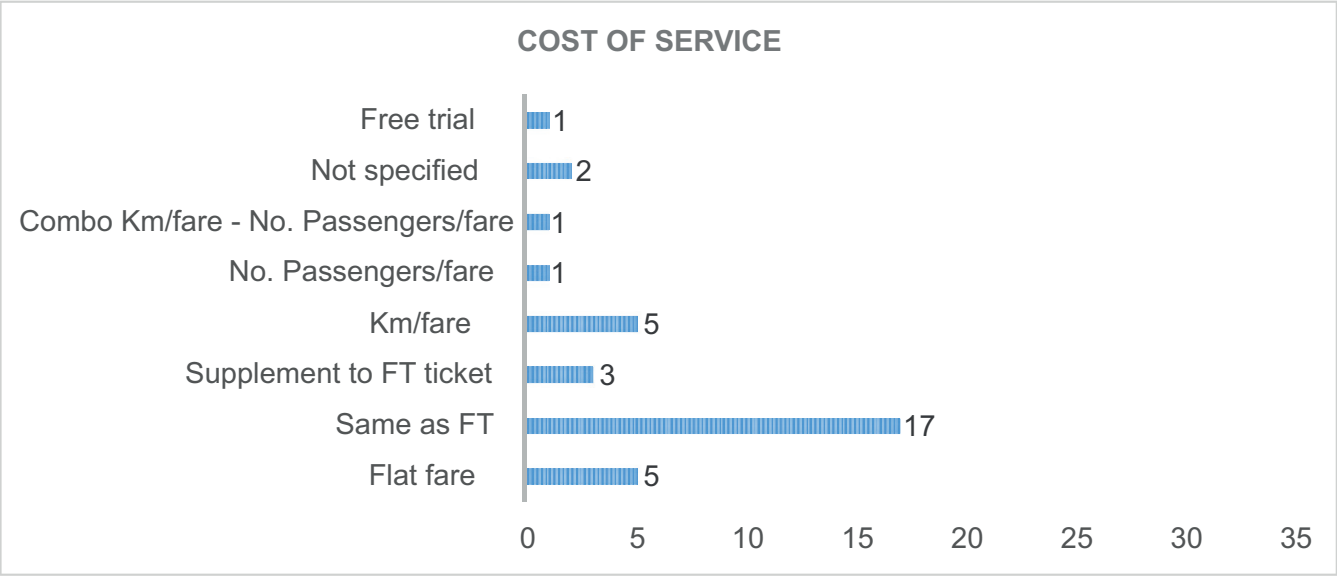

Figure 3. Cost of service. Source: Own elaboration.

4.3. 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 the 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 analyzed provide some indications of PTAs choices also in terms of service flexibility.

As regards the route, as shown in figure 4, in 29 cases observed (83%) it 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 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).

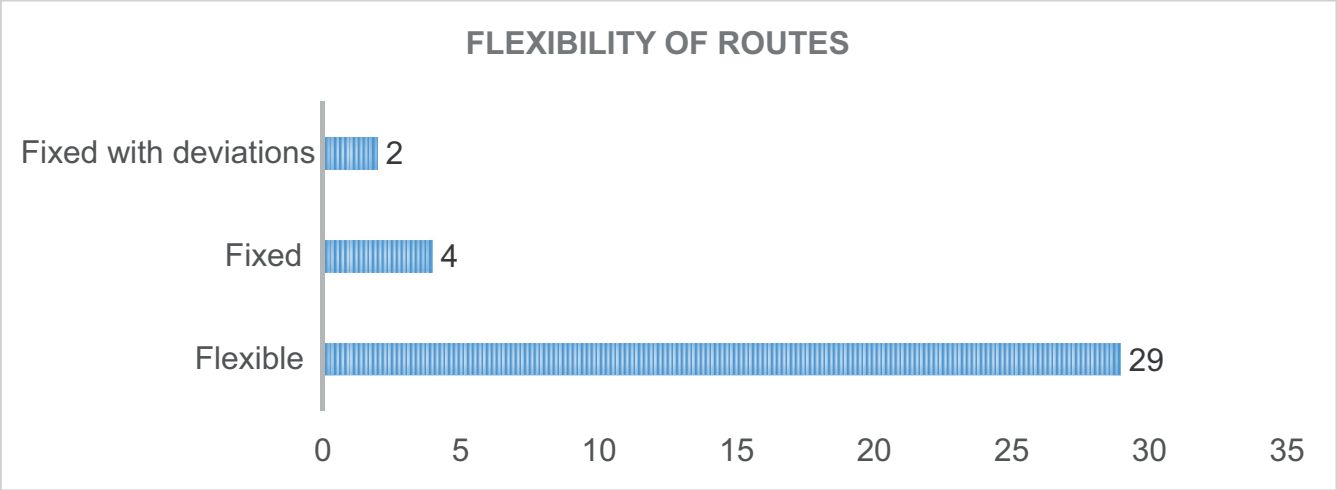

Figure 4. Flexibility of routes. Source: Own elaboration.

4.4. Flexibility of stops

As regards the degree of flexibility offered in terms of on-call transport stops, figure 5 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 kilometer rate (2 €/km).

No completely flexible stops were found in the analysis.

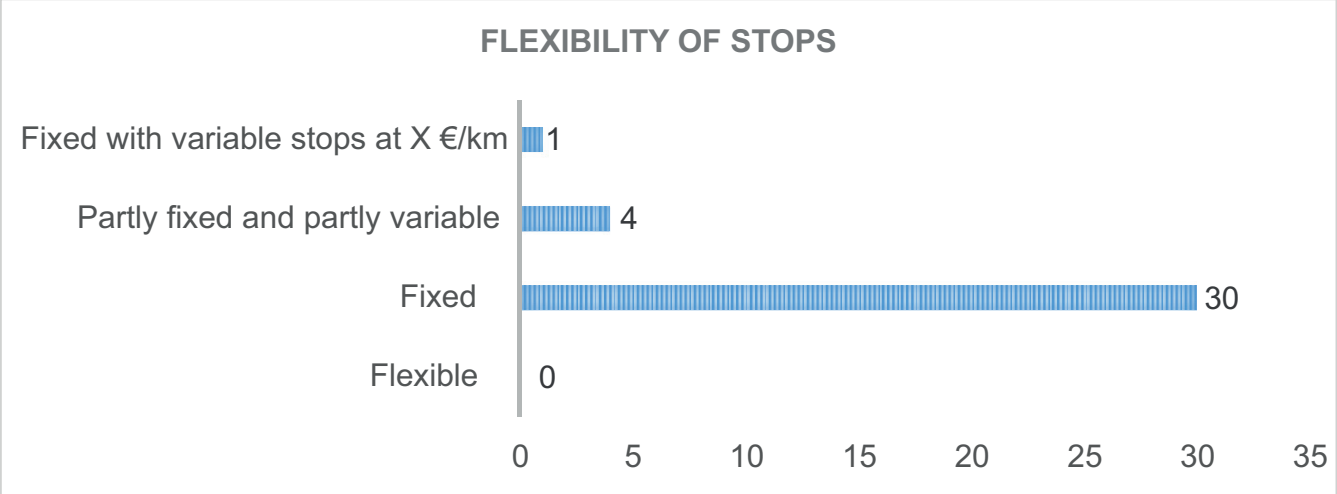

Figure 5. Flexibility of stops. Source: Own elaboration.

4.5. Service models

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

Figure 6 shows that the most widespread service model adopted in Italian rural contexts is characterized by flexible routes and fixed stops (26 cases, 74%). This kind of service model fits perfectly into 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, flexible and sized 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 the nominal line.

Three DRT cases examined (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 result 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 favor of PTAs, it becomes very difficult to realize such flexible DRT services.

The proposed evaluation method (score from 1 to 6 points based on the flexibility of the service) 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 (as illustrated in figure 7).

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 in the course of 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.

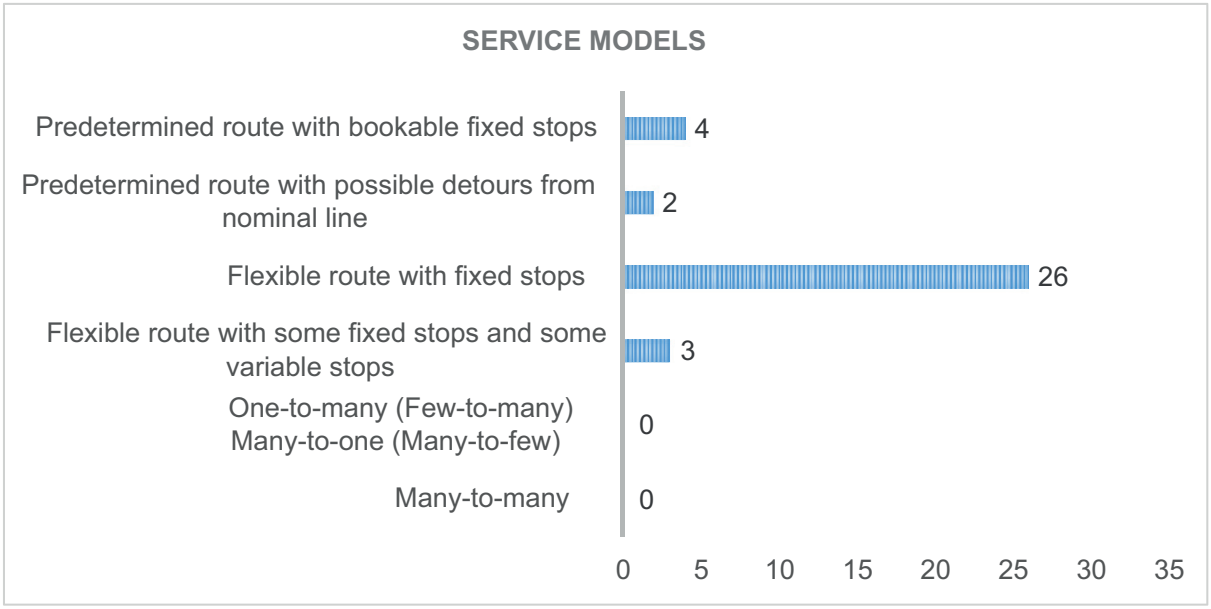

Figure 6. Service models. Source: Own elaboration.

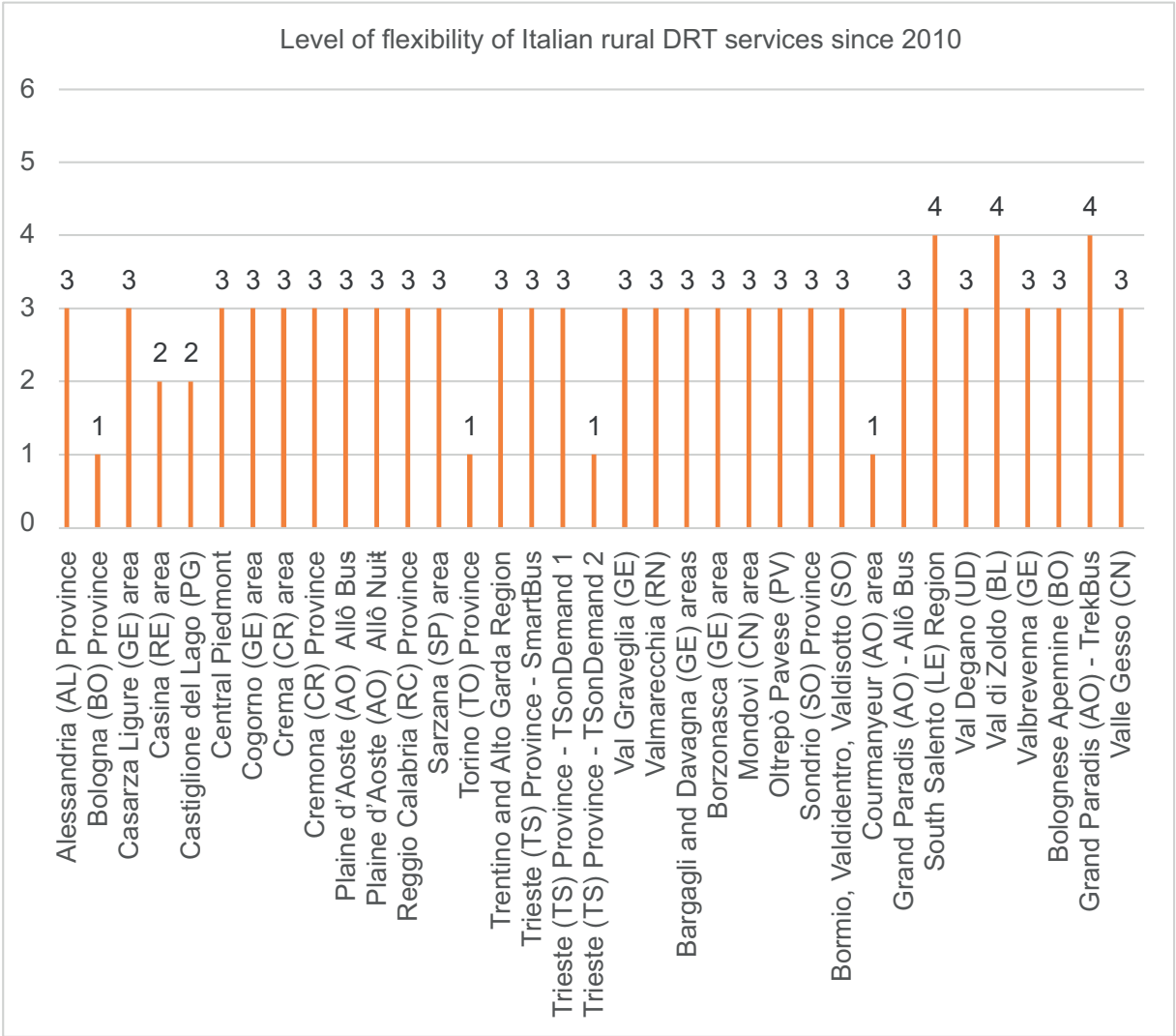

Figure 7. Level of flexibility of Italian rural DRT services since 2010. Source: Own elaboration.

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 routes with some fixed stops and further variables depending on 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 service characterized by a fixed route and fixed stops: PTAs have aimed at containing costs by simply replacing some lines of fixed transport with on-call service.

4.6. Dedicated App availability

Finally, 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 8.

Taking into account only PTAs that have developed a DRT dedicated app, figure 9 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 possible because having invested money in the development and implementation of the app, PTAs aim to cut the costs of the Operative centre.

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

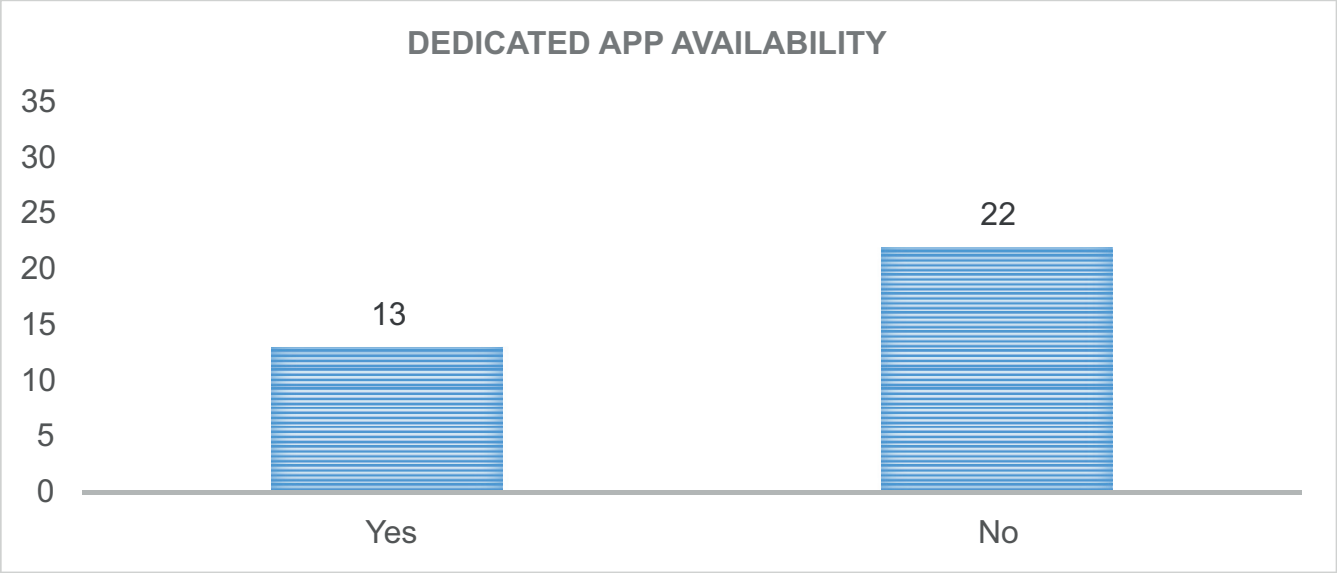

Figure 8. Dedicated App availability. Source: Own elaboration.

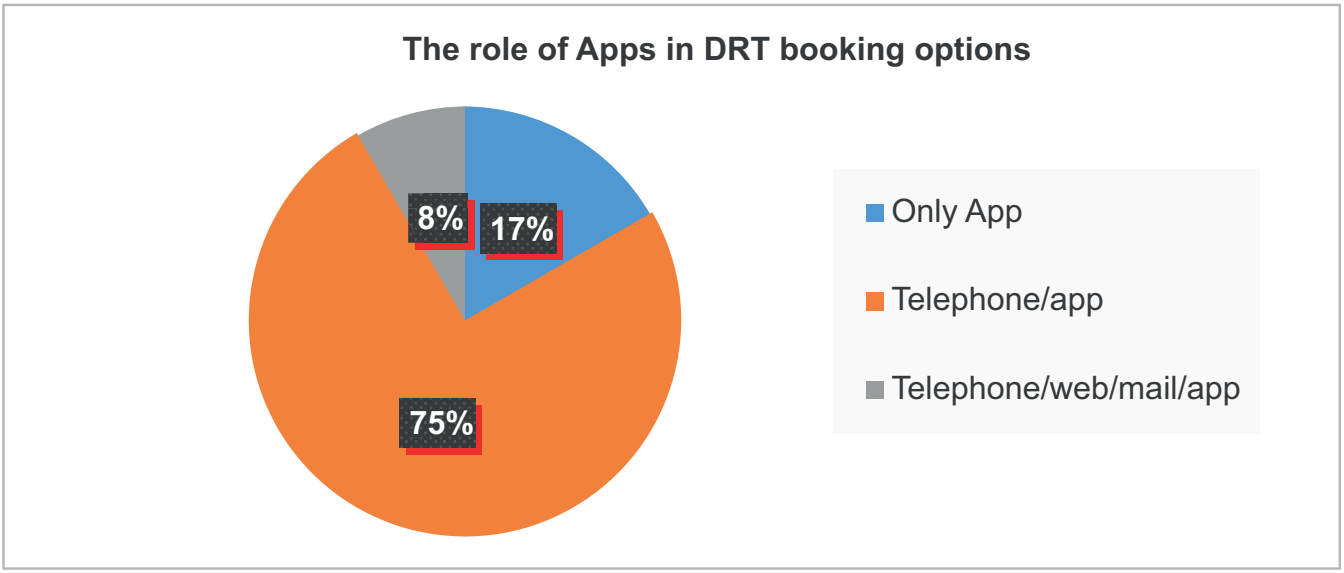

Figure 9. The role of Apps in DRT booking options. Source: Own elaboration.

5. DISCUSSION AND CONCLUSIONS

In this section, above results are discussed highlighting the potential that DRT service presents in each context identified by the SNAI strategy.

Population residing in outlying areas, although living outside the major centers, continues to enjoy the benefits offered by urban fabric: for these areas, DRT can be an important resource for integrating urban areas and suburbs FT mobility network (Schlüter et al. 2021).

The intermediate areas, located at a median distance between the more remote settlements and the major centers, present definite mobility needs: in these territories, FT service, typically infrequent and of poor quality, can be integrated or entirely replaced by DRT technology after an in-depth analysis of the transport demand to meet the mobility needs of citizens (Dytckov et al. 2022).

DRT transport, carried out with small buses, allows PTAs to carry out a widespread service (reaching even the most remote stops), to make their rides more efficient in economic and environmental terms and to become a valid alternative to cars.

The most remote inner areas (peripheral and ultra-peripheral) are characterized by a rather impervious morphology of the territory (of a rural or mountainous type) which makes FT service particularly inadequate mainly due to low accessibility of standard-sized FT vehicles and the financial unsustainability of the service as a result of the very low transport demand. In such contexts, DRT service can be even more useful than in previous scenarios and truly represent the only solution to ensure mobility for citizens, especially for the weaker segments of the population.

This work, through an analysis of the state of the art and the innovations of rural services of DRT in Italy, intends to provide the management of PTA, policymakers and scholars with a broad and updated overview of the most widespread technical and technological characteristics of the DRT services implemented in contexts with low transport demand. This is particularly useful in reshaping the mobility sector in the post-Covid 19 era: residents in suburban and rural areas, with a view to the gradual abandonment of private cars in favor of public transport, need an increasingly accessible, inclusive, efficient and economical transport. The recent pandemic has changed various people's habits, starting with the way they work: today more and more employees work remotely and have more flexible working hours. This new paradigm consequently changes their mobility needs, who move less at scheduled times: the public transport sector must face this change by offering increasing degrees of service flexibility. This article presents the following limitations: it was conducted only in the Italian context and through a web search and the vision of Framework Project Agreements of the Italian Regions and sector agency websites. Future research can be conducted at the European level and

through in-depth interviews with PTA managers. Furthermore, this paper considers DRT as a unique solution to the problems of fixed transport: new studies can be aimed at analyzing the joint implementation of this technology in rural contexts with new forms of mobility and paradigms such as shared services (Bruzzone et al., 2021) and Mobility as a Service (Barreto et al., 2018; Hult, 2021).

In academic literature, DRT technology has been studied for many years and in various fields of application: however, little is found on the potential of this innovation in contexts with low transport demand. This paper analyzed the state of the art of Italian DRT services in rural areas, with particular attention to the state of innovation of the services offered. The study, conducted through a web search by keywords and the vision of the Framework Program Agreements of the Italian Regions and sector agency websites, investigated the main technical characteristics of the 35 DRT case studies identified.

From a purely technical point of view, the identified 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 the PTAs, flexibility of the service and availability of DRT dedicated Apps.

The results of the analysis show that the call center 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 center) 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 were 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 center must receive reservations in advance of the time of the ride to allow the dedicated software to plan and optimize vehicle trips.

As regards service models, the 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 fully flexible DRT service in a 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 LDAs 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%). An analysis confirming the greater worldwide diffusion of app-based for public transport was conducted by (Abdullah et al., 2021), who studied the Pakistan case. In terms of innovation, as stated by (Velaga et al., 2012), the technological progress connected to DRT services inevitably requires rapid technical adaptability to transit providers and transport policies open to change and evolve.

Responsible reporting and conflict of interest

The author states that there is no conflict of interest in relation to the publication of this article. This paper represents an extract of the PhD thesis "Rural Demand Responsive Transport: An overview of the Italian scenario and analysis of Antola-Tigullio inner area case study" that will be discussed in 2023.

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