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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

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A car-centric mobility system has had over time a cumulative effect, resulting in harmful externalities evident in both urban and rural areas, such as road traffic, air and noise pollution, reduced space for pedestrian and cycling paths, the lack of parks, etc. This has forced policy makers to create solutions aimed at encouraging citizens to use public transport and more sustainable mobility modes. In cities, public transit is already widespread and simply needs to be restructured to gain people's trust. But in rural and mountainous regions, it is not economically feasible due to the low transport demand and long distances to travel, so new and creative forms of public transport need to be devised.

Areas which are considered to be "inner" are known for their great divide from major cities which offer essential services such as education, health, and mobility. Since accessing these services can be difficult, people living in these areas, especially students and families, have opted to move to nearby towns. This influx of migration has been an ongoing trend since the 1950s and is still continuing today, leading to the abandonment of inner areas and the aging of the population remained. This population shift has a range of different effects, such as social, environmental, and economic. From a social point of view, the departure of the younger generations from these places and the aging of those that remain puts a lot of strain on the country's welfare and pension system.

Environmentally, this situation resulted in the abandonment of cultivated fields, causing hydrogeological problems as well as posing a risk for landslides. From an economic and financial perspective, it led to the closure of local businesses and a lack of interest from private companies in investing in the area: this consequently means that the working-age population must travel for long hours to reach their workplace.

In order to tackle the issue of depopulation and economic and social isolation of rural areas, a viable option is to utilize on-demand transport technology. This system allows transport providers to reduce their costs by optimizing services (maximizing vehicles' load factor) and residents to have better access to public transportation possibly abandoning using their cars.

In 2014, the Italian government took the initiative to halt the decrease in population in such isolated portions of territory that take up 60% of the country and are home to 23% of its population. The National Strategy for Inner Areas, which is part of a wider European initiative, set out to reverse this trend and add value to such regions. The SNAI strategy opted to focus its resources and efforts on 72 inner areas on a



nationwide scale: the main aim for each of the targeted areas was to stimulate economic and productive development, as well as to provide essential services that discourage people from leaving for the cities. To this end, areas with the highest level of precariousness but which still possess latent potential were chosen.

The Italian scenario is structured with numerous medium-large centres and small settlements located around which are often deficient in essential services. SNAI therefore classified them in terms of their distance from major poles, especially with regard to services such as education, health, and rail transport. The so-called “outlying areas” are still quite close to the reference centre, typically within 20 minutes’ travel. Therefore, the people living in these areas can have easy access to essential services by taking advantage of the integration of suburban and urban public transport services. Additionally, Demand Responsive Transport can fill the gap of some traditional transport lines not well designed or cover certain times not well served. SNAI, in addition to “outlying areas”, has identified three bands of distance - “intermediate areas”, “peripheral areas”, and “ultra-peripheral areas”. When it comes to “intermediate areas” (with a 20 to 40 minute distance from the attractive pole), demand responsive transport can still provide a connection between fixed-route transport (FT) services, serving some routes or certain times not yet catered to. However, moving away from the centre, in the “peripheral areas” and “ultra-peripheral areas”, the socio-economic and mobility conditions of citizens deteriorate significantly: in these contexts, which are 40 to 75 minutes and more than 75 minutes away respectively, DRT service has to take over from the traditional public transport which is not economically viable in providing these services.

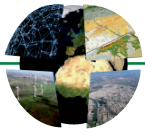
In academic literature, urban and peri-urban DRT services have been analysed extensively, but little has been studied at the rural level: the purpose of this article is to highlight the technical details of this technology in Italy and its degree of innovation, so that decision-makers can have the necessary information to solve above-mentioned issues. The research questions that this study aims to address are the following: *“How do transport operators intend to structure their on-demand services in rural areas? What is the level of technological maturity of this tool?”*

In order to answer above questions, this paper conducted an in-depth analysis of all cases of DRT in rural areas implemented in Italy in recent years, describing their qualitative characteristics: methodologically, each case study was identified through an internet search by keywords, a review of the Italian Regions’ Project Framework Agreements (PFAs) and sector agencies’ websites.

As per the web search, the analysis was carried out by entering “Rural DRT cases”, “on-demand transport low demand areas” and “Demand Responsive Transport in rural areas” in the Google and Microsoft Edge search engines in conjunction with the word “Italy” and the name of each Region. Furthermore, 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. To selected DRT services, evaluated on the basis of their main technical characteristics (service area, service name, booking system, service cost, itinerary, stops, app availability), were then assigned a respective flexibility score: the proposed evaluation method assigned values from 1 to 6 based on the increasing level of flexibility of the service model used (predetermined route with bookable fixed stops, predetermined route with possible detours from nominal line, flexible route with fixed stops, flexible route with some fixed stops and some variable stops, One-to-many/ Many-to-one, Many-to-many).

Booking options, cost of ticket, service models and availability of DRT dedicated Apps were all compared from a technical point of view: the innovative factor has been studied by observing the characteristics of booking methods, DRT dedicated Apps and flexibility of service.

The results of this study show that call centre is the most widely used booking tool in Italy and that most of PTAs usually provide only one booking option to customers (rarely more) to contain costs: this confirms that, as already observed in literature, technological innovations always need time to find full validation. Regarding service models, it was found that Italian PTAs favoured those with an average level of flexibility (74% of cases presented flexible routes and fixed stops), demonstrating that more flexible models are prohibitively expensive when low public funding is present. As per the service costs of the examined DRT cases,



the pricing strategies used by PTAs were evidently distinct: PTAs decided, in 49% of cases (the most common pricing strategy), to maintain the cost of on-demand service tickets at the same level as FT regular ticket in order to attract passengers. Pricing strategies such as flat fares, kilometeric fares, integration with traditional public transportation tickets and rates based on the number of passengers on board, a combo rate (Km/fare - No. Passengers/fare) and free pilot were implemented in a residual manner.

Last but not least, the development of specialized Apps is expanding but only affects 37% of PTAs, confirming what stated in academic literature about the great worldwide diffusion of App-based for public transportation. Data achieved show that, in terms of innovation, the development of technology related to DRT services inevitably necessitates quick technical adaptation to transit providers and flexible transportation policies: these factors are essential for developing a public transportation system that is tailored to the actual mobility requirements of the population living in inner areas and has positive effects on the social, economic, and environmental spheres.

The article's limitations include the fact that it was restricted to the Italian context and that it only looked at Framework Project Agreements of Italian Regions, sector agency websites and a web search: future studies could include in-depth interviews with PTA managers and research at the European level. Additionally, this paper takes into consideration DRT as a singular solution to fixed transportation's issues: future research can examine how this technology can be applied in rural areas alongside alternative modes of transportation and new mobility paradigms like shared services and Mobility as a Service.