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Transportation Research Procedia 90 (2025) 178–185

Transportation Research Procedia

www.elsevier.com/locate/procedia

AIIT 4th International Conference on Transport Infrastructure and Systems (TIS ROMA 2024), 19th - 20th September 2024, Rome Italy

From stand-alone local accessibility enablers to integrated first-mile solutions: the role of DRT services within Beigua-SOL and Arroscia Valley Ligurian Internal Areas.

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Abstract

Demand Responsive Transport (DRT) services were firstly introduced with the aim of assuring mobility right to groups of users traditionally constrained in their possibility to access ordinary public transport supply (e.g. the elderly, people with disabilities, residents of peripheral and low-density areas), to release captive users. Nowadays, they are frequently addressed as first-mile solutions to be integrated within wider Mobility-as-a-Service ecosystems, enhancing modularity and customization, also due to higher ICT standards that have been developed. This originally niche solution has been indeed growingly applied to various targeted users and territorial contexts, in order to support an overall flexibilization of local public transport supply, matching sustainability and rationalization needs coming from mobility providers and local administrations. This progressive transformation -which is still on-going- developed into different ways to address DRT services. In this direction, Project Areas selected by National Strategy for Internal Areas have been one of the main test-beds for DRT solutions in Italy, recently, since they share accessibility and marginalization issues, as well as low transport demand levels. Consequently, several DRT initiatives have been launched, thus showing different approaches, depending on the perceived reliability and relevance of local mobility providers, as well as on administrative boundaries and specifical transport needs. In details, Beigua-SOL and Arroscia Valley case-studies from Liguria Region (in Italy) will be investigated, to deepen how DRT services may play a quite variable role, waving from stand-alone mobility enabler, linking sparse settlements thus supporting local accessibility and modal-shift, to first-mile solution pouring users into the main Public Transport network, thus constituting an interesting opportunity for mobility providers, as well.

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2352-1465
10.1016/j.trpro.2025.06.056

Keywords: Demand-Responsive-Transport; Sustainable Public Transport; Territorial accessibility; Integrated mobility; Internal areas

1. Introduction

Providing effective, reliable and sustainable public transport (PT) services within remote and dispersed areas is one of the main challenges both for policy makers and mobility providers (Saeed and Kurauchi, 2015). Conflicting issues are indeed emerging. On one hand, demographic shrinkage and decline within rural and inner areas (Eurostat, 2023) makes PT-related per passenger provision costs and expenses higher (O'Shaughnessy et al., 2011), while, on the other hand, local demand for accessibility and equal individual mobility increases dramatically (Vitale Bovarone and Cotella, 2020) together with ageing (Shergold and Parkhurst, 2012) and migration trends. Flexible services are frequently addressed to fill precisely this gap: balancing operational costs reduction to meet mobility providers' needs and remote and inner areas' population demand for improved territorial access and easier mobility (Avermann and Schlüter, 2019). Among several alternatives, on-demand solutions constitute interesting options in this direction, especially whenever targeted users' needs are concerned (Davison et al., 2012). They could act indeed as relevant key-tools to enable individual mobility, to release captive users (Enoch et al., 2004) each time personal and/or context-related issues may hamper accessibility to services and opportunities (Nelson et al., 2009). Their implementation in this direction contributes significantly to future sustainable transition of transport systems, thus supporting at the same time social empowerment (Grieco, 2006) and reducing current use of private vehicles when collective and shared solutions are not present or universally accessible (Delponte and Costa, 2022). Nevertheless, since they represent a quite widespread solution, their applications may be declined differently according to territorial will, needs and features. Saif et al. (2024) highlighted recently that provided role to DRT services within local context and mobility systems influence significantly their relevance as well as the magnitude of their territorial and social impacts. Similar feature has gained more and more value as far as DRT solutions are nowadays addressed as pivotal components of Mobility-as-a-Service (MaaS) systems. Their almost full flexibility and customization, together with their modularity makes them the most suitable tool to be integrated within MaaS ecosystems (Kamau et al., 2016) to complement traditional transport services' supply (Alonso-González et al., 2017). They may represent indeed first-last/mile solutions that, differently from sharing services requiring drivers' license (such as car and scooter sharing) and/or physical capability and effort (bike sharing), provide a universally accessible option, cheaper than traditional taxi supply.

Present work aims at investigating how DRT solutions may be given different roles within urban and metropolitan mobility system, focusing on the comparison between two specific case-studies where marginalization and depopulation trends are faced through the implementation of similar services. Within the framework of Italian National Strategies for Internal Areas, two project areas from Liguria region, namely Beigua-SOL and Arroscia Valley, defined local mobility initiatives based on DRT solutions, thus addressing different needs related to the perceived reliability of local public transport provider, as well as to the different relations linking them to the main cities along the coast. Subsequently, a further deepening of DRT services features and potential role within transport systems will be provided in Section 2. Section 3 will introduce Beigua-SOL and Arroscia Valley case-studies within the framework of Italian National Strategy for Internal Areas. Different application of DRT solutions within the two areas will be discussed in Section 4 and particular attention will be paid to the relevance of institutional perceived reliability and urban-rural relations for the effective implementation of similar services. Finally, potential outcomes for the implementation of metropolitan/regional MaaS initiatives would be discussed.

2. DRT services and accessibility

Demand Responsive Transport services were firstly introduced in Atlantic City in 1916 (O'Leary, 1975), but larger upscaling came only during the '60s and the '70s when optimization algorithms to improve "many-to-many" schemes in terms of demand assignation and resources rationalization were initially developed (Wilson et al., 1969). Nevertheless, immature technologies and high operational costs (Wilson and Simpson, 1975) deemed several initiatives to fail. Dramatic innovation in the Information and Communications Technologies' led to a new boost for

DRT services at the end of last century. Similar services were specifically targeted as "niche" solutions (Ryley et al., 2014) providing alternatives for selected groups having difficult access to traditional transport supply. According to Transit Cooperative Research Program (2004), women, low-income residents, the elderly and people with disabilities were the main target of similar services. In details, main variables influencing the choice of on-demand services were identified as it follows (Nelson and Phonphitakchai, 2012): i. gender (women more than men); ii.age (the elderly prevail); iii.income and employment (low income and retired constitute the main target); iv.vehicles availability (people without private cars choose DRT services) and v.individual capability (people with disabilities often look for similar alternatives). Targeted users do not represent the only application field of similar solutions. The possibility to define customized routes/travel constitute also a specifical advantage for low transport demand areas (Mortazavi et al., 2024). Several services were therefore designed and implemented to answer dispersed and scattered mobility demand (Shibayama and Emberger, 2023). Rural areas (Lakatos et al., 2020; Poltimäe et al., 2022), urban and suburban sites (Mageean and Nelson, 2003) were therefore provided with DRT services thus integrating traditional network on a regular basis, as well as according to specific time-dependent variations (at nighttime (Gomes et al., 2015), at weekends, etc…); urban/rural relations were often addressed through similar solutions, too (Schlüter et al., 2021).

It is therefore clear the potential added value that DRT services may bring into Mobility-as-a-Service (MaaS) ecosystems. Their progressive affirmation and spread is in fact related to the availability for users to plan, book and buy integrated travel tickets, thus combining more modal and service alternatives at once. In this direction, first pilots and experiences allowed scholars to highlight some initial results. Although Public Transport (PT) represents the key-component of MaaS system, a deep reconfiguration of traditional network and supply is required to meet new customization and flexibility necessities (Hensher, 2017). Inflexible service provision needs indeed to be smoothed, thus targeting modular and redundant schemes (Santos and Nikolaev, 2021). User-centred perspective is therefore essential to support metropolitan transport system adaptation to new mobility needs (Lopez-Carreiro et al., 2020). In this direction, DRT services may play pivotal role to provide first-mile and last-mile services (Charisis et al., 2018). They could actually work as flexible and affordable alternatives to shared mobility options, offering some further advantages, as well. From mobility providers point of view, they could actually strengthen PT relevance and share within MaaS ecosystem, thus competing with private sharing mobility companies (Mulley and Nelson, 2009). At the same time, users would be provided with cheaper services (being PT services, DRT could actually benefit from public subsidies) that, differently from most of sharing services would not require dedicated qualifications and/or individual capabilities (e.g. specific drivers' licenses).

3. Case studies

Starting from similar considerations, it is therefore self-evident why DRT services play a leading role within Italian National Strategy for Internal Areas. One out of five project areas selected on-demand transport services as potential solutions to local accessibility issues (Italian Territorial Cohesion Agency, 2023). Nevertheless, each of them shapes DRT services according to local features. In this direction, it is particularly relevant to deepen how similar DRT solutions were declined differently within two among Ligurian project areas, Beigua-SOL and Arroscia Valley.

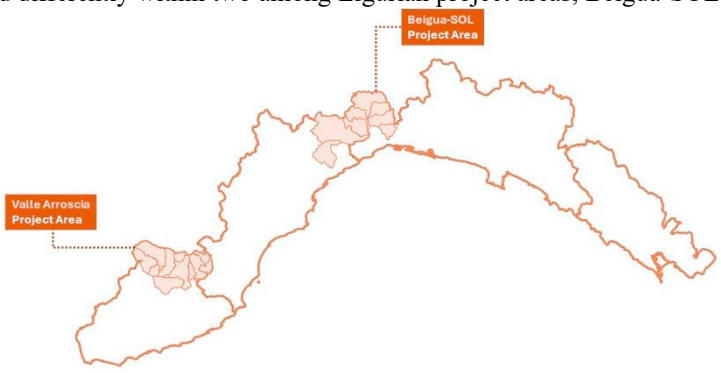

Fig. 1. Beigua-SOL and Arroscia Valley Project Areas

3.1. Beigua-SOL

Beigua-SOL internal area is located between Genoese Metropolitan City and Savona Province. It gathers eight municipalities belonging to two different mobility basins. The local strategy addresses DRT services through the purchase of one small bus for each municipality and the design of a new on-demand service to be introduced. First part of the strategy aimed indeed at filling local gap in terms of performing vehicles to supply basic mobility services (such as school and healthcare-related transports). It is therefore easy to understand that limited resources belonging to similar small and remote municipalities, usually translate into the availability of few and outdated vehicles, often unable to cope with local needs. In this direction, shared and joint service provision is therefore suggested by Arcelus et al. (2015) to increase cost-efficiency and improve local services performance and quality and similar approach was supported indeed also through Internal Areas National Strategy. An area-based co-design of DRT services constituted finally the expected outcome.

In this direction, first step was to identify municipalities' needs in terms of PT vehicles. Unsurprisingly, three larger municipalities closer to Genoese boundaries required bigger vehicles (e.g. 21 seats); peripheral municipalities on the Genoese side, as well as the ones belonging to Savona Province asked for 16 seats-buses, while only one among the peripheral municipalities belonging to Savona Province required a 9 seats-bus in order to allow non-professional drivers to use it -according to Italian transport legislation.

Nevertheless, two main criticalities emerged. Regional competencies in terms of transport regulation and planning clashes with national setting of the Strategy (i). Initial goal to provide each of the involved municipalities with a small bus, for instance, is coherent with the idea to balance local limited resources, but does not comply with Ligurian legislation that requires school services to be provided through dedicated buses, so that two different vehicles should be used to deliver both ordinary and school public transport.

Secondly, (ii) the definition of public transport mobility basins on a metropolitan/provincial basis, as well as (iii) specifical regional discipline on flexible services that need to be mainstreamed into mobility providers existing PT provision contracts or delivered through non competing hours and routes, thus not interfering with traditional supply, constitute relevant barriers within this project area.

As far as DRT service is concerned, being the central part of the area particularly remote from the coastline and made up by sparsely populated municipalities located along provincial border, it did not have significant appeal to both Genoese and Savonese PT providers. On the other hand, municipalities located closer to main towns represented interesting context for mobility operators, due to the opportunity to strengthen existing relations between their not-urban and urban networks.

Institutional interlocution and co-design process led indeed to the definition of a double provision scheme. Municipalities closer to the coastline agreed with provincial PT providers to integrate new DRT services within existing PT supply, thus relying on their structure and resources (e.g. drivers, booking system and call centers), thus proving themselves vehicles to provide the service. Remote municipalities developed different DRT services to be provided by local associations and cooperatives, thus registering new vehicles as rental buses, in order to allow their mixed use for school and ordinary services. Service hypothesis -which is currently under evaluation- was consequently to define a weekly DRT (Monday to Saturday) to be provided during non-peak hours (9.00-12.00/14.00-18.00). Booking should be made one day in advance within remote municipalities service perimeter (local association and cooperatives require longer times for demand management and optimization) through a dedicated call center; while for service segments managed by PT providers, reservation can be made until 30' prior to the journey start, through the call center or via mobile application, thus relying on pre-existing infrastructures.

Chosen DRT service model was to deploy pre-defined bus stops, in order to balance operating costs' reduction and service flexibility and responsiveness. Service integration with traditional PT network was provided by maintaining the same start and end-point both for DRT and scheduled buses.

3.2. Arroscia Valley

Arroscia Valley represents a quite different context. It is located in the Western part of the region, fully belonging to Imperia Province, despite bordering with Savona territory. The local Strategy includes the design of an innovative mobility service to improve local accessibility and contrast social and territorial marginalisation.

Similar project follows previous attempts made by local community to define DRT services to enhance PT connections between peripheral municipalities and Pieve di Teco, main centre of the area. Differently from the other case study, Arroscia Valley constitute a quite coherent gathering of municipalities, institutionally recognized as a "unione di comuni" (namely "municipalities' union") since 2014. Most of services, shops and opportunities are provided in the main centre, counting approximately one third of global area population made up by eleven municipalities.

DRT was therefore considered as the most suitable solution to support local accessibility and enforce pre-existing territorial relations within project area. Initial concept was to provide similar flexible transport service autonomously, thus relying on the initiative and resources of independent subjects (such as NGOs, associations and cooperatives) belonging to local *milieu*. Similar intention was due also to the limited trust in the Province public transport provider, currently undergoing deep structural changes linked to unstable financial contingencies.

Nevertheless, the need to design independent service not competing with traditional PT supply, as well as to identify material and human resources to provide DRT service, both in the booking (e.g. call centres employees and software) and operational procedures (e.g. drivers and vehicles), supported a progressive shift towards local PT provider. From the community point of view, despite the initial resistance due to the lack of mutual trust, similar choice showed several advantages in terms of improving connections with traditional PT service lines, as well as to reduce local administrations commitment in terms of locally owned resources.

Differently from the first case study, a PT provider-driven DRT service constitute relevant value also for the company. Due to financial difficulties, flexibilization of some pre-existing services supported operational costs rationalization, thus supporting the company recovery.

At the same time, the design of an effective and innovative transport service to be provided within a remote area, currently poorly reached by PT traditional supply may contribute to enlarge local PT users' share, thus pouring them into Imperia urban PT network and increasing tickets revenues.

Finally, in a short-term perspective, PT provider may benefit from resources coming from National Internal Areas Strategy to bypass current difficulties. In this direction, new vehicles purchase as well as wages-dedicated resources may be allowed through the definition of an additional branch of pre-existing service provision contract.

In this direction, together with PT company technical division, three DRT services converging to Pieve di Teco centre were designed to improve local accessibility to public services and attractions for northern, southern and central part of the valley. Traditional public transport supply was then rescheduled to improve connections between the new-born services and the main lines taking to coastal centres of Imperia and Albenga (belonging to Savona Province).

Service hypothesis -which in currently undergoing operational implementation- was to define a seasonal scenario: in winter weekly DRT (Monday to Saturday) would be provided during non-peak hours (8.30-12.00/15.00-18.30), while in summer during all day (6.00-20.00). Booking should be made before 12 pm of the day before the journey, through local PT provider call center. Partially-flexible service model was chosen for Arroscia Valley, as well, thus relying on existing bus stops.

Despite the remoteness of the area, overlapping interests of local community and PT company supported the design and implementation of a significant re-shaping process of the overall mobility supply.

4. Discussion

Beigua-SOL and Arroscia Valley case-studies represent interesting experiences in terms of potential DRT applications within wider transport and mobility systems. As previously stated, modularity and flexibility provided by similar solutions are often addressed as pivotal element to support progressive transition to territorial MaaS experiences. Nevertheless, their role within the eco-system may change deeply according to variable boundary conditions. Starting from similar assumptions, strategical and operational contingencies proved to be extremely different (Fig. 2). In details:

- Both areas were selected by Italian National Strategy according to their poor accessibility conditions to public services. National classification frames indeed the former one with three out of eight municipalities and the latter with 100% of the municipalities involved requiring citizens to drive more than 40' to reach reference service provision centres;

- They may be both framed as cross-border areas, being the first one effectively crossed by provincial boundary between Genoa and Savona, and the latter located along the line separating Imperia and Savona Provinces;
- They both addressed DRT services as pivotal tool to increase local accessibility and improve PT service territorial and time coverage within dispersed and poorly service-equipped contexts.

On the other hand, deep differences may be traced, as well:

- Municipalities from Beigua-SOL project area actually belong to two different Provinces and consequently to different transport basins. Similar configuration constitutes a relevant barrier in terms of service provision and effectiveness;
- Institutional municipalities gathering in Arroscia Valley represent a significant expression of local sense of community, cooperation and cohesion. This element represents an important driver for service design and implementation;
- From PT companies perspective, the opportunity to mainstream new users' share to their own urban network proves to be unequal: Beigua-SOL split hampers the actual potential of DRT service as a way to drain effectively and significantly users to two different PT networks. On the contrary, Arroscia Valley remote location and belonging to an only basin support similar process. Their engagement and involvement is therefore maximized for the latter, while in the first project is limited to municipalities closer to the coastline.

Consequently, the first project area benefits from DRT service only as a stand-alone solution, whose application proves to be autonomous from traditional PT. Local mobility providers commitment is quite limited, due to the poor business interest within the area, sparsely populated and parted between two different companies.

On the other hand, the effective engagement of Imperia PT provider within Arroscia Valley project allowed to define integrated re-design of local public transport supply, both on the DRT and traditional side. It is therefore evident that, in this direction, DRT constitute a first/last-mile solution, thus following the scheme traditionally implemented within urban contexts.

Targeting a MaaS perspective, both of the configuration may represent interesting opportunities to reach remote areas through innovative public transport services, nevertheless potential outcomes both for the local community and mobility providers should be taken into account. In this direction, first data coming from service pilot implementation would be extremely useful to assess comparatively potential appeal and perceived usefulness of similar solution.

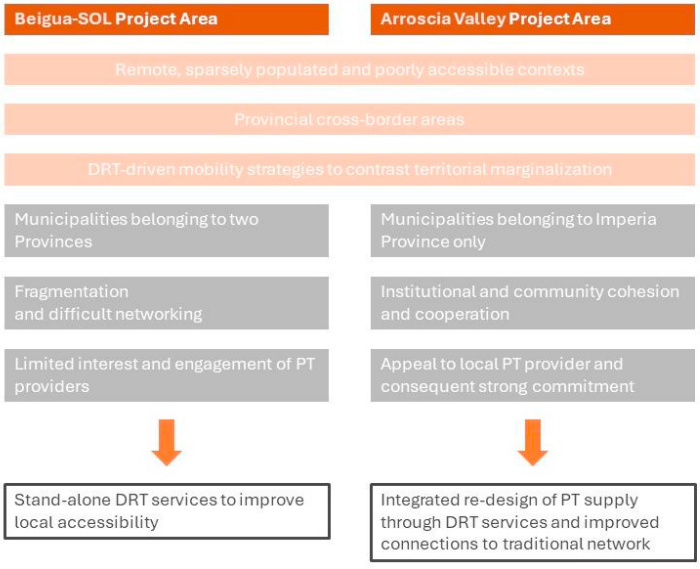

Fig. 2. Beigua-SOL and Arroscia Valley features and DRT services

5. Conclusions

Present work focuses on the potential role that Demand-Responsive-Transport may play within local mobility systems, especially when remote and internal areas are involved. Respective Italian National Strategy heavily relies on similar services to improve local accessibility and contrast social and territorial marginalization processes.

Ligurian experiences of two project areas helped the authors to highlight significant relevance that context-related features may have for the design of innovative and flexible transport services.

Administrative borders, local community cohesion and cooperation, trust in local mobility providers, as well as companies' potential business interest for the area, heavily influence service configuration and structure.

Similar considerations may be seen as residual considerations on remote and sparsely populated areas, nevertheless, according to a future MaaS perspective, DRT role within the eco-system may prove to be pivotal.

The deepening of Ligurian case-studies enables to highlight how the same technical solution -namely DRT services- may be declined differently according to peculiar boundary conditions (e.g. territorial, socio-economic and administrative milieu), thus inducing dramatically different outcomes.

Administrative borders-related barriers proved indeed significantly relevant in hampering potential DRT implementation within Beigua-SOL area, even though material resources (e.g. vehicles) have been effectively provided. On the other hand, limited trust in local PT provider within Arroscia Valley, despite requiring longer bargaining times to reach a shared view and project on local DRT service hypothesis, has proved not relevantly determinant in terms of operational implementation. In this sense, direct involvement and interest of local PT provider allowed effective development of the design process.

Moreover, PT commitment to similar experiences and services, going beyond the pilot phase would be key-factor to support widespread accessibility and sustainability of a similar transport supply. It is therefore evident that whenever non-competitive areas are considered, being them urban peripheries or rural contexts, PT providers role and responsibilities need to be carefully examined and defined, to support an inclusive process of MaaS solution implementation, thus limiting potential further segregation of low-accessibility communities.

In this perspective, targeting deep integration of similar services within MaaS ecosystem, interesting hints may come from the investigation of drivers and barriers affecting effective implementation of DRT solutions, both in terms of reached users -when considered pilots will become operational- and in terms of qualitative features of provided services, thus supporting a comparative evaluation of administrative, management and context-related factors involved.

Despite stand-alone solutions may actually achieve enhanced local accessibility to service and opportunities, they prove, according to the role itself they have been assigned, the lack of PT providers commitment and interest, as well as a limited integration potential. Similar pre-requisites lead to growing criticalities going from the pilot phase to the ordinary service step. Consequently, both on the governance and economic sides, public intervention needs to balance significantly reduced commercial appeal of similar services. On the other hand, integrated first/last-mile solutions may constitute more interesting opportunities for PT providers, filling the gaps of ordinary PT supply, thus supporting the growth of reference market. At the same time, seamless integration may represent pivotal factor in attracting new users' shifting from private mobility, thus feeding a positive feedback loop.

Finally further analysis of DRT appeal towards users' and PT providers according to the peculiar role played within mobility ecosystem and supply may provide relevant insights on potential territorial applications, as well as on governance mechanisms and respective business models.

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