The Development of Integrated Public Transport and on Demand Services (PTs-DRTs) for Greater Flexibility and Complementarity of Transport Mode Choices

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Abstract. Rapid urbanisation and technological developments in the mobility sector underline the importance of the deployment of flexible and complementary public transport services (PTs), such as Demand-Responsive-Transport (DRTs). The deployment of these services is strongly influenced by transport demand; hence it is shaped by socio-economic factors such as booking methods, reasons for travel, and time of travel. Additionally, travel habits and the specific needs of users as well as deployment in areas with low transport demand. This can include not only peripheral regions but also other locations. The integration of DRTs-PTs in Europe and the UK presents a significant opportunity to enhance mobility and sustainability in both urban and rural areas. DRTs have the potential to address the specific transport needs of different regions and contribute to reducing social and gender inequalities while avoiding service bias toward high-demand urban areas. The main goal of this research is to conduct an in-depth analysis of the current state of the art. It focuses on sustainability in the context of DRT mobility, and it also highlights benefits and criticalities through a SWOT analysis approach. This study analyses strengths and weaknesses, opportunities and strategies involved in implementing an integrated DRT-PT service. Ultimately, the findings of this research provide a foundational framework for better deployment of more flexible and complementary PTs, enhancing accessibility and ensuring service equity for all users.

Keywords: Public transport · DRT services · SWOT analysis · Integrated Transport System · Sustainable Mobility

1 Introduction

The European recommendations include the 2030 Agenda and in particular Goal 11 [1], “Make cities and human settlements inclusive, safe, durable and sustainable”. By 2030 access to all transport systems must be ensured. The transportation system should be understood as safe, sustainable and affordable, especially for the most vulnerable groups.

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In the logic of the 2030 Agenda goals, innovative approaches in the mobility sector are growing rapidly, and with them the inefficiencies and shortcomings of the traditional transportation context. Demand Responsive Transit (DRT) refers to flexible transportation services that can be adapted to different needs, based on digital technologies useful to optimize vehicle management and improve the accessibility of public transportation services. This increasing service is characterized not only by flexibility, but also by efficiency for the user, providing passengers with the ability to book transportation according to their desire/need, differently from traditional scheduled public transportation (PT). The introduction of this on-demand service can bring significant benefits in terms of environmental sustainability, by reducing private car dependency [2–4].

Additionally, it can foster economic sustainability, since DRT could optimize the cost of public transportation by working on the fuel efficiency and low-cost pair (i.e. pricing as a DRTs implicate costs between 5–15%, compared to 15–40% for public transport) [5]. Integration of PTs-DRTs therefore leads to significant cost savings, resulting in greater system efficiency. Benefits are also foreseen for social sustainability in terms of accessibility to sustainable mobility for all, especially for those with special needs. [6].

Such integration can be an effective strategy to address mobility challenges not only in urban but also rural areas by improving the efficiency and accessibility of the transportation system. In fact, PTs, based on pre-established routes and fixed timetable, are complementary to DRTs. In this way they can provide flexible and on-demand services, able to cover areas with low population density or low demand schedules.

In current scientific literature, are often analyses peculiarities of DRT, main drivers of demand and diffusion. However, despite the growing interest in this topic, the importance of synergies between DRTs and PTs, which is the focus of this study, is not sufficient. It is often thought that on-demand service can be the enemy of PTs, in fact DRTs, starting from their financial strategies, follow financial models that often rely on sub studies [7].

So, in terms of the innovative design of these services, the issue is to make DRT the most efficient/appropriate option compared to other modes of transportation (conventional buses, taxis). The ways in which DRT can operate compatibly with public transport are varied; it can propose itself, for example, as a service extended to PT therefore optimized [2, 8, 9].

The aim of the paper is to examine the characteristics of DRTs integrated with PTs, focusing on strategic planning by applying SWOT analysis.

This research paper introduces a state of art analysis in Sect. 2 and therefore aims to explore the characteristics of DRT transport service integrated to PT through a three steps analysis described in Sect. 3. The first introductory step is a literature review in the European Union and UK landscape; the second step aims to apply a strategic planning tool, SWOT analysis, to assess the strengths, weaknesses and opportunities for the implementation of an integrated DRT-PT service.

This SWOT analysis considers different viewpoints, from user to public administration and the operators, respectively, of the DRT and PT services. Finally, the analysis of application cases follows, which verify the stated assumptions. Section 4 additionally provides some suggestions for improving the integration of the above services for future

research developments, introducing possible flexible and complementary transport solutions for passengers and small goods in order to improve public transport and last mile delivery.

2 Background

Previous studies have focused on transportation services, highlighting the peculiarities of DRTs; Brake et al. (2004) [10] describe it as "an intermediate form of public transport, somewhere between a regular service route that uses small low floor buses and variably routed, highly personalized transportation services offered by taxis".

As also mentioned by Lews et al. [11] DRTs can be defined as an intermediate and highly flexible mode of transportation that can give rise to a range of uses and functionalities thus representing a strategy to be deployed to address mobility challenges.

DRTs are able to cover transportation needs in weak demand areas and consequently ensure more efficient accessibility to all, especially for vulnerable users. This reflects a growing interest in improving and reducing social exclusion [10, 12].

At the same time, the service makes it possible to define forms of transportation that can be complementary and integrated with public transport by covering weak demand areas in the same way [6].

Papanikolaou et al. [13] analyses the gap between the public transportation market and DRT, proposing a possible framework so that integration between the two services is possible and successful. The innovative element of this research concerns the conceptualization and categorization of DRTs. It's based on the potential match with PTs and the possible optimization of transportation costs.

In agreement with Ryley et al. [14] several case studies emphasize the difficulties in terms of cost in the implementation and use of DRTs, also stressing the need for a combined transport service for an approach that is not only environmentally sustainable but also economically and socially sustainable.

Concerning social impact, the research conducted by [15] highlights social benefits of DRTs and the difficulties of implementing such services in the UK. They emphasize some critical issues related to economic self-independence.

Several demand models have been applied in literature for social and economic benefit assessments. In agreement with [16, 17] it is shown that the application of mixed logit models has generated interesting simulations that can build a DRT network model enabling the interaction between supply and demand, and between a rigid public transportation system with a flexible and efficient on-demand transport system.

Similarly, in the case of public transport services, it is crucial to define the benefits not only in terms of the environment, but also for the economy and society, which are often influenced by user satisfaction [18].

For both scheduled and flexible transport services, research conducted by [14] indicates that service frequency, travel time and flexibility are necessary not only to satisfy the user, but also to create the right conditions for using the service. This implies that all features must be available for each user cluster, so that no one is excluded and discouraged from using these services [19, 20].

There is no doubt that today's literature lacks studies related to the integration of DRTs, as pointed out by Desaulniers and Hickman [21], who emphasis the need to implement more integrated type services to strategically improve the service design, thus minimizing costs and ensuring the most comprehensive service possible.

The innovative design of a DRT integrated with the PTs, as suggested by Gorev et al. [22], could ensure flexible modes of public transport services implemented at the DRT by taking certain actions:

- an analysis of demand in the affected area not disregarding population density, condition of existing road and transport networks, income level and motorisation level;
- identification of factors that may adversely affect DRT;
- development of an organisational plan between DRT and PT;
- and calculation of necessary costs and the possibility of receiving subsidies from Local Authorities.

In accordance with their findings, the adoption of modern technologies could greatly increase PT integration and flexibility, allowing thus DRT to choose the best option that matches to user's needs.

In a last resort, in economic terms, costs could be balanced and contained, since DRTs require significant investment and subsidy. It is then recommended that combined solutions could be used to the benefit of users and service providers.

From the literature review, it is clear the importance of the complementarity of the two services, which integration through strategies and technologies can ensure environmental, economic and social sustainability.

This integration turns out to be efficient because first and foremost it helps PT to establish itself in weak demand areas, where it is lacking, supporting the principle of social sustainability in the first place and addressing issues of social exclusion and social needs [14]. It helps DRTs to establish itself and to sustain excessive costs as many of these results, show how difficult it is to make this service work economically, thus supporting an approach of economic sustainability and beyond.

This examination highlights the positive and negative aspects of the integration of the two services found in literature.

Unfortunately, it still does not emerge, through a SWOT analysis, the examination of strengths and weaknesses, therefore opportunities and threats on the topic of DRT-PT integration.

3 Methodology

The earlier sections have highlighted the growing need for deploying DRT services to meet 3 main objectives:

- Connect peri-urban areas to each other.
- Provide a first-last-mile mobility solution.
- Optimise operational costs by facilitating the digital transition of on-demand transportation services.

It is essential to understand the benefits and challenges that the implementation of a DRT services can offer. This understanding is fundamental not only for users of the transport system but also for Local Authorities and the management companies in the short, medium and long term.

This paper proposes a triple analysis, which could also be defined as a hybrid systematic literature review, as articulated and summarised in Fig. 1.

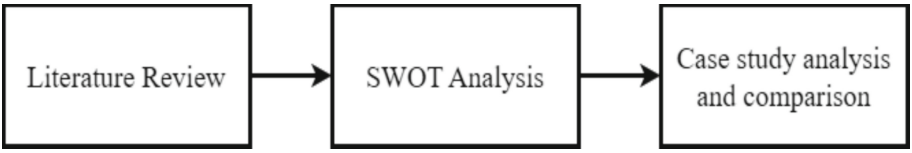

Fig. 1. Methodological steps applied in this study.

The first step, concerning literature analysis, involves defining specific keywords and searching on major search engines such as WOS, Science Direct.

Specifically, a smart literature search was conducted using the combination of keywords and Boolean operators used on search engines is of the type:

ALL = ("Public transport") AND (ALL = (DRT) OR ALL = ("Demand-responsive transit") OR ALL ("ON DEMAND BUS SERVICE")
ALL = (DRT) AND ALL = (PT) OR ALL ("Integrated transport system")

Among the criteria for selecting research results in this paper, the year of publication very important criterion in determining whether an article is included or excluded. This search targeted publications between 2014 and 2024.

From this analysis, 15 articles are selected that appear to be relevant related to the DRT-PT integration issue with spatial-temporal distribution defined in Table 1.

The second methodological step is SWOT analysis of the main elements of on-demand transport system integrated with PT. SWOT matrices inherent in the main elements of the on-demand transport system are then defined. A third and final step is the evaluation of selected application case studies in European Union and UK context in order to test the literature hypotheses.

Case studies from literature review are compared to verify scientific trends, models analysis and to better understand what has been demonstrated using the SWOT analysis technique.

SWOT analysis is a well-known technique for conducting a strategic study and consists of defining a matrix in which the main strengths, weaknesses, opportunities, and threats of a specific project alternative are stated.

In this case, the analysis involves determining the goal of the transportation service and identifying the internal and external factors for achieving the goal. The SWOT is useful when it is used to convert weaknesses into strengths and threats into opportunities [34, 35]. Several studies in the literature have applied the SWOT matrix definition for evaluating transportation mode choices [36, 37] and/or infrastructure planning [38, 39].

In recent years, the SWOT matrix has been used in different fields and has provided a good basis for strategy formulation when used correctly [40].

Table 1. Spatial-temporal distribution of main literature review analysed

Year	Reference	Spatial distribution
2014	[14]	UK
2015	[23]	Lincolnshire, UK
2017	[13]	–
2020	[24]	Amsterdam, NE
2020	[22]	Russia
2020	[25]	Baltic Region
2021	[26]	Styria
2022	[27]	Peri urban area
2023	[28]	Tampere, Genoa, Braunschweig
2023	[29]	Benevento, IT
2023	[30]	Netherlands
2023	[31]	Rural areas
2023	[32]	General planning strategy
2024	[33]	Sweden
2024		Tennesse, USA

However, inadequate application development of SWOT analysis leads to conclusions with long lists of generic, even meaningless and overly descriptive factors. Moreover, the results of the SWOT analysis are highly dependent on the knowledge and skills of the experts involved [41].

Therefore, this research aims to analyse various perspectives on implementing a DRT transport service, capturing both positive and negative aspects by considering users as customers, managers as service providers, and administrators as local authorities. The preliminary study of the benefits and criticalities deriving from a careful analysis of the literature and pilot cases from various parts of the world has made it possible to highlight some peculiarities of DRT services as well as some gaps to be filled for a wider dissemination of these modal choices.

4 Results and Discussions

4.1 The Main Advantages of PT-DRTs Integration

In general, scientific literature emphasises the most important advantages of DRTs, those are briefly described in the following:

- Potential high service flexibility i.e. convenient connections for large rural areas, support for citizens with reduced mobility, environmental benefits through reduction of private vehicles on the road.

- Improved quality of life in rural areas (in terms of accessibility, environmental, economic, and social impacts) and providing solutions for weak demand areas (increased coverage of areas, increased perception of transportation safety, increased user independence).

In summary the main impacts that should be paid attention to, include:

- Social impacts (road congestion, inclusion).
- Environmental impacts (reductions in air pollutants emissions and noise).
- Economic impacts (increased efficiency of PT in areas of weak demand).

This will encourage more businesses, tourism enterprises, commuters and families to access to sparsely populated areas with a lack of transport connectivity. Each new demand service responds to a customer challenge or need. By analysing past cases and considering a range of boundary situations, the service offered can be improved by optimising travel demand management and producing not only community benefits but also benefiting economic growth. To engage potential customers and encourage them to use DRTs, it is necessary to identify and understand their needs. Several studies in the literature point out that customers within the target group do not always share the same needs, which complicates efforts to maximise the impact of marketing strategies [42]. Therefore, Table 2 shows a SWOT analysis considering the users' point of view.

Table 2. Analysis SWOT Race-Sharing Services-Users

Strengths (S)	Weaknesses (W)
Flexibility	Costs
Dual evaluation system (client/driver)	Payment methods
"Independent" subjects	Type of reservation
Development of courtesy services (i.e.blablacar) and/or brokerage technology services with commercial purposes	
Opportunities (O)	Threats (T)
Increase in relational aspects	Drivers and customer switching platforms
Enhancing technological innovations	Frequent legal battles
Sharing on social media	Growing competition is leading to thinner profit margins
Sharing the costs of travel	Partial regulation of the industry
Automated matching of supply and demand	Self-driving cars

In this sense, parameters presented in the previous table serve as a guide to define the key aspects of the user needs, therefore supporting the evaluation of the optimal service performance that can be provided.

As next step, it is essential to investigate the behavioural aspects of the users through travel surveys and interviews, and integration of transport data, such as ticket prices to evaluate socio-economic and environmental impacts resulting from the use of a DRT.

The DRT Market Report for Europe and Beyond provides accurate market insights into trends in consumer preferences and behaviour, as well as an overview of market data and key companies.

Promotion and education are essential, and several key actions should be implemented by.

- Incentives for DRT mode choice- vouchers for a free trip and other incentives to encourage trials of the service, as well as encouraging user feedback and reviews.
- Reassurance regarding the reliability of travel service and building customer trust.
- Pairing technology (booking system based on App) with a call center to ensure accessibility to all the users.
- Strong partnerships collaboration between operators and local authorities to ensure the successful introduction and smooth operation of the service.
- Valuable role for DRT as part of the overall transport mix.

Regarding the factors related to local governments, Table 3 presents the most relevant attributes identified across the selected literature studies.

Table 3. SWOT Analysis Ride-Sharing Local Government

Strengths (S)	Weaknesses (W)
Flexibility	Costs
Reduced need for parking spaces	Informal and often disorganised service structure
Reduced pollution	Non-recurring service
Reduced traffic congestion	
Opportunities (O)	Threats (T)
Increasing modal choices	Limited regulation
MaaS enhancement	Potential safety problems on board
Automated matching of supply and demand	Pre-agreement between users

Regarding the Service Managers, it is possible to consider the viewpoint of the PT and DRT managers as defined in Table 4.

The presence of the two transport services as separated options could generate the following problems.

- Users will inevitably have two separate booking apps (one for DRT and one for public transport) or even more if shared mobility and micro-mobility are considered. This leads to user confusion and a reluctance to use alternative modes of transport.
- There is an unnecessary duplication of hardware and software solutions in the vehicle, with huge additional costs, especially for installation and maintenance.

Table 4. SWOT Analysis Ride-Sharing services PT and DRT Services Managers

Strengths (S)	Weaknesses (W)
Exclusive licences (taxis and NCCs)	Costs
Some platforms have global reach (such as Uber)	Potential privacy issues
Favourable contractual arrangement with drivers	The company failed to achieve consistent profitability
Company enjoys strong brand recognition	Unpredictable business model
Unique pricing system	Unethical working practices
Offers cheaper prices than its competitors	Low customer loyalty
Revolutionary business model	
Dual evaluation system (customer/driver)	
Low operating costs	
Opportunities (O)	Threats (T)
Enhancing one's reputation through greater responsibility and performance	Frequent legal battles
Investing in the future	Increasing competition is leading to thinner profit margins
Expand its operations	Partial regulation of the sector
Invest in green technology	Self-driving cars
Strengthen and diversify their products	

- Transport executives will continue to struggle to effectively manage day-to-day operations and successfully manage the overall mobility scenario for their organisation.
- Public administrations that subside the mobility ecosystem with taxpayers' money will suffer from the duplication of unnecessary costs to support both public transport and potentially unnecessary DRT services and vice versa; consider, for example, a user who books a door-to-door service with his DRT app, completely ignoring that a fixed-route bus is potentially just around the corner and would fully meet his needs.
- The use of both top-down and bottom-up approaches to evaluate past data of DRTs sales and revenue can improve the current market scenario. Therefore, evaluation of different service types, applications, end-users, major regions, and key industry participants is crucial.

The literature review also suggests addressing and mitigating some critical issues related to the lack of a regulatory framework and specific guidelines, as well as macroeconomic indicators that may influence the use of these services.

It is essential to understand the regional situation and the needs of citizens. This involves collecting data and analysing demographics and traffic patterns of the region, as well as the current modal split.

This data is needed to determine the best business model to implement.

- Public authorities can guide this data collection, but it should also be made available to transport operators so they can identify opportunities for implementing a new service.
- Although economic performance is important, the expected social impact of the service should be emphasised.

The key components of DRT implementation plans should include:

- Local user needs analysis: Conduct a thorough analysis of the mobility needs of local communities, taking into account demographic characteristics, travel habits and gaps in existing transport services. This will help identify areas that require priority intervention.
- Set accessibility standards: Setting minimum accessibility standards for transport services to ensure that all communities, regardless of size or location, have access to appropriate mobility options.
- Stakeholder involvement: Actively engage stakeholders, including citizens, local authorities, civil society organisations and businesses, in the planning process. This collaborative approach ensures that solutions are tailored to the actual needs of the community.
- Develop customised solutions: Creating mobility solutions tailored to the specific needs of different rural areas.

Therefore, greater user participation in service improvement could help to identify the main factors related to service deficiencies and develop short-, medium- and long-term strategies that can be implemented by service managers and local authorities to improve service and communication. For example, focusing on providing information and training on these modes, thereby reducing the use of private vehicles.

Public authorities can take the lead by bringing together the necessary stakeholders to initiate discussions and act as neutral partners to encourage collaboration. If properly implemented, communicated to users and integrated with traditional fixed services, DRT has the potential to shape the mobility of the future.

4.2 PTs-DRTs Integration: Case Studies

The best practices analysed underline how the DRT system is revolutionising. Indeed, this service would make it possible to respond to different mobility needs, not only in urban areas but also in rural areas. Among the different models of DRTs, three stand out: [43].

- LOCALISED DRT, capable of meeting targeted user needs with more flexible journeys, both in terms of timing and departure/arrival points.
- RURAL DRT, able to cover rural and low demand areas.
- FIRST- MILE/LAST-MILE, to meet the need to reach strategic hub areas.

The success of DRT integration with other transportation services, as noted by Pavanini et al. [28], relies on DRTs being recognised as one of the most efficient solutions to public transport challenges. This applies not only to rural areas but also to the various logistical difficulties that often compromise the effective use of traditional public transport services. This refers not only to rural settings but also to all the logistical difficulties that often make it difficult to use PTs.

Below, in Table 5 are described the peculiarities of each case study as an integrated DRT-TP service.

This research analyses the scientific literature and evaluates each case study in the European and UK context that has used an on-demand service integrated with public transport. Then through the discernment of said services, it is possible to confirm the hypotheses formulated using the SWOT analysis technique, which are useful for planning integrated services.

Table 5. Peculiarity of case studies analysed

Anno	City/Region	Context	Ref	Fleet type	Slot time	Reservation	Ticket price
2002	Genoa (IT)	Peripheral areas (4 areas not served by PT)	[28]	8 Minibus (14 seats)	07 am-08pm	App, call center, bus stop	There is only a €1 surcharge over the cost of an ordinary public transport ticket
2021	Tampere (FI)	8 on-demand services covering 18 peri-urban areas. Integrated service with LPT (72 bus lines, 2 tram lines, 3 railway lines) and 700 bicycles	[28]	Minibus (14–16 seats)	8.30 am 2.30 pm	Call center or bus stop	3.50 €, same price as PT
2020	Braunschweig (DE)	Suburban areas: Salzgitter, Helmstedt, Wolfsburg. (LPT consisting of buses and trams available in and around urban areas)	[28]	Taxi e minibus	Fixed timetable compatible with PT	Call center. App under development	Ticket and unit cost for both services

(*continued*)

Table 5. (*continued*)

Anno	City/Region	Context	Ref	Fleet type	Slot time	Reservation	Ticket price
2020	Morristown, Tennessee (USA)	Urban area	[33]	Minibus	Until 6 pm. Door-to-door service	Call center	Ticket of $3 for rides within the urban area. Ticket $6 for rides along the county boundaries
2020	Denmark (DK)	Rural areas	[25]	Minibus	Flexible timetable	Call center	
2020	Northway (NO)	Urban area, covering and replacing three PT lines	[25]	Taxi and minibus		Call center	
2015	Lincolnshire (UK)	Rural areas	[23]	Minibus (8–16 seats)	24hse-Monday-Sunday	App or bus stop	

The analysis of the case studies presented in Table 5 provides an insight into the services implemented in the European context and beyond, highlighting some of the optimal characteristics for defining better strategies and actions for the planning and design of integrated transport services.

In particular, the study carried out by Pavanini et al. [28], included in Table 5, explains how DRTs, when considered as an integral part of PTs, can be understood as a development strategy for less prosperous areas.

With reference to the considerations made within the SWOT analysis, the three cases of Genoa, Tampere and Braunschweig turn out to be emblematic because they describe most of the strengths for the user, from the flexibility of the service to the consolidation of the social dynamics of interrelations. It also emerges that the integration of the two DRT-PT services also has significant benefits for local authorities, i.e. strengths ranging from pollution reduction to better traffic management, thus the possibility of increasing modal choice and ensuring a more comprehensive, flexible and accessible offer.

In this way the economic sustainability problem about the case studies of Genoa, Tampere and Braunscweig present some differences about PTs' role. In Genoa, the PT is taking on more responsibility for DRT, and in both Genoa and Braunschweig, new service models are being implemented. Genoa is also the one that invests the most, has an efficient collaboration with PTs and has a DRTs valid in urban, rural and metropolitan levels [28].

Other results, such as the Benevento case study [29], also show how the integrated approach can create a beneficial and economically sustainable dynamic. The integration with the on-demand service could have a positive impact on the attractiveness of public transport, guaranteeing a reduction in journey times of up to 33%.

Regarding the Tennessee case study [33], the novelty that can be identified is the precision, i.e. the geo-localised method by which the area is represented. This allows not only to operators but also to customers to have a considerable accuracy of geographical

coordinates. The novelty of the Morristown case study is that this paratransit service is designed to serve people with disabilities, as recommend by ADA, and it is not simply an on-call system for public.

In addition to the peculiarities already listed in Table 5, it is important to note that the reservation system records and collects data such as demographic variables, age and sex, travel distances and schedules. In this way it is possible to analyse the demand and the corresponding characteristics and then understand which user group is more likely to use DRTs.

Referring to the SWOT analysis, the strengths offered by this service are mainly related to the service operator, since the DRT operator himself has the ability to functionally reorganise the service. In this way, an advantageous contractual arrangement with DRT operators can be created. In this way, public transport would be given a high profile and be able to cover timetables and areas that were previously outside its scope.

At the same time, weaknesses could be identified from an economic point of view. Indeed, it should be noted that if economic resources came from private investors, i.e. DRT operators, the business risks and uncertainties of PT operators could be minimised [3].

The opportunities that can be considered are obviously future-oriented, because with an increase in supply, and thus in entry costs, it is possible to invest in the future and in sustainable/green technology right from the fleet.

Examining Table 5 and focusing on the best practices from the Baltic region [33], we can identify certain strengths and weaknesses that local governments and operators need to address. Enhancing user involvement could greatly improve the service operations. Additionally, by integrating the DRTs with the PTs in a flexible and efficient manner, the dependency on private cars use can be gradually reduced.

Beyond the European Union context, the UK County Councils Network reported that in 2023 several rural areas buses services have reached an historic low, with 344 million fewer journeys in 2022 because of reduced services [44]. As a result, several county authorities have acted to rolling out DRTs. The UK has had notable success with DRT, particularly in rural areas where public transport options are limited, and mobility challenges are significant. Transport policy in the UK [45] is facilitating the emergence of DRTs, as it can be seen these systems are also successful in solving social problems. Laws et al. [11] analyse the typical design and operating system that should be followed for the functional design of a DRT. These recommendations are drawn from a comprehensive of all flexible route bus systems operating in the UK. The survey, sent to 36 local authorities, resulted in approximately 99 registered systems offering detailed overview of each service, including geographical coverage, operational models and characteristics (e.g. routes), applied technologies and booking methods. The findings provided valuable guidelines and considerations for the design of a DRT system.

Within the UK context, the case of Lincolnshire stands out as a particularly noteworthy example, as detailed in Table 5.

Wang et al. [23], examining the case study of Lincolnshire in England, highlight the various difficulties and challenges facing PTs today. These factors that influence the use of the DRT system. Clearly, the most vulnerable users, those with specific needs that are not compatible with the rigid PT system, are more likely to use an on-demand system.

Identifying these data highlights the importance of offering valuable recommendations for designing services to include under-represented market segments.

It then becomes clear that the involvement of local authorities is important here, and also allows a further reference to the SWOT analysis developed above. As key stakeholders, local authorities play a crucial role in planning and coordinating integrated transport services. Their neutral position enables them to foster collaboration among operators and encourage greater acceptance among passengers. More importantly, their influence can drive significant positive impacts, including reduced congestion and the development of more flexible and adaptable transport systems. This integration also paves the way for innovative, technology-driven solutions—notably the advancement of Mobility as a Service (MaaS)—offering seamless, user-centric travel experiences through interconnected transport options.

5 Conclusions

This paper evaluates the integration of scheduled PT with flexible DRT services, an area that has seen limited academic research. Unlike traditional fixed-route systems, DRT offers dynamic routes that adapt to user demand. It is advantageous in low-demand areas like suburbs and rural regions where conventional public transport is often insufficient. DRT, with its potential to enhance access to essential services and combat social isolation, is a significant step towards addressing these pressing social issues in these areas.

This research paper conducted a hybrid systematic literature review to identify relevant studies. The results show that literature studies reveal an uneven distribution of DRT services due to various social, economic, and regulatory factors. It emphasises that integrating DRT with conventional transport can lead to technological advancements and improved cost management.

The research emphasises the need to implement SWOT analyses during the planning phase of these transport services, focusing on the categories of users (users, local administrations and service managers) trying to return a snapshot of the territory, its resources as well as its areas of particular fragility and that will be further deepened with in-depth surveys and greater citizen participation in local choices and reflections by technicians that will lead to the updating of the urban and mobility planning tool.

It is clear that the research presents an initial step of analysis that will have to provide for greater cohesion in the future between the results of the SWOT with respect to the partnership context that it realises in order to ensure greater cohesion on the theoretical and political levels of implementation.

Furthermore, this research study reviews relevant case studies in Europe and the UK and identifies strategies for enhancing integration. It concludes that this synergy can diversify transport options, improve economic and logistical efficiency, and create added environmental and social value. Key factors like service reliability an understanding transport demand are essential for developing adequate digital Mobility as a Service (MaaS) platforms and promoting sustainable urban mobility planning strategies and increasing accessibility for all users. Future steps will conduct a SWOT analysis through a participatory workshop, so that all aspects of the stakeholders are considered. In this way, strengths can be used for the benefit of all stakeholders.

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Credit Author Statement. This paper is the result of the joint work of the authors. In particular, the "Abstract" and "Conclusion" were jointly written by the authors. TC with CS wrote "Background". AR and CS wrote "Methodology". CS, GuT and TC wrote "Results and discussion" and related subparagraphs.

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