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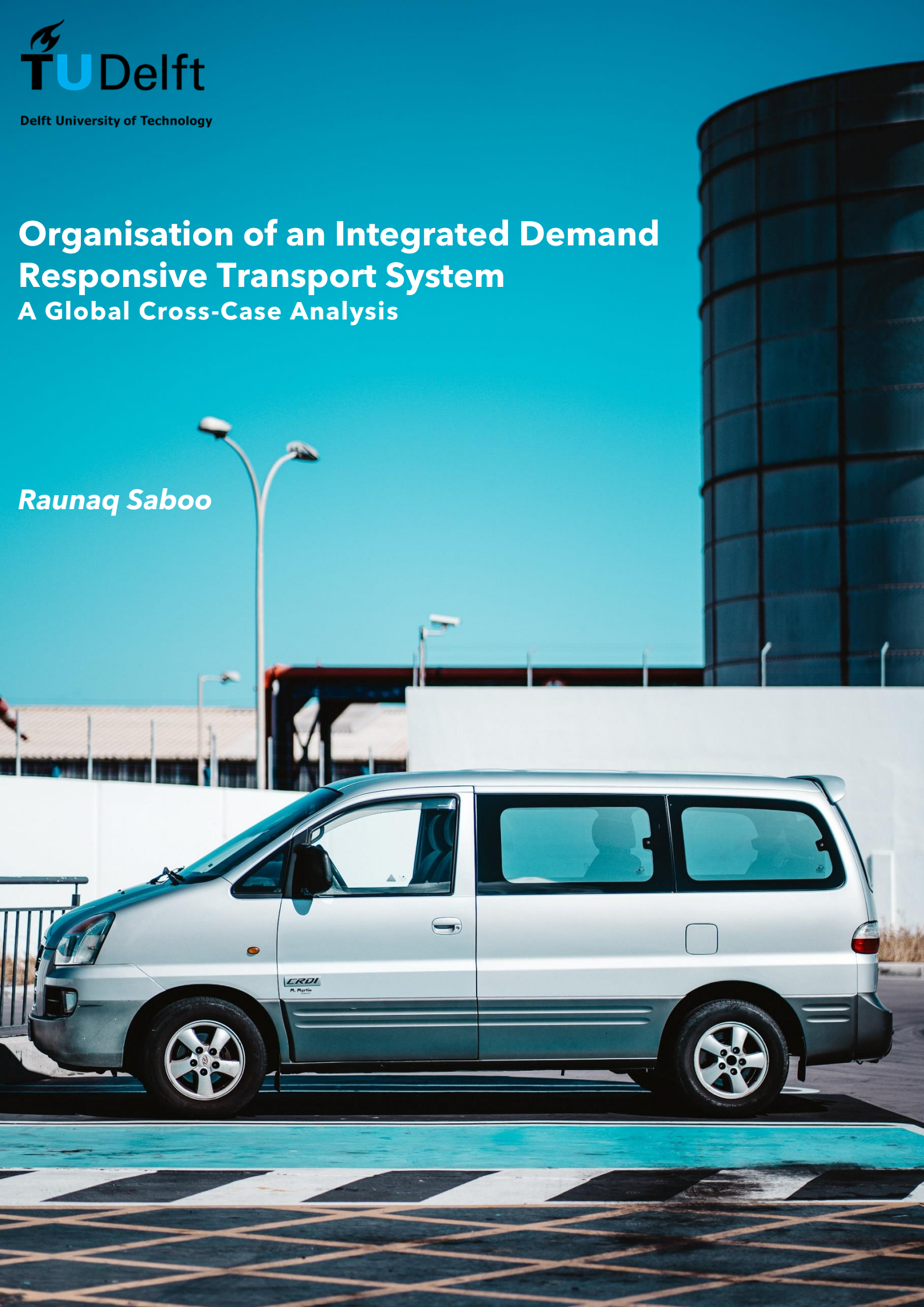
# Organisation of an Integrated Demand Responsive Transport System

## A Global Cross-Case Analysis

*Raunaq Saboo*



# Organisation of an Integrated Demand Responsive Transport System

## A Global Cross-Case Analysis

By

Raunaq Saboo

to obtain the degree of

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# Preface

This thesis marks the end of my 27 months journey as a master's student of Transport and Planning in TU Delft. I have been working on this thesis for the last 8 months. Both, this thesis, and my studies here at TU Delft would not have been possible without the support of many people.

Thank you, Niels for guiding, supporting, and encouraging me during all the major milestones: thesis, internship, and the part-time. Thank you, Wijnand for the being my go-to person for all the content related problems. Thank you, Otto for introducing me to the topic of Demand Responsive Transport and for helping me ideate during our regular bi-weekly meetings. Thank you, Serge for your inspiring words during our meetings. Thank you, Daan for sharing your insights on the practical aspects of DRT. Thank you, Robert, for the brainstorming sessions every other Thursday and for your constructive critical feedback throughout the thesis. Thank you, International team of Mobycon, for inviting me to the weekly stand-up meetings and for asking me to assist on some of your projects. They proved to be a much-required distraction from my thesis. Thank you, all the people who agreed to be interviewed for this research. Your practical perspectives are one of the core elements of this thesis.

Thank you Mummy, Daddy, Mahak, Maa, Daadu for your belief and optimism. Everything that I do is to make you all feel proud. You are my strength and motivation. And, most of all, you are the best listeners.

Staying away from family for 27 months was challenging, especially, because of COVID. But it became easier because of you. Thank you, Deeksha for always being there for me.

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Raunaq Saboo

Delft, November 2021

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# Executive Summary

The provision of scheduled public transport in rural areas is diminishing through either disappearance of bus lines or decrease in the frequency of the bus lines. It is, however, important to provide some sort of transport service for people who rely on public transport. They are, for example, people from vulnerable groups such as people with low incomes, single-parent families, ethnic minorities, the elderly, people with disabilities, and people from households without a car (Stiglic et al., 2018). Given these obstacles, the rural areas provide room for new and innovative solutions to satisfy existing mobility demands. One of the solutions that have often been cited is Demand-Responsive Transport (Sörensen et al., 2021; N. Velaga et al., 2012)

Effective integration of DRT into the public transport system can provide an opportunity for the public transport authorities to improve accessibility and to increase public transport usage in rural areas by addressing the first/last mile problem. A significant amount of work has been done on the technical and operational requirements for the integration between the two systems by using either mathematical modelling, simulation, or agent-based modelling approaches (Narayan et al., 2020). However, the literature on the institutional arrangement and organisation of the DRT as a part of the public transport system is limited. Moreover, to persuade the authorities to pursue this solution, research documenting examples of the solution through case studies have been mentioned to be beneficial.

Therefore, this research aims to develop an organizational structure for the DRT's integration with scheduled public transport. To do that, DRT services that have shown to be integrated with scheduled PT will be studied.

To meet the research aim, the following research question is formulated:

***How can a demand-responsive transport system be organised as a part of a public transport system?***

After reviewing the current literature on DRT integration, some aspects were identified that should be considered while organising DRT as a part of the public transport system. These aspects were: the function of the DRT system in relation to the public transport system, information provision, fares, tickets, marketing and brand identity, cooperation with other transport services, and ICT and data standardisation.

For the research, a case study methodology was chosen. It was assumed that the initiatives coming from the market are not part of the public transport system, and therefore, are not a part of this study. Thus, only the initiatives from the authority are considered. The initiative by the authority can be distinguished into 2 types, based on the number of modes included in the contract. When only one mode is tendered, the contract is classified as unimodal. A multimodal contract is a contract where two or more modes are contracted simultaneously. 4 cases were studied in this thesis and the table shows an overview of the 4 cases. The data collection for the 4 cases was done in 2 phases. The first phase of data collection was collecting data regarding DRT service context and operations from the available scientific literature and grey literature This was done by conducting desk research and by reviewing the available scientific literature and other publicly available grey literature such as policy documents, webinars, conference presentations, magazines, and newspaper articles etc. The next phase of data collection was done by conducting interviews with the stakeholders from the cases. The questions to be asked during the interviews were prepared beforehand in the form of the interview guide.

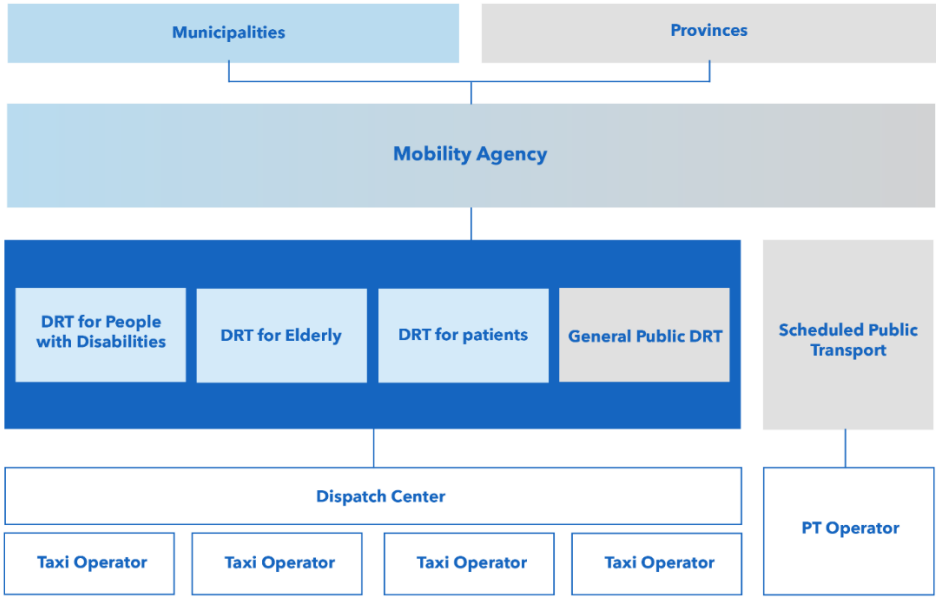
| Case | Description | Reason |
|---|---|---|
| AML Flex | Multimodal Concession from Amstelland Meerlanden region of the Netherlands. | A single operator focuses on the door-to-door journey of a passenger and thus provides shared bikes, shared DRT apart from the bus services. |
| Zoov | Unimodal DRT service operating in the rural Achterhoek region of the Netherlands. | A unique service from the Netherlands that integrates different forms of target group DRT and general public DRT into a single system |
| Flextrafik | A nationwide DRT service that brings DRT for general public, target groups under a single system. | A unique example of how to organise and manage DRT for the best possible integration of different regional, municipal, and public transport services. |
| Flexride | DRT service that is provided by the in the Denver metro area. | A growing body of experiences of DRT and PT integration from the USA. Flexride has been operating since 2001 and has been a good source of information for the integration between the two systems. |

After the data was collected for the 4 cases, a cross-case analysis was conducted between them. From the cross-case analysis, the key learnings relevant for integrating demand responsive transport with the public transport system, were discussed and are shown in the table.

| Integration Aspects | Key Learnings |
|---|---|
| Function | • DRT has a higher likelihood to be integrated with the public transport system if it is planned in a top-down approach, via public policy.<br>• The concentration of knowledge, and responsibility of developing the public transport system (including DRT and scheduled PT) in a single body gives the body control over the whole PT chain.<br>• A single body can also be a central point of contact for both internal stakeholders, external stakeholders, and the passengers. |
| Information | • Making travel information open and in a standardised way is important for information integration of DRT and the public transport system.<br>• Use of dispatch centres to provide travel advice can be an important resource in, especially in areas where the use of trip planners applications are limited due to digital illiteracy, lack of mobile phones or internet coverage.<br>• Dispatch center can leverage the open-sourced real-time scheduled public transport operations data to provide seamless transfers between the two systems. |
| Fares | • The question of fare integration is a policy decision. If, uniform fare scheme is desired then, a long-term financing strategy and a well-defined business model will be important.<br>• If uniform fare scheme is not desired, or a premium is charged, then the passengers and the stakeholders will need to be carefully explained of the reason for the premium. |
| Tickets | • The different types of payment options is going to increase with account-based ticketing. These include smartphones, contactless debit cards, QR codes.<br>• The authority responsible for the development of the DRT service should take an active role in monitoring the developments happening on the MaaS front because MaaS can support ticket integration. |
| Brand Identity | • Lack of awareness amongst the potential passengers of the DRT system has plagued a lot of DRT services. |

| | |
|---|---|
| | • Authorities should commit to significant communication and marketing efforts, as well as strategic branding and partnerships to spread the word about the service. They can leverage their position as a trustworthy government body and can be at the forefront of the branding and marketing strategy.<br>• Involving the community presents benefits by using the local knowledge of the participants |
| Cooperation with other transport services | • Collaboration between different stakeholders (providers of different types of DRT services) is desirable as it can lead to an increase in cost efficiency, reduction of duplication of services, resource sharing and knowledge sharing.<br>• For collaboration to take place, the stakeholders must be aware of the potential advantages and challenges of the collaboration<br>• A leader (Municipality, Province or even the National Government) is needed who can ensure that the stakeholders "get around a table" and discuss the obstacles to integration and the way forward. |
| ICT infrastructure and Data standardisation | • Standardised open IT architecture and data communication specification that allows coordination between the operations of different operators are essential in a system with multiple operators.<br>• There is also a need to standardise data formats that are used to describe the DRT system in trip planners. Authorities at the National level can act as the "champion" that can nudge/incentivise developers to create such a standard for information sharing in the context of DRT.<br>• PTAs can incentivise or demand through their contracts, the operator to publish their data in a defined, recognised format so that trip planners can include DRT in their service offering. |

Finally, an organisational structure was recommended by taking inspiration from the cases. Because of the different needs of stakeholders, passengers involved in the DRT industry, an integration between different systems at the policy level is a good approach. Through a mobility agency, the policy boundary between the different systems can be removed. By bringing expertise and policy to one organisation, it is expected that an alignment of the mobility policy at strategic, tactical, and operational levels between the different transport systems will be possible. The figure shows the organisational structure which is followed by the explanation.



Bundling different types of DRT into one system that can be used by both the general public and the target groups can have potential efficiency gains by achieving economies of scale. This bundled system is called integrated DRT. In the Netherlands, the municipalities are responsible for most forms of DRT that are used by target groups, and the provinces or the public transport authorities are responsible for the DRT for the general public. In such a case, the municipalities of the province can pool their resources and provide the DRT service together. By pooling their resources, the municipalities can gain a procurement advantage since economies of scale can be achieved. In true cooperation, all funds would go into one central "pot", and this would be used to fund all the different transport services. The idea here is that combining financial resources will result in a more integrated approach to the various transport systems. For such a "pot" to function, it will be important to have a clear cost allocation and revenue sharing model that is transparent and is preferably automated because of the presence of different stakeholders

The next step is to integrate the bundled DRT system and the scheduled public transport system. For that, it is recommended to organise both systems by forming a single governing body that represents both municipalities and the province. This body is called "Mobility Agency". This mobility agency will be governed by the representatives of the municipalities and the province. The PTA (province) will focus more on the scheduled public transport network, which functions as the backbone of public transport in the province. The cooperating municipalities will focus on the integrated DRT system at the local level, which both public transport passengers and target group transport passengers can use. This mobility agency will be responsible for the management of both systems. The advantage of having such a single body is that the planning of both systems can then happen in synergy. The tendering of both the scheduled public transport and the DRT system will also be handled by this body. This model provides the opportunity for the Mobility Agency to respond flexibly to the change in travel demand. By being in control of the entire chain of a passenger, flexible DRT service and the fast network of buses can be exchanged, depending on the passenger demand changes. Since the mobility agency will be the sole body responsible for the entire public transport system of the region, it can thus, push for integration of information, fare, tickets and brand identity by providing minimum requirements for the same in the contracts. Furthermore, the mobility agency will concentrate the knowledge, expertise and responsibilities into a single body. This will provide a single source of information for both passengers, as well as the stakeholders (including external stakeholders). There is also a possibility that due to this concentration of knowledge, an alignment of the different policy themes that affect mobility can happen.

For the operations of the scheduled public transport, the mobility agency can contract a public transport operator. For the operations of the integrated DRT, a dispatch centre can be set up at a provincial scale which will be responsible for taking the ride requests, planning the service, and dispatching the vehicle to the location. Finally, the execution of the trips can be done by taxi companies that are already active in the province. Taxi companies usually have local knowledge of the passengers and the remote areas in which they live which can prove to be a great resource.

The scale at which the second organisation model can function comes with a trade-off. The trade-off will be between the possibility to achieve economies of scale at a higher scale (at the provincial scale, for example) and the increase in complexity in achieving cooperation between more actors. Cost efficiency would increase with an increase in the number of municipalities. The level of quality can be higher, due to the combined knowledge of the extra people that join in the cooperation. This advantage would continue until the size of the organisation reaches a tipping point where there is no additional growth in scale, but scale disadvantages start to emerge such as control and management problems, slow decision making due to bureaucratic inertia. Thus, in general, it can be argued that there is a relationship between the number of cooperating municipalities and their costs, including administrative costs. Another issue with an increasing scale is communication. With an increase in scale cooperation between the municipalities and the province can be time-consuming due to the diversity of local wishes and policies. With an increase in the number of municipalities, the control and influence of the participating municipalities over the functioning of the mobility agency may reduce which may not be desirable, especially for, big municipalities because of a lower possibility to govern on their initiative.

It will be critical for the municipalities and the province to have a good relationship with each other, which can make cooperation between them easier. Aspects such as a common vision between the actors, sense of urgency, willingness to cooperate, trust and transparency, trust can be the bedrock for cooperation. In true cooperation, all funds would go into one central "pot", and this would be used to fund all the different transport services. Because the target group transport is paid for from many different schemes, thus, it would be beneficial the create this central "pot" by integrating different money streams. The idea here is that combining financial resources will result in a more integrated approach to the various schemes. For such a "pot" to function, it will be important to have a clear cost allocation and revenue sharing model that is transparent and is preferably automated because of the presence of different stakeholders. Volunteer participation of the municipalities is recommended because, in volunteer participation, the municipalities could choose with whom they want to cooperate. Alignment of all the contracts with the different operators, including the scheduled public transport. A workaround for that could be to start small with pilots, first starting with a few municipalities (for example the "leaders") and then gradually expanding to include other municipalities and the scheduled public transport.

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# Chapter 1: Introduction

## 1.1 Background

Rural areas are characterised by long distances and a low population density that makes provision of transport challenging and expensive. areas. The distances between villages, cities and their facilities are more extensive than in urban areas. Also, accessibility to transportation services is different compared to an urban environment. For example, rural areas are well accessible by road, but not by public transportation. Research on mobility in rural services has shown that a decrease in demand leads to a decrease in investments which further produces downward spirals of decline (Bock, 2016; J. Powell et al., 2018) The costs are not only economic but social, too. Inadequate public transport reduces accessibility, with disproportionate effects on those without alternatives, including younger people, who face restricted access to education and employment, and older people, for whom reduced mobility can contribute to loneliness and social isolation (J. Powell et al., 2018)

The demographic trends (especially ageing) have increased the demand for certain services, especially in remote and sparsely populated regions. In the EU, 29 % of citizens live in rural areas – which has been rising (Sörensen et al., 2021). It is not only a question of increasing demand for existing services but there are also the new kinds of services and mobility solutions that need to emerge (Copus et al., 2016). For instance, with a decreasing and ageing population, fewer people use regular public transport whilst there is an increasing number of people who are reliant on special transportation systems such as hospital and paratransit trips (Wang et al., 2015). Besides socio-economic factors that constrain PT in rural areas, austerity policies further hinder the provision of a broad PT network (Wang et al., 2015). The challenge of mobility and limited accessibility of services for rural residents is not a new phenomenon, even though it is further aggravated by the public budget cuts, demographic change, and depopulation (Sörensen et al., 2021)

The provision of scheduled public transport in rural areas is diminishing through either disappearance of bus lines or less frequent bus services. It is, however, important to provide some sort of transport service for people who rely on public transport. They are, for example, unable to drive a motorised vehicle or to pay for journeys over longer distances. This particularly concerns vulnerable groups such as people with low incomes, single-parent families, ethnic minorities, the elderly, the disabled and households without a car s. Given these obstacles, the rural areas provide room for new and innovative solutions to satisfy existing mobility demands. One of the solutions that has often been cited is Demand-Responsive Transport (Brake et al., 2007; Denmark, 2012; Sörensen et al., 2021; N. R. Velaga et al., 2012). This is also addressed in the national vision document for public transport in the Netherlands, "Toekomstbeeld OV 2040", authored by the national ministry, provinces, and a group of transport providers. According to the document, in areas where classic forms of public transport are lacking or are too expensive, flexible, and demand-driven transport would be the solution (IenW, 2019).

Demand-Responsive Transport (DRT) service can be defined as a type of public transport that does not follow a schedule, rather its operation is determined by its demand. DRT has been playing a small but niche role in transport systems for several years. It has been used to provide transport for the physically disabled, the elderly, and those residing in rural areas underserved by scheduled public transport. DRT is not a new concept. The first concept of DRT dates to 1916 in the Atlantic city which was a jitney service that picked up and dropped off passengers according to their requests (Coutinho et al., 2020). Up until two decades ago, most DRT systems in Europe were created and operated locally, evolving from a local need for transportation, without the strong involvement of higher levels of government. It emerged initially to serve the specialist niche markets of remote communities and mobility-impaired people, such as the elderly and those with disabilities affecting their mobility (Wang et al., 2015). However, over the last decade, DRT has attracted more and more attention as a system that can serve 21st-century patterns of dispersed low-density travel. Three main reasons for the re-emergence of DRT services have often been cited (Hensher, 2017; Perera et al., 2020; Sörensen et al., 2021; Wang et al., 2015):

1. With a decrease in the population in the rural and semi-rural regions and an increase in the use of private vehicles causing congestion and greenhouse gas emissions, authorities are actively pursuing ways to support greater use of on-demand mobility solutions which are also more convenient for the users than the conventional public transport services.
2. Due to the advancements in ICT technology (smartphone apps, dispatching systems, GPS) within the last few years, it has become possible to provide DRT services more efficiently. These advancements include an increase in the availability of phones with GPS-enabled applications, overall digitalization of the transport sector, cloud computing and data sharing, real-time booking and routing technologies.
3. Finally, the emerging trend of Mobility as a Service (MaaS) shows that there is an increase in the inclination of people towards shared economies, and in the context of transportation, it involves flexible ways of travel for the passengers in a vehicle that they do not own, without the burdens of registration costs, tolls or parking.

The traditional form of DRT is a transport service, from which passengers can arrange their transport by calling a dispatch centre to make an appointment for the pick-up and drop-off time and place (Mageean & Nelson, 2003a). However, the development of ICT has enabled more innovative solutions, for example how and when a trip is booked and which route the vehicle takes (Volinski, 2019). A request for a ride can be made through an app-based service instead of a lengthy phone call, which improves usability and convenience for the users. Such a platform also allows the operator to collect data in a systematic way to improve the service. Some examples of recent DRT solutions are Brengflex, Via/ViaVan, Kutsuplus, Bridj, Chariot, Padam, UberPool, Lyft Lines and Shuttle. All of them offer shared trips that are between a taxi and a public transport trip and currently, both private and public stakeholders are taking part in the DRT development.

## 1.2 Objective

Effective integration of DRT into the public transport system can provide an opportunity for the public transport authorities to improve accessibility and to increase public transport usage in rural areas by addressing the first/last mile problem (Sörensen et al., 2021; Stiglic et al., 2018). A significant amount of work has been done on the technical and operational requirements for the integration between the two systems by using either mathematical modelling, simulation, or agent-based modelling approaches (Narayan et al., 2020). However, the literature on the institutional arrangement and organisation of the DRT as a part of the public transport system is limited. Moreover, to persuade the authorities to pursue this solution, research documenting examples of the solution through case studies have been mentioned to be beneficial (Murray et al., 2012). It is also speculated that the introduction of the DRT system as a part of scheduled public transport can act as a viable test case in the implementation of MaaS (Mobility as a Service). This is because DRT provides a constructive solution to the first- and last-mile problems and complement fixed transit lines in low-demand locales and off-peak hours. Similarly, given that MaaS is a demand-driven integrated service, it has an association with the operation and governance of DRTs (Sharmeen & Meurs, 2019).

Therefore, this research aims to develop an organizational structure for the DRT's integration with scheduled public transport. To do that, DRT services that have shown to be integrated with scheduled PT from Netherlands and other countries will be studied.

To meet the research aim, the following research question is formulated:

***How can a demand-responsive transport system be organised as a part of a public transport system?***

To answer the main research question, the following sub-research questions are formulated:

1. *How is the integration of Demand Responsive Transport and Scheduled Public Transport defined?*
2. *According to the literature, what aspects are important while considering the integration of DRT with the public transport system?*
3. *How are these aspects addressed in different implementations of demand responsive transport systems in the Netherlands and other countries?*
4. *What are the key elements for an integrated demand responsive transport system?*

## 1.3 Scope

This thesis considers DRT systems that fall both within the "ride-sharing" and "on-demand transit" definitions. Shared DRT systems that are only considered. Therefore, ride-hailing DRT, which includes taxis and transportation network companies such as Uber and Lyft and are not built around shared rides are not considered in this research. Furthermore, only the DRT service that operates as a public transport service is considered in this research. As a result, only the DRT services that operate in rural areas are included. Here, it is assumed that rural areas do not come with financial viability for commercial DRT services that do not necessarily operate as a public transport service, to be present. Additionally, this thesis focuses on projects which have leveraged recent advances in technology platforms as part of their operations. Finally, on the topic of integration between DRT and public transport, the infrastructure and vehicle requirements are not considered, as they are not expected to have a role in the governance of DRT systems. This concerns the design and location of stops and stations, transfer hubs, design of accessible public transport systems, design of accessible vehicles.

## 1.4 Thesis Outline

The rest of this report is outlined as follows. Chapter 2 provides a brief overview of the existing literature on the topic of demand responsive transport and its integration with the public transport system. Based on the literature, Chapter 3 outlines the methodology adopted for the study. Chapter 4 presents the 4 cases that are studied in this thesis. This is followed by a cross-comparison of the cases which is discussed in Chapter 5. Chapter 6 presents the 4 alternatives for organising demand responsive transport as part of the public transport system. Finally, the report ends with conclusions, recommendations, and limitations in Chapter 7.

# Chapter 2: Literature Review

The chapter presents a literature review presents and discusses results from the current body of literature conducted on Demand responsive transport and its relationship with the public transport system. To gather relevant literature for their review, the following steps were taken:

- Google Scholar, Research Gate and Science Direct were scanned for peer-reviewed journal articles, reports, conference papers, grey literature, and dissertations from 2000 to early 2021. Literature written in English was included in this review.
- To limit the search, several keywords were used, which were Demand Responsive Transport; Dynamic Demand Responsive Transport; DRT; Dial-a-Ride; Dial-a-Bus; Community Transport; Microtransit; open DRT; DRT-PT integration; PT integration; cooperation; integration; public transport governance, public transport, public transport contracts.
- To find the literature efficiently, a review of the bibliography of relevant publications and theses was conducted (snowballing). This was instrumental in narrowing the search for the required literature. Snowballing was performed throughout the search phase.
- To further refine the gathered literature, a review of the title and abstract of the publications was done.

The goal of this literature review is to present the state of the art of demand responsive transport services, along with the common challenges faced by DRT. On the topic of DRT and public transport integration, it was found that very limited literature on DRT-Public transport integration has been published, specifically, ones that talks about the governance aspect. Therefore, public transport integration, in general, is considered.

## 2.1 What is DRT?

Many terminologies are used to describe the field of demand responsive transport systems. A field that has evolved rapidly in recent years. Terms such as demand-responsive transport, on-demand transport, and microtransit, ride-pooling are sometimes used interchangeably in scientific literature. Some of the terms that are used in association with DRT are flexible transport services (FTS), paratransit and microtransit. FTS is an umbrella term for all transport services that do not include a fixed route and/or schedule. Microtransit is a form of DRT that is privately operated (Shaheen & Cohen, 2018). In the USA, Paratransit is a form of DRT, but available to pre-qualified user bases, such as people with disabilities and the elderly

According to Wang et al. (2015), a transport service can be called a DRT service, if it can be used by everyone (open), uses low capacity vehicles such as minibus, vans, cars, which respond to change in demand by updating its route and/or its timetable and, collects fares on a per passenger basis. In contrast to scheduled public transport, a DRT service is mostly or completely tailored to the passenger's specific trip. Passengers register via a mobile application or by calling a telephone number and requesting a trip. The trip requests are scheduled through an automated or manual system. Vehicles are scheduled and routed following the specific elements of the trip request, such as the origin, destination, desired pickup time and/or desired arrival time, vehicle requirements, and other trip requirements (Teal et al., 2020). A DRT service can utilise different vehicles according to the nature of the demand. The differences may be in terms of size (for low ridership a smaller minibus or a car can be used), accessibility characteristics (a wheelchair user may have booked a trip) or availability (a taxi may be called upon to cater for last-minute bookings).

DRT is an intermediate form of transport, somewhere between bus and taxi, which covers a wide range of transport services (Currie & Fournier, 2020). At one end of the spectrum, it can simply be a bus service that stops if passengers are waiting at a stop. On the other end, DRT can act essentially as a taxi service, providing fully flexible service whenever and wherever a passenger requests a ride. Between these 2 ends, different permutations of the service can exist that serves the needs of the passenger with some

level of compromise. This is made clear from Figure 1. This image has been taken from (D'este et al., 1994). The author created a time-space diagram that categorises public transport along 2 axes: Spatial Coverage and Service Frequency. Here, the trade-off is between the full spatial coverage by a vehicle and a lower unit travel cost of public transport.

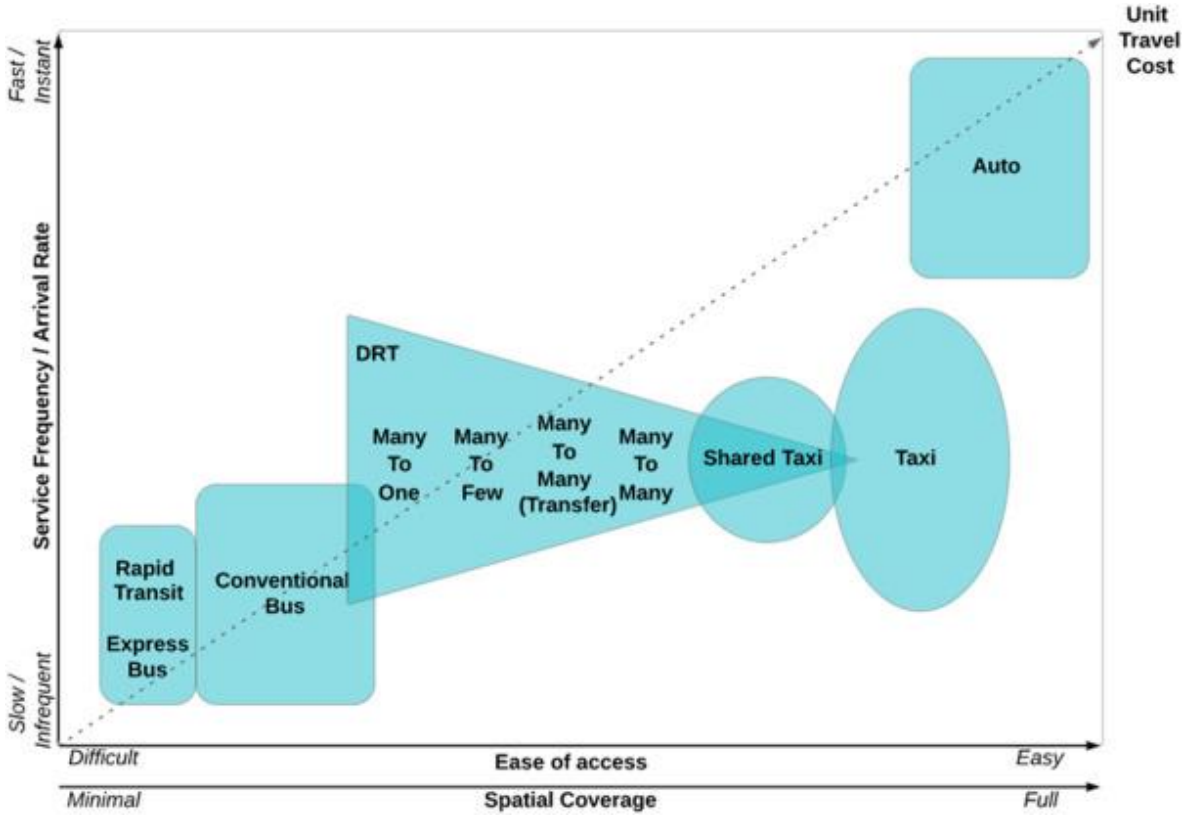


*Figure 1: Time-Space diagram of Public Transport* (D'este et al., (1994)

According to Denmark (2012), there are four basic types of DRT services based on coverage and routing. Figure 2 adapted from Freiberg et al. (2021), illustrate the 4 service types. The 4 types are:

1. Route deviation with fixed stops: Vehicles operate along the main route with fixed stops and can deviate to serve passengers inside a buffer zone within the main route.
2. Point deviation with fixed stops: Vehicles run within a zone or corridor where there are some predefined stops, but no main route
3. Destination demand responsive transport: Vehicles are demand-responsive, but have defined destinations, and can be organized to arrive or leave from a destination at fixed times.
4. Pure demand-responsive: Routes are flexible to passenger needs and are the most flexible of all.

Sloman & Hendy (2008) suggest that in the context of rural areas, large many-to-many schemes (4$^{th}$ type) might achieve economies of scale which enable lower costs. However, a recent study by Currie & Fournier (2020), concludes that historically, simpler DRT operations had lower failure rates compared to more many-to-many service types. This study does not make any distinction between DRT services for urban areas and rural areas. The fourth type is the most flexible service as it provides a door-to-door transport, thus, it provides a high-quality service, which could attract a high number of passengers. However, at some point, with a limited fleet size, an increasing number of passengers will reduce the quality of the service as it will have to deal with more deviations, more complex routes and longer travel times. A solution for that would be to increase the fleet size, but that comes with its own issue of increase in operational costs. Another solution could be to use the fare of the service to induce equilibrium between the demand and supply of the service.


*Figure 2: Types of DRT based on coverage and routing* (Freiberg et al., 2021)

DRT has several advantages over other modes of transport. From the perspective of the user, it can provide an on-demand service that combines the positive attributes of taxis and scheduled buses. It can provide, in a certain case, a door-to-door transport service, and can offer the opportunity to share a ride between multiple users, hence reducing the cost to users. Passenger satisfaction tends to be higher with DRT compared to conventional services, a finding expressed by several researchers (Ambrosino et al., 2004; Laws, 2009; Ryley et al., 2014). Reasons for this include: receiving more personalised service, coverage of the service meeting their needs better than bus services, and higher satisfaction with the customer service provided by drivers operating DRT services. DRT services offer the ability to provide a service to areas or times of low demand at a lower cost than regular bus services, although subsidy is typically still required. While subsidy per passenger trip can be higher than scheduled PT, according to (Volinski, 2019), in certain areas such as low-density rural regions, DRT can be justified when the cost per hour is less than with a fixed-route service due to the use of contractors and smaller vehicles.

Despite the potential advantages that can be achieved with a DRT system, it faces several challenges. The first challenge is its financial viability. Most of the current and past DRT services require a certain level of subsidies, thus making a fully commercially viable DRT service a rare occurrence (Brake et al., 2004; Enoch et al., 2004; Ferreira et al., 2007). This is mainly due to two reasons: First, the low ridership that it generally attracts. DRT competes with other modes of transport such as bikes, private cars. Often, DRT is seen by the passengers as a less attractive alternative for reasons such as reliability, availability of the

service, difficulty. Second, DRT service often comes with a high operating cost. Currie & Fournier (2020) developed a database of 120 DRT services over the last 40 years. Through this huge database, they analysed the cause of success or failure for those schemes. From their research, they concluded that DRTs are very failure-prone, with 50% of all schemes lasting less than 7 years. For most of the failures, high costs were attributed as the main cause. To address the financial viability of DRT services, Potter and Cook (2021) note some of the ways the surviving DRT operations have looked to raise revenue and/or cut costs. The mechanisms to raise revenue are to generate ancillary revenue streams (e.g. advertising), rely on local authority subsidies, or attract new sources of funding from alternative external sources like employers. Cost-cutting methods have included service simplification by reducing service levels (frequencies, switching from door-to-door to stop-to-stop). Another cost-cutting approach has been the use of brokerage schemes to share access to vehicles between community transport, social services, education, public transport operators and voluntary groups, Finally, the back-office system is also a major part of DRT operations, so technological solutions to minimise the staff needed for the functioning of the back office has been used to cut costs. According to Brost et al. (2018), there are opportunities to offset costs through better utilisation of drivers and vehicles, for example by using the vehicles for different purposes at differing times of day The study notes that personnel costs can be as much as 70% of the total cost and are higher than conventional bus operation if more drivers are required to drive several small vehicles. In such cases, Alessandrini et al. (2015) suggest that autonomous vehicles can be a solution as they significantly reduce the operational costs of public transport services which are often dominated by driver labour costs. Finally, the method of booking is a decisive factor in overall DRT service costs. Specifying booking further in advance can reduce costs by enabling more efficient scheduling, but this will reduce the "responsiveness to demand" of the service.

The next challenge that DRT faces is the institutional and legal barriers. Cooperation between different transport operators, public transport authorities, and passengers are essential prerequisites for setting up a DRT service. However, achieving such cooperation has been proven to be a challenge (Mageean & Nelson, 2003a).

The next challenge that DRT faces is the lack of user awareness and user adoption. Many potential passengers are simply unaware of the existence of such a service or unfamiliar with it, thus do not choose to make use of the service (Wang et al., 2015; Weckström et al., 2018). A 2018 post evaluation of the unsuccessful Kutsuplus pilot, an urban DRT system in Helsinki, highlighted a lack of understanding among end-user target groups, insufficient marketing among the reasons for the pilot's failure (Weckström et al., 2018). Cultural barriers have also affected user acceptance. For example, in the UK the passengers of a DRT service were not comfortable with sharing a ride with strangers in small vehicles (Enoch et al., 2004). Similarly, in rural Ireland, a DRT service was considered as a "feminized" transport mode by the male population and therefore, was not used by them (Ahern & Hine, 2012). Trust in the operations and security of a DRT service has also been known to play a major role in its adoption especially by vulnerable groups such as elderlies and people with disabilities. In some cases, passengers are misled with unclear pricing practices and are only accessible to young, well-to-do, and educated people. Concerns over public safety have also been raised (Schasché & Sposato, 2021).

Finally, some authors have also criticised DRT by arguing that they increase congestion through induced demand or competition with public transport, walking and cycling (Rayle et al., 2016). The possible contribution of DRT services to the reduction of carbon emissions is scarcely explored, and results are inconsistent. For example, (Interreg Europe, 2018) state that DRT has the potential to reduce carbon emissions. On the other hand, in their research about the Swiss public transport system, Petersen (2016) mentions DRT achieves occupancy numbers similar to those of taxis and concludes that DRT cannot contribute to the reduction of carbon emissions.

## 2.2 Public transport integration

"Through public transport integration, passengers perceive the transit system as one, unified, rather than a fragmented system, and the offered services as "seamless" journeys with minimum interruption,

independently of the number of modes or operators involved". Integration is used when the coexistence of more than one mode or operator leads to cooperation issues (Saliara, 2014). The goal is to create a unified system of PT, which is clear to (potential) users. While conducting a literature review, it was found that the literature on the integration of DRT and public transport is limited. Therefore, first, a generic case of public transport integration is considered. Integration in public transport can be viewed from the perspectives of the three actors defined. In this study, different perspectives will be distinguished based on the actors involved. The actors considered here are explained in the next section, which is followed by their perspectives.

## Actors

Three actors are relevant in the public transport sector. These are User, Public Transport Authority (PTA), and Operator. The PTA defines the goals and minimum requirements of the public transport system. When an operator is contracted for a particular contract, it receives a subsidy to provide services. The operator submits a plan which must satisfy the objectives set by the PTA. The operator provides the service to the user. The revenue generated by the usage of the service goes either to the PT authority or remain with the operator, depending on the contract agreement. Moreover, the PTA and operator get insight into the travel patterns of the user from the data collected. Using that data, the services can be improved (Hoekstra, 2018). This relationship is visualised in Figure 3.

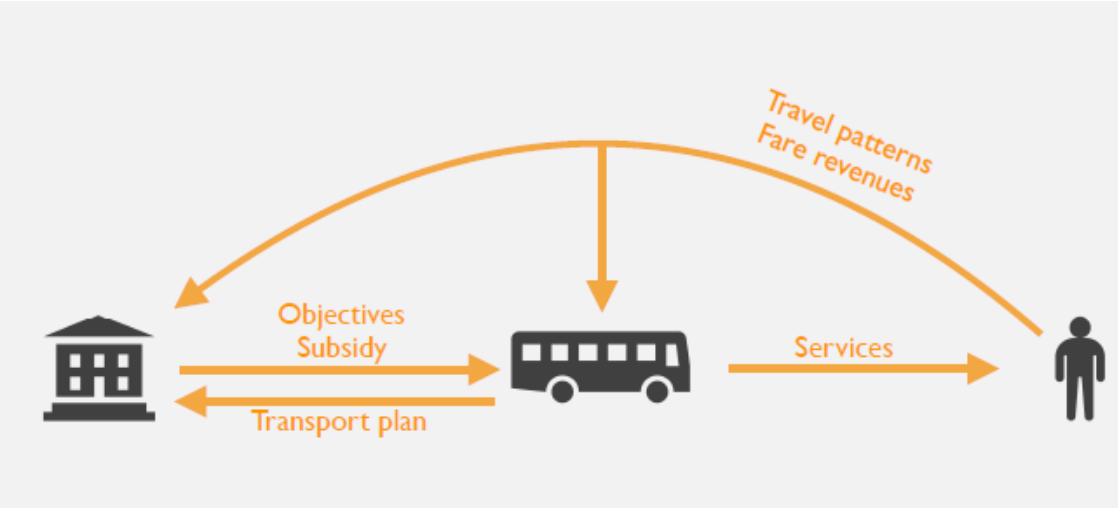


*Figure 3: Relationship between the actors involved. Adapted from* (Hoekstra, 2018).

## Passenger perspective

First, integrated information provision about routes, timetables and fares of the different transport operators means that the system is seen as 'a whole'. The method of providing information and the information itself has been known to influence the way travellers use the system (Nielsen et al., 2005). Integrated trip planners developed to integrate information from both public and private transport solutions have also been studied. Given that these integrated planners are relatively new, very few studies have analysed the impact of IMTI on the modal shift from car to shared mobility modes (Audouin, 2019). According to Ben-Elia & Avineri (2015), the low success of trip planners could be because of "experiential information (EI)", which is the kind of information that people gain by learning and experience. It has also been shown that the willingness to pay passengers to have access to travel information is generally relatively low (Audouin, 2019). Lyons et al. (2012) suggest that since most of the travel undertaken by people is local and routine, trip planners are not consulted as often as one might think. Even though there might be a better initiative for people to travel, people are used to their travel routines and are quite reluctant to change behaviours. In other words, people seem to be "adopting 'good enough' travel options rather than optimum (utility-maximized) solutions" even in the digital transport era.

Secondly, tickets and fares can be integrated. In this way, obstacles can disappear, such as a possible price difference between similar journeys operated by one or more carriers. An Integrated Tariff System (ITS) eliminates the need to purchase a ticket for each trip, which makes it easier for passengers to transfer from one line or mode to another (Saliara, 2014). A tariff system must satisfy two requirements to become integrated: no additional costs for transfers and all modes and services use the same ticketing system (Sharaby & Shiftan, 2012). Integrated fares enable users to pay for a journey regardless of the number of modes or vehicles they use to complete that journey or pay for a series of trips within a defined timeframe. The benefits of adopting integrated ticketing systems include ease of use for passengers, easy transfers. Operators benefit from improved patronage data, reduced-to no driver-passenger ticketing interaction (which can translate into reduced trip time variability) and improved fare box revenue. Payment options such as smart cards and advanced payment could potentially offer time savings as these methods remove the need for drivers to carry money and deal with queues (Laws, 2009).

A single image for the public transport system (e.g., logos and joint marketing) are also important. It is usually preferred by the governments to have a common brand identity for their public transport system so that it is recognisable (NEA Transport research and training, 2003). The purpose of this integration is to inform the potential traveller about the travel possibilities offered by the system as a whole.

### Operators' perspective

From the perspective of the operators, cost and revenue implications due to integrations are important (NEA Transport research and training, 2003). If operators provide services that are complimentary to each other, they are likely to benefit from compatibility and network effects. However, the costs and the divisions of costs that will be incurred to achieve compatibility and the expected changes and division in revenues, after achieving integration, are important reasons to achieve or not achieve integration.

Coordination between services may lead to extra passengers, but in many cases, this will also mean that more subsidies are needed for additional investments in equipment, for example. In that case, the decision to coordinate services depends not only on the relative size of the additional costs and revenues but also on the possibility of obtaining a higher subsidy.

### Authority Perspective

The previous two perspectives do not talk about how integration can be implemented. Therefore, the governance perspective is proposed. A major problem is that organizations operating in related fields, such as providers of supplementary transport services, cannot be expected to automatically evolve in compatible directions when this is not legally regulated. Since integration in public transport does not automatically occur in the market, the government needs to intervene. Mutually beneficial actions can be developed when there are appropriate forms of cooperation. Whether this is the case depends on several factors, including, for example, culture, traditions, trust, regulations (NEA Transport research and training, 2003).

Sørensen & Longva, (2011) analysed coordination in public transport using the concepts of (W. W. Powell, 1990). According to W. W. Powell (1990), there are three forms of economic organisation: market, hierarchy, and network., which are:

- Market: In this, coordination is organised through a contract. This contract mentions how the exchange of benefits takes place between the actors. In this, actors do not need to collaborate on their own and the relationship between them is defined in the contract. Furthermore, trust is not required to design the contract.
- Hierarchy: In a hierarchy, coordination is achieved through an authoritative system of orders and commands. The concept relies on rules and formal power. The upper hierarchical level actor directs the actor on a lower hierarchical level on what to do.
- Network: When formal coordination mechanisms (market or hierarchy) are absent, coordination through informal ways becomes possible. Coordination in a network is through mutual trust.

> Parties in network coordination seek complementary strengths and interdependence is of the essence because the actors are dependent on each other.

This perspective also deals with the role of the authority in the provision of the services, which depends on whether the service is initiated by the market or by the authority. In both situations, the authority has a role in monitoring the parties' compliance with general laws and regulations. This involves, for example, standard things, such as carriers having to meet certain technical standards and legal requirements. In addition, the authority may establish specific rules for certain forms of transport, such as those relating to vehicle accessibility. In a situation where the market has the initiative, the authority may still have a role as a provider of subsidies. The authority may have different reasons for this; to stimulate the general offer of services by subsidising the transport company and/or to meet certain target groups by subsidising them with, for example, fare reductions (D. van de Velde, 2004). In the case where the authority has the initiative, services can be provided by the authority by granting a contract through competitive tendering. This can be done in two ways: tendering out the service with regular public transport in one concession or tendering it out separately from regular public transport. The authority has the freedom to set its own goals and requirements regarding public transport. These requirements concern, for example, the equipment, the service, the financial accountability, the accessibility, and the timetable.

## 2.3 Integration between DRT and Public Transport

In their research, Davison et al. (2012) argue that DRT services work most efficiently when combined with traditional public transport. Their analysis demonstrated that, in cases where DRT services are integrated with traditional public transport systems, passengers have increased accessibility to public transport in areas with low passenger demands, via extra services or entirely new routes. Effective integration of DRT into the public transport system can provide an opportunity for the public transport authorities to improve accessibility and to increase public transport usage in rural areas by addressing the first/last mile problem. This section will discuss the integration aspect that are relevant when considering the organisation of DRT as a part of the public transport system.

### 2.3.1 Aspects

The level of integration between DRT and Public transport depends on the functions that the different systems fulfil in the transport system of an area. The function would thus, determine whether integration is desirable and to what extent (NEA et al., 2003). A DRT system can have 3 functions, concerning the public transport system: Competitor, Complementary or Substitutive (Freiberg et al., 2021).

Complementary model DRT schemes are integrated with public transit to some degree and operate as a part of the system as a whole. Users could be encouraged to use a DRT in combination with other services through the design of the service. For example, DRT systems can be designed to offer a connection between the passenger's origin or destination and a transportation hub such as a train station or a bus station. DRTs are a logical solution in areas where long distances and low population density make scheduled public transport more costly, as they combine flexibility, especially during off-peak hours, and cost reduction.

Substitute model DRT schemes take the place of public transport, typically in places where it has been discontinued in favour of on-demand services. Some cities and regions have entirely replaced their public transport operations with on-demand services. The substitute model is like the supplementary in that it results from public policy. The decision to replace regular public transport partially or completely is generally a government decision.

Competitor DRTs tend to be developed and controlled by private companies to meet a specific market niche, with little to no governmental interaction or control and no integration with public transit. Passengers may use this mode to transfer to another mode of transport, however, this occurs spontaneously and not because of public planning. Thus, the operators of this DRT service do not necessarily operate as a public transport service and do not try to incentivise or facilitate their users'

integration into the public transportation network. Competitor DRTs are essentially parallel services that compete with public transit for passengers.

The next aspect of integration is information integration. This concerns provision about existing DRT services, and the integration of DRT services into public transport information systems. The form and quality of information, available booking methods and knowledge about existing services in general (and resulting complexity or hassle) strongly influence the willingness to use DRT services (Schasché & Sposato, 2021; N. R. Velaga et al., 2012). General transit feed specifications (GTFS[1]) have become the de facto data standard for publishing the timetables of fixed-route services on an open-data platform. Similarly, the functionality of this standard can also be extended to include DRT services for discovery purposes. Trip planning applications such as Google Transit, 9292 can use this data to generate itineraries for the passengers. A proposed extension of GTFS to include DRT services, called GTFS-Flex, is currently in development, with its first-ever application being implemented in a state-wide trip planning application in Vermont, called "Go! Vermont" (Godavarthy & Hough, 2019). Therefore, not only just the data, but it is also necessary for applications that use proposed standards to be developed and made available, as these applications will facilitate the acceptance of discovery data specifications. Furthermore, it is still not clear how Google will react when it comes to implementing the GTFS-Flex extension in the official GTFS specifications. Moreover, until there is at least one operator that publishes data on their DRT services and there is one data consumer (trip planner) that has implemented the published data, providing information of DRT services in the trip planners will be a challenge (Teal et al., 2020).

The next aspect of integration is fare integration. Here, it is important to consider whether the fare for both DRT and PT systems should be the same everywhere and if the transfer between the two systems is free. On the one hand, it should not matter where you travel, but on the other hand, it is questionable whether a possible difference is an obstacle for the traveller and whether he or she attaches much value to this (Perera et al., 2020). In the literature, there is no consensus on the amount of fare that must be paid. Denmark (2012) suggests that having the same fare system as scheduled PT, which is generally low, can lead to an increase in demand which in turn can lead to higher operating costs, because of the need to have a higher fleet size. According to Daniels & Mulley, (2012) the fare structure should resemble the level of service that is offered by the DRT. If the service offered is of higher quality, then the imposition of a premium over the scheduled public transport fare is appropriate. However, if it is a form of public transport, a public transport fare seems more appropriate. The Dutch Travellers Association (ROVER) indicate that the fare of DRT should be the same as the public transport system. However, they also understand that a flexible system may be more expensive because it offers more comfort and has a higher level of service (ROVER, 2018).

The next aspect is the integration of tickets. Here, the idea is that the DRT should adapt to existing public transport ticket systems. This integration allows for easy booking and payment for the DRT system. A tariff system must satisfy two requirements to become integrated: no additional costs for transfers and all modes and services use the same ticketing system (Sharaby & Shiftan, 2012). Here, again ROVER indicates the passenger must be able to rely on being able to use one type of ticket in all public transport in the country. For the elderlies living in the Netherlands, (Jittrapirom et al., 2019) surveyed the preferences of the elderlies living in the Netherlands, concerning DRT systems, and found that integrating payment method with the nation-wide smart card system, OV-Chipkaart, was preferred for a convenient travel experience. However, in cases where local taxi companies are used to provide DRT, the cost to operate the service is kept as minimum as possible, and since, providing a passenger to pay with OV Chipcard is not a legal obligation for DRT in the Netherlands, forms of payment other than the OV Chipcard are usually chosen, such as cash payment, mobile ATM, multi-trip cards, registration in

[1] GTFS is a data specification, developed by Google, that allows PTAs and operators to publish their timetables, fare, and geographic transit information; comparable to the BISON standard used in the Netherlands.

combination with direct debit, etc (Jacobs, 2018). Integration of ticketing and payment systems requires high investments including interoperability between different operators. This is a particular obstacle for small and medium businesses. The public transport industry in the Netherlands is preparing to gradually move away from the OV-Chipcard to a full account-based ticketing system that can support multiple payment methods such as contactless bank cards, QR codes (Kok & Lipt, 2020). Account-based ticketing is a system in which the information on the traveller like tickets and subscriptions is stored on a personal account in the back-office of the system. Cards or other identifiers like QR codes can be used to enter the public transport system, the traveller can choose the type of identifier that is most suitable for them (or use multiple identifiers). The hardware required for an ABT system is less expensive, as the software becomes more crucial to the functioning of the system (Rikken, 2019).

The next aspect is common marketing and brand identity. The passenger organisation in the Netherlands, state that it is important to have the same name for a system with different transport operators. This way, it is clear and convenient for the traveller, and he does not have to deal with the different operators behind it (ROVER, 2018). Visibility of flexible services must be maintained aggressively since the more flexible the service, the less obvious it is to the public in terms of route and vehicle used (Brake et al., 2007). It is also, perhaps, more important to market a DRT scheme more intensively than a conventional service due to the 'culture change' associated with DRT services (Laws, 2009).

The next aspect is the cooperation between general public DRT with the DRT for target groups, to bring them under one system. Different types of DRT services usually come under the management of different stakeholders such as municipalities, provincial governments, PTAs, etc. For example, in the Netherlands, Municipalities are responsible for most forms of DRT that are used by target groups such as people with disabilities, whereas the provinces or the public transport authorities are responsible for public transport (Veeneman & Mulley, 2018). In research commissioned by the Dutch National Government, it was found that efficiency gains of 20-30% are possible after bringing different types of DRT systems under one system (MuConsult, 2016). Furthermore, in the Netherlands, due to demographic and social developments, the number of people with mobility impairments is expected to increase by 8.3% between 2016 and 2030 (Zijlstra & Bakker, 2016). This will result in an increase in expenditure on providing transport for people with disabilities or other target groups, and therefore, the provision will be under pressure if no additional resources are made available or opportunities for efficiency gains are not exploited. If such cooperation between the two systems has to happen, a cross-governmental collaboration must take place. Sometimes, there might be different operators (profit and non-profit) providing transport services for their clientele. These could be volunteer-driven services or a transport service for a nursing home. For example, in the USA, there are more than 50 different transportation programs that are funded by the National government. The impact of the different types of programs has been inefficient service delivery, underutilization of vehicles, variations in service quality, and a lack of information about available services, particularly for those who seek the information and the transportation (Mulley & Nelson, 2016). In this case, a need to increase partnership between the different operators to enable sharing of knowledge and resources has been cited (Mulley & Nelson, 2016; Volinski, 2019). Brake et al., (2007) state that well-structured partnerships between operators of different DRT services have the potential to save both marginal and operating costs for example through the pooling of resources, however, its realisation could be difficult to achieve if the initial effort is not put into the creation of a stable partnership.

The next aspect is the standardisation of the ICT infrastructure and data specification[2]. This aspect has an important role in enabling the coordination of operations between different operators. When different operators use different scheduling software, their systems do not readily interoperate with one another, This results in an inability to exchange the information about vehicle capacity, schedules, or routes that

[2] Here, a data specification is a clearly defined format that allows two different software to communicate directly with one another without the need for special conversion tools (Teal et al., 2020).

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are needed to plan and deliver trips that occur in the same service area. In that case, a standardised ICT infrastructure can be used to coordinate between different operators (Lynott, 2020). For this, the operators must agree to exchange data about each trip in a common data format and automate assigning a passenger to service and vehicle. An example of this is the case of FlexDanmark in Denmark, which has one ICT operations centre for the whole country (Westerlund, 2016b). FlexDanmark is a technology company owned by five Danish regional public transportation authorities. It was created to address inefficiencies in DRT delivery. It has been crucial in integrating more than 550 unique private operators into a single system that serves both urban and rural customers throughout Denmark.

## 2.4 Summary

First, the literature review presents the DRT systems in general. DRT has been studied under multiple terminologies such as dial-a-ride, microtransit, on-demand transport and more. This has led to inconsistency in its definition which has complicated the development of a unified scientific approach in the field of DRT. DRT is an intermediate form of transport, somewhere between bus and taxi, which covers a wide range of transport services. At one end of the spectrum, it can simply be a bus service that stops if passengers are waiting at a stop. On the other end, DRT can act essentially as a taxi service, providing fully flexible service whenever and wherever a passenger requests a ride. Between these 2 ends, different permutations of the service can exist that serves the needs of the passenger with some level of compromise. DRT has the potential to be very effective in extending and changing public transport in mainly rural areas and can become an accepted form of public transport. From past experiences, some challenges associated with DRT are recognised. These areas are financial, institutional, lack of user awareness. The next step was to study the integration in Public transport. For this, the perspectives of 3 actors were considered: Passenger, Operator, and the Authority. The passenger perspective focused on the quality of the system for the traveller. It concerned the comfort and ease with which the traveller can travel. The components that were found to be important from the perspective of the traveller were the provision of information of the service or service discovery, and a common logo/branding and customer interface. Costs may relate to, among other things, the alignment, equipment, personnel, and planning system. Revenues may be related to the alignment, subsidies and (extra) passenger revenues. Finally, from the perspective of the authority, it was concluded that to realise integration in public transport, some level of “working together” is needed between the various parties. To shape this cooperation, several factors are important. It concerns for example the (common) goals, the behaviour and the trust of the different parties involved. The next step was studying the integration of DRT with public transport. After reviewing the current literature on DRT integration, it was concluded that there is a lack of knowledge on DRT and PT integration. For this research, some aspects were identified that should be considered while organising DRT as a part of the public transport system. These aspects are shown in the Table 1.

*Table 1: Integration Aspects and their description*

| Integration Aspects | Description | Related Literature |
|---|---|---|
| Function | The function that the different systems fulfil in the transport system of an area. It would determine whether integration is desirable and to what extent. | (Freiberg et al., 2021; NEA Transport research and training, 2003) |
| Information | This concerns provision about existing DRT services, and the integration of DRT services into public transport information systems. | (Schasché & Sposato, 2021; N. R. Velaga et al., 2012) |
| Fares | This concerns whether the fare for both DRT and PT systems should be the same everywhere and if the transfer between the two systems is free | (Brake et al., 2007; Daniels & Mulley, 2012) |
| Tickets | This concerns whether DRT should adapt to existing public transport ticket systems. The integration would allow for easy booking and payment for the DRT system | (Mulley & Nelson, 2016; ROVER, 2018) |
| Brand Identity | A unified marketing and brand identity would allow the passengers to see the system as part of one whole PT system. | (Brake et al., 2007; NEA Transport research and training, 2003) |
| Cooperation with other transport services | This concerns cooperation between general public DRT with the DRT for target groups, to bring them under one system and to improve resource sharing, knowledge sharing and reduction of duplication of services. | (MuConsult, 2016; Mulley & Nelson, 2016) |
| ICT and Data standardisation | This concerns the data standards that allow coordination of operations between different operators | (Lynott, 2020) |

# Chapter 3: Methodology

This chapter outlines the methodology. First, the framework used in the research is described. This is followed by the research methodology. In this research, a case study methodology is adopted. For the case studies, the data is collected by conducting desk research, and then interviews with the relevant stakeholders of a particular case.

## 3.1 Framework

Regarding the provision of the public transport services, a distinction can be made between the "initiative with the authority" and the "initiative with the market". This distinction refers to two different forms of organizing the provision of public transport services.

When the initiative lies with the transport authority, transport services emerge through a deliberate action of the authority. Within this, a distinction can be made between a situation based on concessions and a situation based on public ownership. In the case of a concession, the authority selects a (private) company that may operate the public transport services exclusively. The selection process can take place according to different procedures (such as direct selection, negotiations after pre-selection or competitive tendering). When there is public ownership, the authority or a public company carries out the services (D. M. Van De Velde, 1999)

When the initiative lies with the market, commercially viable transport services emerge from the market. In this situation, different parties can compete with each other within the same area. Often, intervention by the authority is not absent. It can, for example, monitor companies, set 'rules of the game' and possibly provide subsidies to adjust When left to the market, there is also the risk that the (changing) needs of the market are not met because of another problem, market failure (van de Velde, 1999).

In an authority led initiative, the authority can steer the design of the contract to some extent. Several characteristics that can differ within a contract are the type of contract, the distribution of the revenue risk, the service design function, the use of incentives, and the size or scale of the contracted area. If the initiative is left to the market, the transport authority does not initiate the tendering process but limit itself to setting up possible 'rules of the game' or granting subsidies. Market parties are then free to organise this on their initiative.

In this thesis, it is assumed that the initiatives coming from the market are not part of the public transport system, and therefore, are not a part of this study. Thus, only the initiatives from the authority are considered. The initiative by the authority can be distinguished based on the number of modes included in the contract. When only one mode is tendered, the contract can be classified as unimodal. A multimodal contract is a contract where two or more modes are contracted simultaneously.

The contracts can also be distinguished based on the distribution of the revenue risk. These are A gross-cost contract in which the authority takes the financial responsibility and a net-cost contract, in which the operator takes the financial responsibility (Hoekstra, 2018). In the case of the gross-cost contract, the passenger revenues are collected by the authority and the operator receives some financial incentives to improve service quality. In the case of a net-cost contract, the operators receive the passenger revenues but also receives an annual subsidy. Furthermore, in the case of a gross-cost contract, since the authority carriers the revenue risks, the authority fully specifies the services that have to be provided, and in the case of a net-cost contract, the operator is given service design freedom, however, the minimum requirements are set by the authority (D. van de Velde, 2016). The type of contract goes together with the development function. This usually lies with the party with the revenue risk. This function, therefore, lies with either the transport operator or the transport authority. In practice, however, there is rarely complete retention or transfer of the development function. In most cases, there is a hybrid form involving cooperation between both parties (D. van de Velde & Eerdmans, 2016). Once, the case studies were determined, information was collected to study how the integration aspects identified from the literature review were addressed in the cases.

## 3.2 Research Methodology

### 3.2.1 Case studies

For the research, a case study methodology was chosen. According to (Baxter & Jack, 2008), a case study as a research methodology is appropriate when "the focus of the study is to answer "how" and "why" questions" or when "you cannot manipulate the behaviour of those involved in the study". It is also well suited to qualitative data collection and the incorporation of multiple data collection methods. Case studies are particularly useful when understanding the decision-making process and uncovering different mechanisms. Moreover, the flexibility inherent to case studies allows an exploratory research approach. In this research, multiple cases are studied, thus, a multiple case study research. Because of relatively limited resources and to ensure sufficient depth per concession, the selection is limited to 4 cases. Selecting multiple cases instead of one makes it possible to compare the selected cases with each other. Moreover, selecting multiple cases allows getting a first idea of the generalizability of the results (Creswell & Poth, 2018)

Case study research is also met with criticism due to its dependence on a small set of cases, which makes could it make it difficult to generalise the conclusions. Furthermore, the researcher could end up "getting lost" in the copious amount of data collected during case study research. Therefore, systematic organisation and management of data are of paramount importance. It could also be challenging to define the boundaries of each case (Yin, 2011). A limitation of a multiple case study is that by examining multiple cases the depth per individual case is less because the available resources have to be divided over multiple cases (Creswell & Poth, 2018). In the case of a single case study, it is possible to focus entirely on a single case which allows for more depth for the particular single case. However, it is not possible to form a picture of how things are in other cases based on this. For this reason, the benefits of multiple studies in the case of study are found to be greater.

#### Selection of case studies

In this research, the cases that are studied from the Netherlands are distinguished based on the number of modes involved in the contract (multimodal or unimodal). For a multimodal contract, AML was chosen. The idea behind the AML concession is that a single operator focuses on the door-to-door journey of a passenger. Therefore, different modalities such as shared bikes, shared DRT were also provided apart from the bus services.

For a unimodal contract, the case of Zoov from the Achterhoek region of the Netherlands was chosen. ZOOV, launched in 2017, is a DRT service for people that have no other possibility to travel within the region Achterhoek in The Netherlands. This is a unique service because it integrates different forms of target group DRT and general public DRT into a single system.

Furthermore, by conducting a scan of the DRT services from different countries, it was identified that there is a growing body of experiences of DRT and PT integration from the USA. This is mainly due to the decrease in PT ridership, advancement in ICT technologies, declining budgets of PTAs, an increase in the political will to address transport equity and the emergence of private players such as Uber, Lyft, and Via, which have made the product "passenger-oriented" instead of the general "supply-oriented" nature of PT (Shaheen & Cohen, 2018). Hence, a case from the USA is also considered interesting to study in this research. Another reason for choosing a case from the USA is because the information available publicly is abundant and is in English. Thus, data gathering saved a lot of time and effort. The experience from the USA involves both market initiatives as well as authority initiatives. However, in this research, again the authority initiatives were considered. The American case chosen in the research was RTD Denver. RTD Denver has been developing and operating DRT since 2001 and according to Volinski (2019), "No other transit agency provides as much DRT service, and RTD has been extremely generous in sharing its experience. RTD is the best source of practical information on how to provide general public DRT as efficiently as possible."

Finally, a case from Denmark is chosen. This is because the Danish model of Flextrafik has been cited to be a strategic example of how to organise and manage DRT for the best possible integration and coordination of different regional and municipal passenger transport services (Lynott, 2020; Westerlund, 2016b). It is characterised by cooperation in the organisation, technology, monitoring, along with the formation of a nationwide ICT infrastructure by FlexDanmark, which is owned and operated by all public transport authorities. Thus, it was concluded that it would be interesting to incorporate the Danish case in the research. Table 2 shows an overview of the cases included in this thesis.

*Table 2: Overview of the cases included in the thesis*

| Case | Description | Reason |
|---|---|---|
| AML Flex | Multimodal Concession from Amstelland Meerlanden region of the Netherlands. | A single operator focuses on the door-to-door journey of a passenger and thus provides shared bikes, shared DRT apart from the bus services. |
| Zoov | Unimodal DRT service operating in the rural Achterhoek region of the Netherlands. | A unique service from the Netherlands that integrates different forms of target group DRT and general public DRT into a single system |
| Flextrafik | A nationwide DRT service that brings DRT for general public, target groups under a single system. | A unique example of how to organise and manage DRT for the best possible integration of different regional, municipal, and public transport services. |
| Flexride | DRT service that is provided by the in the Denver metro area. | A growing body of experiences of DRT and PT integration from the USA. Flexride has been operating since 2001 and has been a good source of information for the integration between the two systems. |

### 3.2.2 Data Collection

#### Desk Research

The first phase of data collection was collecting data regarding DRT service context and operations from the available scientific literature and grey literature This was done by conducting desk research and by reviewing the available scientific literature and other publicly available grey literature such as policy documents, webinars, conference presentations, magazines, and newspaper articles etc. The data collected was collated to form a storyline regarding the case study. Two main techniques were used to find the relevant information: using keywords and the snow-ball method.

#### Interviews

The first phase of data collection led to some unanswered questions about the respective case study. Furthermore, it was not yet possible to get the perspectives of the practitioners. To account for this, interviews with experts from the field were conducted. According to Mack et al. (2005) interviews as a research method "is a technique designed to elicit a vivid picture of the participant's perspective on the research topic." Therefore, they can be used to gather information about the perspective of an individual rather than a community or a group. The interview could be structured, semi-structured or unstructured depending on the format of the questions asked during the research. Usually, in an interview, there is flexibility in the type of data being collected. Interviews are beneficial as they allow the collection of data regarding the personal feelings, opinions etc of the participants. Moreover, due to an interview being face-to-face, the participants tend to feel more comfortable as some interviewees may feel less self-conscious in a face-to-face situation (Laws, 2009). Finally, since there will always be an interviewer present, there are opportunities for clarification, elaboration and explanation of questions and their responses. However, the quality of the data collected during a semi-structured or unstructured interview relies on

the interviewing skills of the interviewer. Furthermore, interviews can be time-consuming as the process of conducting an interview must be done repeatedly and with multiple participants (Qu & Dumay, 2011). Due to the ongoing COVID-19 pandemic, interviews were virtually conducted with the experts relevant to the case study. Table 3 below shows the interview list.

*Table 3: List of interviewees and their description*

| Case | Organisation | Position | Perspective | Interviewee ID |
|---|---|---|---|---|
| AML Flex | Vervoerregio Amsterdam | Concession Manager | Public Transport Authority | Interviewee 1 |
| | Connexxion | Account Manager | Public Transport Operator | Interviewee 2 |
| Zoov | Zoov Beheer | Executive | Authority | Interviewee 3 |
| Flextrafik | NT | Planner | Public Transport Authority | Interviewee 4 |
| | FlexDanmark | Product Manager | Technology Provider | Interviewee 5 |
| Flexride | RTD-Denver | Service Development Manager | Public Transport Authority | Interviewee 6 |
| | DemandTrans | Executive | Technology Provider | Interviewee 7 |

## Interview guide

The questions to be asked during the interviews were prepared beforehand in the form of the interview guide. An interview guide contains a list of questions and topic areas that should be covered during the interview. "Usually, the interviewer will have a prepared set of questions but these are only used as a guide, and departures from the guidelines are not seen as a problem but are often encouraged" (Silverman, 2013). That way, the interviewer can add extra questions about an unexpected but relevant area that emerges, and sections that don't apply to the participant can be negated. The questions in the interview protocol were set out under five generalised headings. These headings were applied to each of the interviews and ensured that each interview covered a similar structure and area of questioning. The interview protocol is attached in the Appendix A. The headings and the required information from the headings were:

- Goals of the DRT service: To ascertain the involvement of the interviewees in the scheme and to obtain information on the factors surrounding the development of each scheme.
- Role Division: To determine the division of the roles and responsibilities of the stakeholders involved in the implementation of DRT
- Service Design: To provide additional data as to how each of the schemes is designed and if and how integration between DRT and PT takes place in practice.
- Data Infrastructure: To determine the perception of the stakeholders on the data infrastructure behind a DRT service and the roles of the stakeholders in its management.
- Effects on Passengers: To determine the effects (if measured) on the DRT-PT integration on the passengers.

Only for the Interviewee 7, different set of questions were used. The questions related to the expertise of the Interviewee 7, which was in the field of ICT systems, data specification, and standards. The Interviewee 7 was the involved in the development of the ICT architecture for Flexride. Each interview lasted between one and two hours. Before the interview, the interviewees were asked for their consent to record the interview. The recorded interviews were subsequently transcribed to make it easier to analyse the data. The overview of the transcripts from the interviews are attached in the Appendix B. Finally, the

interview data were combined with information obtained from the desk research. By combing, the data from multiple sources, the validity of the data can be enhanced (triangulation). Therefore, the information used to describe and compare the case studies come from the academic and grey literature, policy documents, and interviews with key stakeholders from diverse affiliations.

# Chapter 4: Case Studies

This chapter presents the 4 cases that are studied in this thesis. First, the multimodal public transport concession in the Amstelland-Meerlanden region of the Netherlands is presented. This is followed by the unimodal contract of Zoov in the Achterhoek region of the Netherlands is presented. This is followed by the Danish case called Flextrafik. This chapter is concluded by presenting the American case or the RTD-Denver case. The information presented in all the cases has been collected through desk research and by conducting interviews with the stakeholders relevant to the cases.

## 4.1 AML Flex Case Study: A Multimodal Contract

### 4.1.1. Background

The Amstelland Meerlanden concession covers the municipalities of Aalsmeer, Amstelveen, Haarlemmermeer, Ouder-Amstel and Uithoorn. The concession area covers more than 300 $km^2$ and has a population of more than 300,000. It is home to an important driving force of the Dutch economy: Schiphol Airport. The concession area is visualised in the Figure 4 below. R-net, which is a high-frequency public transport system, forms the largest part of the AML public transport network. Moreover, there are also some small cores in the concession area that are not always served by public transport.

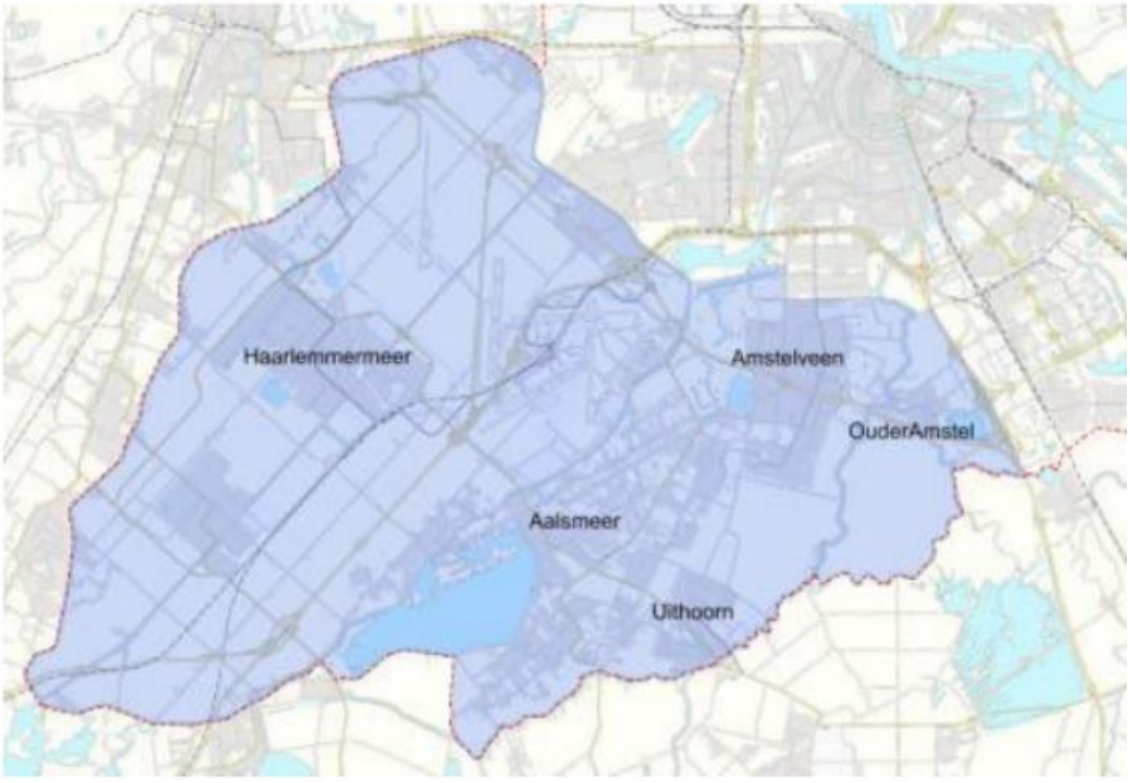


*Figure 4: Amstelland Meerlanden Concession Area* (Stadsregio Amsterdam, 2016)

In 2016, the PTA for this region, Vervoerregio Amsterdam, established the program of requirements for the new concession, which started in 2017. The PTA requested a chain concession in which a single operator would be responsible for the door-to-door journey of the passenger. The reason for requesting a chain concession was "based on the idea that broadening the perspective contributes to a more effective and efficient use of public funds: more/better (public) transport for the same (operating) contribution" (Willemse, 2021). The duration of the new concession was initially planned for a period of 10 years, however, in 2019, the concession duration was extended by 5 more years, till 2032. The bid for providing

the public transport services in the concession area was won by Connexxion, which also operated during the previous concession.

The program of requirements for the new concession acknowledged the emergence of new ICT enabled mobility such as shared taxis and bikes. The document asked for 'An operator that does not limit itself to 'its own' bus product, but also sees a role when it comes to improving pre- and post-transport in connection with 'its own' bus product, by optimising the connection to other (public) transport systems.'. The document sets broad objectives and minimum requirements, leaving a lot of room for the operator to develop new services that respond to the new context (Hirschhorn et al., 2019). It mandated that the core of the public transport system would remain the bus lines, however, advanced ICT enabled transport systems such as shared DRT, shared bikes would act as supplements to the core bus network. Partly for this reason, a DRT system was set up: AML Flex.

In the concession, the operator was given the freedom to provide DRT, with the ambition that it could demonstrate that the DRT service would lead to an improvement of the public transport offering of the area (Stadsregio Amsterdam, 2016). The mechanism used to stimulate the ambition was using the assessment criteria in the concession. In the tender for the AML concession, the operator was rewarded with the award of points. The points could be earned by offering solutions for the door-to-door approach of public transport (chain mobility). For offering a good chain mobility system, the operator could earn 3 out of 100 points. Furthermore, the transport operator could also earn 2.5 out of 100 points for an alternative interpretation of basic mobility that better met the demand (Stadsregio Amsterdam, 2015). This could mean that the decision to offer demand-driven mobility was influenced by the fact that extra points could be earned with a good offer of chain mobility. Hence, it can be argued that AML Flex was perhaps not the product of a motivation to provide a better product for the traveller. Possibly, the motivation of the operator comes more from the commercial interest to win the tender.

### 4.1.2. AML Flex

AML Flex is a public transport service that began operating in December 2017. It is a demand-responsive transport service that runs from the bus stop to the bus stop and can be ordered by passengers through either a mobile app (OV Flex) or by calling a call centre. The service was introduced along the 3 corridors, where the number of inhabitants and the usage of public transport is traditionally low (Interviewee 1), namely:

- Rijsenhout - Hoofddorp/Schiphol-Rijk
- Abbenes/Buitenkaag - Nieuw Vennep Getsewoud
- Uithoorn - Nes a/d Amstel - Amstelveen

These corridors and the stops that are used in the AML Flex operations are shown in the Figure 5.

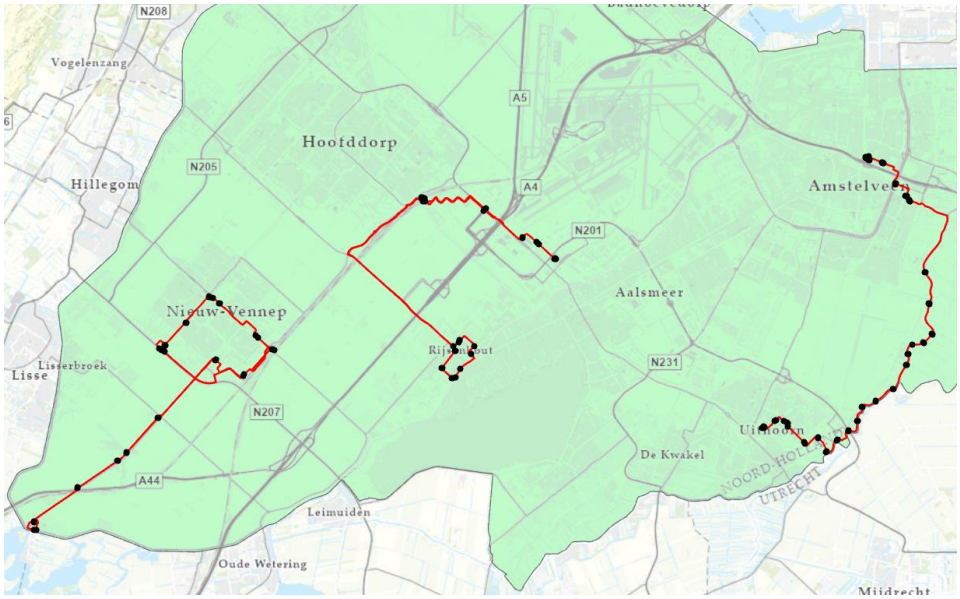


*Figure 5: AML Flex service corridors and their stops*

The daily operations of the service were outsourced to a taxi company called A-Tax. The planning of the service was done by Connexxion using the same algorithm that was behind the planning of Abel. Abel was a shared DRT service in Amsterdam that operated from 2017. The booking of the service was possible via an app, where travellers could see exactly what the arrival time was and who the driver was. Transdev, which also owns Connexxion, started Abel (Interviewee 2). Connexxion provided the service using Nissan Leaf electric vehicle as shown in Figure 6.


*Figure 6: Vehicle used for AML Flex operations* (Connexxion, 2021a)

The information about the service was available via an app and a website. From the 9292-trip planner, the user was directed to download the OV Flex app and then plan the ride. Apart from that, the phone number of the call centre was also present. Figure 7 shows a screenshot for a trip between Hoofddorp station and Rijsenhout, planned on 9292. Google Transit also showed the information about the service, however, only the phone number of the call centre was present. The service is also listed in the NS travel planner. In all the three planners, it was nowhere to be found that a ride had to be booked via an app or the telephone in advance.

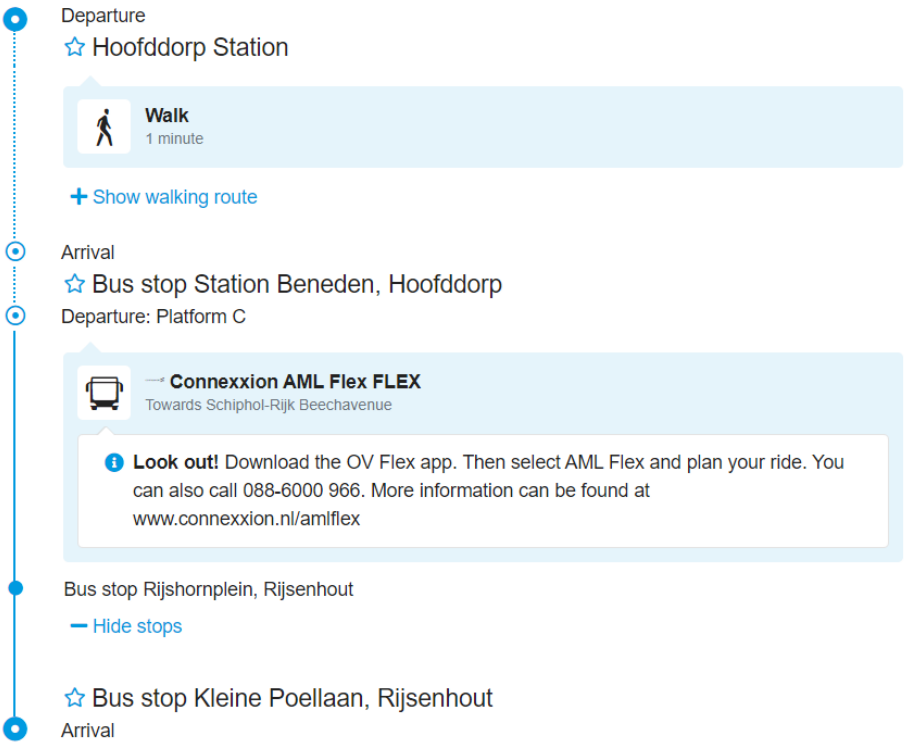


*Figure 7: Trip between Hoofddorp station and Rijsenhout, planned on 9292*

Passengers using the service paid the public transport fare, same as the fare for the bus service. Fare prices are the sum of a national boarding fee and a regional per-km fee set by each PTA. When transferring to a bus line, they are not charged the boarding fare again. Season tickets and student cards were also valid on AML Flex. For the payment of their trip, the passenger could pay while booking the ride or on the vehicle with their OV chip card, credit card or debit card. OV Chip card is the public transport smartcard valid across all PT modes and operators. The smartcard is managed by a joint venture owned by all operators in the country. To facilitate the use of an OV chip card in the vehicle, the vehicles were equipped with a handheld OV chip card reader.

CXX developed several campaigns about AML Flex using both digital and social media, as well as outdoor and print ads in the newspaper. CXX promoted AML Flex the same way they advertised their other services. This was because the marketing of their operations from door to door was mandated by the PTA.

AML Flex was set up as a pilot for the first 2 years. VRA was enthusiastic about the service and decided to provide the start-up capital of AML Flex to Connexxion for the 2-year pilot (Interviewee 2). This led to the money provided to Connexxion for their operations in the entire area coming from 2 different streams, start-up capital and subsidies for the core bus network (Interviewee 2). At the end of the two-year pilot, it was decided that an extensive evaluation would be done. Based on the evaluation, either the service was to be converted into a fixed-line service or Connexxion would continue operating the DRT service but without the financial contribution that was provided during the pilot years. From that evaluation, it was found that the service in its current form was too expensive and that the uncertainty factor which was introduced due to the need for booking a ride at least 30 mins in advance was not appreciated by the travellers. This led to Connexxion converting the AML Flex into a fixed bus line, which operates from 6 AM to 7 PM on the weekdays. The DRT service still runs after 7 PM and on the weekends.

### 4.1.3 Integration with the Public Transport System

The DRT system had a substitutive function in the public transport system, such that it was used as a replacement for bus lines. AML Flex replaced three bus lines from the previous concession that were too costly to operate as a fixed route. As a replacement, AML Flex was a stop-to-stop DRT service. According

to both interviewees, The DRT service was mainly used for connecting to stations (first/last mile). This could be due to the stop-to-stop nature of the service. The PTA mandated that the bus services be the core of the public transport system. An issue that Connexxion faced during the operation of AML Flex was the interoperability between the systems used by A-Tax and Connexxion (Interviewee 2). According to interviewee 1, when an operator has a subcontractor for the day-to-day operations, the operator must take an active role in monitoring the service operations from day one. This was, however, not the case in AML. According to interviewee 2, "At the start of the concession, the management of the service was chaotic". This was because Connexxion did not spend enough time monitoring the DRT services provided by A-Tax and focused more on "other parts of the concession". Furthermore, the ICT system at the A-Tax and the ICT system of Connexxion was not compatible. This made the exchange of information between Connexxion and A-Tax a challenge.

An important form of communication with the passengers, namely the travel information, is integrated with the commonly used travel planners like 9292, NS travel planner and Google Transit. This was possible because it was demanded by the PTA that Connexxion publish their data to the NDOV (National Databank Public Transport) open data platform. NDOV collects and stores both static and real-time travel information from all operators in the country. This information is available as open data for any party that wants to develop a travel information product (D. van de Velde & Eerdmans, 2016). However, Connexxion found it challenging to provide information about the service by the means of trip planners because DRT does not follow a specific timetable and the current trip planners are based on fixed timetables (Interviewee 2). The workaround for this challenge was that the user was redirected to Connexxion's website, OV Flex app, or phone number for planning a ride. Another method of information provision is the transit map, which has information about the bus network and AML Flex service areas. These transit maps are also present at the stops from where AML Flex vehicles can be boarded (Interviewee 2). An example of the transit map showing AML Flex and the R-Net is shown in Figure 8.


*Figure 8: Cut-out of a Public Transport Map for Amstelland Meerlanden* (Connexxion, 2021b)

Finally, with fare integration, PTA expected that the fare should be the same as the public transport system because it is a public transport system (Interviewee 1). However, the same fare structure as the public transport system was found to be inappropriate for AML Flex because of its higher operating cost (Interviewee 2). In this case, either the authority should allow a premium fare for the service, or the authority provides the difference between the revenue generated and the operating costs as subsidies.

It was possible to pay with OV Chipcards in the AML Flex vehicles. However, it was not possible to book a ride using trip planners such as 9292. Furthermore, from the OVFlex app, it was only possible to book an AML Flex ride and not for other scheduled public transport services offered by Connexxion. The portable OV chip card readers that were used in the vehicles involved in the operations of AML Flex have been available for quite some time in the market, therefore, making it possible for the passenger to pay with their OV Chip card was not an issue (Interviewee 2). However, according to Interviewee 1, the stability of the OV Chip card system could be improved as there were multiple instances (complaints towards PTA from AML Flex users) in which the portable chip card reader was not functioning properly.

Connexxion developed several campaigns about AML Flex using both digital and social media, as well as outdoor and print ads in the newspaper. Connexxion advertised AML Flex the same way they advertised their other services and all the vehicles used in the operations of AML Flex had the same brand image as their other public transport services. One of the KPIs that Connexxion had proposed in their bid was that after 1 year of operation, 50% of inhabitants in the service area would have heard of the service (Interviewee 1). According to Interviewee 1, awareness of the service and the residents of the service area not understanding how the service operated, remained a challenge.

AML Flex was a DRT service that was open to the general public. In theory, people with disabilities could access the service, as it was possible to indicate through the app or call, that a wheelchair equipped car was needed (Interviewee 1). However, along with the PT system operated by Connexxion, there exists another transport system for target groups such as people with disabilities which is not integrated with the former. This system is managed separately by the municipalities, either in partnership with each other or on their own. Thus, two different systems exist at the same time. However, now the PTA has recognised the opportunities for cooperation between the two systems and therefore have the ambition to stimulate this cooperation. This cooperation aims to "bring the worlds of public transport and target group transport closer together" (Vervoerregio Amsterdam, 2020).

Since it was the single operator for both modes, a standardisation of ICT infrastructure was not required. However, Connexxion worked with subcontractors specifically for its DRT operations, therefore, a standardised way of information sharing would have been beneficial, as there were some issues in the exchange of operational information between Connexxion and the taxi company that they had subcontracted for their operations. Interviewee 2 mentioned that they had access to travel data for both modes and therefore, they were able to optimise their services using this travel data.

### 4.1.4 Discussion

The type of coordination between the two modes that were visible in the AML case was internal coordination. Internal coordination is the case when one operator who is responsible for different modalities, organises integration internally, without any formal arrangements (D. M. Van De Velde, 1999). In the AML case, the operator had the freedom to design the service on its own. Through the schedule of requirements for their concession, the PTA had defined minimum standards for the operators to serve their goals. Thus, the role of the PTA was to set minimal requirements concerning operational planning and integration of the modalities.

AML Flex was mainly used to reach the fixed-line bus network. This was in line with the goal of the PTA who wanted that the fixed bus line should act as the "backbone" of the public transport network. The PTA decided to apply the same guidelines related to information, fares, tickets, marketing, for both modalities. This meant that AML Flex acted as a public transport system in the AML area, and not as a stand-alone service. PTA demanded in their schedule of requirements that the marketing, travel information and tickets of the operator must be based on the entire journey of the traveller, i.e., from door to door.

In a multimodal concession, it is easier to achieve these integration aspects because of the presence of one operator. Furthermore, in the case of AML Flex, it was in the interest of Connexxion to arrange the integration, as this would be in line with the goals of the VRA which was that the operator should act as a

director of the mobility chain. From the passengers' perspective, integration would theoretically make it convenient. However, data on the perception of integrated information provision, tickets, fares, and marketing on the passengers were not collected and therefore, no conclusions can be drawn on the effects on passengers. However, in literature, it has been concluded that this has a positive impact on the experience of passengers to have a unified system (Enoch et al., 2004; Mulley et al., 2012; Weckström et al., 2018).

A single operator would also eliminate the need to have data-sharing agreements between different operators for the optimisation of the entire travel chain. A single operator would also eliminate the need to have a standardised data format for the exchange of information. However, in AML's case, since there was a subcontractor involved, a standardised way of communication would have been beneficial.

Possibly the motivation to provide AML Flex came more from the commercial interest to win the tender compared to the motivation to provide a better product for the traveller. The bus network makes up approximately 90% of the entire AML concession (Interviewee 1). As such, AML Flex forms a very small part of CXX's service offering in AML. Hence, it is plausible that CXX would focus more on the high-frequency bus network, which has a higher ridership, compared to AML Flex. Thus, a challenge of having a single operator is that the operator might perceive offering DRT as a side activity, and therefore would not pay enough attention to it or have the means for it, which would mean that the service remains limited.

The operation of DRT may require specialist knowledge that the public transport operator may not have in-house. If a certain service is not the core business of a company, there is a risk that the company pays too little attention to it (Pieper, 2019). This could be the case, for example, with emerging new forms of mobility such as shared taxis and shared bicycles, which are not part of the natural service package of public transport operators. This was one of the reasons for choosing a public transport concession and organising the other mobility services, such as DRT differently, in the province of Flevoland, Overijssel and Gelderland (Jacobs, 2019). Even in the PTA, there would also be a need for staff members who are experienced in operations and monitoring DRT services.

Another limitation of having a multimodal concession is that increasing the scope of the concession will make it difficult for small operators to be present in the bid. Furthermore, due to the substantial investments required, the skills and the experience required to manage a different modality, not all the operators would be willing to or able to participate in the concession. This could ultimately lead to a decrease in competition in the public transport sector.

In the Netherlands, there is a debate when it comes to the question of whether DRT is part of the public transport system. The Passenger Transport Act (WP 2000), through a concession, gives exclusive right to an operator to operate public transport in an area. However, if DRT is not part of the public transport system, it is possible that other operators in the area can also offer DRT services. Public transport concessions in the Netherlands have a relatively long duration of 8 - 15 years (D. van de Velde, 2016). This also makes it important to consider whether new forms of mobility such as DRT can be locked into a concession and will it be possible for the concessions to keep up with the developments in this field (Hensher, 2017).

In their study, (Mageean & Nelson, 2003a) concluded that in an environment with a single operator responsible for all transport modes, it should be easier to implement DRT. This is because the operator with a monopoly will be able to plan services as they see fit, which should lead to a service without duplication, gaps, and the fear of losing customers to competitors. The operator could see an increase in ridership and customer satisfaction, whilst reducing operating costs. However, for that to occur, the presence of an innovative authority is necessary which takes a long-term view of the service. This is also applicable in this case. In their schedule of requirements, the PTA had given the freedom to the operator to offer their interpretation of basic mobility. Furthermore, the operator was also asked to come up with

the key performance indicators that would be the most appropriate for the evaluation of the service. This could mean that the PTA was still searching for the right control method for shared mobility.

Regarding the funding of the service, since money for the concession area was coming from 2 different pots (subsidies and start-up capital), it can be argued that financially, DRT and the bus network could be perceived as 2 different systems instead of a part of an integrated system. This was also confirmed by Interviewee 2 who mentioned that a single pot of funding from VRA would have led to better serve as the core public transport system and the DRT system would have been perceived as a single integrated system. AML Flex suffered from high operating costs during its operations. This highlights the importance of having a long-term strategy for funding which has also been recognised by previous DRT projects (Brake et al., 2007; Jokinen et al., 2019; Mageean & Nelson, 2003a; Mulley et al., 2012) and was also mentioned by interviewee 1. Another thing to consider is that AML Flex was started as a pilot. With pilot projects, there is the potential for setting unrealistic expectations or over-selling of the service to get it funded and operating. This can create problems towards the end of the pilot where despite offering what would otherwise be adequate service, the pilot does not meet the expectations set initially and is therefore discontinued (Klumpenhouwer, 2020).

### 4.1.5 Summary

Table 4 shows the summary of the AML Flex case and the integration aspects that were present in the case.

*Table 4: Summary of AML Flex*

| Integration Components | AML Flex |
|---|---|
| Function | Substitutive/Complementary |
| Information | Integrated |
| Fares | Integrated |
| Tickets | Partially Integrated |
| Brand Identity | Integrated |
| Cooperation with other transport services | Not integrated |
| Data standardisation | Not needed |

The idea of providing AML Flex was substitutive in nature concerning the public transport system operated by Connexxion. Connexxion provided AML Flex as a replacement for 3 bus lines from the previous concession. However, the use of the AML Flex was also complementary in nature as it was mainly used by the passengers to reach a station or hub, from where the passengers would transfer to either, the bus or the train network.

Regarding the provision of the information about the DRT service, it is concluded that it is integrated because the information for both DRT and scheduled public transport was available on common platforms such as 9292, Google Transit, etc. In this case, the authority mandated the operator to publish the data required to generate itineraries on trip planners as open source.

Similarly, the fares of the 2 systems were also integrated such that both systems followed the same fare structure. This was also mandated by the PTA and the reason behind this requirement was that the PTA considered AML Flex as a public transport system. The tickets were also seen to be partially integrated since the passenger could use their OV-Chipcard for their trip. Connexxion already had the required back-end infrastructure required for OV-Chipcard, thus, providing a passenger to pay with an OV-Chipcard on an AML Flex vehicle did not require Connexxion to arrange the backend infrastructure from scratch. To provide the option for the passenger to pay with their OV-Chipcard, Connexxion used portable OV Chipcard validators for the operations of AML Flex.

Regarding the marketing, Connexxion used the same marketing channels that they used for the regular public transport system, and therefore, is considered here to be integrated. However, some user awareness challenges were evident during the operations.

In this case, the choice of a governance system that allowed the concentration of the responsibilities at a single body, Connexxion in this case, had the incentive to integrate information, fare, ticketing, and marketing across all their public transport services.

In AML Flex, Connexxion provided DRT which was open for the general public. However, the transport system for target groups such as people with disabilities is still another system with no integration with the public transport system operated by Connexion. This system is managed separately by the municipalities that are present in the AML region, either in partnership with each other or on their own. Thus, two different systems exist at the same time, albeit for different target groups. Thus, an integration between DRT for the general public for other transport services that were running in the AML region was not visible. Municipalities are responsible for most forms of target group transport, whereas the public transport authorities are responsible for the scheduled public transport - so the integration runs through different organisations. Moreover, different forms of target group transport and scheduled public transport are funded by different ministries of the national government, which leads to a funding boundary between the different systems.

Finally, the standardisation of ICT infrastructure to ensure interoperability between the two systems was not required because Connexxion was the sole operator responsible for both public transport and DRT. However, Connexxion worked with subcontractors specifically for its DRT operations, therefore, a standardised way of information sharing would have been beneficial, as there were some issues in the exchange of operational information between Connexxion and the subcontracted taxi company.

## 4.2 Zoov Case Study: A Unimodal Contract

### 4.2.1 Background

Since 2015 municipalities in the Netherlands have been given more responsibilities concerning target group transport. Target groups transport plays an important role in moving specific groups of residents. People who cannot travel by regular public transport or independently use another means of transport can make use of the target group transport to still participate in society.

At the same time, The province of Gelderland made itself responsible for the core network of public transport connections between the urban hubs in the province, which include main bus lines and regional rail lines, and it delegated the responsibility of running Regiotaxi to the regions (collection of municipalities). Regiotaxi is a DRT service that operates in several regions in The Netherlands. It is a door-to-door service that picks up a user from an origin point and takes them to their destination. The system has no fixed stops or routes. Other travellers may also be picked up en route. Regiotaxi is a form of DRT which is open to the public but is also combined with social mobility programs, which provide mobility options for groups like school kids, impaired people and people working in sheltered workshops. Thus, in the province of Gelderland, the municipalities have been made responsible for the target group transport and general public DRT.

The province laid down the framework of cooperation between the municipalities before the handover of operations, which concluded in 2017. One of the cooperation was between the municipalities of the Achterhoek region. The Achterhoek region is made up of the municipalities of Aalten, Berkelland, Bronckhorst, Doetinchem, East Gelre, Oude IJsselstreek and Winterswijk, which are shown in Figure 9. This collective aims to provide all the residents of the Achterhoek region with a transport system with which they could travel independently and at a reasonable rate. The transport system was aimed to integrate mobility options for groups like school kids, people with disabilities, and public transport users. The reason for achieving integration was to minimise costs by bringing different transport options under a single system. The system was called Zoov.

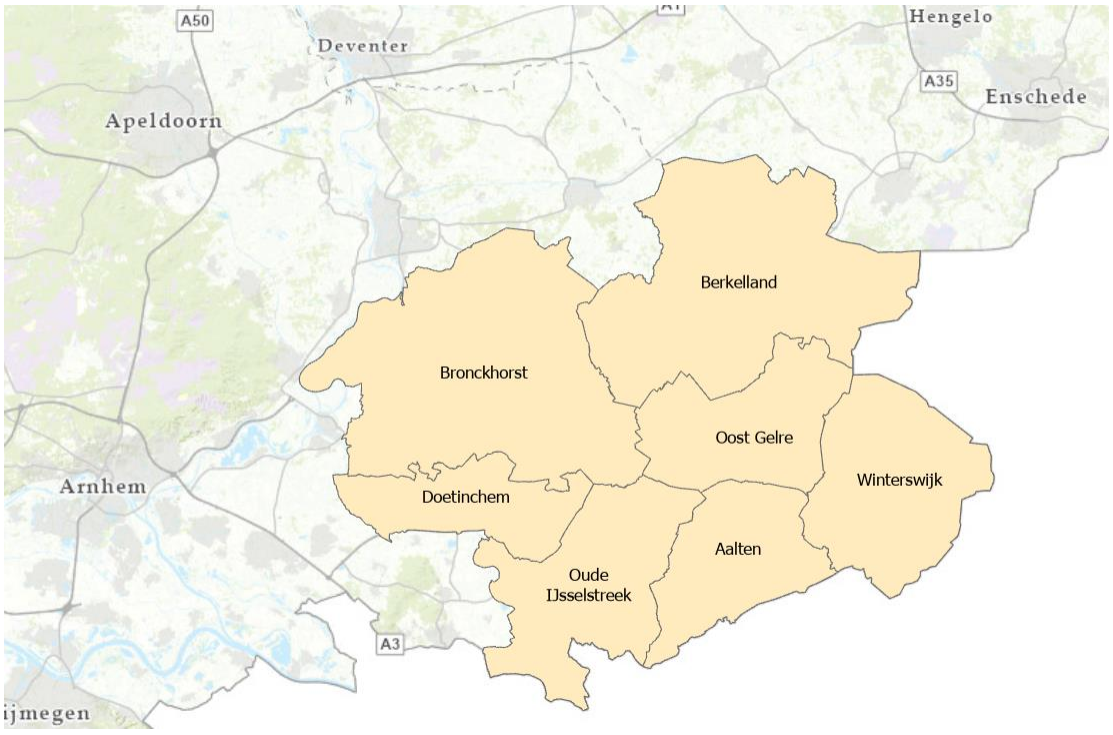


*Figure 9: Municipalities of the Achterhoek Region*

### 4.2.2 Zoov

The transport system that emerged from the cooperation between the municipalities of the Achterhoek region was called Zoov. ZOOV is the supplementary transport system in, from and to the Achterhoek region. The operation area includes the surrounding of the Achterhoek with a scope of 40 kilometres. It offers a travel option for passengers who are unable to reach their destination using any other transport. A trip must be pre-booked by phone or via its website and should be booked at least an hour in advance. The target groups are all the people of the region Achterhoek: visitors, citizens, students, and in particular for people with reduced mobility. The service is provided using small buses and cars as shown in the Figure below. Zoov offers 3 types of products based on the trip purpose:

- Zoov Tailor-Made (Zoov op Maat in Dutch): Which is for social and recreational trips
- Zoov School: This is for students with disabilities who want to travel to their school
- Zoov Work (Zoov Werk in Dutch): This is for people with disabilities who have to go to their office.


*Figure 10: Vehicle used for the operations of Zoov* (Krabbendam, 2019)

When the system started, Zoov had the following system goals:

- The system should integrate as many forms of transport as possible in one system
- The system should provide opportunities for small to medium-sized companies and local entrepreneurs
- The systems should be flexible to react to future developments.

Apart from the system goals, there were 3 operational goals, which were:

- Customer satisfaction of the system should remain at least the same during the operations.
- The operational efficiency expressed in average vehicle occupancy, operational km per operational hour, etc, should increase.
- The annual operating cost should not increase more than the indexation.

For the planning, management, and procurement of the DRT service, Zoov Beheer was set up. ZOOV Beheer is advised by a board of representatives, which consists of one representative from each municipality, the province and ZOOV Beheer. The province of Gelderland is responsible for public transport and therefore also for the public transport part of Zoov (without WMO indication). The

province decides on all aspects of public transport. Whereas the municipalities are responsible for various types of target group transport such as WMO transport, and student transport.

The operations of the service are split between two parties. One party, Munckhof, is responsible for booking rides and planning and another party, local taxi operators, are responsible for the execution of the service. Munckhof provides journey advice, books the ride, plans the journey, and dispatches its execution to the contracted carriers. Thus, Munchkof fulfils the role of the travel dispatch centre (also called Regiecentrale in Dutch, or control centre). Thus, in this case, two contracts were put out for tender: One for the dispatch centre and one for the execution of the transport service. Arriva, the public transport operator in the Achterhoek region, has also subcontracted Zoov to operate it operates demand-responsive transport for Arriva in the weekends and the evenings. Apart from Arriva, multiple third parties have also contracted Zoov to provide taxi operations. This operational model is represented in the Figure 11 below.

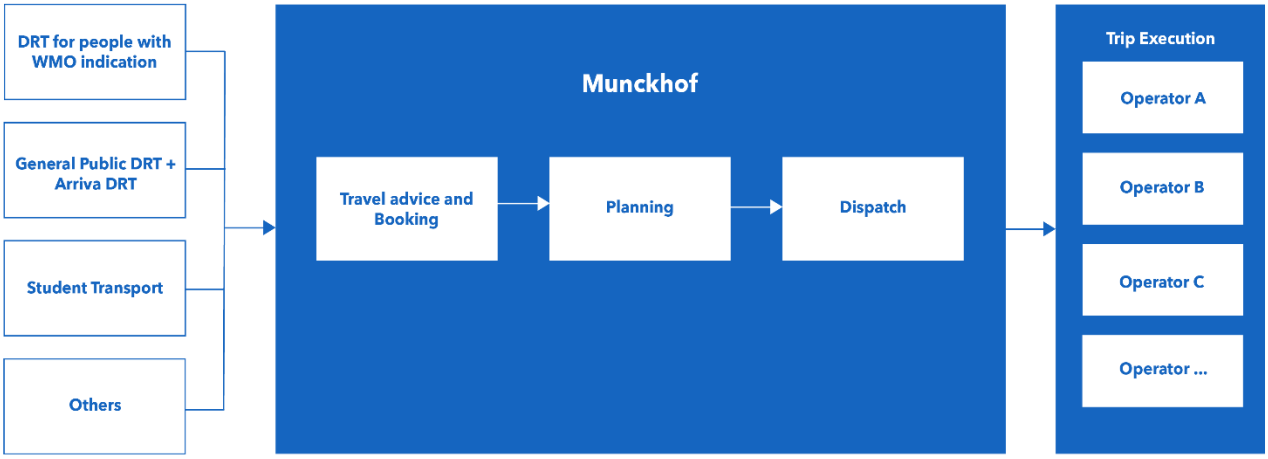


*Figure 11: Operational Model of Zoov. Inspired from* (Projectgroep Basismobiliteit Achterhoek, 2015)

Most of the passengers who use Zoov are people with reduced mobility. In the Netherlands, the municipalities give people with reduced mobility a "WMO indication" – this means that they can make use of dedicated transport like a taxi. The operations for transport for people with WMO indication is financed from the transport budgets of the participating municipalities (since they are responsible for WMO transport). The province of Gelderland finances the transport service for public transport function, which is open to use for people without the WMO indication.

The dispatch centre is compensated by a fixed monthly fee. In addition, there was a one-off implementation fee that was divided between the participating municipalities. Both, the dispatch centre and the operators are incentivised in the form of an annual bonus to achieve annual objectives defined by themselves at the beginning of the year.

For journey advice and ride-booking, Munckhof operates a call centre. For travellers, without a WMO indication, the call centre operator first checks for alternative travel options with ordinary public transport. Based on this advice, the passenger can decide to either book a ride or use the regular public transport option. The ride can be booked via a website as well. Information about Zoov on trip planners is not available. The trip planner, 9292, only describes the service and redirects the user to Zoov's website. However, it does not show Zoov as an alternative. Zoov is unavailable on other trip planners like Google Transit and NS Reisplanner.

People who have the WMO indication can travel for low fares with ZOOV because of their various have transport demands. For people without the indication, a higher fare is charged. Fare prices are the sum of a boarding fee and a per-km fee. A higher fare is charged to regulate the demand of the service. For people without an indication, the fare structure is determined by the province. Whereas, for people with WMO

indication, the fare structure is determined by the participating municipalities. The fare structure is shown in the Table 5.

*Table 5: Fare Structure in Zoov*

| Type of traveller | Description | Boarding Fee | Per-km fee | |
|---|---|---|---|---|
| | | | Up to 20 km | 20-40 km |
| Without WMO Indication | If it is possible to ride with regular public transport | € 6.07 | € 0.95 | € 2.21 |
| | If it is not possible to ride with regular public transport | € 3.25 | € 0.51 | € 2.21 |
| With WMO indication | On weekdays days between 06.00 and 09.00 | € 1.62 | € 0.31 | € 2.21 |
| | Other times | € 1.00 | € 0.21 | € 2.21 |

In 2022, a restructuring of the transport system will happen again. The province of Gelderland will take back the responsibility of managing the general public DRT from the 6 regions including Achterhoek. The province will thus implement HalteTaxi, a new stop-to-stop DRT system that will be available in the entire province. This new system will be an open system and can be used by anyone. The reason for this restructuring and unbundling of the transport systems is "because the province expects both systems to be optimized in this way" and "because the province itself wants to have control over transport to simplify decision-making processes (Santangelo, 2021).

### 4.2.3 Integration with the Public Transport System

According to interviewee 3, the system offers an additional transport option for the residents of the Achterhoek region who do not have access to any other transport option. This means that it could act as a complimentary function to the regular public transport, or it could as a stand-alone government subsidised transport service for Achterhoek. In its role as the complimentary function, Zoov tries to provide seamless transfers. On booking the ride over the telephone, the passenger has the option of letting the operator know the details of their train journey. From this information and the open-sourced real-time data from the train operations, Zoov tracks the train and dispatches the vehicle accordingly. This is only possible when the journey has been booked via the telephone (Interviewee 3). This feature not being available on the website does not seem to be a big issue as the percentage of people who book rides via the website has always been less than 10% since it began operating (Zoov, 2020).

The travel dispatch centre acted as a single point of information for the residents of the Achterhoek region. It provided information about all the possible public transport alternatives available in Achterhoek. When a passenger called to book a trip, the TDC would provide other possible travel options, if applicable. However, this was only available for the people who called the TDC. Furthermore, Zoov was not available as an option in a trip itinerary in any of the commonly used trip planners such as 9292, Google Transit, and NS trip planner. Regarding its operations for Arriva, Zoov management had the ambition to integrate the travel planning app used by Arriva with the travel planning of Zoov. However, due to the decision of the province of Gelderland to discontinue the public transport function of Zoov, there was no incentive for Arriva to integrate their travel planners with Arriva. However, according to interviewee 3, the integration did not face any technological barriers.

Ticket and Fare integration with the public transport system was not achieved in this system because of two reasons: the OV chip card system is legally only mandatory for public transport and Zoov was not

seen as public transport by the Province. Secondly, it was too costly to bring the Zoov system under the integrated ticketing system because of a large scale of operations that required many vehicles. Furthermore, paying with bank cards and automatic debit payments was cheaper and easier to arrange (interviewee 3). For their operations with Arriva, having OV chip card readers in the taxi was not economically feasible because of the low ridership that it attracted. Thus, it was not demanded by the province (interviewee 3).

Zoov Beheer is responsible for the marketing and the design of the brand identity. This made it possible to have a single brand image across all the different transport services for the different target groups that are present in the service offering. For their operations with Arriva, having a common brand image was not required. This could again be because of the low ridership of Zoov's operations for Arriva. According to interviewee 3 "Arranging a common brand image for our Arriva operations, depended more on the economical reason. However, to arrange the practicalities was not an issue for Zoov"

Since Achterhoek is mainly a rural region with small towns and villages, it was important to cooperate because providing separate DRT services in the participating municipalities would have been too costly for them (Interviewee 3). Finally, the province also transferred the implementation of Regiotaxi (DRT open for everyone) to the municipalities. The cooperation between them was also made easier because the 7 participating municipalities had been working together for a long time and therefore, already had established good working relationships (Interviewee 3). Regarding their operations, interviewee 3 mentioned, "It was in the interest of Arriva to subcontract Zoov for their DRT operations because we already were operating in the area. By combining this in our transport system, their DRT operations could become efficient. Having a good relationship and "being on speaking terms" with Arriva was the basis of our partnership".

Since multiple operators were providing the service, with a travel dispatch centre directing them, a standardised method of exchange of information between the vehicle and the dispatch centre was necessary. This was proven to be easy to arrange because, in the Netherlands, taxis must be equipped with an onboard computer, the specification for which has been standardised by the Dutch government. Furthermore, these onboard computers were provided by the dispatch centre to the operators.

### 4.2.4 Discussion

Zoov fulfils the role of providing a DRT for people that have no other possibility to travel within the region Achterhoek in The Netherlands. The system is subsidized by the government. This guarantees a good service at a very cheap price for the passengers. The system is based on the integration of different types of transport services. The rationale behind this was that this strategy would lead to a lean system with a limitation in costs. Based on the system goals of Zoov, the operational model that was chosen in this case was the most appropriate. In this model, the system could be planned efficiently because all booking requests come to a single point and thus, can be planned integrally.

Furthermore, the dispatch centre checks for each journey request whether the same journey can also be made by regular public transport. This creates a one-stop-shop for travellers where they can go for information and make reservations. This created a single point of information for all modes of transport in the Achterhoek region.

The Zoov system seems more directed towards people with WMO indication and less towards those without the indication. This is also evident from the ridership data. Since it began operating in 2017 (and excluding 2020 because of the COVID-19 pandemic), the average annual ridership for people with WMO indication has been approximately 234,000. These rides were made by around 5600 unique passengers. However, for people without the WMO indication, the average annual ridership has been approximately 8,800 (Zoov, 2020). Zoov has also seen positive experiences from its operations. The customer satisfaction for the service has been 8 on a scale of 1-10 since 2017 and the passengers of the service appreciate the fact that the drivers and the companies are local and are known to them. Local knowledge

has also been an important resource in the operation of DRT services in another Dutch context (Jittrapirom et al., 2019) as well as in international contexts of Ireland, Finland (Ambrosino et al., 2004; Weckström et al., 2018).

The system offered opportunities for small and local taxi operators. Moreover, they were able to participate independently in the operations without being dependent on the main contractor. Out of the 14 operators that execute the 3 types of services for Zoov, 7 operators are local taxi companies (Zoov, 2020).

This split of planning and execution of the service provided flexibility in the operations. This flexibility is important because of the uncertainties that arise from future developments in this field. For example, if needed, new modes can either be removed or added to this model.

For this system, it was paramount that good and stable cooperation between the stakeholders grew. The cooperation was possible because a bottom-up approach was possible between the municipalities. Furthermore, because Achterhoek is mainly a rural region with small towns and villages, it was important to cooperate because providing separate DRT services in the participating municipalities would have been too costly to operate. This was also made easier since the 7 participating municipalities have been working together for a long time and therefore, already had established good working relationships.

A challenge that occurred initially was the split of planning of the transport and the actual execution of the transport. When the tender was published, this gave a lot of hesitation among the possible contract partners. When the system was implemented, the planning and transport partners had to get used to each other and to the way of cooperation (van Egmond et al., 2019).

Another challenge that could arise out of this model is the added complexity due to the management of the contracts with all the different operators and with the travel dispatch centre. This model requires a skilled and ambitious project team that plays a central role in the management of the operations. In the case of Zoov, this role was filled by Zoov Beheer. They were responsible for setting the service requirements, contracting the operators, day-to-day management of the contract. Furthermore, Zoov Beheer was also actively involved in maintaining contacts with the passenger and for feedback and complaints.

### 4.2.5 Summary

Table 6 shows the summary of the Zoov case and the integration factors that were present in the case.

*Table 6: Summary of Zoov*

| Integration Aspects | Zoov |
|---|---|
| Function | Substitutive/ Complementary |
| Information | Partially Integrated |
| Fares | Not Integrated |
| Tickets | Not Integrated |
| Brand Identity | Partially Integrated |
| Cooperation with other transport services | Integrated |
| Data standardisation | Needed |

The aim of the municipalities and the province, providing this service, was to provide the residents of the Achterhoek a transport alternative, in areas where providing scheduled public transport was difficult because of low passenger demand. However, the use of system was also aimed to complement the scheduled public transport system.

The travel dispatch centre that was formed to coordinate the operations between different DRT services also acted as a single point of information for the residents of Achterhoek region. The dispatch center also provided information about all the possible public transport alternatives available in Achterhoek. The information about the service was not however, available via commonly used trip planners. Thus, the information integration in Zoov was partial. On the other hand, since less than 10% of people book the service via Zoov's website, the provision of information about Zoov via online trip planners seems less relevant.

Fare integration between the DRT for general public and scheduled public transport was also not achieved. The fare scheme for DRT for general public was divided into 2 parts: a higher scheme if another public transport alternative was available and a lower one if no other public transport alternative was available. In situations where there is another public transport alternative, Zoov provides a premium taxi like transport service due to its address-to-address operations, and therefore, achieving fare integration is questionable.

Zoov Beheer was responsible for the marketing, customer awareness, and for the designing the brand-identity of the service. With these responsibilities concentrated at one organisation, Zoov Beheer, it was possible to have single brand identity across all the different transport services for the different target group that are present only in their service offering.

The DRT service integrated DRT for the target groups and for general public by creating an integrated DRT service. In 2017, the province of Gelderland, the PTA for the province, delegated its task of providing DRT for general public to the five regions in the province, including the Achterhoek region. The province retained their responsibility for the public transport connections between the urban hubs in the province. The Achterhoek region's ambition regarding the basic mobility was to enable all inhabitants of the Achterhoek region to travel independently. Because of government budget cutbacks, the province and municipalities collaborated with the seven municipalities in the Achterhoek region to jointly work towards the ambition of basic mobility.

A standardised method of exchange of information between the taxis and the dispatch center is needed to coordinate the operations between multiple operators. In the Netherlands, the taxi operators are legally obliged to be equipped with on-board computers which has been standardised by the Dutch government. Finally, for the operations, the dispatch center provided these on-board computers to the operators and therefore, the computers could be customised for the operations.

## 4.3 Flextrafik Case Study: A Nationwide Coordination Model

### 4.3.1 Background

The institutional structure of public transport in Denmark was influenced by two pieces of the Danish legislature. First, The Structural Reform Act of 2007, which sought to reduce duplication of government services consolidating 14 counties into 5 regions, and 271 municipalities into 98 municipalities. Second, the 2007 Law for Public Transportation, which established regional public transportation authorities (PTAs) (Lynott, 2020).

In Denmark, local and regional public transport services are determined and funded by local government (municipalities for local PT and regional government for regional PT). The detailed planning, contracting and monitoring of those services, is done by the PTA which is collectively owned and governed by the municipalities and the regions. So, whilst the municipalities and regions decide on the level of services they want and provide the funding for the same, the PTA is responsible, in cooperation with the municipalities, for developing the policies into planning, travel information, fares and ticketing and procurement of networks of fixed services that fulfil the overall aims and wishes of their constituent regions and municipalities (Urban Transport Group, 2017). Overall, there are six PTAs in Denmark, which are shown in the Figure 12.


*Figure 12: The 6 PTAs of the Denmark* (Urban Transport Group, 2017)

Both municipalities and regional governments have obligations under national law to provide scheduled PT through their PTA. Municipalities and the regions are also responsible for providing transport services for their residents with qualifying disabilities (called Flextrafik). It is possible for both, municipalities, and the regions to voluntarily hand over this responsibility to provide Flextrafik services to the PTA. This structure enables cross-border collaboration and coordination of mobility between different municipalities. It's a decision made by the municipalities and regions whether they allocate these DRT services to their PTA's or organize these services by themselves (in-house or procurement process). It is also possible for the municipalities and the regional government to fund transportation services for their constituents, through their PTA.

### 4.3.2 Flextrafik

Flextrafik is the name given to all demand-responsive transport services in Denmark. The main services that are included in the Flextrafik suite, according to the offer of the PTA Nordjyllands Trafikselskab (Danish for North Jutland's Transport Company) or NT, are:

1. Flextur: Flextur is a flexible alternative when the bus is not running. It is public transport from address to address. Flextur can be used every day of the week from 6:00 AM to 11:00 PM.
2. Plustur: Trips are ordered from an address to a bus/train stop, or from a bus stop/railway station to an address. However, the actual location of the pick-up and drop off of passengers at their origin or final destination may be a mobility hub. A mobility hub is a pre-defined location where different mobility options should be available. In rural areas, mobility hubs in their most basic form are often just a post with a sign signalling. Plustur can only be ordered using the public transport planner in conjunction with a bus or train journey. Thus, the service is only available whenever the public transport system is operating.
3. Flexhandicap: It is a service designed for people with physical disabilities It includes driving to leisure activities, family visits, shopping, cultural events, etc. and can be used all days of the week, 24 hours a day.
4. Flexaktivitet (FlexActivity): It is a service designed for elderly people who need to be driven to day centres, rehabilitation, or health centres. Contrary to Flextur and FlexHandicap, FlexActivity operates on fixed routes and fixed times. Moreover, the municipality in which the person resides approves them to use FlexActivity.
5. Flexlæge (Flex Doctor): It is a service designed for people who need to visit hospitals for examinations or recurring treatments and cannot use regular public transport. The municipality in which a person resides approves them to use FlexDoctor.
6. Flexskole (FlexSchool): It is a service for children with special needs, such as children with disabilities or children living in remote areas and cannot use regular public transport. There are regular routes and at fixed times when several students ride together in the same carriage. The students are examined (approved) for Flexskole by the school administration in the municipality of residence.

The two services, Flextur and Plustur are the “open services” which are the services that can be used by anyone (Interviewee 4). These services can be used as a transport option that complements other public transports such as buses or trains by offering first/last mile trips (Plustur), or they can provide an alternative to buses and trains in areas and times where no such train or bus service is available (Flextur) (Interviewee 4). Figure 13 Figure 14 illustrates the two services.


*Figure 13: Illustration of Flextur service. Adapted from* (NT, 2017)

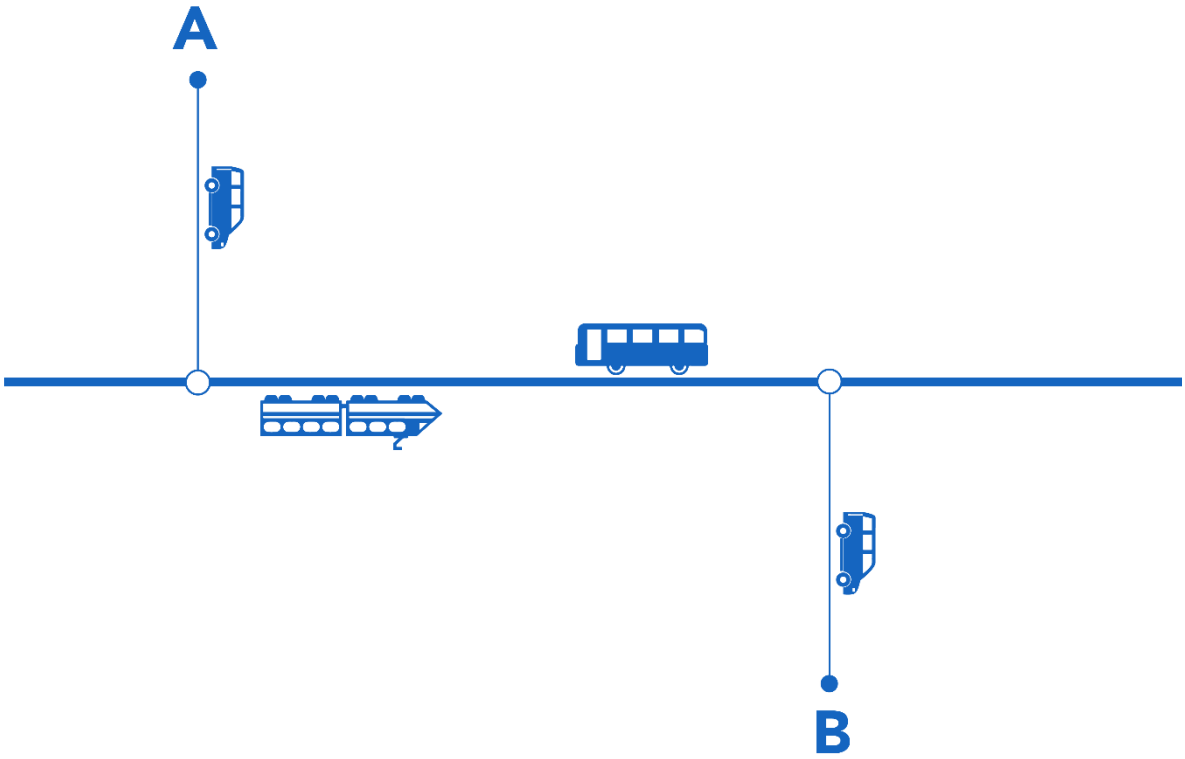


*Figure 14: Illustration of Plustur service. Adapted from* (NT, 2017)

A passenger can book a Flextur trip by either using the nationwide Danish trip planner app called "Rejseplanen", via a website or by calling a dispatch centre. On the other hand, Plustur can only be booked via Rejseplanen. Booking for both the services must be done at least 2 hours before and no earlier than 2 weeks before the customer wishes to travel. The two services are operational between 6 AM and 11 PM. The services run within or between the municipalities that participate in Flextrafik.

The municipalities that participate in Flextrafik decide the fares of the DRT services for the citizens in its administrative area. For Flextur, the fare structure, which is the sum of a fixed fee and a price per kilometre, is the same for all the municipalities. However, the actual fixed fee and the price per kilometre may differ between the municipalities. Therefore, the fares in the different municipalities are different and, in some cases, the price also varies between urban and rural areas (Interviewee 5). The municipality finances part of the trip and the passenger pays the rest according to the tariff set by the respective municipality (Interviewee 4).

On the other hand, the PTAs are responsible for determining the fare and the service levels for Plustur in their administrative boundaries. The service levels are then presented to the municipalities who can then decide to finance the operations of Plustur in their area (Interviewee 4). As a result, the fare for Plustur within the boundary of a PTA is the same. The fares can, however, be different for the different PTAs. For example, for Plustur managed by Movia, the fare structure for a Plustur trip is a flat 25 DKK whereas, for the Plustur managed by Midttrafik, the fare structure for a Plustur trip is the same as a 2-zone single ticket.

FlexDanmark is a technology company owned by 5 Danish PTAs. FlexDanmark is responsible for planning and coordinating the Flextrafik services, without carrying out any journeys themselves. FlexDanmark outsources the journeys to other transport companies. The reasons for setting up FlexDanmark were to reduce the total cost of transport, to improve the in-house system and to provide a better service for the traveller (Interviewee 5). The rides are distributed among the different types of vehicles depending on the region, availability and needs of the client. The model, therefore, tries to optimise each trip. The ICT

platform developed by FlexDanmark integrates more than 550 unique private transportation providers into a single system that serves both urban and rural customers throughout Denmark (Interviewee 5). The platform assigns the requested trips to different transport operators and optimizes them based on available vehicles, needs and convenience of the individual customer.

To make sure to get the lowest prices for the execution of the trip, a complex and tailored tendering system was designed. This bidding system distinguishes two types of contracts: “fixed” or “spot-marked vehicles”. In the first one, the transport operators provide a fixed number of vehicles for a given period (usual contract duration of 2-4 years). The operators are paid irrespective of the use of the vehicles. This type of contract is mainly used for special vehicles to ensure that the delivery of vehicles for the transportation of disabled passengers is maintained (Darbéra, 2017). For the latter, the operator provides a unit cost for transportation (price/hour) and the number of different types of vehicles they can provide by the day of the week and time of day. Based on these parameters, the PTAs choose the operators and makes annual contracts. Once the contracts are finalised, the drivers cannot refuse trips, without a good reason (Lynott, 2020). The five PTAs negotiate and manage contracts with the operators in their region on behalf of all municipalities that participate in Flextrafik. The PTA’s combine several types of demand-responsive services in a single tender; thus, the bidders are allowed to bid for a very large volume of services (Lynott, 2020).

This procurement process used by the PTAs gives FlexDanmark access to a pool of approximately 1,700 vehicles, however, all of them are not available at the same time (Lynott, 2020). The vehicles are registered in the IT system with price, geographical location (called home zone) and type of vehicle. When an order is received in the system from a municipality, a region, from the online order, the system automatically calculates which vehicle will be the cheapest to run the trip based on a generalised cost. The generalised cost is based on vehicle operating costs (as established in the contract), arrival and departure time requirements, Service level (e.g., customer’s wait and travel time), Customer needs (e.g., wheelchair-accessible vehicle), Time of day, and rush hour traffic, company quality rating, vehicle proximity to the rider (Lynott, 2020).

All the services that are part of the Flextrafik suite are comingled regardless of the target market. At the same time, it is also possible for different clients such as hospitals, medical offices, nursing homes, to request a trip through remote online ordering modules All these trip requests are scheduled from the same pool. Thus, the people from the different types of services share the same vehicle (Interviewee 4). This has been made possible due to the nationwide ICT infrastructure provided by FlexDanmark which supports the Flextrafik operations.

The region or the municipality that orders the transport pays the share of the cost for their specific transports. The cost of every transport is divided between the authorities according to their actual use and level of service needed. The benefit for the authorities is the reduction in the cost they get from pooling their transport tasks together. In a study by Deloitte Consulting, the business models for the delivery of DRT services currently in use in Denmark were compared (Mulley & Nelson, 2016). Denmark uses two business models: the local model, in which tendering (procurement) is conducted by individual municipalities and regions, and a coordinated model, in which the tendering is managed by regional public transport authorities. The two models are shown in Figure 15.

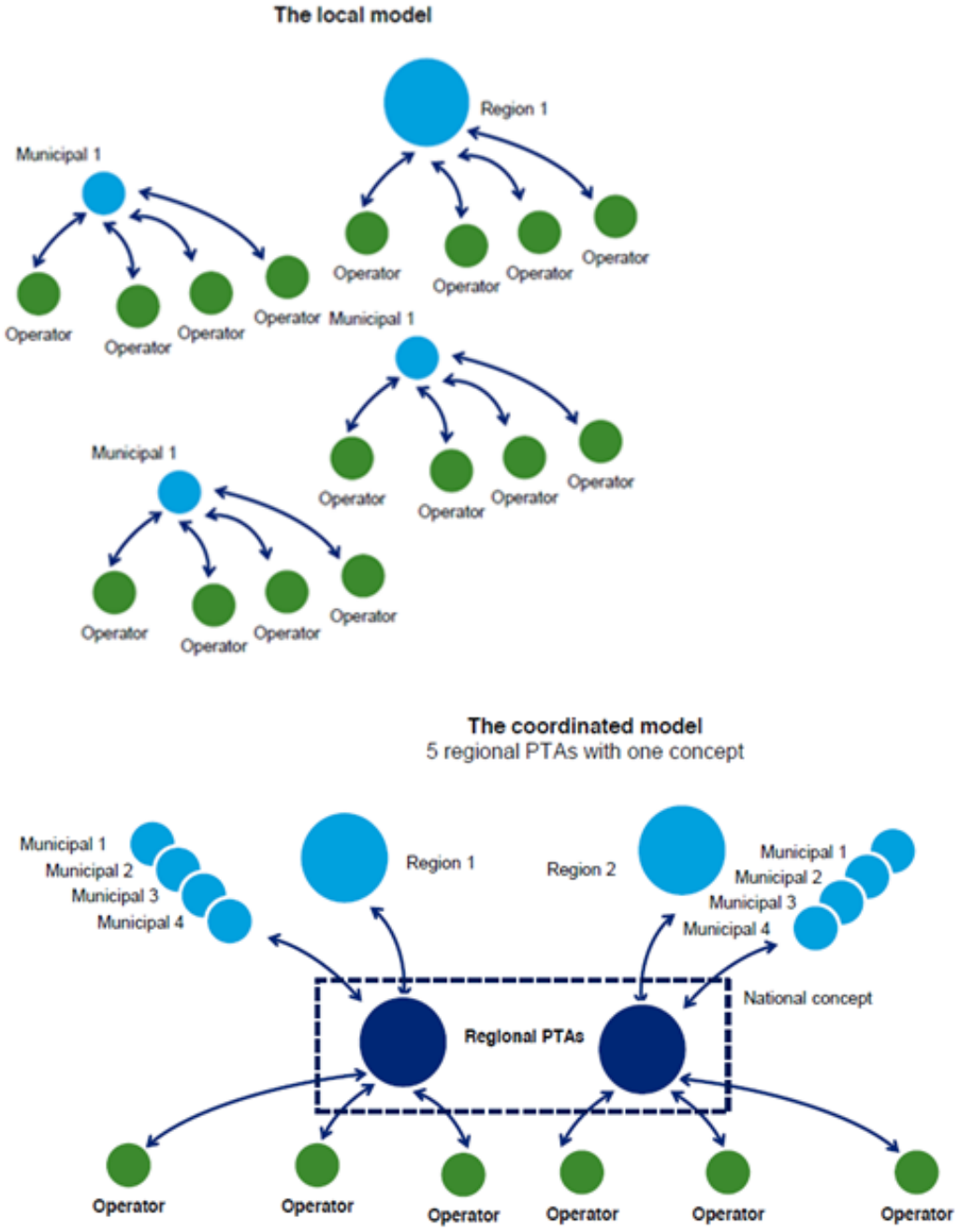


*Figure 15: Contracting models used in Flextrafik* (Pedersen, 2014)

The study of Deloitte Consulting compared the cost-effectiveness of the two approaches. The coordinated model showed a 15% savings compared with the cost of the local model according to measures of both costs per kilometre and cost per minute. The study concluded that the reason for achieving a 15% was a mix of both based on a mix of more efficient use of vehicles and more professional tendering (Pedersen, 2014).

In 2017, FlexDanmark handled more than 6 million Flextrafik trips at a combined pay-out of about 150€ million. This results in approximately 22€ per trip on average considering all the different services. They moved more than 250.000 passengers using more than 5.000 vehicles and 750 transport operators. According to (Lynott, 2020), 95% of trips from all of the Flextrafik services have been on time, which is defined as the vehicle arriving no later than 15 minutes after its scheduled arrival time.

### 4.3.3 Integration with the Public Transport System

The DRT service had both roles: complementary and substitutive, however, it depended on the type of product. The service called Plustur had the complementary role whereas, the service called Flextur had the substitutive role. Plustur is designed to take the passenger from an address to a bus or train station. It is only offered if it can be combined with bus and/or train is not offered as an option if it is quicker to walk or cycle to the nearest stop. On the other hand, Flextur is designed to take a passenger from an address to an address. It is used in line with the regular bus service in areas where regular bus services are not economically viable due to low passenger numbers. To ensure that Flextur was not used in competition with the PT system, the fare for Flextur was set at a significantly higher fare.

The integration of information about the DRT and public transport in Rejseplanen was made possible because of the collaboration of Rejseplanen with Hacon. Hacon is a German company that developed an engine called HAFAS which allows multimodal planning and integrated ticketing (Hacon, 2018). In the context of Flextur/Plustur, Rejseplanen works according to the following rules (EMTA, 2019):

1. When a person searches for a travel itinerary, first, the engine searches for all possible public transportation options such as bus and train exclusively.
2. If it is not possible to take the trip using bus or train exclusively, then Plustur will be presented to passengers and bring them to and/or from public transportation in fixed routes (first/last mile) (by using a 2km walking distance threshold).
3. When it is not possible to combine Plustur with bus or train, a journey exclusively with Flextur will be offered.

Once the itinerary is presented on Rejseplanen, the passenger is directed to the FlexDanmark platform for booking the trip (Interviewee 4). The passenger can book a ride as well as pay for the entire trip via the application, thus, eliminating the need to pay separately for all the different modes in the trip chain.

For Flextur, the participating municipalities can decide the fares for their administrative boundaries. Hence, the same service can have different fares, which could lead to confusion amongst the passengers. One of the challenges that can arise with Flextur is that it can compete with the scheduled public transport system, since, essentially, it is a shared-taxi service that can be used door-to-door. Therefore, to prevent that, the municipalities often set the Flextur fare high enough to encourage the use of scheduled public transport. However, in areas, where scheduled public transport is not an option, the out-of-pocket costs for Flextur passengers are comparable to that of scheduled public transportation.

For Plustur, for all PTAs, the fare structure of Plustur was the same as the fare structure of bus service (a zone-based fare structure), with the fare levels being set as the fare for 2 zones (same as PT). The idea here is that Plustur is designed to bring a passenger from an address to a bus or train service. Furthermore, it is not offered if it is possible to walk or cycle to the nearest stop. Thus, the service replicates a public transport service that only runs from address to a stop, and therefore according to the philosophy of PTA, the fare structure mimics the fares structure of scheduled PT.

The PTAs were responsible for the marketing of all the services that it manages, such as Bus, Train, DRT etc (Interviewee 4). Furthermore, all the PTAs design a brand identity that contains the logo of the PTA and a colour scheme that should be present on all the vehicles that operate for the PTA.

When Plustur was started in 2018 by NT (PTA for the North Jutland region), the goal was to have an annual ridership of 50,000 passengers. However, for the first year, the annual ridership was only 10,000 passengers. One of the reasons for the lower ridership, according to Interviewee 6, has been user awareness. After its one year of operation, a survey was carried out by NT which studied the user awareness of Plustur in the North Jutland region. From the survey, it was found that approximately 70% of the residents had not heard of the service. According to Interviewee 6, the majority of the marketing material on the service was available on the PTAs website and in the info-screens of the buses and trains.

The cooperation between the stakeholders such as municipalities and regions was possible because of the law that allowed the municipalities and regions to enter into voluntary agreements with the PTAs to take over the task of managing the special transport services, part or in whole. In this arrangement, the municipalities defined the service levels and also verified if a passenger is allowed to use special transport services. For the tendering and managing of the contract, the role was transferred to the PTAs. The PTAs negotiated contracts with the operators on the behalf of the municipalities and thus, were able to get a better contract price (Westerlund, 2016a). Furthermore, since, PTAs also advise the municipalities while deciding on the service level, it is likely that some coordination of the service levels between different municipalities can be achieved because the PTAs would have an overview of all municipalities. Once this arrangement was in place, it was possible for the coordination of provision of different transport services. However, as mentioned, the handing over or the participation of the municipalities in the Flextrafik was voluntary. Thus, to make that handover, the municipalities need to have confidence and trust the PTAs can handle the management of the service. This has also prevented some municipalities from not handing over the operations. Some municipalities, especially the larger ones do not hand over because of "municipal autonomy" as there is a desire to have a say in how such important social functions operate (Westerlund, 2016a).

In the Danish DRT industry, the coordination of operations of the different types of DRT systems and the public transport was possible because all operators in the system have a standardized approach to exchange trip data. The exchange of information is based according to a data specification called the SUTI standard (Teal et al., 2020). SUTI, which is an abbreviation of the Swedish text “Standardiserat Utbyte av Trafik Information”, was formalized in 2002. SUTI standard is used throughout Sweden, Norway, Finland, and Denmark for the exchange of DRT information between the operators and their clients (i.e., the organizations responsible for DRT services) (Teal et al., 2020). It was originally developed in Sweden. The Swedish national government played a central role in the development and the nationwide adoption of the SUTI standard. The Swedish government is financially responsible for social services that also necessitate transportation services for citizens, and it wanted to ensure that the local governments who were responsible for organizing nationally funded DRT services prevent vendor lock-in (Interviewee 7). Vendor lock-in happens when a customer becomes dependent on a vendor for products and services and are unable to use another vendor because of high switching cost. The solution for that was to develop a data specification that would allow communication between the operators and the agencies providing the service (Interviewee 7; Larsen et al., 2018). In Denmark, however, FlexDanmark has taken an active role in investing in and institutionalizing the SUTI standard. All operators must have the necessary onboard hardware to facilitate the exchange of information between the vehicles and the IT system. Furthermore, FlexDanmark has approved 8 technology providers to provide the necessary onboard hardware required for the communication (Interviewee 5). It is also possible for an operator to use their hardware if it is compatible with the IT system. The SUTI standard is made available at no cost to the operators and the software vendors (Teal et al., 2020).

### 4.3.4 Discussion

Flextrafik services represent one group of services the PTOs deploy when advising local authorities regarding mobility offers and efforts. The PTOs manage the Flextrafik services in accordance and collaboration with the participating authorities.

One of the features of the Flextrafik services is that the passengers should share rides as much as possible. As a result, it is possible that people from different types of DRT services can be combined in a single-vehicle. Due to this comingling of trips, different groups of people may have different requirements such as a longer alighting or boarding time for people with disabilities. These requirements needs to be taken into consideration while scheduling the trips. FlexDanmark does this by storing passenger profiles, which has information about the passenger's specific needs such as the requirement of wheelchair accessible vehicle or additional time to board. Using these passenger profiles, the requirements can be accounted for while planning the trip. Furthermore, it is also possible to indicate if the trip can be made individually. For example, a hospital staff requesting rides for their patients can indicate if the individual needs a private vehicle without other passengers. The subsidising authority would have to pay extra in this case (Interviewee 5).

Another important factor that has been crucial in the operation of Flextrafik is the volume both in terms of supply and demand (Interviewee 5). Concerning the demand, the system covers the transportation needs of different types of user groups such as people with disabilities, patients, people with no access to public transport etc. With this increase in the volume of demand, the likelihood that several passengers could share the same vehicle increases. Furthermore, concerning the supply, FlexDanmark has access to a pool of approximately 550 operators which ensures meeting the service levels with the lowest possible costs (Interviewee 5).

The procurement model for the DRT services in Denmark is set up with a high level of competition. There is one unique system for all DRT provisions in Denmark. The pool of operators include individually owned taxi companies, major shared taxi companies, individually owned minibus companies. The contracting used in this case allows easy access for small companies and is transparent (Interviewee 5). Therefore, small, and local operators have the opportunity to participate in the bidding according to their ability are not excluded, for example, operating the patient transport services simply because they cannot run the entire patient transport service themselves. However, this procurement process also comes with the added complexity of managing contracts with multiple operators.

The system is transparent because all the operators are provided with access to a website where they can see the details of the trips and the payments (Interviewee 5). Furthermore, FlexDanmark uses reverse invoicing, in which, the FlexDanmark system generates invoices automatically, rather than the operators generating an invoice. This is possible because the system records the timestamps and geo-stamps for each pickup and drop-off location, thus enabling it to calculate the travel time and trip distance. The system of reverse invoicing makes administration easier for small companies, thus providing easier access to them (Interviewee 5).

The structure of Flextrafik is at the same time both centralised and decentralised in the sense that different organisations can choose to have their service levels and fares. However, at the same time, the management, contracting and monitoring are done by a central body (PTA). Furthermore, the scheduling of the trips is also done by a nationwide body (Flexdanmark). FlexDanmark develops and manages a technological platform for ordering, planning and traffic management of the DRT services. Apart from its ICT operations, it also has a body with specialists who are well placed to manage its operation and provide advice to the PTAs on the operations of the service.

The SUTI standard that forms the basis of coordination between different operators and service providers, was originally developed in Sweden, in the late 90s and early 2000s. The development of SUTI was influenced significantly by the Swedish national government since they funded the special transport

services in Sweden. Therefore, the Swedish government wanted to ensure interoperable end-to-end functionality of the key components of DRT technology such as reservations systems; vehicle scheduling systems; taxi dispatch systems etc. In Denmark, however, FlexDanmark has taken an active role in investing in and institutionalizing the SUTI standard. SUTI is an important part of the tendering process in Denmark procurement process, as all 550 plus operators must have the necessary onboard hardware to facilitate the exchange of information between the vehicles and the IT system. Furthermore, FlexDanmark has approved 8 technology providers to provide the necessary onboard hardware required for the communication (Interviewee 5). It is also possible for an operator to use their hardware if it is compatible with the IT system. The SUTI standard is made available at no cost to the operators and the software vendors (Interviewee 5).

### 4.3.5 Summary

Table 7 shows the summary of the Flextrafik case and the integration factors that were present in the case

*Table 7: Summary of Flextrafik*

| Integration Components | Flextrafik |
|---|---|
| Function | Complementary/Substitutive |
| Information | Integrated |
| Fares | Partially Integrated |
| Tickets | Partially Integrated |
| Brand Identity | Partially Integrated |
| Cooperation with other transport services | Integrated |
| Data standardisation | Needed |

Flextrafik services represent a group of DRT services that can be provided by the authorities based on the market demands. Some of the DRT services are required by law, for example, DRT for people with disabilities, while others exist to complement or substitute the scheduled public transport services. The service called Plustur, functioned as first/last mile to the scheduled public transport and could only be ordered in combination with a scheduled public transport. On the other hand, the service called Flextur, functions as a shared taxi service from an address to address. However, the aim of the service is to provide a transport service where the demand for a scheduled public transport alternative is too low.

The company, called Rejseplan, that operates and develops the nationwide trip planning application is jointly owned by the PTAs. Since, 2020, it has been possible for the passengers to be generate trip itineraries and book trips with scheduled public transport in combination with Flextur, Plustur, carpooling, bike sharing etc. Thus, proving to be a nationwide MaaS platform.

The cooperation between the stakeholders such as municipalities and regions, was possible because of the law that allowed the municipalities and regions to enter into voluntary agreements with the PTAs to take over the task of managing the special transport services, part or in whole. The municipalities decided the requirements for service levels and the PTAs translated those the requirements into service design and contracted the operators for the execution of the trips.

Due to this arrangement of concentrating the responsibilities and the governance of the management of the service in a single body, PTA, it was possible for the coordination between different transport services. The PTAs also jointly own Flexdanmark, the company behind the ICT infrastructure for its Flextrafik services. Thus, it can be argued that single body ownership of Flexdanmark and Rejseplan allowed for the development of a MaaS platform that integrated information and tickets.

For the coordination between the operations between different transport services, Flexdanmark mandated its operators to adhere to standardised data specification called SUTI standard. When FlexDanmark, a PTA owned organisation and a doorway to publicly funded DRT services in Denmark, mandated adherence to a data specification, the technology companies and the operators had no alternative but to adhere, if they wanted to be a part of the DRT industry.

## 4.4 Flexride Case Study: A family of services

### 4.4.1 Background

In 2000, an existing bus line that ran once an hour in the city of Brighton, Denver performed poorly according to the standards set by the Regional Transportation District-Denver, the public transport authority of the Denver Metropolitan Area. As a replacement to the bus line, a demand-responsive transport service called Call-n-Ride was proposed. The positive experiences from the first Call-n-Ride deployment led to RTD considering placing Call-n-Ride service in other areas where existing public transport services were performing poorly (Volinski, 2019). RTD-Denver, develops, operates, and maintains a public transportation system that operates over 6,070 km$^2$ area and serves 3.08 million people within an eight-county service area. The service areas of the Flexride is shown in Figure 16. The public transport network of RTD Denver is attached in the Appendix C.

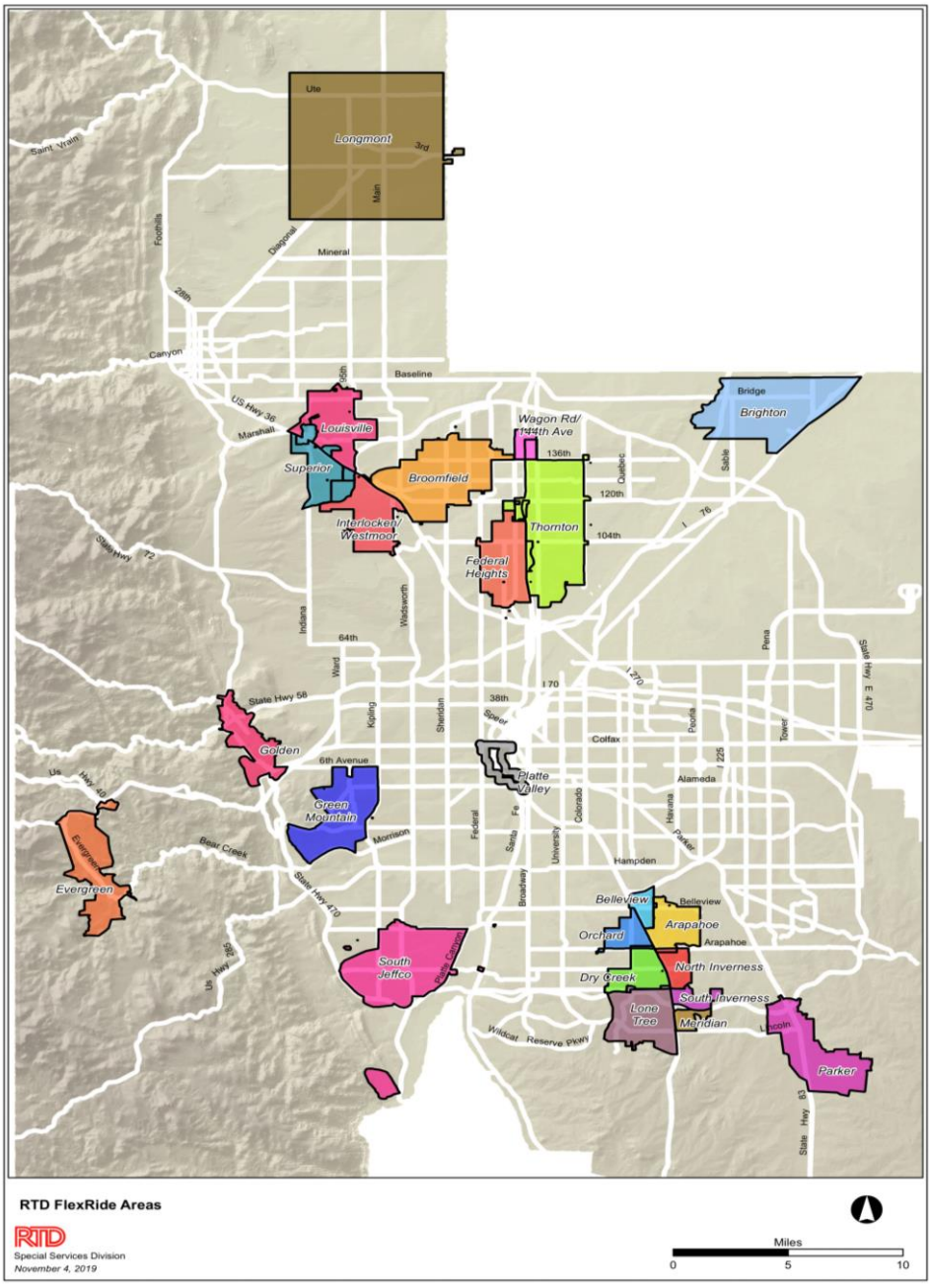


*Figure 16: Flexride service areas* (RTD-Denver, 2021a)

### 4.4.2 Flexride

Flexride, earlier called Call-n-Ride, is the Denver region's general-public demand-response service. RTD operates 24 Flexride zones across the Denver region, with each zone served by 1-4 vehicles depending on demand. Customers can reserve a trip in advance by calling, or through a website or a mobile application. Operating hours vary between service areas, but in most service areas, it runs on weekdays between 5:30 a.m. and 7:00 p.m. Only a few service areas provide weekend service. The service can either be door-to-door or stop-to-stop depending on the service areas.

RTD established Flexride service for the following reasons (Volinski, 2019):

- To be relevant in suburban, lower density areas where fixed-route transit is inefficient.
- To serve areas with dispersed travel patterns and non-contiguous streets more effectively than is possible with large, fixed-route buses.
- To address issues of jurisdictional equity for areas that provide tax support but receive no service.
- To complement the transit network by providing connections to regional service.

The philosophy followed by the PTA is that DRT is a part of multiple services and will be used wherever appropriate. The service, thus, forms a part of a "family of services" (Interviewee 6). This "family of services" comprises of train, bus, DRT, Ferry, Paratransit, and Ferry. This means that Flexride is just an option among others intended to fill in the gaps of the public transport network of the Denver region. Flexride is used by RTD to serve two primary markets: first mile/last mile service and community circulation within zones for internal trips in a residential and mixed-use area. According to Interviewee 6, RTD believes in fitting any level of demand with the most appropriate service from their family of services. RTD's experience is that Flexride is an appropriate service and attractive than a comparable bus service in many suburban areas with a low-to-moderate density of 3 to 12 population + employment per acre and dispersed travel patterns (Volinski, 2019).

The service areas for the first/last mile market features cycle points, usually railway stations or park-and-ride facilities that are connected to the bus network. These cycle points are visited by a Flexride vehicle frequently and according to a schedule. Apart from cycle points, some service areas have scheduled checkpoints that are locations that the vehicles visit according to a schedule, however, the visits are infrequent or during certain hours of the day (e.g., peak periods, school hours). Service areas can also have demand checkpoints, which are predefined locations for passenger pickup or drop-off, but only when there is demand. The first/last mile service connects to one of the rail services or regional bus routes. Figure 17 below shows a map of the Orchard. The Orchard station is a light rail station and Orchard station gate A acts as a scheduled checkpoint for the Flexride. The various points marked as "Landmark" in the legend act as demand checkpoints.

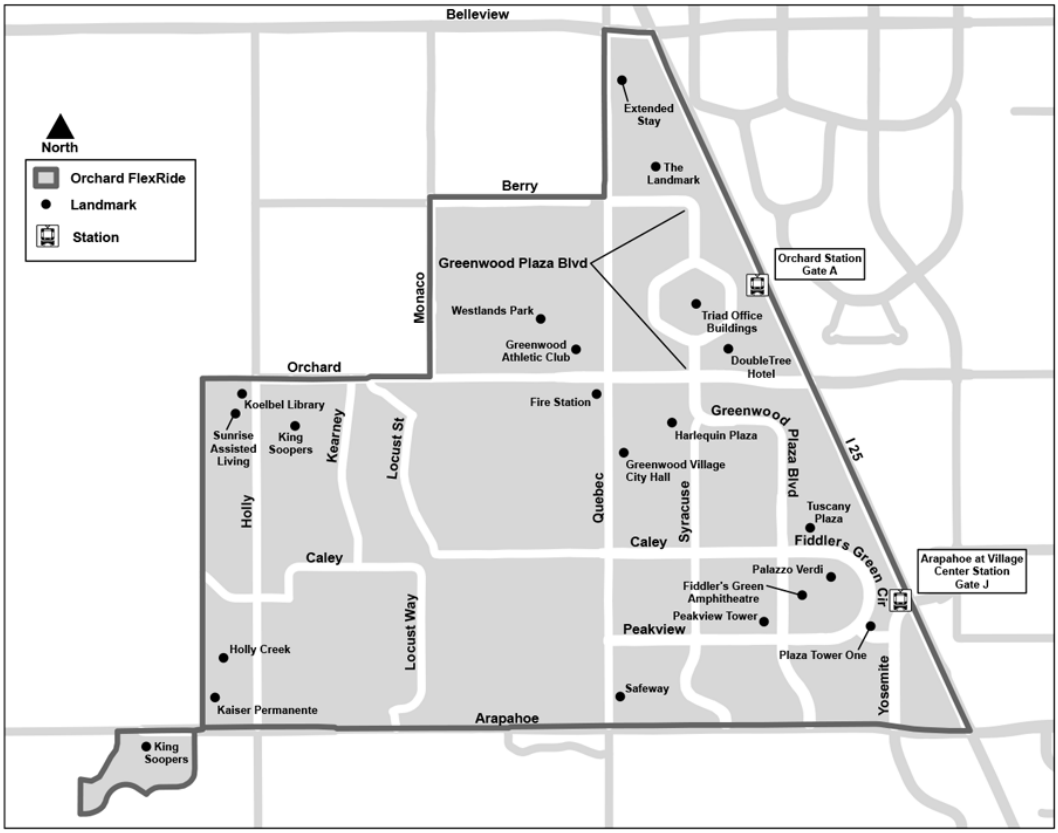


*Figure 17: Map of the Orchard service area of Flexride* (RTD-Denver, 2021a)

Fares charged for using RTD's general public DRT services are the same as fares charged for regular fixed-route bus service: $3 with a free transfer, with discounts available for seniors, passengers with disabilities, and youth. The reason for the same fare structure was aligned with the philosophy that DRT is a part of RTD's family of services. The notion of the same fare structure is not a legal obligation for RTD as there are other examples from the USA, wherein, the fares for DRT services sometimes differ from other services provided by the transit agency (Volinski, 2019).

The current Colorado state law sets the maximum percentage of outsourced public transport at 58%, including Flexride services and the minimum at 50% (Volinski, 2019). RTD Denver contracts the operation of Flexride to private operators. However, RTD provides the vehicle and the fuel for the operation of the service Apart from that, RTD also provides the required onboard technology for the service provision. While awarding the contracts, RTD not only uses low bids as their exclusive determinant but also, give weightage to the experience of the company and the staff dedicated to the service (Interviewee 6). For its operation, RTD uses 15-seater minibuses, which are the same as the vehicles for their paratransit services. The vehicles are lift-equipped, and the drivers undergo training on accommodating people with disabilities in the vehicle. The Figure 18 below shows the vehicle used in the Flexride operations.


*Figure 18: Vehicle used in the operations of Flexride* (RTD-Denver, 2021a)

The source of funding for RTD's general public demand–response services include RTD tax revenue, fares from operations, and some matching funds for vehicles. The tax revenue is collected by the state of Colorado.

Flexride services are enabled by a technology platform that its technology partner, DemandTrans Solutions, developed in close cooperation with the RTD. RTD chose to develop the technology platform because, at the time, an off the shelf technology platform that met the requirements of RTD did not exist (Teal & Becker, 2011). The technology system is called MobilityDR and has been deployed across all its service areas since 2010. MobilityDR is a fully automated web-based scheduling and vehicle management platform. It is also responsible for notifying the passengers about the status of their requested ride. The total cost of all the technology components (e.g., software, hardware, or technical assistance) for Flexride was estimated to be approximately only 3% of the total costs associated with providing the service (Volinski, 2019).

RTD Denver employs the similar marketing channels that they use for their other public transport services such as bus and rail, building on the idea that Flexride, is a part of their family of services. Furthermore, the vehicles used in the operation did have a distinct branding, as visible in the Figure above. However, the vehicle was also clearly marked with the logo of the transit agency funding the service. As a result, the passengers recognize both the service name (Flexride) and the vehicle colour scheme as being synonymous with DRT (Teal & Becker, 2011).

RTD believes that Flexride is still public transport and therefore, it should be evaluated the same way it evaluates fixed-route service (Interviewee 6). RTD has established clear guidelines, known as Service Standards, which state that the 10% least (and most) productive public transport services should be evaluated each year, either for additional market efforts, for revision, or elimination (RTD-Denver, 2016). The productivity of the services is measured in two ways: subsidy per passenger and number of trips per vehicle hour. Figure 19 below shows the "Efficiency-Productivity" chart for local suburban bus routes and the Flexride from 2019. Effectiveness measures attainment of the objective—maximize ridership within the budget—and is presented on the y-axis as subsidy per boarding. Productivity is represented on the x-axis as boardings per vehicle hour.

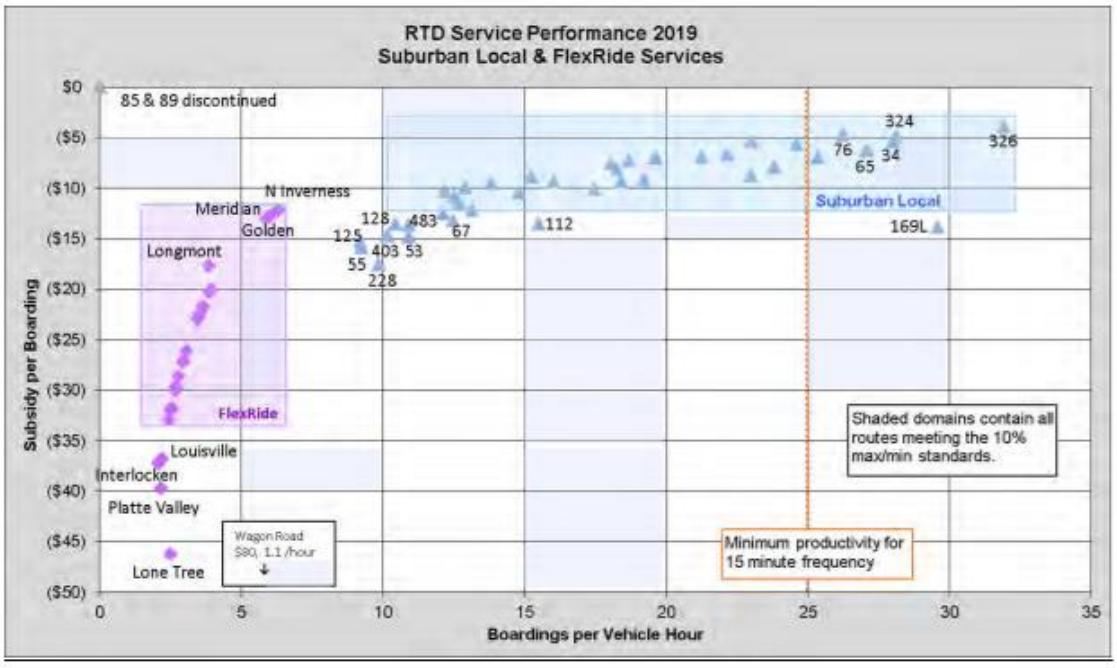


*Figure 19: "Efficiency-Productivity" chart for local suburban bus routes and the Flexride from 2019* (RTD-Denver, 2020)

The shaded areas for each mode show those that meet the 10% standard. The Flexride services and suburban local bus routes that fell outside the framework in 2019 were subject to action. There is a fairly clear limit at 10 passengers per vehicle hour for when it is more cost-efficient to move from DRT to more scheduled public transport (interviewee 6). In 2019, Flexride achieved only a 7% farebox recovery ratio, which is the fraction of operating expenses that are met by the fares paid by passengers. However, the operating cost per hour to provide service was less than that for fixed-route service, had it been running in the service area.

RTD Denver obtains passenger feedback and requirements via occasional formal on-board passenger surveys and via regular driver interaction with passengers. In a 2008 on-board survey of passengers, the Denver RTD's Flexride service had an overall customer satisfaction rating of 4.6 (on a 1–5 scale), compared to a 4.2 rating for the agency's bus service, with the former excelling in driver performance, comfort, security, customer information and fares (Becker et al., 2013). Before the COVID-19 pandemic, Flexride achieved an average of 1900 boardings on a weekday (RTD-Denver, 2020).

### 4.4.3 Integration with the Public Transport System

Flexride had both roles to the public transport system, complementary and substitutive. The use of the type of service (complementary or substitutive) was structured according to the service area. In some zones, the DRT service had the function of first/last-mile service. In these zones, there were checkpoints points, which were visited by a vehicle at a defined interval. These checkpoints points were almost always located in the vicinity of the areas where the most boarding or alighting (concentrated demand) takes place within the DRT zone, for example, a train station, a business compound etc. The use of such checkpoints minimizes the number of stops a DRT vehicle needs to make, which allows it to operate with more frequency or serve larger areas (Volinski, 2019). After boarding the service, the driver would drop the passenger to their destination, following the route generated automatically on their onboard tablet. Furthermore, these checkpoints also offered opportunities for people to board a DRT service vehicle without needing to make a reservation. On the other hand, in the zones, where the demand is more spread over a wider area, then, the DRT service had a substitutive role, in which case, the public transport service was replaced with a DRT service that served the requests for internal trips within the zone.

RTD's experience is that DRT used for the first/last mile purpose generates higher ridership than a stand-alone, demand–response service. Among RTD's DRT services that are predominantly substitutive, average hourly ridership is typically in the range of 3 to 4.5 passenger trips per operational hour, whereas, service areas where Flexride is used as a first/last mile option, the average hourly ridership ranges between 5 to 9 passenger trips per operational hour (Volinski, 2019). Thus, first/last mile service seems to be more productive than a stand-alone DRT. This is made clear from the Figure below. The data is from 2011. Figure 20 presents an analysis of experience for the two types of markets Flexride serves, showing the percentage of spontaneous boardings (passengers who boarded the vehicle at cycle points or checkpoints), subscriptions, cancellations, and no-shows as a percent of the total (boardings + cancellations + no-shows) and productivity (boardings per hour). The chart in the figure is ordered by decreasing boardings per hour to facilitate analysis. From the figure, Flexride is more productive as a feeder service (first/last mile) than a non-feeder service (substitute). Secondly, the feature of spontaneous boarding has a positive relationship with the average hourly ridership. Although the data used in the figure below is from 2011, RTD's experience shows that these conclusions are still valid (Volinski, 2019).

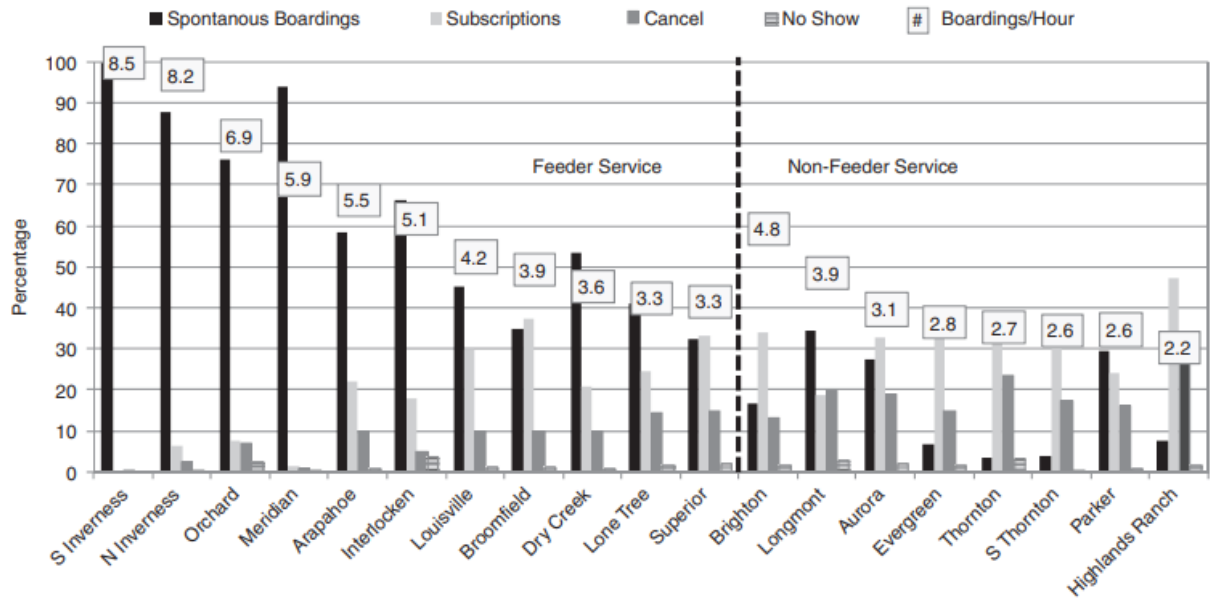


*Figure 20: Spontaneous boardings, subscriptions, cancellations, and no-shows for the Flexride service areas from 2011* (Teal & Becker, 2011)

RTD uses the Open TripPlanner (OTP, an open-source application) on its website to generate travel itineraries for its passengers. The trip planners such as Google Transit, Transit, etc, use the General Transit Feed Specification (GTFS) to produce trip itineraries. However, GTFS is a specification for scheduled public transport. For the publishing of data for flexible services, including Demand Responsive transport, GTFS-Flex specification is currently in development. GTFS-Flex is a proposed extension to GTFS, which will allow trip planners to show flexible services such as DRT in trip itineraries (Craig & Shippy, 2020). In 2021, RTD in partnership with Kyyti Group developed an application, called RTD Trips, that allowed the passengers to book their FlexRide trip and see connections with bus and rail in real-time (RTD-Denver, 2021b). The application shows Flexride in combination with other public transport options, if available. Furthermore, it is also possible to book the Flexride trip from the application. The image below is of a screenshot from the application which a trip itinerary in which Flexride is offered with a bus service. The data that forms the backbone of this application, follows the format of GTFS Flex and is published by RTD as open data. However, despite this data being openly available, Flexride is not

shown as a mode of transport in commonly used trip planners. This is because the data format, GTFS-Flex, is not adopted officially by Google (Interviewee 7).

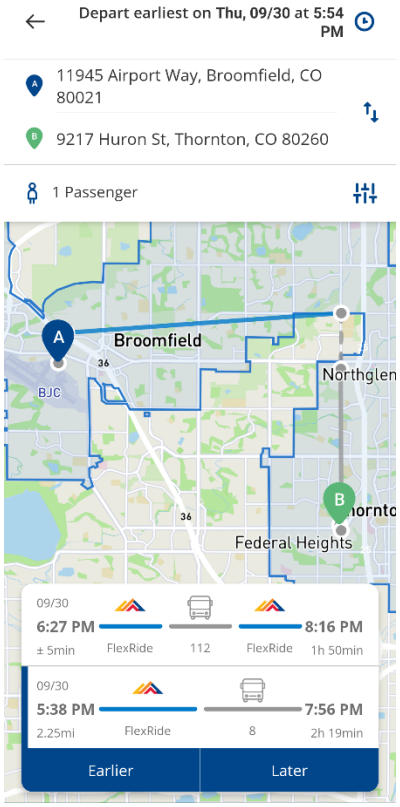


*Figure 21: Screenshot of RTD Multimodal Trip Planning Application*

An integration of fare was visible in this case. Fares charged for using RTD's general public DRT services are the same as fares charged for regular fixed-route bus service: $3 with a free transfer. The reason arose from the PTA's philosophy of DRT being a member of their family of public transport services, and therefore, the fare structure and the payment methods of DRT should mimic that of their other public transport services.

Ticket integration in the case of Flexride was also visible. All the different types of tickets that are sold by RTD Denver, including a fare card called "MyRide" are valid in all public transport services including Flexride. In 2017, RTD, in partnership with a private company called Masabi, developed a mobile ticketing platform called "RTD Tickets". The mobile app and the account-based back office were developed by Masabi.

Via this application, a passenger was able to buy electronic tickets for all types of PT services, including Flexride.

For passengers that need to board the vehicle from a scheduled checkpoint, making a reservation is not required. Passengers simply access the station or checkpoint on the published schedule and walk on, telling the driver their destination. The driver enters that information into the MobilityDR application on a tablet computer, and the automated scheduling system then provides a schedule and a route to be followed. This feature of the technology platform is called Quickboard (Volinski, 2019). The use of spontaneous boarding has its challenges, such as the time that must be allocated to handle the uncertain number of spontaneous trips at cycle points and checkpoints, the need to quickly board multiple people having different destinations, the need to quickly schedule and route a suitable vehicle tour, and the need to incorporate trips that are reserved for pickup after the time allocated for dropping off the spontaneous boardings into the tour. To counter these challenges, the shortest path–travelling salesman algorithm was

used in the platform. This algorithm provides a computationally rapid, near-optimal solution to the problem of scheduling spontaneous boardings (Becker et al., 2013).

In Flexride, RTD Denver employs the similar marketing channels that they use for their other public transport services such as bus and rail, building on the idea that Flexride, is a part of their family of services. Furthermore, the vehicles used in the vehicles used were marked with the logo of the RTD. Also, since RTD uses the same vehicles for both, operations of Flexride and Access-a-Ride, both services have a unified brand image. In 2019, RTD rebranded its DRT service, from previously being called "Call-n-Ride" to "Flexride". According to a press release[3], "the new name better reflected the flexible nature of a service designed with each community's needs in mind. Along with the new name, Flexride vehicles have a new brand identity". In a 2008 passenger survey for its services, RTD collected information about the passenger perception of the brand image of the then called Call-n-Ride and concluded that the passengers recognized both the service name (Flexride) and the vehicle colour scheme as being synonymous with DRT (Teal & Becker, 2011). Such a study has not been conducted again after the rebranding.

In areas, where DRT services are also provided by organisations other than RTD such as nursing homes for elderlies, some level of coordination between their services has occurred due to a project called "Mobility Services for All Americans (MSAA)" funded by the US Department of Transportation (Mobility Services for All Americans, 2016). The stakeholders involved in this project are presented in Table 8.

*Table 8: Stakeholders and their role in the MSAA Project*

| Stakeholders | Role |
|---|---|
| RTD Denver | PTA of the Denver region |
| Via Mobility Services | Private, a non-profit organization that provides DRT for people with disabilities in Boulder county. |
| Broomfield Easy rides | Provides DRT to the elderly and People with Disability in the City of Broomfield |
| Senior's Resource Center | A non-profit organisation that provides DRT to elderlies |
| DemandTrans | The software company that Developed the MobilityDR platform and Trip Exchange |
| RouteMatch | The software company that provides DRT technological solutions to all the operators other than RTD-Denver. |

Source: (Teal et al., 2020)

One of the two accomplishments of this project was the development of an institutional framework for the coordination between the operators of different DRT services. The stakeholders that participated in the MSAA project forged strong working relationships and a collective set of objectives for the development of DRT services. The framework was based on strong working relationships and collective objectives and has the potential to accommodate for-profit, non-profit, and volunteer services (Lynott, 2020).

The other accomplishment of this partnership was the development of a web-based technology platform called Trip Exchange Hub. The Trip Exchange enables multiple transportation providers, each with its own DRT software system for reservations, scheduling, and dispatching to share data with other providers to enable coordination of the operations between them (Interviewee 7). The Trip Exchange hub

[3] "RTD celebrates the launch of FlexRide" RTD News Release, 25/02/2019 https://www.rtd-denver.com/sites/default/files/2019-03/FlexRide%202.25.19%20NR.pdf

is designed to work with any external software system through application programming interface (API) connections. An API is a software module that enables one computer system to interact and exchange data with another computer system; the two systems can be anywhere as long as they can connect via the internet (Lynott, 2020). This allowed the passengers from Flexride and passengers from a nursing home, for example, to share the same vehicle for their trip. While the Trip Exchange is still in its formative stages, it is operational and demonstrates that multiple interested and motivated parties can work together to develop a common platform to enable interoperability among DRT systems. The figure below shows the basic functionality of the trip exchange hub. The participating system is the operators with their own DRT software that communicates with a web-hosted communication system through their proprietary APIs. The functionality of the Trip Exchange is shown in Figure 22 and is explained in detail (Teal et al., 2020).

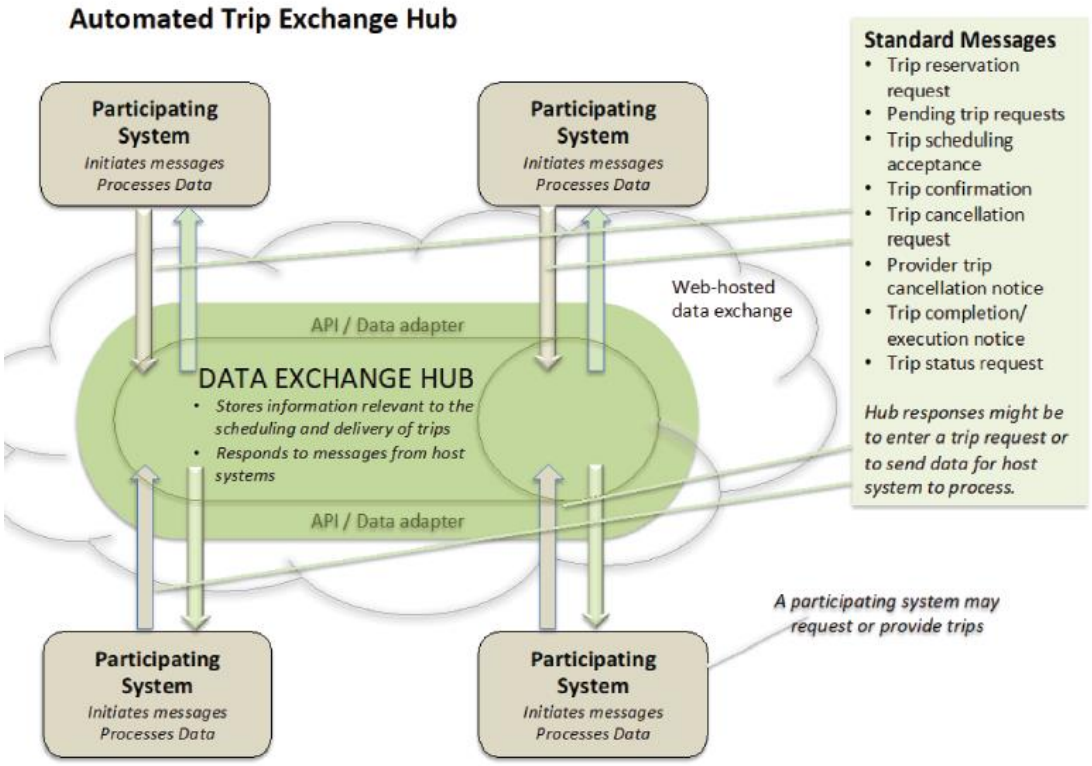


*Figure 22: Automated Trip Exchange Hub* (Teal et al., 2020)

### 4.4.4 Discussion

In this case, the PTA had the role to determine how integration is to take place. The PTA took the role of a planner and designed the full network, determined the fares and tickets, and provided information to passengers. Instead of the operator in a multimodal concession, the PTA now controls the whole system and thus, organises the integration between different modes. The philosophy followed by the PTA is that DRT is a part of multiple services and will be used wherever appropriate. Even for the evaluation, this philosophy is followed. RTD established clear guidelines, known as Service Standards, which state that the 10% least (and most) productive public transport services should be evaluated each year, either for additional market efforts, for revision, or elimination (RTD-Denver, 2016).

RTD has been developing, implementing, and managing Flexride services for almost 17 years. With 22 Flexride zones and more than 42 general public DRT minibuses to oversee, several staff members are assigned and have developed procedures and skills for this service, including performance evaluation and reporting, and the interviewee indicated that this has been important in establishing the services.

RTD's encourages competition during the bidding process by not only using low bids as their exclusive determinant of awarding contracts but also by giving weightage to the experience of the company and the staff dedicated to the service. RTD also wants to know the proposed salaries for contracted employees to ensure that the contractor will be paying realistic (not too low) salaries to help avoid employee turnover (UITP, 2021).

Experience of RTD suggests that service areas configured with a variety of scheduled checkpoints have higher productivity than those without this feature. Historically, it has been seen that "simpler" routes defined as a fixed route with deviation, had lower failure rates and that simpler service designs have been contributing to developing successful DRT services (Currie & Fournier, 2020). The use of scheduled checkpoints in the DRT operations could potentially make it easier for the passengers as they do not have to make a reservation in advance. In the case of Flexride, this has been appreciated by the passengers as well (Becker et al., 2013). However, it is possible that while waiting for people to spontaneously board the vehicle, waiting time for people who have already boarded increases.

In the USA, coordination between different operators in the field of DRT to increase the scale of operations or/and improve cost efficiency is virtually non-existent (Teal et al., 2020). The reasons for this have been lack of leadership, lack of knowledge about the benefits of standardised ICT platforms amongst the agencies that fund the services. In the case of Denver, due to the lack of such specification, the APIs to "communicate with the software of other transport providers". For this communication, to happen, a data exchange platform was developed called Trip Exchange Hub. The development of such a platform was because the various transport services providers saw an opportunity to combine their resources for scaling up their operations and for more efficient use of their services, thus reducing service duplicity. However, due to the use of APIs, the number of different operators with their ICT platforms that can "plug" into this Trip Exchange Hub is limited, thus reducing the scalability of the operations (Lynott, 2020). The alternative to that is a standardised data specification that can be used by transportation providers to seamlessly transfer and share data about a trip among a network of operators.

Due to this partnership and the development of the "Trip Exchange Hub", it was possible to use the vehicle for the general public (RTD) and the passengers from the other clients (nursing home, for example). One of the challenges that could arise due to this comingling is the difference in the passenger expectations and service levels. For instance, the time to board and alight for people with disabilities and elderlies can be anywhere between to be 2-5 times compared to the general public (Kostyniuk & D'Souza, 2020; Mobility Services for All Americans, 2016). It is also possible that the travel time of the general public increases due to the extra assistance required by people with disabilities and elderlies. This happened in practice as well, as there was some resistance initially to mixing different types of passengers in the same vehicle. However, after a while passengers " just got used to it" (Mobility Services for All Americans, 2016).

### 4.4.5 Summary

Table 9 shows the summary of the Flexride case and the integration aspects that were present in the case.

*Table 9: Summary of Flexride*

| Integration Components | Flexride |
|---|---|
| Function | Complementary/Substitutive |
| Information | Paritally Integrated |
| Fares | Integrated |
| Tickets | Integrated |
| Brand Identity | Integrated |
| Cooperation with other transport services | Partially Integrated |
| Data standardisation | Needed |

Flexride forms a part of the family of public transport services that is provided by RTD Denver. RTD Denver uses Flexride to serve two functions: first/last mile service that connects to one of their high-frequency rail services or regional bus routes, or for internal trips within a service zone.

The information for the service is partially integrated because of Flexride was only available on RTD proprietary multimodal trip planning app which allows trip planning along all its services including Flexride. Fares were also integrated such that the cost for using the service was the same as the cost for the local bus service, with free transfers. Flexride had the same payment methods as the other PT services of RTD, and therefore had integrated ticketing.

RTD Denver is responsible for planning, developing, monitoring the public transport system in the Denver region. RTD is also responsible for the providing the information about the system, deciding the fares of the system, developing the payment systems and the marketing of the entire public transport system. Thus, with all these responsibilities concentrated at a single body, RTD had the incentive to integrate information, fare, ticketing, and marketing across all their public transport services. Having uniformity between all their public transport services is also aligned with the RTD's "family of public transport services" philosophy.

Regarding the coordination between transport services that also operate in the Denver region, the US Department of Transportation funded project incentivised the development of the partnership with the service operators. Due to this project, the stakeholders developed not only the institutional framework for coordination, but also the technological requirement to enable coordination. To facilitate this coordination, a standardised method for data communication was needed.

# Chapter 5: Cross-Case Comparison

This chapter compares the 4 cases included in this research. The variables (integration components) used for the comparison were derived from the literature review and were thus used to compare the cases. Table 10 shows how the variables were addressed in the 4 cases. This is followed by an explanation of the integration components for the cases. Finally, the chapter concludes with the key learnings from the cross-case analysis. The key learnings are for the integration aspects that are studied in this thesis.

*Table 10: Cross-Case Comparison Table for the 4 cases*

| Integration Components | AML Flex | Zoov | Flextrafik | Flexride |
|---|---|---|---|---|
| Function | Substitutive/Complementary | Substitutive/ Complementary | Complementary/Substitutive | Complementary/Substitutive |
| Information | Integrated | Partially Integrated | Integrated | Paritally Integrated |
| Fares | Integrated | Not Integrated | Partially Integrated | Integrated |
| Tickets | Partially Integrated | Not Integrated | Integrated | Partially Integrated |
| Brand Identity | Integrated | Partially Integrated | Partially Integrated | Integrated |
| Cooperation with other transport services | Not integrated | Integrated | Integrated | Partially Integrated |
| Data standardisation | Not needed | Needed | Needed | Needed |

## 5.1 Comparison

The following section presents the explanation of the cross-comparison table for the integration aspects studied in this thesis.

### Function

In the AML Flex, the DRT system had a substitutive function in the public transport system, such that it was used as a replacement to bus lines. AML Flex replaced three bus lines from the previous concession that were too costly to operate as a fixed route. As a replacement, AML Flex was a stop-to-stop DRT service. In this case, the PTA mandated that the bus services be the core of the public transport system. Since it was the same operator for the scheduled public transport and DRT, the functional integration between DRT and PT was easy to arrange. In this case, the Connexxion must have experience in designing, operating, and managing a DRT service as in this concession it was the responsibility of the operator to design the public transport service that would address the door-to-door journey of a passenger. AML Flex was first conceived as a pilot programme, with the PTA providing capital for the start-up costs to Connexxion. However, this capital was different from the subsidy that they provided for the operations of their bus network. Hence, financially, AML Flex was seen as a separate system to the bus network.

In Zoov, the DRT system had a more substitutive role than a complementary one. The DRT system is an address-to-address service, which is more in line with a substitutive service. However, in some cases, it was also used as a first/last mile solution, which is in line with a complementary system. In the Zoov case, there was a limited integration between the public transport system operated by Arriva and Zoov. Firstly, the ICT platform used in Zoov, tracked the location of the train and buses using the open-sourced real-time operations data to provide a smooth transfer between the PT system and Zoov. Secondly, Arriva had subcontracted Zoov to operate Arriva's DRT service. Due to this partnership, the operations of Zoov and the operations of the DRT for Arriva were coordinated on the same ICT platform used by Zoov, thus

allowing for efficient planning. This coordination between Arriva and Zoov happened because both Arriva and Zoov saw the opportunity to make their operations efficient by combining their resources. However, if Arriva had chosen not to subcontract the operations to Zoov, then at the same time, two different systems, with a common user group would have existed.

In the Flextrafik case, the DRT service had both roles: complementary and substitutive. The service called Plustur had the complementary role whereas, the service called Flextur had the substitutive role. Plustur is designed to take the passenger from an address to a bus or train station. It is only offered if it can be combined with bus and/or train is not offered as an option, if it is quicker to walk or cycle to the nearest stop. On the other hand, Flextur is designed to take a passenger from an address to an address. It is used in line with the regular bus service in areas where regular bus services are not economically viable due to low passenger numbers. To ensure that Flextur was not used in competition with the PT system, the fare for Flextur was set at a significantly higher fare. An important reason that allowed the integration of DRT with the public transport system, through Flextur or Plustur, was the high volume of passengers and vehicles. Initially, when Flextrafik was introduced, it was only intended for passengers with special needs, such as people with disabilities and elderlies. However, because of the high volume of both passengers with special needs and a high volume of a vehicle fleet at their disposal, it was possible to make the same service available to other passengers by taking advantage of the same vehicles. The service of Plustur was designed by the PTAs, who was also responsible for the management of scheduled public transport, therefore, it is possible that DRT service was designed in synergy with the already existing scheduled public transport system.

Similarly, Flexride also had both roles. However, the use of the type of service (complementary or substitutive) was structured according to the service area. In some zones, the DRT service had the function of first/last-mile service. In these zones, there were checkpoints points, which were visited by a vehicle at a defined interval. These checkpoints points were almost always located within easy walking distance of areas where the most boarding or alighting (concentrated demand) takes place within the DRT zone, for example, a train station, a business compound etc. The use of such checkpoints minimizes the number of stops a DRT vehicle needs to make, which allows it to operate with more frequency or serve larger areas. On boarding the service, the driver would drop the passenger to their destination, following the route generated automatically on their onboard tablet. Furthermore, these checkpoints also offered opportunities for people to board a DRT service vehicle without needing to make a reservation. On the other hand, in the zones, where the demand is more spread over a wider area, then, the DRT service had a substitutive role, in which case, the public transport service was replaced with a DRT service that served the requests for internal trips within the zone. The PTA was responsible for designing the service and for deciding the function of the service. In this case, the PTA must have the required skill and for the planning of the services. RTD has been developing DRT services for its administrative areas since 2000 and therefore, it can be concluded that they have become skilled in the operations of DRT. Furthermore, apart from designing the service, the PTA has also been actively involved in the development of the IT platform, the trip exchange hub, the integrated trip planner and the mobile ticketing platform. Thus, it can be concluded that RTD Denver has been an innovative authority, which has often been cited as one of the important elements for a functional public transport system (Enoch et al., 2004; Mulley et al., 2012).

## Information

Information was partially integrated in the AML Flex. Here, it was mandated by the PTA to provide information about all PT services, including DRT to the passengers. As a result, Connexxion published static timetables for all its public transport services as open data. This data was then used by the trip-planning apps such as 9292, Google Transit to display AML Flex as a part of their offered itineraries. However, it was not possible to book the trip from these apps, and therefore, the passenger was merely directed from the trip planning apps to the AML Flex website.

In Zoov, a very limited form of information integration was visible. Here, the travel dispatch centre acted as a single point of information for the residents of the Achterhoek region. It provided information about all the possible public transport alternatives available in Achterhoek. When a passenger called to book a trip, the TDC would provide other possible travel options, if applicable. However, this was only available for the people who called the TDC. Furthermore, Zoov was not available as an option in a trip itinerary in any of the commonly used trip planners such as 9292, Google Transit, and NS trip planner.

In Flextrafik, the level of information integration was the highest among the 4 cases. Information about the DRT services which were open to the general public (Flextur and Plustur) was available on the most commonly used Danish trip planner app called Rejseplanen and thus were included in the trip itineraries. Here, the company that owned the trip itinerary, in partnership with a German company, developed a platform for Mobility as a Service, which allowed the inclusion of public transport, DRT, shared bikes, carpooling etc, as means of travel while generating itineraries. It was also possible to book a service and pay for the service through this app.

In Flexride, information was partially integrated. Here, RTD, in partnership with a private company, developed an application that allowed the generation of itineraries with Flexride in connection with other public transport options, wherever applicable. However, this feature was only available through the application developed by RTD. It was not available in other trip planners commonly used in the USA such as Transit, Google Transit. This was possible because the data for Flexride that is used to generate trip itineraries was not published as open-sourced data.

## Fare and Tickets

Integration of fare was visible in the AML Flex case. AML Flex replaced bus lines and provided stop-to-stop DRT. Thus, the PTA mandated that the AML Flex has the same fare structure. However, during the operations of AML Flex, the ridership of AML Flex decreased mainly due to the uncertainty factor which was introduced due to the need for booking a ride at least 30 mins in advance. Thus, it was realised that with the ridership it was attracting, providing AML Flex at the same fare as the PT was too expensive. In the AML case, the reimbursement to the operator for the operations of the public transport systems depended on the passenger revenues. In this case, the operator receives a subsidy according to the ridership it attracts. Therefore, the operator has an incentive to increase ridership which increases revenue, and thus, increases subsidy. Thus, it is possible that although the operating cost for AML Flex is lower than that of a bus service, the increase in ridership due to the bus would compensate for the increase in the operating costs from using the bus. Tickets were also integrated in the AML Flex. Here, it was mandated by the PTA to use the OV-Chipcards in all the public transport operations of Connexxion. Furthermore, since Connexxion already had the required back-end infrastructure required for OV Chipcard, providing a passenger to pay with an OV chip card on an AML Flex vehicle would have not required high investments to be made beforehand. To allow payment with OV chipcard in their vehicles, Connexxion used portable validators that have been available in the market for some time now and thus, procuring them was not an issue. However, it was indicated by the interviewees that the functioning of the portable chip card readers could have been stable.

In the case of Zoov, it was concluded that operating the DRT service at the same fare structure as the public transport would have been too expensive, and thus fare integration was not achieved. Regarding integrated ticketing, it was concluded that bringing the Zoov system under the national OV Chipcard system would have been too expensive because of the significant investments that had to be made to arrange the back-end infrastructure. Furthermore, paying with bank cards and automatic debit payment was cheaper and easier to arrange, and hence was chosen as the method of payment.

In Flextrafik, regarding fare integration, the service that is of interest is Plustur, since it is the solution for the first/last mile. In all the PTAs, the fare structure of Plustur was the same as the fare structure of bus service (a zone-based fare structure), with the fare levels being set as the fare for 2 zones (same as PT). The idea here is that Plustur is designed to bring a passenger from an address to a bus or train service.

Furthermore, it is not offered if it is possible to walk or cycle to the nearest stop. Thus, the service replicates a public transport service that only runs from address to a stop, and therefore according to the philosophy of PTA, the fare structure mimics the fares structure of scheduled PT. However, Flextur, is essentially a taxi service that runs from address-to-address. Their fare is set by the municipalities and the municipalities charge a premium to use the service. The reason for the premium is to regulate the operational costs for the service by regulating the demand though a higher fare. In Flextrafik, an integration of tickets was visible in the case of Plustur and Flextur service. It was possible to book and pay for the ride via the trip planner "Rejseplanen". Furthermore, using the app, it was also possible to buy the ticket of both a bus/train service and Plustur together.

In FlexRide, an integration of both fare and tickets was visible. The reason arose from the PTA's philosophy of DRT being a member of their family of public transport services, and therefore, the fare structure and the payment methods of DRT should mimic that of their other public transport services. All the different types of tickets that are sold by RTD Denver, a fare card called "MyRide" are valid in all public transport services including Flexride. In 2017, RTD, in partnership with a private company called Masabi, developed a mobile ticketing platform called "RTD Tickets". Via this application, a passenger was able to buy electronic tickets for all types of PT services, including Flexride. In the case of Denver, since RTD is responsible for designing, developing, and managing the service, RTD has the incentive to develop partnerships with private companies to increase the attractiveness of the public transport system. Also, the partnerships with private companies are important for RTD because the companies have the expertise in the field of ticketing, trip planners etc, which are lacking in RTD. Furthermore, the development of the mobile ticketing app, the trip planning app has been a part of a larger trend of mobility-as-a-service (MaaS) in the USA, wherein, the PTAs are trying to integrate different modes under a single platform to improve the experience of a passenger (Shared-Use Mobility Center, 2021).

## Brand Identity

In AML Flex, Connexxion had the incentive to market all their services as much as possible because their remuneration from the PTA directly depended on the ridership. As a result, Connexxion developed several campaigns about AML Flex using both digital and social media, as well as outdoor and print ads in the newspaper. Connexxion advertised AML Flex the same way they advertised their other services and all the vehicles used in the operations of AML Flex had the same brand image as their other public transport services. However, for the DRT for target groups that operate in the same area as Connexxion, there is no uniformity in the branding as it is a completely separate system.

Since Zoov Beheer was responsible for the marketing and the design of the brand identity, it was possible to achieve a single brand image between the different types of DRT services provided in Zoov. However, there was no integration of the brand identity between the public transport operator Arriva and the DRT system of Zoov. This made it possible to have a single brand image across all the different transport services for the different target groups that are present in the service offering. For their operations with Arriva, having a common brand image was not demanded by the province.

In the case of Flextrafik, the PTAs were responsible for the marketing of all the services that it manages, such as buses, trains, etc. Furthermore, all the PTAs designed a brand identity that contained the logo of the PTA and a colour scheme that should be present on all the vehicles that operate for the PTA, including DRT. Thus, it was possible to have a similar brand identity for the DRT as well as scheduled public transport.

In Flexride, RTD Denver employs the similar marketing channels that they use for their other public transport services such as bus and rail, building on the idea that Flexride, is a part of their family of services. Furthermore, the vehicles used were marked with the logo of the RTD. Also, since RTD uses the same vehicles for both, operations of Flexride and Access-a-Ride, both services have a common brand image.

## Cooperation with other transport services

In AML Flex, Connexxion provided DRT which was open for the general public. However, the transport system for target groups such as people with disabilities is still another system with no integration with the public transport system operated by Connexion. This system is managed separately by the municipalities, either in partnership with each other or on their own. Thus, two different systems exist at the same time. However, PTA is now working towards cooperation between the 15 municipalities. In this cooperation, the PTA will assume the role of coordinator between the various stakeholders such as the 15 municipalities, the public transport and target group transport operators and the end-user, and the passengers. This collaboration aims to "bring the worlds of public transport and target group transport closer together" (Vervoerregio Amsterdam, 2020).

The cooperation between the 7 municipalities in the Zoov case happened intending to organise the transport system more efficiently. Because of declining budgets, the province of Gelderland and the 7 municipalities could not leave the transport system "as it was". Furthermore, since Achterhoek is mainly a rural region with small towns and villages, it was important to cooperate because providing separate DRT services in the participating municipalities would have been too costly for them. Finally, the province also transferred the implementation of general public DRT to the municipalities. Thus, one of the reasons this cooperation worked out was because both, the municipalities and the province saw an added value, a possibility to make the DRT system cost-efficient in Achterhoek. The cooperation between them was also made easier because the 7 participating municipalities had been working together for a long time and therefore, already had established good working relationships. In the Netherlands, it seems that there are no legal restrictions for different municipalities to coordinate their tasks of providing DRT to their residents, as it was possible in the Zoov.

In the case of Flextrafik, the cooperation between the stakeholders such as municipalities and regions was possible because of the law that allowed the municipalities and regions to enter into voluntary agreements with the PTAs to take over the task of managing the special transport services, part or in whole. The stakeholders that wanted to participate could see the added value in the joint management of the services. However, to make that handover, the municipalities need to have confidence and trust the PTAs can handle the management of the service. This has also prevented some municipalities from not handing over the operations. Some municipalities, especially the larger ones do not hand over because of "municipal autonomy" as there is a desire to have a say in how such important social functions operate (Westerlund, 2016a). However, to have some control over the design process, the municipalities defined the service levels and were also responsible for verifying if a passenger is allowed to use special transport services. For the tendering and managing of the contract, the role was transferred to the PTAs. The PTAs negotiated contracts with the operators on the behalf of the municipalities and thus, were able to get a better contract price. Furthermore, since, PTAs also advise the municipalities while deciding on the service level, it is likely that some coordination of the service levels between different municipalities can be achieved because the PTAs would have an overview of all municipalities. Once this arrangement was in place, it was possible for the coordination of provision of different transport services. This arrangement is also seen in the Zoov case, wherein, the participating municipalities are responsible for defining the service levels and Zoov Beheer is responsible for tendering and managing the contracts with the taxi operators. A difference in the Zoov case is that the fare levels and the service levels of all the participating municipalities are the same, whereas, in Flextrafik, the fare levels for some of the services differ from municipality to municipality.

In Flexride, RTD is responsible for all types of public transport services including the DRT service for people with disabilities called Access-a-Ride. However, in places, where DRT services are also provided by clients other than RTD such as nursing homes for elderlies, some level of coordination between their services has occurred due to a project called "Mobility Services for All Americans (MSAA)" funded by the US Department of Transportation (Mobility Services for All Americans, 2016). One of the two accomplishments of this project was the development of the Trip Exchange Hub. The other was the

development of an institutional framework for the coordination between the operators of different DRT services. The stakeholders that participated in the project developed stable working relationships and a collective set of objectives for the development of DRT services. The framework, that is based on strong working relationships and collective objectives have the potential to accommodate for-profit, non-profit, and volunteer services (Lynott, 2020).

### ICT Infrastructure and Data standardisation

In the AML case, a standardisation of ICT infrastructure was not required because Connexxion was responsible for public transport and DRT. However, Connexxion worked with subcontractors specifically for its DRT operations, therefore, a standardised way of information sharing would have been beneficial, as there were some issues in the exchange of operational information between Connexxion and the taxi company that they had subcontracted for their operations.

In the case of Zoov, since different operators were providing the service, with a travel dispatch centre directing them, a standardised method of exchange of information between the vehicle and the dispatch centre was necessary. This was proven to be easy to arrange because, in the Netherlands, taxis must be equipped with an onboard computer, the specification for which has been standardised by the Dutch government. Furthermore, these onboard computers were provided by the dispatch centre to the operators. The platform that was used by the dispatch centre was thus able to communicate with all the vehicles of the fleet.

Similarly, in the case of Flextrafik, a nationwide DRT system would not have happened without all the operators agreeing to exchange information between them based on a data specification called SUTI. Through this specification, it was not only possible for the multiple operators but also for the multiple clients such as hospitals, municipalities etc, to "speak" with the FlexDanmark platform, and hence indirectly with each other. The development of SUTI was influenced significantly by the Swedish national government since they funded the special transport services in Sweden. Therefore, the Swedish government wanted to ensure interoperable end-to-end functionality of the key components of DRT technology such as reservations systems; vehicle scheduling systems; taxi dispatch systems etc. This was done to prevent vendor-lock in. Vendor lock-in is when a customer becomes dependent on a vendor for products and services and are unable to use another vendor because of high switching cost.

In the USA, coordination between different operators in the field of DRT to increase their scale of operations or/and improve cost efficiency is virtually non-existent (Teal et al., 2020). The reasons for this have been lack of leadership, lack of knowledge about the benefits of standardised data specifications amongst the agencies that fund the services. In the case of Denver, due to the lack of such specification, a workaround was sought. This was the use of APIs to "communicate with the software of other transport providers". For this communication, to happen, a data exchange platform was developed called Trip Exchange Hub. The development of such a platform was because the various transport services providers saw an opportunity to combine their resources for scaling up their operations and for more efficient use of their services, thus reducing service duplicity. However, due to the use of APIs, the number of different operators with their ICT platforms that can "plug" into this Trip Exchange Hub is limited, thus reducing the scalability of the operations (Lynott, 2020). This allowed the passengers from Flexride and passengers from a nursing home, for example, to share the same vehicle for their trip. While the Trip Exchange is still in its formative stages, it is operational and demonstrates that multiple interested and motivated parties can work together to develop a common platform to enable interoperability among DRT systems.

## Elements of an Integrated DRT-PT System

Following the cross-case comparison, certain key elements that are necessary for an integrated DRT-PT system are discussed below. These elements concern the integration aspects studied in this thesis. This is followed by the table that consolidates the key learning.

A DRT system can enable PTAs to fulfil their responsibilities to provide mobility to as many people as possible to enhance their access to the widespread opportunities or gaps that exist in their regions. The more DRT is developed as a top-down approach, that is through public policy, the higher the likelihood it will be integrated with the public transport system because, in this way, DRT would not be planned in isolation from another transport system. Thus, the DRT could become a part of a PTA's family of public transport services that are provided according to the passenger and market demands. DRT services that are complementary to the public transport system must be coordinated with the schedules of the rail or bus lines to which they connect. The coordination of schedules can come in the form of operating hours, availability of vehicles at stations or scheduled checkpoints, like in Denver, but can also take other forms—for example, tracking the location of buses or trains in real-time to provide seamless transfer between the two modes, like in Zoov. In 3 out of the 4 cases, knowledge, and responsibility of developing the public transport system (including DRT and scheduled PT) was concentrated in a single body. This single body could be an operator (AML Flex) or the PTA (Flextrafik, Flexride) Furthermore, in the case of Zoov, developing the DRT system for both the general public and target group was concentrated in a single body (Zoov Beheer). The advantage of such a concentration is that a single body has the incentive to plan the twos systems in synergy. A single body can also act as a central point of contact for both internal stakeholders, external stakeholders, and the passengers.

It seems that opening travel information is important for information integration of DRT and public transport. Usually, the necessary information is often already available with the transport companies. When this information is available as open data, market parties can develop applications that make it possible to offer customised solutions to passengers. Based on passenger profiles and the situation of the traveller, suitable travel advice can be given for that moment. In this way, integrated travel advice can be given to travellers of the DRT system. Apart from the trip planners providing travel advice, the dispatch centres, as seen in Zoov, can also offer this feature, especially in areas where the use of trip planners applications are limited due to digital illiteracy, lack of mobile phones or internet coverage. When the dispatch centres provide travel advice using up-to-date information about the user and real-time travel information, the user can be encouraged to opt for other modes of transport, such as DRT and scheduled public transport. However, in this case, the dispatch centre must be well informed of the existing public transport options, which should not be an issue since, the schedules and real-time information for the scheduled public transport service is already available as open source. The advantage of automated travel advice provision from trip planners over dispatch centres is that it can be easier to scale up. Because of the labour costs, the use of dispatch center comes with an extra cost for transport and therefore the automated advice provision could be a suitable option.

In the cases where fare integration was achieved, it was sought by the PTA as one of their goals. However, in those cases, revenue from the service could not cover the cost of the service and subsidies were needed to operate the service. This was observed in other DRT operations from other countries as well. It can be argued that since DRT is an intermediate service: higher service level than a scheduled PT but not an exclusive ride like a taxi, a fare should be struck in between the two with a premium being charged over and above a normal bus fare. On the other hand, it can be argued that DRT service is provided as a public transport service and that "normal" fares should be applied. However, it is also possible that if DRT fare is low, same as scheduled PT, then it can lead to induced demand which can increase the operational costs. Therefore, if fare integration between DRT and public transport has to be achieved, then the authority will likely have to pay more in subsidies. In that case, a long-term financing strategy and a well-defined business model will be important. Finding funding for DRT that is aimed to reduce social exclusion has been relatively easy to find because they cater to the "social inclusion", "access for disabled", "rural mobility" policy areas (Enoch et al., 2004; Mageean & Nelson, 2003b). However, this could also be extended to include policy areas of "resource efficiency", "integration".

When considering fare and ticket integration, it is also important to consider whether a possible difference between the fare structure is an obstacle for the traveller and whether he or she attaches much value to this (Perera et al., 2020). The interviewees from both Denver and Denmark suggested that since

the DRT (Plustur in Denmark) complemented the public transport service, there was an added value of fare integration for the passenger. Similarly, (Jittrapirom et al., 2019) surveyed the preferences of the elderlies living in the Netherlands, concerning DRT systems, and found that integrating payment methods with the nation-wide smart card system, OV-Chipkaart, was preferred for a convenient travel experience. From an operational point of view, the use of smart card systems can make revenue distribution between operators and local authorities easier. However, to provide smart cards as a method of payment, smart card validators will also have to be provided. For that, the scale of operations should be considered. For instance, AML Flex has a small fleet and small service area compared to the big fleet and a larger service area of Zoov. Thus, in the AML case, the number of such validators required would also be less and therefore, less expensive to provide, compared to the Zoov case. However, the public transport industry in the Netherlands is preparing to gradually move away from the OV-Chipcard to a full account-based ticketing system that can support multiple payment methods such as contactless bank cards, smartphones, QR codes (Kok & Lipt, 2020). Furthermore, arranging payment for the trips through electronic forms of payment could be relatively easier, as was visible from the Zoov case. However, the use of electronic forms of payment or mobile applications that necessitate the use of credit cards or debit cards or a bank account and internet access raises the question of how to serve unbanked or low-income passengers who do not have access to a smartphone. Finally, with the developments happening globally on the Mobility as a Service (MaaS) front, it seems that the integration of booking and paying (ticket integration) for a DRT trip in combination with scheduled public transport will eventually happen, as was also visible in Denmark. Here, it will be important that the authority responsible for the development of the DRT service takes an active role in monitoring the developments happening on the MaaS front.

One common issue that has been seen in AML Flex, Flexride and Flextrafik, specifically Plustur, is the lack of user awareness. The challenge of user awareness has also plagued DRT services from other countries as well (Brake et al., 2007; Daniels & Mulley, 2012; Weckström et al., 2018). According to (Brake et al., 2007), the visibility of DRT must be maintained aggressively since the more flexible the service, the less obvious it is to the public in terms of route and vehicle used. It seems that marketing activities targeted towards the different end-users are never too much. Thus, one of the requirements for DRT to succeed is that the authorities should commit to significant communication and marketing efforts, as well as strategic branding and partnerships to spread the word about the service. The authority can leverage its position as a trustworthy government body and can be at the forefront of the branding strategy like it is seen in Flexride. A shared vision between the stakeholders is also an important condition for a successful marketing strategy. Another element that should be considered is the involvement of the community that the service plans to serve. Involving the community presents benefits by using the local knowledge of the participants and harnessing the role that they can play in the marketing of the scheme. However, the element of community involvement needs careful management and can increase budgets due to outreach programmes.

3 of the 4 cases showcase that collaboration or a partnership between different stakeholders (providers of different types of DRT services) is desirable as it can lead to an increase in cost efficiency, reduction of duplication of services, resource sharing and knowledge sharing. However, to make that step towards collaboration, initial efforts into forming stable partnerships by a 'leader' is important. Sometimes, it could be the PTAs who assume this role, sometimes it could be a municipality. For the collaboration to take place, the stakeholders must be aware of the potential advantages and challenges of the collaboration. Here, the national government can play a role. For example, in the areas that are thinking about the integration between DRT and public transport, the national government can take the lead in ensuring that the provincial or municipal stakeholders (public transport authorities, municipalities, transport operators) “get around a table” and discuss the obstacles to integration and the way forward. By providing a financial incentive to achieve the integration, the national government can steer the achievement of integration. The partnership will also require sharing of information on operational characteristics such as availability of vehicle types, the duration of their availability, the duration of their driver availability, operator’s price for providing the service. Before the stakeholders start providing a

coordinated service, they should consider whether they can reach a clear and equitable cost-sharing agreement. Due to this coordination, a comingling between the passengers of different transport services will be a possibility. In this case, storing passenger profiles which has information about the passenger's specific needs such as the requirement of wheelchair accessible vehicle or additional time to board, can be useful. While planning a trip, the ICT platform can use these profiles to schedule trips.

Standardised IT architecture and data communication specification that allows coordination between the operations of different operators are essential in a system with multiple operators. The SUTI specification, used in Denmark, helped standardize trip request data across multiple authorities and more than 550 operators, which in turn helped lower costs of entry into the market and lower costs of DRT. However, for the development and the adoption of a data specification by the stakeholders, there has to be a "champion" that can advocate the development of such a standard. Such a champion in the development of the SUTI standard was the Swedish government, whereas for its adoption by the DRT industry in Denmark, FlexDanmark, which is an organisation owned by the 5 PTAs, was the champion as they mandated all their all operators to adhere to the SUTI standards. In the USA such a champion at the national level does not exist. Therefore, in the US, RTD had to assume this role. In the case of Zoov, this role was fulfilled by Munckhof, who provided the operators with the onboard computers that allowed communication between different operators. It can be argued that in AML Flex, this champion was Connexxion because they were responsible for the interoperability between the ICT systems of the transport services. However, they still faced issues with the interoperability between their system and their subcontractors' system. For the adoption of a data standard, there has to be a role of a champion. An authoritative government mandating the development and adoption can be the champion. Another champion could be a collaborative initiative of the PTAs, operators, technology providers, academic (for example-TOMP-WG[4]). Irrespective of who the champion is, the body funding the development and adoption has to be made aware of the business reasons for investing in a data standard. As discussed before, there is also a need to standardise data formats that are used to describe the DRT system in trip planners. Such a standardised format already exists for scheduled PT (BISON, GTFS). Therefore, it is recommended that the authorities at the National level can act as the "champion" and can nudge/incentivise developers to create such a standard for DRT as well. Once a standard is available, it can be published via the National Data Public Transport (NDOV) database. However, simply developing a standard is not enough, the data also must be made available in the standard so that the trip planners can use the data. In such a case, the PTA has to incentivise or demand through their contracts, the operator to publish their data in a defined, recognised format. On the international front, MobilityData, a not-for-profit organisation that manages data standards like GTFS, has launched a working group of government agencies, non-profits organisations, operators, and trip planning companies (Transit) to create an open data standard for all types of on-demand services including DRT, which is called General On-Demand Feed Specification, or GOFS [5]. It is, therefore, important to keep an eye on these developments and to investigate if, and how they can be adapted in the Dutch context.

[4] TOMP-WG is collaborative initiative to create standardised language for communication between operators and MaaS providers https://tomp-wg.org/

[5] MobilityData website: https://mobilitydata.org/why-on-demand-transportation-needs-to-be-standardized/

*Table 11: Key Learnings from the cross-case analysis*

| Integration Aspects | Key Learnings |
|---|---|
| Function | • DRT has a higher likelihood to be integrated with the public transport system if it is planned in a top-down approach, via public policy.<br>• The concentration of knowledge, and responsibility of developing the public transport system (including DRT and scheduled PT) in a single body gives the body control over the whole PT chain.<br>• A single body can also be a central point of contact for both internal stakeholders, external stakeholders, and the passengers. |
| Information | • Making travel information open and in a standardised way is important for information integration of DRT and the public transport system.<br>• Use of dispatch centres to provide travel advice can be an important resource in, especially in areas where the use of trip planners applications are limited due to digital illiteracy, lack of mobile phones or internet coverage.<br>• Dispatch center can leverage the open-sourced real-time scheduled public transport operations data to provide seamless transfers between the two systems. |
| Fares | • The question of fare integration is a policy decision. If, uniform fare scheme is desired then, a long-term financing strategy and a well-defined business model will be important.<br>• If uniform fare scheme is not desired, or a premium is charged, then the passengers and the stakeholders will need to be carefully explained of the reason for the premium. |
| Tickets | • The different types of payment options is going to increase with account-based ticketing. These include smartphones, contactless debit cards, QR codes.<br>• The authority responsible for the development of the DRT service should take an active role in monitoring the developments happening on the MaaS front because MaaS is very likely going to be a reality and thus, can support ticket integration. |
| Brand Identity | • Lack of awareness amongst the potential passengers of the DRT system has plagued a lot of DRT services.<br>• Authorities should commit to significant communication and marketing efforts, as well as strategic branding and partnerships to spread the word about the service. They can leverage their position as a trustworthy government body and can be at the forefront of the branding and marketing strategy.<br>• Involving the community presents benefits by using the local knowledge of the participants |
| Cooperation with other transport services | • Collaboration between different stakeholders (providers of different types of DRT services) is desirable as it can lead to an increase in cost efficiency, reduction of duplication of services, resource sharing and knowledge sharing.<br>• Collaboration to take place, the stakeholders must be aware of the potential advantages and challenges of the collaboration<br>• A leader (Municipality, Province or even the National Government) is needed who can ensure that the stakeholders "get around a table" and discuss the obstacles to integration and the way forward. |
| ICT infrastructure and Data standardisation | • Standardised open IT architecture and data communication specification that allows coordination between the operations of different operators are essential in a system with multiple operators.<br>• There is also a need to standardise data formats that are used to describe the DRT system in trip planners. Authorities at the National level can act as the "champion" that can nudge/incentivise developers to create such a standard for information sharing in the context of DRT.<br>• Through their contracts, PTAs can incentivise or demand the operator to publish their data in a defined, recognised format so that trip planners can include DRT in their service offering. |

# Chapter 6: Organisation of Demand Responsive Transport System

This chapter presents three alternatives for the organisation of DRT systems as a part of the public transport system. The organisational structures are described first, followed by their limitations and challenges. Finally, this chapter concludes with a discussion on the alternatives and the requirements for organisation structures.

## 6.1 Organisation Structures

A multimodal concession, as seen in Amstelland and Meerlanden region is a concession, in which transport modes such as DRT, shared bikes are present in addition to scheduled public transport. One reason for the emergence of multimodal concession is the emergence of new mobility services. Integration of these modes of transport in the concession can promote the chain approach. In a chain approach, the idea is that a single operator is responsible for the door-to-door journey of the passenger and thus, public transport can be made attractive by also providing transport modes for the first and last-mile leg of a journey. Thus, the expectation with a multimodal concession is that shared mobility modes such as DRT and shared bikes can complement high-frequency bus lines. In a general sense, if DRT and PT are complementary to each other and the use of DRT can stimulate an increase in ridership for the scheduled public transport then organising DRT and PT in a multimodal concession makes sense. One operator then becomes responsible for the entire chain and ensures good mutual coordination and connection of different modes, and for the passengers, the advantages could be one source of information, integrated payment methods, integrated fares and common brand identity.

However, a multimodal concession is typically designed to address the travel needs of the general public. There is another group of passengers for whom the need to provide transport system is important. This system is the DRT system for target groups (Doelgroepenvervoer in Dutch) such as people with disabilities and elderlies. Many rural areas in the Netherlands are or will be faced with a declining and ageing population. The use of this type of system is expected to grow in the future and with an increase in costs, there is also a need to organise this system more efficiently. A way to organise the system efficiently is through bundling different types of DRT into one system and thus creating a DRT system that can be used by both the general public and the target groups. This system could be called integrated DRT. Thus, this system will bring the different types of DRT services such as for people with disabilities, elderlies and the general public, and bring them into a single system. In the Netherlands, Municipalities are responsible for most forms of DRT that are used by target groups, and the provinces or the public transport authorities are responsible for the DRT for the general public. In such a case, the municipalities of the province can pool their resources and provide this DRT together, as seen in Flextrafik and Zoov. By pooling their resources, the municipalities can gain a procurement advantage as far as economies of scale can be achieved. The case of Flextrafik and the study commissioned by the Dutch government show that efficiency gains can be obtained by bringing the different types of DRT systems under one system.

By this bundling, there will exist two types of the public transport system in a region: a scheduled public transport system and an integrated DRT system. The next requirement will be to integrate these 2 systems to provide the residents with a public transport system that is a mix of both fixed and flexible transport systems that can operate in synergy. The organisation of the integration between the 2 systems can be done in three ways that are discussed below.

### First Organisational Structure

First at the operational level. The municipalities and the province agree on shared visions and goals of the public transport in their region. The province as the PTA translates this vision and goals into the minimum requirements and contracts an operator who is then made responsible for both DRT and PT. This contract would be a multimodal contract. Here, the operator will be responsible for achieving the integration of the two systems based on the collective requirements set by the municipalities and the

province. The advantage of such an organisational structure is that the operator is made responsible for the whole PT chain, which creates more solution space for the operator.

Provision of information to passengers about the entire chain can be integrated, which means that passengers can consult, trip planners timetables and maps for public transport and integrated DRT from one location, the operator. Also, a common branding strategy can be developed. Another advantage of such a structure is that contract management will become relatively easier, because of a limited number of stakeholders. Such an organisational structure is referred to as the First Organizational Structure and is shown in Figure 23

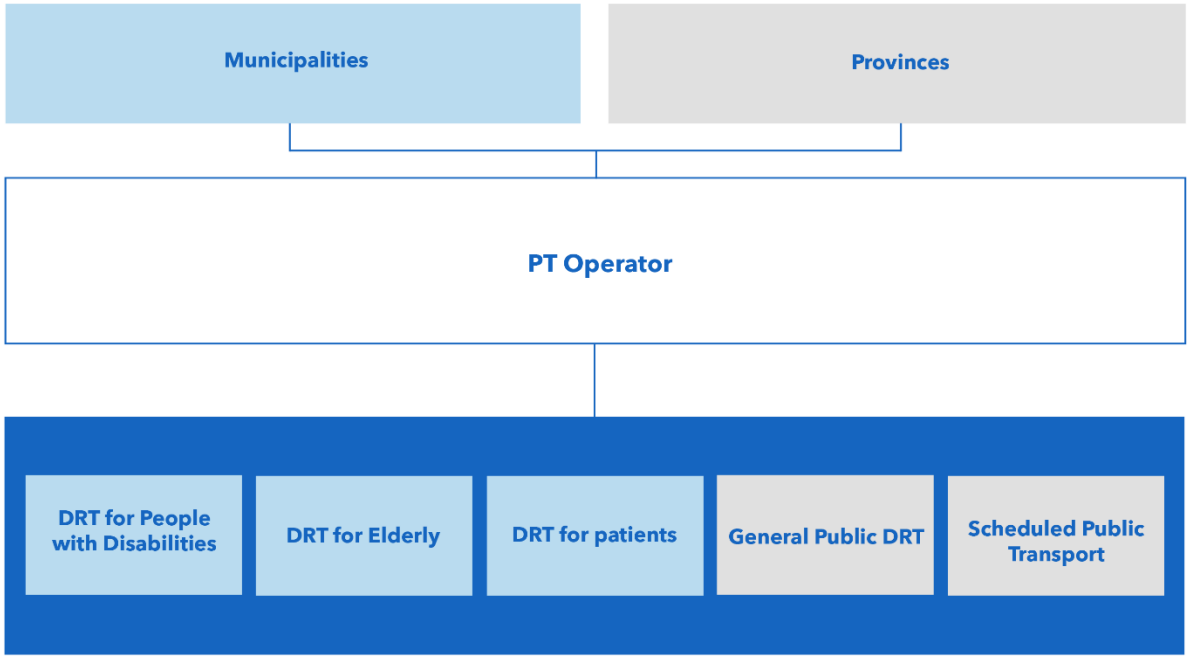


*Figure 23: First Organisational Structure-A Multimodal Structure*

In the first organisation structure, due to substantial investments, the skills and the experience required to manage different modalities, not all the operators would be willing to or able to participate in such a multimodal contract. This could ultimately lead to an increase in the contract price. Another limitation of having such a multimodal contract is that increasing the scope of the contract will make it difficult for small operators to be present in the bid. If such a structure is adopted, then awarding the contract to a single operator for all PT operations might lead to diseconomies of scale. Finally, there can be a legal barrier with the provision of all types of public transport services by a single operator.

## Second Organisational Structure

The second way of integrating the two systems is by forming a single governing body that represents both municipalities and the province. This body is called “Mobility Agency”. This mobility agency will be responsible for the management of both systems. The advantage of having such a single body is that the design of both integrated DRT and the public transport system can then happen in synergy. The tendering of both the scheduled public transport and the DRT system will also be handled by this body. This mobility agency will be governed by the board consisting of representatives of each municipality and the province. Thus, the PTA (province) will focus more on the connecting network, which functions as the backbone of public transport in the province. The cooperating municipalities will focus on the DRT service at the local level, which both public transport passengers and current passengers of target group transport can use. The attention of the PTAs is then primarily focused on scheduled PT, which is a direct, comfortable, and fast transport system for large groups of passengers over long distances. The municipalities will be responsible for the DRT system in the rural areas. This will also enable the

municipalities to be more involved in the design of public transport in their area. This model provides the opportunity for the Mobility Agency to respond flexibly to the change in travel demand. By being in control of the entire chain of a passenger, flexible fine-meshed mobility and the fast network of buses can be exchanged, depending on the passenger demand changes. Since the mobility agency will be the sole body responsible for the entire public transport system of the region, it can thus, push for integration of information, fare, tickets and brand identity by providing minimum requirements for the same in the contracts. Furthermore, the mobility agency will concentrate the knowledge, expertise and responsibilities into a single body. This will provide a single source of information for both passengers, as well as the stakeholders (including external stakeholders). There is also a possibility that due to this concentration of knowledge, an alignment of the different policy themes that affect mobility can happen.

For the operations of the scheduled public transport, the mobility agency can contract a public transport operator. For the operations of the integrated DRT, a dispatch centre can be set up at a provincial scale which will be responsible for taking the ride requests, planning the service, and dispatching the vehicle to the location. Finally, the execution of the trips can be done by taxi companies that are already active in the province. The advantage of using taxi companies is that the taxi companies usually have local knowledge of the passengers and the remote areas in which they live. Thus, the local knowledge of the taxi companies can prove to be a great resource. For the operations of the dispatch centre, a private company can be contracted. The role of the dispatch centre can also be done in-house by the agency. However, in this case, the mobility agency will also have to invest in buying the ICT platform required for the planning of the DRT operations. There are some private companies such as Via, Padam Mobility, that develop such platforms and therefore, can be possible alternatives. Such an organisational structure is shown in Figure 24.

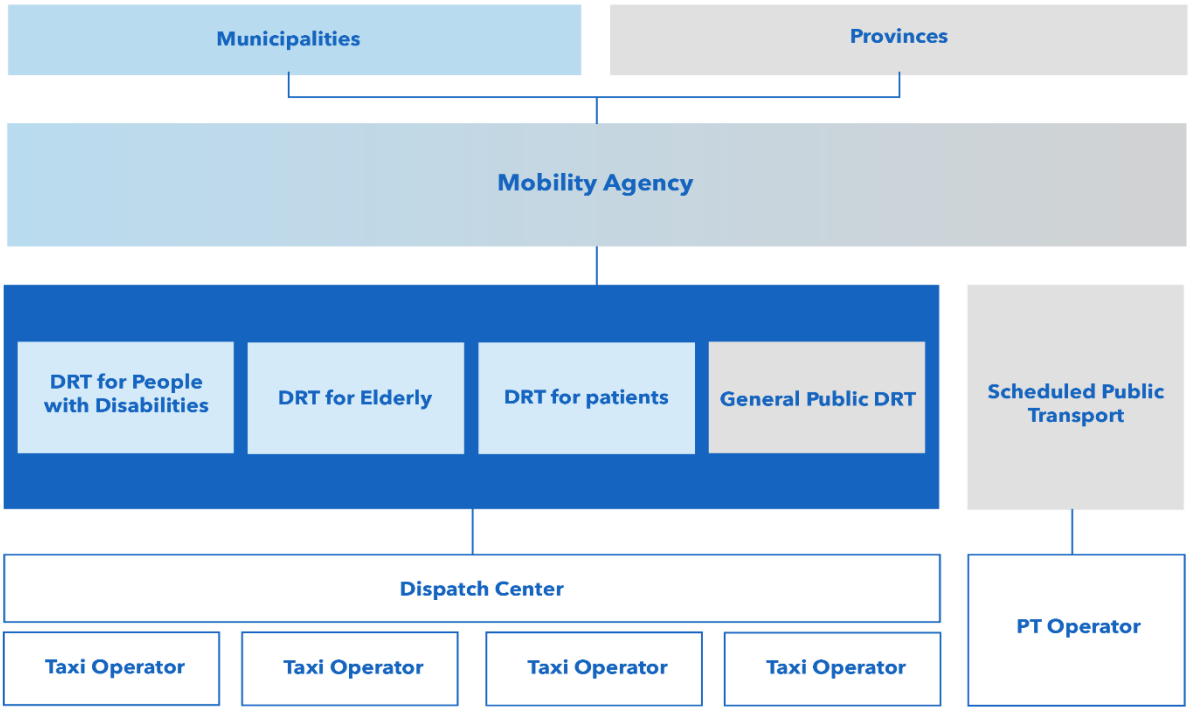


*Figure 24: Second Organisational Structure: A Mobility Agency Structure*

The scale at which the second organisation model can function comes with a trade-off. The trade-off will be between the possibility to achieve economies of scale at a higher scale (at the provincial scale, for example) and the increase in complexity in achieving cooperation between more actors. Cost efficiency would increase with an increase in the number of municipalities. The level of quality can be higher, due to the combined knowledge of the extra people that join in the cooperation. This advantage would continue

until the size of the organisation reaches a tipping point where there is no additional growth in scale, but scale disadvantages start to emerge such as control and management problems, slow decision making due to bureaucratic inertia. Thus, in general, it can be argued that there is a relationship between the number of cooperating municipalities and the cost for the functioning of the system. The costs also include transactional costs which according to Bel & Warner, (2016) consists of costs for coordination of activities during the decision making, negotiation on decisions, ensuring that the agreement will be executed and ensuring representation of particular municipalities during the process towards a decision. The transaction cost would be higher more municipalities cooperate and lower when there is a smaller number of collaborating municipalities. However, it can also be argued that with more municipalities participating in the Mobility agency, a more flexible system that has a variety of resources is created which can, therefore, handle a variety of challenges that may occur. Another issue with an increasing scale is communication. With an increase in scale cooperation between the municipalities and the province can be time-consuming due to the diversity of local wishes and policies. "Simple" issues such as how a vehicle should be branded, may take much time to resolve. The argument of exerting control over the functioning of the mobility agency is also crucial. With an increase in the number of municipalities, the control and influence of the participating municipalities over the functioning of the mobility agency may reduce which may not be desirable, especially for, big municipalities because of a lower possibility to govern on their initiative.

It will be critical for the municipalities and the province to have a good relationship with each other, which can make cooperation between them easier. Aspects such as a common vision between the actors, sense of urgency, willingness to cooperate, trust and transparency, trust can be the bedrock for cooperation. In cooperation, the political leadership of the cooperating municipalities will have to share power and prestige. The ambitions of municipal leadership, their pride and their limited ability to compromise could lead to conflict and hamper cooperation. This could result in a deterioration of relationships instead of an accumulation of trust among partners, which in the long run could endanger the sustainability of the Mobility agency.

In any case, volunteer participation of the municipalities is recommended because, in volunteer participation, the municipalities could choose with whom they want to cooperate. Alignment of all the contracts with the different operators, including the scheduled public transport. A workaround for that could be to start small with pilots, first starting with a few municipalities (for example the "leaders") and then gradually expanding to include other municipalities and the scheduled PT. Starting as a pilot also allows an opportunity for the sceptics and critics to examine the structure before extensive commitments are made. However, with pilots, there is a potential for setting unrealistic expectations or over-selling of the service to get it funded and operating.

## Third Organisational Structure

A third structure is to keep the operations of the integrated DRT and the scheduled PT separate. To achieve the integration between the two systems, the operators work together on the integration of the two systems. A common way to do this is by forming a partnership. The municipalities and the province can incentivise the operators of each system to form partnerships and collaborate and to achieve this integration. In this case, the province and the municipalities will have to agree on the requirements for the integration between the two systems. Thus, this structure will require the province and the municipalities to define the standards on the tactical and operational planning level that can help to increase integration. The standards could be about an integrated trip planning app, integrated ticketing systems, a MaaS application at a provincial scale, or a brand identity for example. Once these standards are in place, the operators for both systems form partnerships with each other to integrate the two systems according to the standards defined by their respective clients. Such an organisational structure is referred to as the third organisational structure and is shown in the Figure below.

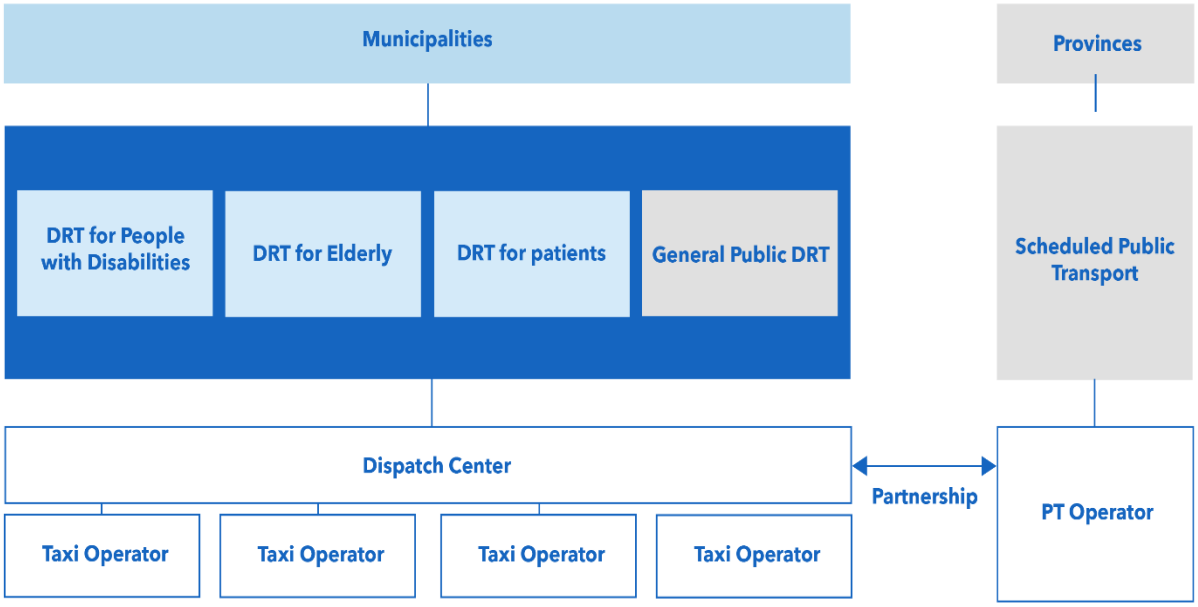


*Figure 25: Third Organisational Structure-A Partnership Structure*

In the third organisation structure, the integration will solely depend on the willingness of the operators to partner. However, since the requirements of the passengers of the two systems are very different, just forming partnerships may not be the most effective as they can be non-committal. Furthermore, the willingness to adapt the public transport system in a situation where changes have to be made in the operations of either service, due to a change in the passenger demand or requirements, will depend on the nature of this partnership and the flexible attitude of the two operators (if it exists). If such an agreement between the two operators is not present, there is a possibility of duplication of services which will essentially, lead the integrated DRT system competing with the public transport system. In such a structure, the province and the municipalities will need to develop steering mechanisms such as bonus/malus schemes that will incentivise the operators to work towards integration. The incentives in this system will have to be significant enough for the operators to interest them to work towards the integration. For instance, in areas, where there is a limited potential for a DRT service, the scheduled public transport operator may not be inclined to cooperate with the integrated DRT operator, if the incentives are not significant enough for the schedule PT operator. Finally, the success of this partnership will also depend on the trust each actor has in the other one.

## 6.2 Discussion

A complicating factor while bundling different DRT services into a single system could occur that due to the diverse needs of the specific traveller segments, normally using the service. This wide range of functional requirements needs to be considered where each put considerable demands on managerial and production resources, vehicles, equipment, information systems, etc. The characteristics of the target groups and general public are different, therefore knowledge about the needs and requirements of the passengers is needed to successfully bundle the two systems. It might be relatively easier to combine some predictable rides, such as student transport. On the other hand, combining unpredictable and incidental rides can be a challenge. One way to counter this challenge is to include flexibility in either time or space while operating the service. If time is made flexible, then travellers must wait longer at their origin or destination before they can depart. If spatial flexibility is included, then travel time will be longer because vehicles will have to make a detour. Including a flexible approach allows for more flexible trip planning and more efficient service. However, because of flexibility the service level of the DRT service will decrease since, the passengers will not be able to almost always leave at the desired time or will have to reach a meeting point to get on the vehicle.

Due to the involvement of different types of target groups, stakeholders, and their varying needs, simply placing the responsibility of the integration on the operators, as is done in the first and the third organisational structure is not appropriate. On the other hand, the first and the third organisational structures could be easy to set up.

However, with the second organisational structure, the integration between different systems can happen at the policy level. Through a mobility agency, the policy boundary between the different systems can be removed. By bringing expertise and policy to one organisation, it is expected that an alignment of the mobility policy at strategic, tactical, and operational levels between the different transport systems will be possible. For this system, the precondition is close cooperation between the province and municipalities to realise the coordination between the different transport systems. In true cooperation, all funds would go into one central "pot", and this would be used to fund all the different transport services. Because the target group transport is paid for from many different schemes, thus, it would be beneficial the create this central "pot" by integrating different money streams. The idea here is that combining financial resources will result in a more integrated approach to the various schemes. For such a "pot" to function, it will be important to have a clear cost allocation and revenue sharing model that is transparent and is preferably automated because of the presence of different stakeholders

When the role of the dispatch centre is tendered to a private operator as in the case of the Zoov, its operation must be closely monitored by the mobility agency, not just for control over the quality, but also to prevent this operator from retaining the information that would give him a competitive advantage when the contract is tendered for renewal. The dispatch centre could be instrumental in developing cost allocation and revenue-sharing model, since, they will have access to operational data such as the type of passenger, pick-up and drop-off location, and travel time. The function of the dispatch centre is thus, dependent on data transfer between the different operators and therefore, the methods of data transfer must be mentioned clearly in the contract.

# Chapter 7: Conclusions

This chapter presents the conclusions of this research. First, the sub-research questions and the main research questions are answered. This is followed by recommendations for practice and future research. Finally, this chapter concludes with the limitations of this research.

## 7.1. Conclusions

A cross-case analysis was conducted between 4 cases where integration of DRT and PT was visible. Of the 4 cases, 2 cases were selected from the Netherlands. These were the multimodal concession of Amstelland-Meerlanden, the unimodal DRT of Zoov from Achterhoek. Two cases from other countries were also selected. These were Flextrafik from Denmark and Flexride from Denver, USA. By doing desk research and by conducting interviews with the stakeholders from all the cases, information on the integration aspects was collected.

To answer the main research question, several sub-questions were formulated. First, the sub-research questions are answered, followed by the answer to the main research question.

***How is the integration of Demand Responsive Transport and Scheduled Public Transport defined?***

The premise of demand-responsive transport has existed since 1916. However, the potential for the service has been greatly improved over the last decade due to demographic changes, technological advancements and business innovations. Using fixed-route services or scheduled public transport services such as bus, train, or metro in areas of a higher population densities population and employment seem the most efficient and productive way to operate. However, technology-enabled DRT that uses a smaller, adaptable fleet of vehicles can be implemented in specific contexts such as low population density areas with scattered demand for transportation, and to improve coverage and accessibility in areas that lack transport alternatives, or to offer last mile and connection to the high-capacity mode of transport, such as bus, train, or metro. Thus, with an integration of the DRT with the public transport system, the DRT service aims to fill in gaps in the scheduled public transport network by serving areas or times of lower demand for service. DRT can complement the scheduled public transport network by addressing the first and last-mile challenges faced by the passengers. A DRT service can also be provided for the internal trips in an area where the demand is dispersed over a wider area. This service would then aim to be a public transport alternative and would substitute a scheduled public transport system in that service area. In either case, DRT has the potential to play an important role in the public transport provision and thus, an integration of DRT into the public transport system can provide an opportunity for the public transport authorities to improve accessibility and to increase public transport usage in rural areas. With the integration between DRT and scheduled PT, rather than two systems running parallel, they will support each other. Although there is abundant literature on the operational and technical requirements for the integration of DRT with PT, there is, however, limited literature on the organisation and governance of integration of DRT and the public transport system. As a result, a generic case of PT integration was studied. For this, the perspectives of 3 actors were considered: Passenger, Operator, and the Authority. The passenger perspective focused on the quality of the system for the traveller. It concerned the comfort and ease with which the traveller can travel. The components that were found to be important from the perspective of the traveller were the provision of information of the service or service discovery, and a common logo/branding and customer interface. From the perspective of the operator, costs and revenue components are relevant. Costs may relate to the alignment of equipment, personnel, and planning system. Revenues may be related to the alignment, subsidies and (extra) passenger revenues. Finally, from the perspective of the authority, it was concluded that to realise integration in public transport, some level of "working together" between the different stakeholders is needed. To shape this cooperation, several factors are important such as (common) goals, mutual benefits, behaviour and the trust of the different parties involved.

***According to the literature, what aspects are important while considering the integration of DRT with the public transport system?***

Aspects that should be considered while organising DRT as a part of the public transport system were identified from the literature. The first aspect was the function of the DRT system in relation to the scheduled public transport system. The function of DRT can be complementary, substitutive, or competitive. The function that DRT determines whether integration is desirable and to what extent. The next aspect is the integration of information. This concerns provision about existing DRT services, and the integration of DRT services into public transport information and booking systems. The form and quality of information, available booking methods and knowledge about existing services in general (and resulting complexity or hassle) strongly influence the willingness to use DRT services. The next aspect of integration is fare integration. This considers whether the fare for both DRT and PT systems is the same and if the transfer between the two systems is free. The next aspect is the integration of tickets. Here, the idea is that the DRT should adapt to existing public transport ticket systems. This integration allows for easy booking and payment for the DRT system. A tariff system must satisfy two requirements to become integrated: no additional costs for transfers and all modes and services use the same ticketing system. The next aspect is common brand identity. When there is a common branding between the two systems, it becomes clear and convenient for the traveller, and he does not have to deal with the different operators and therefore, the passenger perceives the system as one. The next aspect is the cooperation between general public DRT with the DRT for target groups, to bring them under one system. By bringing all the different DRT systems under a single system, it is possible to make the system cost-efficient by achieving economies of scale. Furthermore, it also provides a chance for people from target groups to participate in the public transport system. Finally, the last aspect is the standardisation of the ICT infrastructure and data specification. This aspect considers the ICT infrastructure that enables the coordination of operations between different operators. When different operators use different scheduling software, their systems do not readily interoperate with one another, this results in an inability to exchange the information about vehicle capacity, schedules, or routes that are needed to plan and deliver trips that occur in the same service area.

***How are these aspects addressed in different implementations of demand responsive transport systems in the Netherlands and other countries?***

The next step was to conduct a cross-case analysis A cross-case analysis was conducted between 4 cases: AML Flex, Zoov, Flextrafik, and Flexride. By conducting desk research and by interviewing the stakeholders from all the cases, information on the integration aspects was collected. Once this information was available, the 4 cases were compared with each other by using the integration aspects as the variables of comparison. A cross-case comparison table was created and is shown below.

| Integration Components | AML Flex | Zoov | Flextrafik | Flexride |
|---|---|---|---|---|
| Function | Substitutive/Complementary | Substitutive/ Complementary | Complementary/Substitutive | Complementary/Substitutive |
| Information | Integrated | Partially Integrated | Integrated | Paritally Integrated |
| Fares | Integrated | Not Integrated | Partially Integrated | Integrated |
| Tickets | Partially Integrated | Not Integrated | Integrated | Partially Integrated |
| Brand Identity | Integrated | Partially Integrated | Partially Integrated | Integrated |
| Cooperation with other transport services | Not integrated | Integrated | Integrated | Partially Integrated |
| Data standardisation | Not needed | Needed | Needed | Desired |

***What are the key elements for an integrated demand responsive transport system?***

From the results of the cross-case analysis, certain key elements that are necessary for an integrated DRT-PT system are discussed below.

A DRT system can enable PTAs to fulfil their responsibilities to provide mobility to as many people as possible to enhance their access to the widespread opportunities or gaps that exist in their regions. The more DRT is developed as a top-down approach, that is through public policy, the higher the likelihood it will be integrated with the public transport system because, in this way, DRT would not be planned in isolation from another transport system. Thus, the DRT could become a part of a PTA's family of public transport services that are provided according to the passenger and market demands. DRT services that are complementary to the public transport system must be coordinated with the schedules of the rail or bus lines to which they connect. A single body that concentrates knowledge and the responsibility of the entire would support the integration of DRT and PT. The advantage of such a concentration is that a single body has the incentive to plan the two systems in synergy. A single body can also act as a central point of contact for both internal stakeholders, external stakeholders, and the passengers.

Opening travel information is important for the integration of DRT and public transport. Usually, the necessary information is often already available with the transport companies. When this information is available in real-time as open data, market parties can develop applications that make it possible to offer customised solutions to passengers. Based on passenger profiles and the situation of the traveller, suitable travel advice can be given for that particular moment. In this way, integrated travel advice can be given to travellers. Apart from the trip planners providing travel advice, the dispatch centres can also provide integrated information, especially in areas where the use of trip planners applications is limited due to digital illiteracy or lower internet coverage. The use of a dispatch centre for this role can be particularly useful when the DRT system is provided predominantly for an ageing population.

It can be argued that as DRT is an intermediate service: higher service level than a scheduled PT but not exclusive ride like a taxi, and thus, the fare for the service should be struck in between the two with a premium being charged over and above a normal bus fare. On the other hand, it can also be argued that DRT service is provided in places where scheduled public transport was not appropriate and thus, fares similar to the bus service should be applied. However, if the DRT fare is low, or the same as scheduled PT, then it can lead to induced demand which can increase the operational costs. Having a uniform fare

scheme for the two systems is a policy decision. If a unform fare scheme is desired then the authority will likely have to pay more in subsidies, because a commercially viable DRT service is very rare. In that case, a long-term financing strategy will be important. If it is not desired, and a premium fare is charged for the service, then the passengers will need to be carefully explained about the reason for a premium.

The question of ticket integration is particularly relevant when the DRT service has a complementary role to the public transport system. Different types of payment options is going to increase with account-based ticketing. These include smartphones, contactless debit cards, QR codes. These payment options could be possible alternatives when thinking about ticket integration. However, the use of electronic forms of payment or mobile applications that necessitate the use of credit cards or debit cards or a bank account and internet access raises the question of how to serve unbanked or low-income passengers who do not have access to a smartphone. With the developments happening globally on the Mobility as a Service (MaaS) front, it seems that the integration of information, booking and paying (ticket integration) of the DRT system with the scheduled public transport system will eventually happen. Here, it will be important that the authority responsible for the development of the DRT service takes an active role in monitoring the developments happening on the MaaS front. It will also become imperative for the authorities to create partnerships with other authorities and private sector players to facilitate working MaaS platforms.

One of the requirements for DRT to succeed is that the authorities should commit to significant communication and marketing efforts, positive user experiences, strategic branding and partnerships to spread the word about the service. The authority can leverage its position as a trustworthy government body and can be at the forefront of the branding and marketing strategy like it is seen in Flexride. This makes the passengers perceive it as easy and approachable. Another element that can be considered is the involvement of the community that the service plans to serve. Involving the community presents benefits by using the local knowledge of the participants and harnessing the role that they can play in the marketing of the scheme. However, the element of community involvement needs careful management and can increase budgets due to outreach programmes.

A collaboration or a partnership between different stakeholders (providers of different types of DRT services) is desirable as it can lead to an increase in cost efficiency, reduction of duplication of services, resource sharing and knowledge sharing. However, to make that step towards collaboration, initial efforts into forming stable partnerships by a 'leader' is important. Sometimes, it could be the PTAs who assume this role, sometimes it could be a municipality. The leader has to play its role with transparency and simultaneously should protect the egos of the smaller municipalities. Equality is, therefore, a key principle. For the collaboration to take place, the stakeholders must be aware of the potential advantages and challenges of the collaboration to instil a sense of urgency, if any. Here, the national government can also play a role. For example, in the areas that are thinking about the integration between DRT and public transport, the national government can take the lead in ensuring that the provincial and municipal stakeholders (public transport authorities, municipalities, transport operators) “get around a table” and discuss the obstacles to integration and the way forward. By providing a financial incentive to achieve the integration, the national government can steer the achievement of integration.

The advantage of a standardised ICT infrastructure and data specification is that it allows coordination between the operations of different operators. The SUTI specification, used in Denmark, helped standardize trip request data across multiple authorities and more than 550 operators, which in turn helped lower costs of entry into the market and lower costs of DRT. However, for the development and the adoption of a data specification by the stakeholders, there has to be a “champion” that can advocate and incentivise the development and use of such a standard. Such a champion in the development of the SUTI standard was the Swedish government, whereas for its adoption by the DRT industry in Denmark, FlexDanmark, which is an organisation owned by the 5 PTAs, was the champion as they mandated all their all operators to adhere to the SUTI standards. Related to information integration discussed before, there is also a need to standardise data formats that are used to describe the DRT system in trip planners.

Such a commonly used standardised format already exists for scheduled PT (BISON, GTFS), however the same is missing for the DRT industry. Therefore, it is recommended that the authorities at the National level act as the "champion" and nudge/incentivise developers to create such a standardised format for DRT as well. On the international front, MobilityData, a not-for-profit organisation has launched a working group of government agencies, non-profits organisations, operators, and trip planning companies (Transit) to create an open data standard for all types of on-demand services including DRT, which is called General On-Demand Feed Specification, or GOFS. It is, therefore, important to keep an eye on these developments and to investigate if, and how they can be adapted in the Dutch context.

***How can a demand-responsive transport system be organised as a part of a public transport system?***

Due to the involvement of different types of target groups, stakeholders, and their varying needs, an integration of governance of the two systems is desired. An organisational structure that allows for such an integration in Figure 26, which is followed by an explanation of the structure.

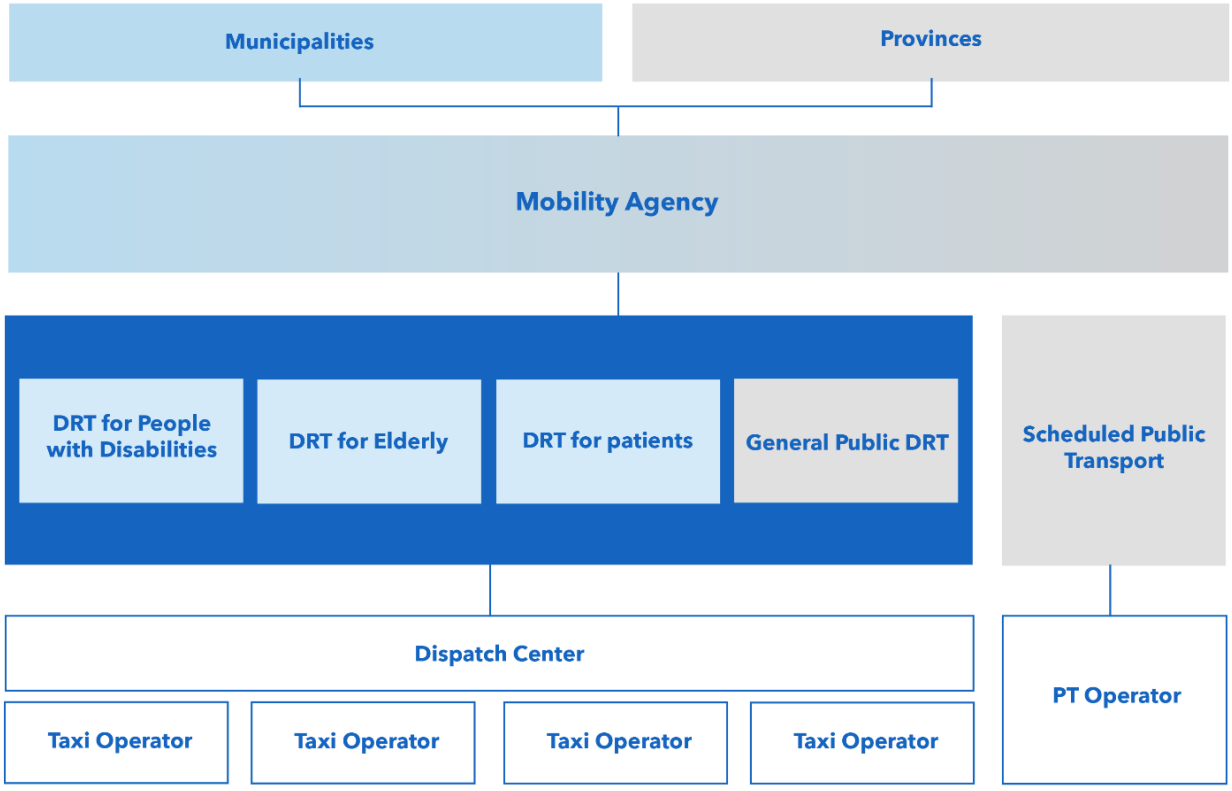


*Figure 26: Mobility Agency Organisational Structure*

Bundling different types of DRT into one system that can be used by both the general public and the target groups can have potential efficiency gains by achieving economies of scale. This bundled system is called integrated DRT. In the Netherlands, the municipalities are responsible for most forms of DRT that are used by target groups, and the provinces or the public transport authorities are responsible for the DRT for the general public. In such a case, the municipalities of the province can pool their resources and provide the DRT service together. By pooling their resources, the municipalities can gain a procurement advantage since economies of scale can be achieved. In true cooperation, all funds would go into one central "pot", and this would be used to fund all the different transport services. The idea here is that combining financial resources will result in a more integrated approach to the various transport systems. For such a "pot" to function, it will be important to have a clear cost allocation and revenue sharing model that is transparent and is preferably automated because of the presence of different stakeholders

The next step is to integrate the bundled DRT system and the scheduled public transport system. For that, it is recommended to organise both systems by forming a single governing body that represents both municipalities and the province. This body is called "Mobility Agency". This mobility agency will be governed by the representatives of the municipalities and the province. The PTA (province) will focus more on the scheduled public transport network, which functions as the backbone of public transport in the province. The cooperating municipalities will focus on the integrated DRT system at the local level, which both public transport passengers and target group transport passengers can use. This mobility agency will be responsible for the management of both systems. The advantage of having such a single body is that the planning of both systems can then happen in synergy. The tendering of both the scheduled public transport and the DRT system will also be handled by this body. This model provides the opportunity for the Mobility Agency to respond flexibly to the change in travel demand. By being in control of the entire chain of a passenger, flexible DRT service and the fast network of buses can be exchanged, depending on the passenger demand changes. Since the mobility agency will be the sole body responsible for the entire public transport system of the region, it can thus, push for integration of information, fare, tickets and brand identity by providing minimum requirements for the same in the contracts. Furthermore, the mobility agency will concentrate the knowledge, expertise and responsibilities into a single body. This will provide a single source of information for both passengers, as well as the stakeholders (including external stakeholders). There is also a possibility that due to this concentration of knowledge, an alignment of the different policy themes that affect mobility can happen.

For the operations of the scheduled public transport, the mobility agency can contract a public transport operator. For the operations of the integrated DRT, a dispatch centre can be set up at a provincial scale which will be responsible for taking the ride requests, planning the service, and dispatching the vehicle to the location. Finally, the execution of the trips can be done by taxi companies that are already active in the province. Taxi companies usually have local knowledge of the passengers and the remote areas in which they live which can prove to be a great resource.

The scale at which the second organisation model can function comes with a trade-off. The trade-off will be between the possibility to achieve economies of scale at a higher scale (at the provincial scale, for example) and the increase in complexity in achieving cooperation between more actors. Cost efficiency would increase with an increase in the number of municipalities. The level of quality can be higher, due to the combined knowledge of the extra people that join in the cooperation. This advantage would continue until the size of the organisation reaches a tipping point where there is no additional growth in scale, but scale disadvantages start to emerge such as control and management problems, slow decision making due to bureaucratic inertia. Thus, in general, it can be argued that there is a relationship between the number of cooperating municipalities and their costs. The costs also include transactional costs which consist of costs for coordination of activities during the decision making, negotiation on decisions, ensuring that the agreement will be executed and ensuring representation of particular municipalities during the process towards a decision. The transaction cost would be higher more municipalities cooperate and lower when there is a smaller number of collaborating municipalities. However, it can also be argued that with more municipalities participating in the Mobility agency, a more flexible system that has a variety of resources is created which can, therefore, handle a variety of challenges that may occur. Another issue with an increasing scale is communication. With an increase in scale cooperation between the municipalities and the province can be time-consuming due to the diversity of local wishes and policies. "Simple" issues such as how a vehicle should be branded, may take much time to resolve. The argument of exerting control over the functioning of the mobility agency is also crucial. With an increase in the number of municipalities, the control and influence of the participating municipalities over the functioning of the mobility agency may reduce which may not be desirable, especially for, big municipalities because of a lower possibility to govern on their initiative.

It will be critical for the municipalities and the province to have a good relationship with each other, which can make cooperation between them easier. Aspects such as a common vision between the actors, sense of urgency, willingness to cooperate, trust and transparency, trust can be the bedrock for

cooperation. In true cooperation, all funds would go into one central "pot", and this would be used to fund all the different transport services. Because the target group transport is paid for from many different schemes, thus, it would be beneficial the create this central "pot" by integrating different money streams. The idea here is that combining financial resources will result in a more integrated approach to the various schemes. For such a "pot" to function, it will be important to have a clear cost allocation and revenue sharing model that is transparent and is preferably automated because of the presence of different stakeholders. In cooperation, the political leadership of the cooperating municipalities will have to share power and prestige. The ambitions of municipal leadership, their pride and their limited ability to compromise could lead to conflict and hamper cooperation. This could result in a deterioration of relationships instead of an accumulation of trust among partners, which in the long run could endanger the sustainability of the Mobility agency.

Volunteer participation of the municipalities is recommended because, in volunteer participation, the municipalities could choose with whom they want to cooperate. Alignment of all the contracts with the different operators, including the scheduled public transport. A workaround for that could be to start small with pilots, first starting with a few municipalities (for example the "leaders") and then gradually expanding to include other municipalities and the scheduled PT. Starting as a pilot also allows an opportunity for the sceptics and critics to examine the structure before extensive commitments are made. However, with pilots, there is a potential for setting unrealistic expectations or over-selling of the service to get it funded and operating.

## 7.2. Recommendations

Based on the results from this thesis, few recommendations can be made. First, the recommendations that are relevant for practice are discussed. This is followed by the recommendations for future research building on this thesis and for the field of demand responsive transport.

### Practice

If a DRT service is provided to address transport requirements of rural areas with low passenger demand, then it is recommended to work towards the integration of demand responsive transport and public transport. For this, a shift is required in the political mindset, such that, there must be a political willingness to let go of the existing system. According to de Jong et al (2011), the topic of integration of different DRT systems into a single system has been a point of discussion in Dutch politics since 2010. This provides an interesting opportunity for the organisation model proposed in this thesis to be considered as an alternative.

When a public transport authority is considering integrating DRT and PT, it is important to look at the experiences of other PTAs and to learn from any problems that may have arisen. It is highly unlikely that one can adopt something that works well, as is, with the expectation that it will work in another setting. It is also recommended to analyse and exchange best practices to shape a shared vision and to implement the resulting changes. While looking at different cases, it might be interesting to look at the experiences of the DRT services or "Microtransit" from the USA, UK, other countries of Europe. In the coming years, additional experience on a lot of ongoing DRT pilots from around the world shall be available. The PTAs can look at these experiences to develop guidelines and service standards.

Several DRT services such as Kutsuplus (Finland), BrengFlex (Netherlands), Chariot (USA) ceased their operations for not achieving financial viability. However, a public DRT service that is provided to increase the accessibility of areas has a different objective than to be financially viable. Thus, evaluating a public DRT service solely based on its financial performance does not seem justified. In such a case, the decision-makers should understand that the benefits of providing a DRT service, in some cases, need not be financial but also other reasons (to reduce social exclusion, for example) and therefore should be incorporated in the evaluation of the service.

There is an expectation that DRT can solve a lot of issues with the public transport world, which was mentioned during the interviews and concluded from the literature. However, past experiences have conduced that is not always true. Sometimes, there are other transport systems such as shared bikes, volunteer-driven systems that could work as well. Therefore, before a DRT system is implemented, the expectations of the actors and the possible solutions should be aligned and the goals that are set for the service are realistic with clear and measurable objectives. For that, it is necessary to plan for the market that the DRT service is intended to serve. The market study should include assessing potential ridership, developing customer characteristics and service area characteristics, passengers' travel patterns etc.

Since an integrated system is not set up overnight, until then it is recommended to improve the provision of information to the DRT passengers about the availability of such alternatives, preferable in real-time. Punctuality and the ability to provide accurate departure and arrival times are important for passengers. Many channels are available to share passenger information such as SMS, emails or push notifications on smartphones. In addition, rating the trips by the passenger allows operators to get a real-time indication about the quality of their DRT service and to quickly consider improvements. For the digital information provision, it is recommended to actively seek out partnerships with the trip planners such as 9292, Transit. Without an available data standard, it is still possible for such companies to provide information about the DRT services by using proprietary APIs of the operator. For this, it is recommended that the authorities demand the operators to provide their APIs as open source and work with third parties. An open API allows for multi-modal app integration. In their program of requirements, the authorities can score the operators on their ability to work with third parties.

For enhancing the potential for combining trips between the different DRT services, the concept of mobility hubs seems relevant. A Mobility hub is a central location in an area, where several transport (shared) modes are combined. By using a centralised location, different rides can be combined. These are the "scheduled checkpoints" from the Denver case. The DRT system brings a passenger to one of these hubs, from where a scheduled public transport takes the passenger to either their destination or to another hub. Thus, the mobility hubs provide an opportunity for door-to-door transport. However, to make the experience of the traveller at the centre at the mobility hubs, it is important to have the right information from the travellers. For instance, how far is it possible for one to walk? It will also be important to make the mobility hubs visible in the area. This can be done by establishing easily recognisable markers for identification. The identification can also follow the same brand identity as the public transport system.

Design the system by keeping the passenger as the central figure. The user experience should focus on passenger information, booking features, method of payment. For an integrated DRT system proposed in this thesis, a significant target group is people with reduced mobility. From non-accessible vehicles to non-adapted digital tools, stumbling blocks lurk in many places and can significantly limit the user experience. The risk with a bad user experience is that the use of the service decreases over time as the user group shrinks. This may eventually lead to the passengers not relying on the DRT service entirely, preferring to use an individual vehicle whenever possible.

A final recommendation is to make DRT an attractive service by using a short waiting time to ensure that the DRT services can be ordered spontaneously. By using an ICT platform that dynamically schedules trips, the average waiting time for a passenger can be reduced. By using truly dynamic DRT that can process numerous, nearly simultaneous requests, it will also be possible for ongoing trips to be combined. In the cases of Denmark and Denver, it was found that technologically, such a platform is feasible.

## Research

To be able to implement the Mobility agency, the municipalities and provinces need to cooperate closely. Future research is therefore recommended to gain more insight into the collaboration models that can be followed by the stakeholders involved in the provision of the public transport system. Here, it would be

interesting, to use a game-theoretical approach to develop the collaboration model, since the game theoretical approach is generally appropriate for multi-actor systems.

Stakeholders such as municipalities, passengers, passenger organisations, taxi companies, technology providers are also important to be considered on the topic of integration. Therefore, it is recommended to add their perspectives in follow-up research. From the passenger perspective, a survey among different groups of passengers could be of added value. From the business perspective, taxi companies of different sizes could be interviewed.

The bundling of different DRT systems into a single system is based on the hypothesis that a bundled system can lead to an increase in cost efficiency, resource sharing. This hypothesis is based on existing literature and experiences from other countries. For the Dutch context, it is recommended to test this hypothesis by conducting a social cost-benefit analysis that compares the potential societal benefits that can be gained from an integrated DRT system against the economic costs, administrative costs of achieving the system

Some aspects such as infrastructure aspects, vehicle aspects are also important in the context of DRT-PT integration, but they were not included in the scope of this research. These aspects concern the design of road networks, stops, and stations, accessible public transport systems (including digital accessibility), accessible vehicles etc. For a follow-up study, it is recommended that these aspects are also included.

Furthermore, several developments in the future could have important consequences for organizing a DRT system. These developments could be the change in travel behaviour due to COVID-19, or autonomous vehicles. On the one hand, it is expected that people may be averse to ride-sharing due to the safety concerns associated with COVID-19. On the other hand, it is also possible that people who want to avoid COVID-19 might eventually come to view ridesharing as a good alternative to public transport where physical distancing is difficult. Travel behaviour has thus likely changed due to the pandemic. Secondly, there is some research done on autonomous vehicles and tests with autonomous vehicles have been conducted in the public transport world by Uber, Via, Transdev, etc. However, automation technology is still far from full penetration. It is speculated that the most promising short-term application of AVs for public transport purposes is to facilitate door-to-door travel, by providing the last mile of a trip (Arem et al., 2015). Apart from the ongoing technological innovations happening in the world of autonomous vehicles, innovation within the vehicle market is also needed to make vehicles suitable for the use of assistive devices, especially in the context of DRT for target groups. Therefore, it is recommended that future research is conducted that studies the effects of these developments on the operations and organisation of DRT systems.

A common finding in the literature and from interviews is the lack of benchmarking measures in the DRT industry. This suggests that there is a need for a set of metrics that measure all aspects of a DRT system's desired performance, including equity and accessibility attributes. Therefore, the final recommendation is that a study be conducted in future that focuses on this research gap.

## 7.3. Limitations

To get a good picture of the different cases, an attempt was made to interview all parties involved. This was not done for all the cases for various reasons. Firstly, because the number of interviews would be very high, and it would take a lot of extra time. Secondly, the question was to what extent these extra interviews would provide new and useful information because similar parties were often interviewed in other cases.

This thesis ignores the influence of other shared modes in the public transport system. The expectation of the organisation model recommended in the thesis is that in the future, it would be possible for the stakeholders to also include shared mobility by forging partnerships with shared mobility operators. Moreover, the research also ignores the effect of active modes such as walking and cycling. Both

Netherlands and Denmark have a high share of active modes (Ton et al., 2019), and therefore, can prove to be an attractive alternative for the passengers, giving a stiff competition to DRT.

Due to the lack of Dutch and Danish language proficiency, much effort and time were devoted to translating the related literature from the Danish and Dutch languages to the English language. Furthermore, it is possible that while interviewing the interviewees for whom English is not the native language, some information was lost in translation. To counter that, the report was sent to the interviewees for review before it was submitted.

The methodology adopted in this thesis is a qualitative approach: a case study. A case study approach depends on the types of cases chosen. While choosing cases, one of the factors was the ease with which it was possible to connect with the stakeholders. Other cases would have interesting to study as well, such as “Via to Transit” from the King County region of Washington, USA, or “MK Connect” from Milton Keynes, UK. The reasons for not including them in this research were: time constraints and the difficulty with getting in touch with the stakeholders.

Finally, a pitfall of conducting interviews for research is that only a few people give their opinion on a topic, which does not provide a full picture of the real situation. By questioning at least two stakeholders in each case, wherever possible, and by also written information from policy documents, it was tried to minimise this effect. Also, interviewer bias is a possibility. The interviewer can influence the respondents. By using several fixed questions as a basis for all interviews, the influential role of the interviewer was reduced.

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# Appendix A: Interview Protocol

This interview is a part of a research into the integration of demand responsive transport with public transport system. The research is part of my master's programme at TU Delft (Transport and Planning). It is being done in collaboration with Mobycon, a mobility consultancy based in Delft. For this research, I will be studying some case studies from the Netherlands and abroad, where some level of integration between the transport systems have been achieved. The goal of the interview is to collect in-depth information about the cases, which would ultimately lead to answers to the research question. The interview is divided into 5 parts: Goals, Role division, service design, data infrastructure, and effects on passenger.

The interview should take approximately 60-75 minutes. Furthermore, with your permission, the interview will be recorded so that it can be used for future analysis and learning. The recordings will not be shared with anyone and will be deleted as soon as the research is over. Your participation in this study is entirely voluntary and you can withdraw at any time. You are also free to omit any question.

Once the research report is ready, it will be shared with the you so that you can review it before it is published. your name will be anonymised. I believe there are no known risks associated with this research study.

### Goals and Functions of the demand responsive transport system

1. Could you explain the demand responsive transport (DRT) system in your region?
2. Are there any official policy documents that states the authority's goal with the DRT service? If yes, what does it say?
3. What are the challenges with the goal and how are you planning to address those challenges?
4. Who is the operator of the service, when did they start operating the service and what were the authority's expectation with operator when the service started?
5. For whom, is the service provided?

### Role Division

1. For the service, who is responsible for the design of the service (information, fares, reservation system, vehicle management, marketing etc), and how was it put in the contract?
2. How is the DRT service contracted in your region? (Who takes the financial risk, how long is it tendered for and what is the scope, how is decision making done, how are conflicts resolved)?
3. Is there a cooperation between the DRT service and the PT (Public Transport) service in your region?
4. If yes, what did the authority do to the facilitate that cooperation between DRT and PT services? If not, why?
5. And what did the operator do to facilitate the cooperation?
6. Are you happy with the way this was done, and would you do anything differently?

### Service Design

1. How is the information about the DRT service provided to the passenger and how is the information provision coordinated with local PT?
2. How is DRT and local public transport coordinated in terms of tickets and fares?
3. How is DRT and local public transport coordinated in terms of branding and marketing?
4. What were the challenges that the authority faced in achieving the integration components from the previous questions?
5. What technological developments do you expect in the future to be important in the field of DRT and what will be your role in its development and its use?

### Data Infrastructure

1. It is expected that ICT (Information and Communication technology) enabled DRT will work with lots of data, what is your role in the data management (ridership data, payment data, operations data)?
2. Standardised data formats can help in interoperability, coordination between multiple operators and help in providing knowledge of the service to a user. What do you think of data standards already in place and about data standardisation in terms of DRT data?
3. What do you think are the challenges in a standardised data format and how can it be overcome?

### Effects on the passenger

1. How is the customer feedback collected? And does it collect information on the integration components mentioned above?
2. If yes, what is the user feedback say about the integration of DRT with PT?
3. What key performance indicators (KPIs) do you use to evaluate your DRT system and what have been the effects on the passenger due to your DRT system? (KPIs such as travel time, travel cost, ability to transfer)?

# Appendix B: Interview Transcripts

# Transcript Overview: Interviewee 1

## Date of Interview: 20/07/2021

**Could you explain the DRT service in your region?**
Yes, well, AML flex or AML flex is a part of the public transport concession of Amstelland Meerlanden, or in short, we say AML. And like I said, it's the most southern part of the Transport Authority Amsterdam, and it's within the municipalities of Amstelveen, Aalsmeer, Uithoorn and Ouder Amstelland and Haarlemmermeer, which includes Schiphol Airport and the DRT system. AML flex was introduced by CXX in this new concession, and it started in December 2017 and it lasts until December 2032. It was introduced for the smallest regions or villages where the number of inhabitants and also the usage of public transport is traditionally low. And AML Flex was introduced in three separate areas and before in the previous concession period, where Connexxion was also the operator those regions had a regular bus line with a low frequency, for example, every one hour bus would come. In short, it works as follows you can travel from bus stop to bus stop, but it has to be within one of those three regions you cannot travel from one AML flex region to another AML flex region you have to travel within the region. But what you do is either through an app called OV Flex, or what a phone call, you can call a sort of help desk. And then you can make a reservation. And you have to do that at least 30 minutes before departure. And then after you make the reservation in your reservation, if you do it in the app, you say, I want to depart from this bus stop, you click, want to go to this bus stop, you click. And then you go to that bus stop. And then if everything works, the driver comes, picks you up, you just pay with your OV chip card, your public transport card. So it's just like in regular public transport, the only difference is you have to make a reservation?

**Are there any official policy documents that states the authority's goal with the DRT service? If yes, what does it say?**
We have, we have what we call in Dutch Programme van Eisen (PVE), which is like the overview of the demands for public transport and in the concession, and it has requirements for the level of public transport that needs to be provided within the concession. But as far as I know, in the PVE, there are no particular demands for DRT. The only thing that we did, if I'm not mistaken is that we provided the operator with an option for those less dense regions, we said you could either have a regular bus line like we had before with the low frequency or if you want to, you could put in a DRT system. So, from the authority side, there was no demand like you, you must or you should have it was just like an option. They were allowed to. But they could also do it like the old fashioned way, so to speak.

**What are the challenges with the goal and how are you planning to address those challenges?**
Well, there were some challenges, like, like I said, it started in December 2017. And the first year of the concession there were a lot of complaints from people within those regions using AML flex. And to give you an idea, I think in 2018, around, I think it was around 60,000 people that make use of AML flex. And most of those people live in Rijsenhout, which is one of those three areas. I think maybe around 90% of the AML flex passengers come from Rijsenhout, and all those other two areas are, really small in numbers using Aml flex. But there were a lot of complaints. People were saying the app is not working, or I made a reservation, there's no driver, he didn't show up all sorts of complaints were there. But one of the problems in my opinion was that what Connexxion did they introduced the AML flex system, this is how it's going to work. And what they did is that they outsourced the whole AML flex to a subcontractor named A-Tax. So the ones who were driving the vehicles were not Conneexxion. The contact between Connexxion and the third party wasn't ideal. Some people were complaining to the authority and some people will complaining at Connexxion. Some people came with their complaints to us. And when I went to my counterpart at Connexxion saying hey, I'm getting complaints and listen. This their first reaction

would be Yeah, but you need to talk to A-Tax because we outsourced it to them. Another big challenge is more a general thing, in my opinion, is that somehow within the authorities and also politically, people are thinking that as long as if we introduce systems like this, then it will solve everything. But the problem is the number of passengers using these kinds of systems is very low, which makes the system expensive to operate. To give you the context, the concession AML is as big as the province of Utrecht, we have around or even pre COVID before COVID, we had around 240 buses driving around, and I think they were doing 28 million kilometres in service a year. And then if you take a look at the AML flex part of it is like, like this is just absolutely nothing compared to the 28 and because of this, there is no money to earn there. But it's still public transport, people are using it. So the quality needs to be high. But I think that's where the tension comes for the operator for CXX, it was more beneficial to focus on the high-frequency BRT lines, where a lot of passengers are making use of those products, where money can be earned, compared to looking at AML flex there was nothing there for them to earn. But that's one of the challenges for this system, we need to understand that it is expensive. And my opinion is that politically that message or that mindset is not between the years people don't understand that people are thinking that if we make something smart like maas mobility as a service, then all those problems of money and having expensive public transport will just disappear but they will not in my opinion. Since January 2021, Connexxion almost made AML obsolete. AML flex is now only available during weekdays after seven till nine PM and on weekends. So they decided that this is not feasible not only because of the complaints but also because of its financial viability.

**For whom, is the service provided?**
It is open for everyone to use. In theory, if you have a disability, for example, if you're in a wheelchair if you take a look at the OVFlex app when you make a reservation for the use of a wheelchair accessible car.

**For the service, who is responsible for the design of the service (information, fares, reservation system, vehicle management, marketing etc), and how was it put in the contract?**
That's all the operator is it's the operator's responsibility and responsibilities for the DRT are just similar with the rest of the public transport in the concession there's no, there's no real difference. So but the responsibility is with the operator. We, as the authorities, minimum standards that they need to reach something.

**How is the DRT service contracted in your region? (Who takes the financial risk, how long is it tendered for and what is the scope, how is decision making done, how are conflicts resolved)?**

Well, it is part of the concession. So it's part of the whole public transport concession. So they can provide the DRT service as long as the demands that we have asked them are met. So essentially, whether it's DRT or regular bus line, we don't care, so to say. However, now I know I do care because I've seen how it works in practice. So I'm a bit more towards regular public transport now myself as and not saying I think DRT can work. But it needs a mindset not only politically like the part we just discussed, but also with the operator and then I think we need to change maybe our demands because we need to push the operator more to focus on operational excellence also in like, for example, DRT and also in areas where there's not a lot of money to make just because we think if we think it's important, then we need to find a for the operators to provide the service. But now it's, this is not the most ideal way I would say. Because from the operators perspective, they have a concession to run and at the end of the line, they need to make a profit and the profit isn't in the DRT area and the profit is the on the bus network with the high frequencies and a lot of passengers. So it's, it's logical for them to have their main focus on the area where they can make money. So yeah, so if we need to, if we want to improve DRT, then then I think our approaches as authority needs to be somewhat different.

**Is there a cooperation between the DRT service and the PT (Public Transport) service in your region?**

I would say yes because formally it's the same operator. Take Rijsenhout for example, which is the largest AML flex service area, the passengers there are travelling in the morning from Rijsenhout to Hoofddorp station and from there, they usually take another connexxion bus or the train. So the DRT functions as a spoke in, a hub and spoke system, then that the DRT system there is like a spoke bringing you to the hub, which is then Hoofddorp from there on the people that came come out of AML Flex is travelling with the train or with another CXX bus. Yeah, there is cooperation.

**And what did the authority do to facilitate the cooperation?**
Well, what we have in our demands, and I'll need to look into that if you need to know them in detail. But what we've done, we've set the boundaries for our public transport needs to look like within AML flex, for example, we will say something like, Okay, if a region has less than x inhabitants, then what we would want for you is to have a service minimum one time every hour, going from that region to one of our hubs or one of our sub hubs and we've defined, for example, Schiphol probably in the demand area as a very prominent hub, and then we have some smaller stations. which we call a sub up. So in that way we've we've, we've given the operator our demands saying these are the boundaries, this is what we want at minimum, and then we will leave it to the operator to make the best, most efficient timetable and best choices, we'll leave it up to them, but we give them the boundary and what it needs to be at a minimum. On the other hand, CXX from the past, because they're already they were already driving, there also in the previous concession. So they know a lot about the way passengers move from different areas. So they have that information. And yes, they did use that. And yeah, this was also was predominantly something that the operator has as a responsibility.

**Are you happy with the way this was done, and would you do anything differently?**
If there's a lot of complaints about something, then most likely something is wrong. And also, from the, again, from the authorities perspective, to give you an idea, we have, of course, we have this huge area, we have over 200 buses, doing 28 million kilometers in surface every year, at least before COVID. And then we have a part of it is like real small, Aml flex. And now you get all I get all these complaints about this, this part of the small part of the concession. Looking back, I would say that we from the authorities perspective need to, of course, it's our responsibility, we give the boundaries, we set demand, we want this one, this, but we all also need to put ourselves in the operator's position, knowing that they're a company that needs to make money. At least that's that's the way we've ordered things at this moment. And we also need to understand that it's wrong for us to expect the operator to put like, very big effort in in this part of all, and there's no money there to make. There was a tender, they promised this is what we're going to do then you need to fulfil your promises. That's one side of the story. They have a responsibility. But if you zoom in I would say it's pretty logical that their focus was not predominantly on the DRT system, which is this will be strange if they would leave the old BRT part, the biggest part of the concession and don't do anything about it and just focus on this small area and have the BRT system, operational functioning, and 100%. very excellent. And then the whole the rest of the concession is just a mess. Yeah, things need to be should be done differently. But then if you would ask the question What? I wouldn't have the like the written out answer like, Okay, if we do it in this in this in this way that everything would be perfect because there's this tension there. And it's Yeah, money is just one part of it. The the the this, this, this this type of public transport that we're discussing the DRT, or broader having public transport in areas where there's less demand, it's a difficult thing. And then again, it's an important thing to have public transport also there where, where the demand is less, because some people are just, dependent on public transport. So it is important, but we need to take a look at the whole scope. And what I think is missing from our side, from the authority side from the political side is just, we've thought about this too lightly. We'll just have mass and we'll have some fancy new apps and stuff and then everything will just work out, which is no, that's not the way.
I would say the most important thing, I've already mentioned that it's what we need to understand. And when I say we it's the authority side, the political side, is that most of what you see is that the DRT systems are used there, where the the the number of passengers is low, and which is a social part of the

public transport, which is a very important part, but it doesn't fit the tender and asking operators to make their own margin and to be profitable. It doesn't really fit in there. And I think that that is something that is not really well understood within people, with the people that make decisions. about how do the people that make decision about public transport, for example, the the amount of subsidies that are going to the operators right now, the 50-50. part, the most important thing. If we want to make the DRT a success is that we need to think the discussion needs to focus more needs to be more at the front saying, Okay, if this is what we want, we need to ask the question about the costs, and where are we going to bring the money from or the other way would be Who's paying for the costs? And we find, is there a perspective that those costs? Are those investments that we need to put in? Are we able to win them back? Or is it is it impossible to win them back? And then still, we find this so important from a social perspective that we still are willing to put in the money, maybe, for example, by putting an extra tax, I don't know on gasoline or usage of cars or to think of something to retrieve the money from somewhere to be able to provide public transport in those areas where there's no way to do it if the provide public transport without just in areas to provide public transport in areas where we cannot make a profit or there's no margin to be made. But where we say this is so important needs to be there. Yes, it costs money. So we'll put in money to have it available.

**How is the information about the DRT service provided to the passenger and how is the information provision coordinated with local PT?**

I think AML flex is in 9292. And I know what connection also did is they've when their concession started. They've made advertisements in newspapers and on Facebook and social media, saying, hey, this new concession is starting and we have something new, it's called AML flex. And also here, so actually in this in the same way that they're actually advertising and doing marketing plans for the regular public transport system. They have also done that for the DRT, obviously, maybe in a less with a smaller scope, and they've spent less money on that, compared to the regular public transport. The passenger that made the reservation, especially when he uses the app, if it works, the app, the app is showing you. Like, for example, let's say we've made a reservation, we want to use AML Flex, we say we're departing from here, and we're going there, and we send in the reservation and it gets confirmed, then you should see was the driver of the bus and where the bus is, you should see in the app, if you open up your reservation, you should be able to see, oh, my bus is now there. And it's coming and he's arriving at then. And then and then. So that's the way it was designed to work. And then the other thing is, you could also, instead of using the app, there's a phone number you could call to make the reservation. And the phone number, which you've used for the reservation is then given to the driver that's going to pick you up. So if he comes to the bus app, and he doesn't see you, then he has your number and he should he can call you saying hey, I'm at this bus stop you made a reservation, where are you?

**How is DRT and local public transport coordinated in terms of tickets and fares?**

Yes, it is. The simple answer is that AML Flex is public transport and therefore, it should have the same characteristics as a public transport system. The idea behind this is that the price you pay when you use AML Flex and the method of payment would be the same if you were using a bus somewhere else in the concession. For the use of OV chip cards, there were portable validators. In buses, these validators are present. However, they are not present in the vehicles are like small vehicles of AML Flex, because there is no place to put expensive validators there. So what they usually have is portable validators. But a lot of complaints were also about the checking in checking out of OV card doesn't work validated doesn't work. So there were also a lot of complaints on that part of in that area. So, I think the stability of the system probably could be improved.

**What were the challenges that the operator faced in achieving the integration components from the previous questions?**

I would probably say if we were looking into the demands, we'll probably see something saying that it needs to be for everybody that wants to use public transport, which then automatically brings you to the

OV card I think from the operator side, their wish would also be to have it, it needs to be public. So you need to find a way to make it available for the public and make it available to travel with whichever offer is cheaper.

**What technological developments do you expect in the future to be important in the field of DRT and what will be your role in its development and its use?**

Well, the the the replacement of the of OV card is something that we're talking about within all our public transport concession. And we're working on it to have it implemented, I think, somewhere next year. If so, that is something that's coming also for for this concession. So I would say my first idea would say yes, that's, that's something that you would then also would like to have in your BRT system, and then, of course, all the discussions about money, because yes, in the long run, it will probably reduce overhead costs, because also the whole system behind the over chip card is, and I'm not the expert on that. But what I under stood about it, it's very expensive. But to have your your validators, and your whole back office, your IT system, ready to be able to accept the new way that the EMV paying with your bank card is also there's investments upfront that that are needed, which are now the discussions we have with our operators, because they're all saying, we have COVID, we have no passengers, we have no money. Yeah, you want us to do this. And so the same discussion, I would expect will arise if you would say yeah, on the DRT end as well, because then you've come to where we started. The DRT is expensive, and there's no the profit and loss. It's not a balance there. So but if you if you if you disregard the money and investments, and just take a look at it from a public transport perspective, I would say yes, of course, you would want everybody to be able to whether it's a BRT bus or a small DRT vehicle shouldn't matter, you should be able to pay with your bank card. So those will probably be really big discussions, but those will be coming.

**It is expected that ICT (Information and Communication technology) enabled DRT will work with lots of data, what is your role in the data management (ridership data, payment data, operations data)?**

We have also some demands for the operator to share with us, their data, and we have a we have a tool called I think it's called it's in the MiPOV , which is the standard that actually all authorities agreed on for sharing, which is model information profile for public transport, was created in 2008, which is like a standard for sharing data, for example. the amount of passengers, the amount of in service hours, the punctuality kilometers that the buses are all sorts of data on public transport is actually in this. So there are standards for sharing information. And based on this standard, we have access to a to a tool I can log in. And I can see on a monthly basis, the amount of passengers, I could see the number of trips that hasn't been that were that didn't arrive. I can see there's a whole bunch of stuff that I can look at information on how public transport is doing actually in my area, I can I can take a look at delays, late departures to early departures. A number of passengers on a particular line or a number of passengers that enter in the vehicle from a certain bus stop. And it was mentioned in the concession contract that you are expected to share this information with us. And the data format that they were expected to share it is the MiPOv.

**Standardised data formats can help in interoperability, coordination between multiple operators and help in providing knowledge of the service to a user. What do you think of data standards already in place and about data standardisation in terms of DRT data?**

I would say those systems need they need a huge upgrade. The problem is that for the regular buses, there is a set timetable with which itineraries can be generate. However, with DRT there are no timetables, and this is where the operator struggles. The input is becoming different with DRT. So the tools need to change. Now I would say those tools are available, but the question,how much does it cost? How much are we willing to invest? The question is on on the authority side and the political side, where do we want to go with public transport, we have all sorts of ideas or ideals. But then when the money and the money thing comes in, then people back off, we want the ideals, but we don't want the investment to be able to reach those ideals. And that that is, I would say, one of the biggest, biggest problems in within public transport. So to come back to your question, , those IT systems that are in place, in my opinion, not

being an expert in it, those are all elderly systems need to be need to be upgraded In terms of the challenges in standardized data, I think money is the biggest issue.

**How is the customer feedback collected? And does it collect information on the integration components mentioned above?**

That information is available at the operator side, For the first question the customer feedback, that was also one of the problems. As I said, it's a big concession. And the DRT system is a small, small part of it. And what we were what we have in our concession is we have mystery guests, who probably I don't know if you're familiar with the concept, but we are paying a a third party, a research company. And they will have their mystery guests travel with public transport and see whether everything is as it should be. For example, when a bus comes on from it should show line number and destination, sometimes those things are broken. All those things we have in our demands, but we can't monitor every bus. So what we do is we have this research company, and they will research every month, they'll go into the concession, make a few trips, with the buses and trams and metros, and check all those all those things, whether it works or not. And they'll come back with a report. The DRT is also part of their of the mystery guest. But within all their measurements, if they do 100 measurements, maybe one or two are with the DRT system, because again, it's a small part. So also in the amount of monitoring, it's also small. And they're much more measurements on line 300, which, which drives her 16 hours, 16 times an hour is much more important for us to know that everything there is okay, because of the high frequency and the high number of passengers compared to the DRT system. So that was one of the problems of what I did. Because I was getting a lot of complaints. But when I took when I looked at the the monitoring done by the research company, I would see two or three measurements every three months. It's too less of it's not enough information to make an objective judgment because all the complaints are subjective. Of course, it's a signal. So I asked some students from a university to conduct a mystery guest experiment of AML Flex, and they used it as a as a public transport system, because the traveling they were doing was also with the OV chip cart, and they tested that part as well, because sometimes they would made a reservation, and the driver would come and they would get in and they will try to check in and it wouldn't work another driver, which doesn't work. The general outcome was that for those trips that they've done 75% of the trips, were okay without problems. So 25% of their trips had had an issue and sometimes multiple issues. So 25% is large. So that was the general outcome

**What key performance indicators (KPIs) do you use to evaluate your DRT system and what have been the effects on the passenger due to your DRT system? (KPIs such as travel time, travel cost, ability to transfer)?**

Well, interesting is that I've asked CXX to do an evaluation on their system, because now like I said, the complaints were coming and coming, So I said, yo, you need to evaluate your system, this this, this can go on like this. So what connection did I have it here in front of me. They made their KPIs before they introduced AML flex, unless they've said those so they these were the goals before they actually started to operate. AML flex they say after one year, the amount of travelers, the amount of passengers using AML flex should be the same as the amount of passengers that were using buses on those routes, which is something they actually achieved the amount of passengers the 60,000 I mentioned, more or less the same amount of passengers that were using the regular bus lines. And then they said after two years, there's an increase in usage of AML flex compared to when it started off at least 10% which I don't think they've they've managed to achieve that. And then the other KPI they had was what they call the combinatie grad, what they would like to do is combine trips, And they have they had the plan that the combination, the level of combination would be on average after one year at 1.75 passengers per trip. And then after two years, they wanted to have it at 2.5 passengers per trip. In practice, what they've done was 1.1, something like that. So that idea to actually, which is something that was this KPI was one of the KPIs that would should help them to reduce the cost. If you can combine trips, then of course, it's it's cheaper to to operate, but it didn't work. And then, let's see, after one year 50% of the inhabitants of those small regions have heard of the system and they know what it what it is, that was one of their KPIs as well. And

then after one year 40% or more of the passengers that use AML flex, give it a score of a seven or higher on a scale from from one to 10. And then they said the reliability of the time that you're picked up, and the time that you arrive should be at 95%. So CXX had their KPIs. They had their plan saying, Okay, this is how we would like to see AML flex developed. But along the way, what we've seen was, it didn't on all those KPIs, actually the number of passengers using thr service was okay. The first year but the level of combination, for example, which is a really important one to reduce costs, they, they were not able to increase the combination level. So they've, they've never been higher than 1.1 or 1.2 travelers per trip. So that that's actually one of the things in combination with COVID would have them rethink of this business model and said, Well, we take a look at this again, and maybe it's better to bring back the regular bus for now. So that's what what happened.

What I would focus on if what we did was to give you an idea, and to make the story complete. So we have all these complaints coming in and I have discussions with CXX saying, Hey, I'm getting these complaints, things are not going well. So they did the evaluation. So they did their own internal evaluation. What they also did, I've pressed them, I said, you need to increase your contact with your subcontractor, make sure that you know what he's doing and that you've, you have regular contact. So those are things that they actually did. And they were doing and what they were assuring me, they were saying, we still believe in the system, we think it could still work. And we're going to put in more effort and they were actually doing those things. They made a whole plan of improvement, which they shared with me. And then actually just after it started, well, they were starting to implement those those those changes to improve things and then COVID came. And then within the new timetable that started from January this year, they decided we're going to cut down on on a more flexible, bring back the regular bus for now. And we'll see in future what happens. I think without COVID, they probably would have done the same thing I my expression.

# Transcript Overview: Interviewee 2

## Date of Interview: 25/08/2021

**Could you explain the AML Flex, the DRT system that you offer in AML area?**

Well, our new contract started, in December 2017, it's always mid-December that new time schedules start here in the Netherlands. So, we want to contract in 2016. And a more flexible demand responsive transport system was offered by connection as a pilot for about two years in, in this contract for AML. And it was done, as an alternative for regions where there is a demand for public transportation. But there is not a regular bus line. So, it's, it's merely a replacement for a normal bus driving very infrequently or only once, once an hour. And it's merely it's a small bus, a small bus full of six or eight people which can be demanded by reservation, either you do it by telephone, or by an app on your mobile phone. And you need to demand for bus, it can only be demanded on short notice, which is 30 minutes upfront. And with the app, you can make a reservation. And then, there is a selection of bus stops, which you can pick on you choose the next day the most nearby bus stop. And you say I want to go from this bus stop to another bus stop in the system. So, there's a limited number of bus stops. You can drive from and drive to because it's nearly as and the same we've seen probably, sometimes it's called a fishbone concept. So, the driver would drive AML flex to the to a hub where you can switch to the regular bus lines or train lines.

**Are there any official policy documents that states the authority's goal with the DRT service? If yes, what does it say?**

The goal is to have a flexible system that allows inhabitants of a certain region to have still have some public transportation and to be flexible, more flexible than it the former cases and to have transportation for public transport price in this region. Well, in theory, it's, it's from a operational point of view, it's very good objective because in in regions where you otherwise wouldn't be able to operate a bus line and more which was the circumstance, which was the circumstances in these three regions here in AML. If there isn't a bus line regular, then we make it flexible because it's, it's quite an opportunity for travelers and quite a good way of having a service anytime at a time you want you would like Have instead of having a rigid time schedule of only one bus per hour or per two hours.

**What are the challenges with the goal and how are you planning to address those challenges?**

We had some challenges in in operation. Challenges in no shows by taxis or not fully understanding how the service is working by our travelers, for instance, you have 30 minutes upfront before the bus on the bus arrives, then there is a plus minus 15 minutes, and you'll be updated by the app on the expected time to arrive of the bus or the vehicle. And you need to be there at the at the right time at the bus stop. Because the driver is allowed only to wait one minute. And if there is no one at the bus stop. The driver can already depart. So that was a challenge. And on the other end, it's a challenge for the taxi company who is performing this service for us. Because they and it's our challenge as well to look after that they drive AML Flex the way it is used, it should be done.

If you put it out there, then we must have a perfect, perfect, perfect operational performance. Because otherwise, travelers, see the consequences, and they feel insecure, because it's the bias. Is the taxi really coming? We had in the beginning; we had a lot of declines of requests. And it was declines of requests, declines of trips. People weren't used to, to order a trip by the app, and by the phone, and that will give difficulties in understanding the service. And because of that, we had quite a lot of negative reactions from our clients.

**Who is the operator of the service, when did they start operating the service and what were the authority's expectation with operator when the service started?**

We piloted it. So, they knew already, or they could have known that a pilot is it's not a regular service. And I wasn't in this service from the beginning. But I think it was a pilot to see if this really could be a good opportunity. Good add on the regular bus lines in these regions. But I'm not sure what their

expectation was, I think, provide it as an excellent opportunity. Maybe it was their expectation. But at least in the first year, it didn't come true. Passenger, and the bus should be the core network. So, anything that CXX does for first and last mile should be sub should be considered as a public transport system, because when there's single operator that is responsible for the entire chain.

**For whom, is the service provided?**

Anyone who wants to use public transport. Anyone who is present in three areas, can use it, even people with disabilities.

**For the service, who is responsible for the design of the service (information, fares, reservation system, vehicle management, marketing etc), and how was it put in the contract?**

It's 100% responsibility of CXX as a as a public transportation operator. And it was put in that in the contract in this way. We are offer you have a bit in our bid, we offer this as a two-year pilot. And can we, for first two years, we had a, we had a contract with a PTA and a certain amount of money per year to, to offer this, pilot. So, we had a financial contribution to this pilot for the first two years. And afterwards, we had an absolute evaluation. And it was supposed to be that we had to go on with this with this service on our own costs. So, it was really a startup contribution payment for from VRA for the first two years. We are quite happy with being the sole operator in the region One of the benefits of having a public transportation contract in an area and being the sole operator is that we are the sole decision maker. In contrary to the, to the British market, where you have multiple operations operators in one region.

**How is the DRT service contracted in your region? (Who takes the financial risk, how long is it tendered for and what is the scope, how is decision making done, how are conflicts resolved)?**

From the first day on our responsibility, that responsibility where we had for a startup, we had a financial compensation. So yeah, so we took the financial risk, and I can tell you, we had a financial risk or financial loss, even in the first two years. We had an evaluation already after the first year, first one and a half year because we had a lot of complaints from our customers. So, we were really asked by VRA, to have an evaluation earlier and to make up some to undertake some steps to improve our operation in front of AML Flex. And the conclusion was that it was in the way it was set out, it was a financial loss for CXX. And we decided by August last year, that in these three regions in we replaced AML flex on from Monday to Friday by a bus line, regular bus line, again in the three regions. It was too costly. We had, we still had too many complaints and customers already kind of begging us to put back regular bus line, because then they had to certainty that the bus line would arrive in time by our timetables published, and it was cost more cost effective for us as well.

**Is there a cooperation between the DRT service and the PT (Public Transport) service in your region?**

It was certainly not standalone, because we figured that was to be featured on hubs. That was the goal. So, we had a hub to hop on a bus stop to bus stop. And you could only when you could, in within a region, you could travel from bus stop to bus stop, for instance, in a region, there were 10 bus stops, then you could go from bus stop to any bus stop. But we saw that most of our travelers chose to travel from a bus stop to a hub because then they had this transfer to the to the public transportation system.

**And what did the authority do to facilitate the cooperation?**

Yeah, well, they, they allowed us to do the pilot, they were enthusiastic. And for the first two years, they gave us financial contribute contribution to, to put up the service. This pilot was written down in the contract. And of course, they had demands which were also present in the contract.

**Are you happy with the way this was done, and would you do anything differently?**

I still believe there was a certain market for this kind of public transportation for his feet of function. What I would do differently is, well, it's to make sure that you have better operational skills, so the managing of the contract or subcontract could have, we could have done much better. In the beginning, it was very chaotic, the start of this concession. We had a subcontractor. And then we were busy with managing other parts of our contract. And that means that we did not take enough time, we had more than enough time, probably as well, to manage the contract with subcontractor as well and to provide and to be sure that we provide the service to the standards we offered.
And secondly, I think this is not a service you can provide for a public transportation fee. I think it's a bit more expensive and the traveler should realize that it is a bit more expensive because we already we always said we deliver a taxi. We deliver a taxi at public transportation costs and that's not realistic. Yeah. So, if you do something like that this this door to door or this last or first mile concept, you should realize as a public transport authority or public transport contractor that if you provide excellent service, then it comes with costs which is more than people are used for public transportation.

**How is the information about the DRT service provided to the passenger and how is the information provision coordinated with local PT?**

Yes, it was integrated. So, if you would plan a trip on 9292 end and you would plan a trip which took place in an AML flex region, then you would be redirected to the AML Flex page on our website. So, yeah, there is some level of integration with the information.

**How is DRT and local public transport coordinated in terms of tickets and fares?**

Yes, it is fully integrated because you can pay by OV chip card. And the fares are also based on chip card fares. We have portable terminals inside the vehicle. Both, fare, and ticket integration were a demand from the PTA because it's technically it's public transportation operation. Because we called it AML flex and it differed from normal bus lines with timetables, regular timetables, it was looked at it entirely different.

**How is DRT and local public transport coordinated in terms of branding and marketing?**

We have information on our bus stops. We provide them to our website, social media. We had a large campaign in local magazines, local newspapers, we had gatherings. It was pre COVID, of course, because we, we invited people in the region in local areas, and we had information gatherings where we explained how it would work and how they could use that service. So, there was a lot of information given to the passengers.

**What were the challenges that the operator faced in achieving the integration components from the previous questions?**

Because AML Flex does not follow a regular timetable. It was a challenge to integrate information. So, that is why we chose to provide information about AML Flex on 9292 and then redirect to our website. Regarding the ticket integration, it's quite easy to use portable terminals because they have been available in the market for some time now.
Regarding the fare, we have these 50-50 components; we have a contribution from our public from our PTA. And we have 50% of our income is by our travelers who pay their tickets. So if you would like to offer or AML Flex as a PT option you should consider as a PTA that it's either you ask more from the travelers, which is not the standard because it's public transportation, or you should realize that you have to pay more for this service as an as a PTA, so the contribution of the PTA should be higher by this. Now the system of providing money for using AML Flex is different because we got a separate amount of money for AML Flex. And for PT, VRA, provided us with a subsidy for the rest of the rest of our public transport lines. So, either you should integrate, AML flex in the subsidy and enlarging the subsidy,

because it's two systems now. The amount of money wouldn't be much higher than it was if you had a plus b. If you do cost benefit analysis for bus lines line, then there are always bus lines who perform bad and merely on data, you say we should skip those lines, but they they're not those lines that feeder to certain other bus lines. That's the principle of the fishbone concept. So, you should always look at the whole system and AML flex is part of the system just like less performing bus lines in concepts of revenue. So, you should always look at the integrated system. because it was a separate subsidy, we looked at it as it was a separate operational system. But it was part of the integrated system. So that's difficult, with AML flex, it was part of the system, but we put it aside, and we looked at it as was a separate

**What technological developments do you expect in the future to be important in the field of DRT and what will be your role in its development and its use?**

I think it's your role as a public transport company that you always should improve and innovate. And there's always room for improvement. Regarding use of account-based ticketing. It will be a bit cheaper but there are always systems in the backend that you have to remove and account based ticketing is a bit cheaper again, system wise, technically system wise. There are a lot of pros for the travelers because now once in every five years you will have to buy a OV Chipkaart for 7.50 euros. If you could pay with your direct debit card and bustle and train so I think it will be easier for your travelers. Integration of tickets and payments is already the case with AML Flex so payment will be easier, cheaper. Because you don't have to have an extra card, you don't have to buy an extra card to upload money on that extra card. But it's the entire system you provide as an operator you should be basis should be. Right. So, if you are operational, if your operation is not good enough, and then no one comes, no one will travel with it

**It is expected that ICT (Information and Communication technology) enabled DRT will work with lots of data, what is your role in the data management (ridership data, payment data, operations data)?**

Data is very important, because we have a lot of data, not only from AML flex but also from bus services and with these data, we are able to improve our service to know where the demand of our travelers is. And you can pinpoint or by data, you can analyze a lot of data to have more information out of them to improve your service.

**Standardised data formats can help in interoperability, coordination between multiple operators and help in providing knowledge of the service to a user. What do you think of data standards already in place and about data standardisation in terms of DRT data?**

Yeah, I think it's, it's, it would be very helpful. Because then you can exchange data and you can, what you would like to as an operator, maybe that's not the answer to your question. But if you provide door to door service, then we would like to analyze the data from door to door and not from system one. And then Okay, we have to switch to system two, and how do we connect these data? So you would like to have standardization so you can follow your, your customers from door to door and analyze what they need, what our information need is. Moreover, it was our call center. And there was not a good connection with the system of the taxi company. So, it was our call system, and the operation was done by taxi company. They could plan upfront, but not instantly. Okay. And that was a lot of difficulties to understand for our passengers. If you can integrate the app with the system of the operator, the planning system of the operator, then it's, it's that that would be the ideal way.

**What do you think are the challenges in a standardised data format and how can it be overcome?**

Well, that's too technical, probably for me, but I think we would like to have more standardized data formats, and we are always moving on our data and combining and connecting and looking for standardized data formats.

**How is the customer feedback collected? And does it collect information on the integration components mentioned above?**

Customer feedback was collected by our customer support. And we had a lot of feedback, which means we had a lot of complaints, to be honest, very, very lot of complaints. So, we organized the gatherings to hear and from social media, but mostly our customer support line. Does it collect information on the integration component? Yeah. Well, I had some personal contacts with some of our clients. And because the service was not consistent in the delivery of the system, they asked us to go back to regular bus lines.

**What key performance indicators (KPIs) do you use to evaluate your DRT system and what have been the effects on the passenger due to your DRT system? (KPIs such as travel time, travel cost, ability to transfer)?**

We use travel costs, travel time, average occupancy which was never got higher than 1.1 or 1.2. Regarding the evaluation, we have done it in 2020 but it is confidential.

# Transcript Overview: Interviewee 3

## Date of Interview: 26/07/2021

**Could you explain the DRT system that you offer in your area?**

The organizer are the municipalities seven municipalities in the Achterhoek? And they chose that Winterswijk will be the head. The customers in our system, the passengers are most of them are people with disabilities. That's, the reason to start the system. And with all everyone who wants to travel in the Achterhoek, and for that trip you want to make there's no public transport available. They can travel with Zoov, they pay a higher price than a disabled passenger. But he can travel from each door to each door from address to address. We don't work with stops. And the maximum distance you can travel is 40 kilometers, and every trip must start or to end in the Achterhoek.

**Are there any official policy documents that states the authority's goal with the DRT service? If yes, what does it say?**

Yes, there are. For the part of the disabled passengers, there is the legal reason why the municipalities want to make that kind of transport. And I have some papers with say why it is organized in this way. Yeah, I can send you some, some information about that. Yeah. It's from 2015 which is recent, there's no newer version, okay. There are three main goals that is that the transport costs may not raise more than the indexation. The efficiency of the transport system must be at least the same. And to have as much as possible several kinds of transport within the system. Achterhoek is a rural region. There is less public transport and travel distance are relatively long, you know so, it is It's just efficient to have as many as different types of transport within your system. Because there are many different types, but they all are very small in number of trips. There is another goal we have with sustainability here. Municipalities had decided in 2025 the system has to be zero emission.

**What are the challenges with the goal and how are you planning to address those challenges?**

Zero emission with wheelchair is a challenge. Our goals are set in 2025. And I don't know if we could reach that in 2024. I don't know if that is the challenge. And now, the province has decided to take the transport for non-disabled people out of our Zoov system. That is not as we have decided in 2015. We will get to lose some of our transport modes and that will make system less efficient than now.

**Who is the operator of the service, when did they start operating the service and what were the authority's expectation with operator when the service started?**

Yes, we have. We work with the system that we have a software planner system also known as in flex Denmark. Same organization formula with one planner, and several transport companies. We have 12 transport companies, and three of them do this kind of demand responsive transport. They started in 2017. We have since the first of July of this year new contracts and one new transport company. The transport companies deliver for us the vehicles and the drivers. And we describe how the vehicles appear with our names on it. And so, they all look the same, but we know there are different companies. The planner is Munkhof. It's also a transport company. But we have our contract such that the company that does the planning may not also be a transporter transport company. So, Munckhof does not put their own taxis for our system.

**For whom, is the service provided?**

It is for everyone in Achterhoek that wants to use a transport service. Most of our passengers are people with disabilities. But it's also possible for someone without WMO indication to use, but they will have to pay a higher fare for that.

**For the service, who is responsible for the design of the service (information, fares, reservation system, vehicle management, marketing etc), and how was it put in the contract?**

I said the municipalities are in first and the provinces. But in the practice, it's Zoov Beheer that does that kind of things. And it's all in one hand with us. So, the transport companies has to do what we tell them to do. We make the brochures; we have the website we have clothing for the drivers to come out from us. And Munckhof is responsible for just the planning part just the taking the trips and sending it to the taxi operators. And all the all the taxis computers are connected with the computer of Munckhof. And

Munckhof collects all the all the travel data and send them to us. And we analyze and make the payments for the transport companies and so on. So the municipalities, the Zoov Beheer are responsible for everything and they direct the operator and Munckhof.

**How is the DRT service contracted in your region? (Who takes the financial risk, how long is it tendered for and what is the scope, how is decision making done, how are conflicts resolved)?**

Zoov Beheer takes the financial risk. But that is in the end, the seven municipalities of course. The decision making at the operational level is done by Zoov Beheer. But more the policy, and the fares is by the municipalities. Zoov Beheer represents the municipalities as well as the Province of Gelderland now. We have a contract with the province also but that ends in 2022. And then after that the re-organization will take place, We also do transport for other companies, when they cannot organize their transport by their own, they can come to us and by transport. So, another company, we say a third company, not a municipality can buy transport by us is a small part, but it's also what we do. It's very easy in this model. To add transport modes. It's easier to do that, then when you have all contracts because we only have to change the planning part and the transport companies who make the vehicles, they do what we asked them to do and it doesn't matter what kind of passenger they have in the taxi. They have to bring them is that that's one of the part and we have several different contracts, to lower the risk, it was to spread the risk. We have some bad experiences with transport companies who said, so when you don't pay me now, I'll stop tomorrow. When you have three companies, you can say, Okay, you've stopped, we have two other two others. And that's also not a challenge with this. It helps that Munkhof have known the area because they are working here for several years. We are lucky with that. We choose to contract as much as possible local transport companies. It helps when they know each other when they are Yeah. And there's another thing that I think why it's working here. Within in the seven municipalities there's no big city. They're all rural municipalities, they know each other very good. They have the same goals. They know they are they must work together because they cannot do it by their own. So, when you go to Rotterdam area where you have big city Rotterdam and a few municipalities around. For them to work together is more difficult there.

**Is there a cooperation between the DRT service and the PT (Public Transport) service in your region?**

There is a cooperation, we know each other very well, we talk to each other. That's the first part. When a passenger wants to make a trip, and he comes with the train and travel further with Zoov, we track the train using open-source real-time data. So, we try and provide a seamless transfer. So, what we did is we get that data in our planning system, and when a passenger wants to make a trip with the train, and Zoov then we put on a flag on that trip. And it will be always checking if it's on time. So, we don't need the Arriva for this because it's open data. That sounds very normal, but it's very special, we made a special for Achterhoek, that's one part. We only have that feature when you call. It was difficult for us to build such a system for our website booking tool. But when you book your trip by phone, and you say I'm arriving at the station, from Doetinchem, for example. And then the operator asked which train it is from its direction with time. And then he sees all the arrivals of the trains so we can pick the one you mentioned. And we also operate the demand responsive public transport for Arriva on Saturday, Sunday in an evening. And we do that mixed with our own system. So it can be that a passenger for the public transport can be in the same vehicle as someone from the disabled transport system. So that's a very nice integration we have made now. So before, the passenger used to call Arriva for transport, and now they call us and we send the cost to Arriva. W have told them for years, we have a demand responsive transport system, please use us because, there are enough places in our system. So, it must be more efficient when we combine that find that we're both kind of transport. They had contracts with another taxi operator. So, when that ended, they decided that we do it together. It's very important, I think, to be on speaking terms about transport system or organizations. Because then you cannot make this when you don't know each other. Then then it stays two different systems.

**And what did the operator do to facilitate the cooperation?**

There was not much problem to do that we have to change our planning system a little bit. Because normally, our vehicle may depart 15 minutes before the planned time. Yeah. But when you are doing DRT

PT, you have to be more on time. Yeah. And that's cost money. That's that is less efficient in our transport system. So we have to make their change our system for that.

**Are you happy with the way this was done, and would you do anything differently?**

It's a difficult question because now we are happy with how the things run. It's okay. Arriva is a PT company, and the province of Gelderland is responsible for the public transport. The contract of Arriva ends in 2025. And what happens then? Then, probably Arriva gets the new contract but probably not. So, in the new contract it would be better if the Province as the PTA makes a contract of set of rules for the demand responsive part. That would probably be better. Right now there is some sort of disconnection between their contract with Arriva and the transport system we operate. In the end, it's all public money, so when you bring that together, you can make more efficient transport system in the beginning. The province of Gelderland now want to change and provide a transport system for when there is no public transport. They want to make a demand responsive system for that works with stops. And they want to system for the whole province, There are six regions in Gelderland. So, now there are six different systems and the province want one system for the whole province. That's okay. But they don't make the connection with the system, the disabled transport system. Which is a much bigger system. So, their own system is a very small system in number of passengers. It's on the first side not very efficient. And that's what the municipalities always say to the province when you take them apart then both systems are getting less efficient. And finally, they do not make the integration with the public transport system. So, the demand responsive public transport, what is made by Arriva, they don't integrate it with their system. So now there are two systems which we integrate more or less in Zoov. But the province wants to take the one so we get three systems. One will be by Arriva, one will be by Zoov and one will be the new system called Haltetaxi.

**How is the information about the DRT service provided to the passenger and how is the information provision coordinated with local PT?**

The, we have our own website. And our passengers can look at the site and they can book their trips. They also can go our call center, most of our passengers do that. Because our passengers are 80 plus the most of them, we have a banner on the website from the planning website for public transport 9292. Yeah. But then then you go to our website, you cannot book really there, you have to go to our site and then book your trip. There's no coordination with the local public transport. But on the side Arriva, when you want to book your demand responsive public transport, then you see call Zoov, there's another phone number that is always up can always book that by telephone, but not with the site. Okay. And you mentioned that it's available on 9292. So that information, is it, you cannot book but you can check the timing, not the timing, but you can check where it's operated from the aerial service area that's available on 9292 you can see when you when you plan a trip on 9292 then he says you can also book with Zoov. Okay. When you go to 9292, and you plan a trip for public transport, DRT public transport and you see our number. What we wanted to do is to integrate the Arriva app, with this Zoov planning and technically, it's not very difficult. But when the province said we want to stop, then for Arriva it is not interesting anymore.

**How is DRT and local public transport coordinated in terms of tickets and fares?**

They are not coordinated and the demand responsive public transport we do for Arriva is for free because we cannot read the Arriva tickets in our taxis. So, the passenger will not pay any price for that trip. The bill is sent directly to the Arriva then. Yes. Okay. Yeah. It's too expensive to get that OV Chipkaart terminals in our vehicles. We are talking about that with Arriva for OV Chipkaart terminals. but the number of trips is very low. They are hundreds in a month. So, it's too expensive. When we decide to pay all the trips with OV Chipkaart in Zoov then it's maybe a better choice. We have thought about it, we have tried to make that. But its organization very difficult, because the OV Chipkaart is a public transport system. And we are not public transport. So, we are not a part of all system. And the system has to change for that. And another thing is, it's very expensive. Now, fares are very low in our system. So, it will be too expensive to make that. And you can only make that if, all or your travel or your passengers run with that system. Then it will be good. Now you can pin in our vehicles or get a bill after with automatic debit and setting up that system is easy and not as expensive. But when we you in the future, probably you can

always travel in public transport with your bank card and probably then it's easier to bring the systems together.

**How is DRT and local public transport coordinated in terms of branding and marketing?**
No, it's not. It's not. The branding and marketing for Zoov that's done by Zoov Beheer. So we decide how the logo, the title of car and their uniform. That's everything is done by this.

**What were the challenges that the operator faced in achieving the integration components from the previous questions?**
They have their own target groups, and we have ours. And there is a small, small group, which covers both and I think it's, you know, we there was no question to do that. The province didn't ask for that, now they do with Halte taxi are they going to do that.

**What technological developments do you expect in the future to be important in the field of DRT and what will be your role in its development and its use?**
Yeah, the most important thing is, is the booking and payments via app. Yeah. We follow that very good. There's another region, Groningen Drenthe, who has now the pilot. Arriva has won the tender for that pilot. So, we are well informed by Arriva, and we want to ride on their success in the pilot. When it works in Groningen-Drenthe, it will work in Achterhoek also. So we follow that the municipalities want to make one app for all kinds of transport. And in the rural area, that's difficult, because you can earn less money with that. So, I think the municipality will take a role in that. Municipalities have the ambition to integrate car sharing ride sharing. bike sharing, everything. So, this discussion is about mobility as a service mass.

**It is expected that ICT (Information and Communication technology) enabled DRT will work with lots of data, what is your role in the data management (ridership data, payment data, operations data)?**
All the data of our system is here. We manage that. Not only the the payment data, but also the travel data. And we are advising our municipalities, for example, for changing in the system, or developments, what we see. We, we work now with Power BI to get more information out of the data. We think data is very important. And but what we see is the data is not well defined with within our system. So, when I see data here and I go to another system in the Netherlands, those are two different languages.

**Standardised data formats can help in interoperability, coordination between multiple operators and help in providing knowledge of the service to a user. What do you think of data standards already in place and about data standardisation in terms of DRT data?**
The data for communication between taxi and dispatch center is standard, because there are a few companies which make planning systems for the taxi. But every region has his own data definitions. Even when they work with the same planning system, there may be differences. We are talking for years. that we have to get that standard. We have made an evaluation A few years ago, based in Gelderland for the six regions. It was almost impossible to compare the system's only in euro it's relatively good standard. Zoov has a very good data. But the data between public transport and our system is another world. How can you fix that with in one system? It's Yeah, we have to a lot of work to do there, which is very important.

**What do you think are the challenges in a standardised data format and how can it be overcome?**
The first step we do is to that we use all the same data definitions. What I say what is a passenger or a trip is a trip one passenger or is a trip to passenger when the there's no show is it the trip is it not? It is the book. And there is no wrong or right definition. Yeah. But if you don't know the definition, that's wrong. Yeah. And that when we are the regions, for example, come to those definitions, then we can put them in our contracts. And then transport companies will use the definitions. Yeah, because it's in the contract, then you can go to a standard. But to ask for all the transport authorities together to make one standard?

Yeah. I think that's a challenge. For the public transport part, it's very well done. But for our systems, it's not. And we talked at CROW. For them, it's not a priority. And because there are no definitions for passengers, its also very difficult to compare the system with other systems.

**How is the customer feedback collected? And does it collect information on the integration components mentioned above?**

We collect feedback by phone we call every day, five passengers who made yesterday a trip and ask their 15 questions, I think about satisfaction about the vehicle, the driver, the trip, etc. And we have a mystery guest survey. And there's also a mystery guest survey for the public transport which also take the DRT public transport. So, we have also a mystery guests sometimes in our taxi from the PT system. And we try to get that data together. We do not have a question about the integration about topic transport and our system is well, it's a good idea and we could make a question and only use the question when we see in our booking system that is a PT connection. Transfer is a good idea.

**What key performance indicators (KPIs) do you use to evaluate your DRT system and what have been the effects on the passenger due to your DRT system? (KPIs such as travel time, travel cost, ability to transfer)?**

The travel time is one and then the total costs that is the transport costs and the divided by the number of booked kilometers. The traveled kilometers can be different from the book kilometers, so that we say it's booked kilometers. And Munckhoff has to make those costs as low as possible. Okay. We want to make as much as booked kilometers. And the cost has to be as low as possible. And then the kilometers of the vehicles without a passenger that relationship is always one of the efficiency indicators. On time performance in our system, is it difficult, because it's dependent on the quality of the planning, and the quality of the driver. So, you can only say that for the whole system. And it's difficult to make sure when it's not so good. Customer satisfaction is important. And we have a bonus system for our transport companies. Based on that satisfaction indicator.

# Transcript Overview: Interviewee 4

## Date of Interview: 24/09/2021

**Could you explain the DRT service in your region?**

We have two products, Flextur and Plustur. So Flextur is basically a taxi trip from one address to another address, with no connection to other public transport whatsoever. So and that that product, we've had that for about the last 10 years, where a customer can call a telephone number and book a taxi to take them from one address to another address. The price for that product is a kilometer based fare. And then, a couple of years ago, we decided to test how about what do I do for the customers who want to get the last mile from the train station to that was outside the city. Because we have a lot of buses and a lot of trains that runs between the cities and passes within the cities. But for the customers who live in the outside the cities, we need a product to take them the last mile home from the station or the bus terminal. And that that's when we introduced this new product that we called Plustur. And the basic concept of the product is that you go to the travel planner website. So that is a web service that both exist as a web address, and also a smartphone app. Yeah, you can use to, to find your to plan your journey. And then you fill in your origin and destination . And if that journey takes you to a place where there's no train on bus available, then the Plustur will pop up as a solution to get you the last mile. You need to book a two to two hours in advance. And that is an order to allow Flexdanmark to actually plan the trip. And know that they have to reserve a car for the trip. So two hours in advance, or the latest that you can book a trip. It's a requirement for you to have a credit card and also use confirm that the credit card is available. When the actual planning has taken place, the actual time of the trip will be sent to the customer. And it can vary between zero and 30 minutes. So yeah, and that is on order to make the planning of the trip a little bit flexible. And so make it possible for you for the car to pick up all customers along the way and so on so forth.

**Are there any official policy documents that states the authority's goal with the DRT service? If yes, what does it say?**

Yeah, well, the goal is the goal was to make public transit available to a larger group of people. Because we know today that if you leave a place where you don't have a bus or a train nearby, you don't use public transit at all, you use the car instead. So our goal was to make public transportation available for a whole more whole, a whole, a whole lot of people who normally wouldn't be able to use public transportation. And then we had an ambition about to get 50,000 trips a year on this PLustur. And that has not been met, we only have about sort of sort of 10,000 trips. We haven't, we haven't met our ambition yet.

**What are the challenges with the goal and how are you planning to address those challenges?**

And we don't know if we ever will because it is a bit of a challenge to get people to use it. Because people don't know the product exists. Because we tell about the product on our web page and in our puzzles. And we have the infoscreens and we have a lot of commercials about the product. But if you never pay a visit our web page, or you never put your feet in one of our buses, you never get to see the commercials for the product because they only available on our web page and in the process, of course. So the challenge is to get the message out to people that we actually have a product that you can use if you don't live nearby a bus or train stop. But people don't know it because they never they never visit our webpage or put that read and Abbas in the first place. So that is a big challenge to get the knowledge about the product out in the broader sense of people. Okay, and I suppose that it's also the explanation for why why don't we have more trips a year, then those are 10,000 trips that I mentioned. That is because people don't know the product exists. Okay. So if they were to put if the words were to put in a search in Alliance plan, and then put in their address and then the where they need to go Of course, they would see the product in ice plane. But if they don't know, in the first place that it is a possibility, they will never open up the ice Plan F in the first place. Because they don't know that the product is there. So we have a challenge in terms of get out a message about this product in the broader sense to all people across the region.

**How is the DRT service contracted in your region? (Who takes the financial risk, how long is it tendered for and what is the scope, how is decision making done, how are conflicts resolved)?**

We have these tenders for the private taxi operators. Basically we have two year tenders. So each tender is a two year has two year span. So maybe maybe we have a tender in, we have a last tender, it's two years. And they are divided into smaller packages that the bidders can can bid on. We have a lot of private taxi operators that are betting on these tenders. And then they we agree, we signed we signed contracts

with each of these smaller taxi operators. And that's a lot of them, that's a whole lot of them spread all across the region. So they can have anywhere from one or two cars to 20 or 50 cars, their fleet is very different. And they vary in sizes and and so on. But we have we have a lot of operators. For the two types of, of transportation in the flex traffic we have the open transportation and the closed transportation and the open transportation that is the open products like a Flextur and Plustur, that is products that all customers can use. They are not restricted to geography. So you're gonna have an taxi operator in one city that gets the trip in another city because he is the nearest car at that time. And then we have the close transportation that is the trips to and from the hospital and the tripsare to and from maybe to or from the schools and those kinds of trips are enclosed, close packages locked to the municipality. So, there might be a package of maybe 10 cars in ine city and then 20 cars in another city. And then in the in the at the time of day when the cars are not running on the closed trips, they are open for what we call the open trips. So the car or the the taxi operators can open and close the cars and make them available for open trips in the planning engine.

The vehicle the types of vehicle different, there may be some mini buses that have a lift and a ramp and accessible for wheelchair and then we have some cars that are only available for people with no disabilities. So the fleet of cars differ from in sizes. So we have a pool of cars that can be used for all kinds of trips both open and closed trips. S o on a Plustur, you could you could be picked up by a minibus or you could be picked up by a regular car. Both both scenarios are possible. And as a customer you don't know exactly which type of car you will get picked up by. But you can see the car will the car will pick you up from pre selected parking space.I don't know if you have I have aware of it. But we have we have made a lot of hubs. We have a have a sign that tells you that here is a place to look for the car. We have some hubs spread across the entire region. And those are the places that we make the change between the Plustur tour and the bus or train. And that is of course the major bus terminals and the major stations but also some major stop points across the the municipalities and in those places we put a big sign that the customer can can see from afar and then they can go to that site and then and they know that the car will park also by that sign and then they will meet each all of there. So we have these hops, where Yeah, places where we can take the bus or the train. And, and what an obvious ambition is that it is it's nice to wait by these hubs, we need to have at least maybe maybe a station or bus terminal that you can go into and and have some kind of shelter for Wayne and wind. Or maybe at the very least you have just an open shelter next to the to the bus stop and wait for the taxi.

**For the service, who is responsible for the design of the service (information, fares, reservation system, vehicle management, marketing etc.)?**

We have a municipality of that pay for the buses, that run within those enclosed municipalities. And then we have the region and the region is the upper, you could say the, the upper municipality of all of them, I mean if you put all of the these 11 ones together, yeah, we have the the outer the outer boundary of this map is the region of Northern Jutland. They pay for the buses, that one between the municipalities that's what we call we call regional buses. And so so that's the buses that creates the regional connection between the municipalities and also the region pays for the local trains that run within this region. The public transit organization that I work for as a what we call NT. We don't pay for anything, we have the contract with the private bus operators that own the buses and have the drivers. So we don't as a public transit organization, we don't have any buses in our in our ownership. We have we have contracts with the with the private bus operators, they operate the buses and we pay them. We pay them to operate the bus lines. And the money for that is provided by the municipalities and the waited. We're the glue that connects the municipalities with the bus operators. Flextur is also financed or paid for by the municipalities. So, for the fare, there is a small amount of money that the customer pays and the rest of it is paid for by the municipality. And you could you could say the same about the buses and the trains.

We as a public transit organization, we are responsible for the design of the product. For plustur, we took a road trip to the to each one of the municipalities and told them we are going to to create this product, are you on board with this? And and also we will decide what parameters will be going into the product. I mean, how long should the customer Wait, and so on and so on and how, how often should the product be available and stuff like that. And then we visited all the municipalities on a road trip each one at a time. And all of them agreed to the terms that we had drafted beforehand. And it was a bit nudging and that in the sense that they needed to be persuaded that it was a good idea and that, that the parameters that we had decided, was responsible and then reasonable. So it didn't didn't take long to persuade all 11 municipalities to agree to the terms that we had drafted. And then the bottom line make the product available to the customers. So we took this road trip to one of the municipalities and and make them all to activate the politicians in the municipalities. I know and another public transit organizations plustur is

not available in all municipalities. We are the only regions of Denmark that have made available to all municipalitie.s and other transit companies. It was a shared effort between our planners here at NT, and the administrative people in the municipalities to make them have to to succeed with getting the politicians to agree to launch the product. We have we have about 10,000 trips a year and that is not a whole lot of trips. But for those people that use the product, it makes a lot of it makes a difference in their day to day life because they now have a way to get from their house and into the station where they can now take the train to work.

The Plustur and Flextur product runs on the same platform of Flexdanmark. They have a planning platform that plans all of these trips and they plan the flextur, doctor, activity, and all kinds of flex product whatever it is. All of these trips are planned by the same engine. And that means that you can have a you can have a taxi with maybe five people on it and one person is taking a plustur trip from the home to a station another passenger is using the taxi on a trip to the doctor. There may be several stops on the way and because we need to pick up customers along the route, take them to different places along the route and Flexdanmark system makes the optimal planning in order to use as to in order to to try to use as few cars as possible and make it as efficient as possible. Basically we want to fill up the cars with customers regardless of where and when they need to go. We want To fill up the class that we really are wanting, in order to make it as cheap and efficient as possible for the municipalities.

You need to book a two to two hours in advance. And that is an order to allow Flexdanmark to actually plan the trip. And know that they have to reserve a car for the trip. So two hours in advance, or the latest that you can book a trip. It's a requirement for you to have a credit card and also use confirm that the credit card is available. When the actual planning has taken place, the actual time of the trip will be sent to the customer. And it can vary between zero and 30 minutes. So yeah, and that is on order to make the planning of the trip a little bit flexible. And so make it possible for you for the car to pick up all customers along the way and so on so forth.

**Are you happy with how things worked out? And would you do anything differently? If, if you had the options?**

Ah, that's a hard one. I suppose I'm happy with how the product turned out in the general sense. I would be happier if we had succeeded in getting the message out to the public more than we have right now. And that job isn't done yet. We still have a job in order to get the message out to people. Would I have done anything different? I don't suppose that I would. And basically, we as a PTA are happy that the customers that use the product, are happy about it. But of course, we could have done more in terms of communication. But yeah, it's hard to know where to where to put in the effort in terms of communication when people yeah, people don't know that the product exists. So we need to get out in a broader sense to where people are, and, and we're doing several things right now. And in that regards, we are starting up some initiatives with the private company is about information campaigns, about all of our products. And we also we are starting up maybe to, to have some, some of our employees in the customer center to be at some central locations across the region. So that they can talk to, to to to potential customers, and their day to day life.

**How is the information about the DRT service provided to the passenger and how is the information coordinated with local PT?**

We have a multimodal trip planner called Rejseplan that is owned by all of the public transit authorities in a joint venture. So and we have to agree in the terms of the service that advisor plan provides for the customers. So that is, yeah, it's a venture between all of the public transit authorities and also the train companies, they are also part of the ownership of DSB, Arriva, Copenhagen Metro company. We as a public transit organization, we deliver the timetables to Rejseplanen and they have the Rejseplan engine that puts all of the timetables for the buses and the trains from all of the public transit organizations they uplaod into their engine and then make it public to the the app and the web page for the customers. For plustur and Flextur, there is a HAFAS engine provided by HACON. The rejseplan engine is a HACON product. So the Rejsplan runs on HACON engine and the plustur runs on HACON engine in that sense that is an add on to the Rejseplanen and engine that Hagen provides and and what that what it does is that it makes it possible to take an existing bus or train line and connect it with my on demand service like Plutus so um so that's some HACON magic that takes place it is a little bit of black box but it works. I mean when when the customer puts in address in Rejseplan, it will search for a bus or train nearby and if there

is no bus or train within a two kilometer radius walking distance the hacon engine will provide a plustur trip to the nearest hub. When a customer has made a search in Rejseplanen and found Plustur then the actual trips gets planned in Flexdanmark's software environment.

**Is DRT and local public transport coordinated in terms of tickets and fares?**

The basic idea is it should the public transit should be as easy as possible for the customer. And how do we make it easy? Well, we will say that you've already paid for your bus ticket, then you don't need to pay for the last mile because you have you have given us some money already so that I feel that you should get the last mile free, so to speak. Just to make it a little more easy for the customer and also make it make the customer more inclined to use the product.

**How is DRT and local public transport coordinated in terms of branding and marketing?**

That is the responsibility of PTO. We provide the marketing of the product and the municipalities pay for the product you can say. We are we are the the eyes of the customer, or I mean the the customer will go to us for complaints and also for information about the product. both the colors of NC on the on the the buses and a slightly different color the trains but yeah but basically the same color palette is both on the buses and the trains. Then we get to Plutus and that is a little more difficult because those are run by these taxi companies and and they don't only one for NC they also have trips for all all they have open trips for their customers. So they don't we don't they don't paint the vehicles in our colors or at least they don't have to but they have to have some kind of recognizability in order for the customer to see that this is an empty vehicle so we have this a yellow line that is that is the symbol of NT. What the ambition is that the customer should always only see us as one company, one company that provides the bus and train and plustur, it should all be as it should all be NT , which is us. In reality, the customer knows that well. We we may be the ones providing the product, but we're not the ones who actually run the train and the bus because those are licensed to the the the operators the customers know that but they also know who to go to when they have complaints about the products. The ambition is to have face to the customer but in reality we know we are aware about that the customer will see different well as different operators along the way of the complete journey

**What key performance indicators (KPIs) do you use to evaluate your DRT system and what have been the effects on the passenger due to your DRT system? (KPIs such as travel time, travel cost, ability to transfer)?**

One key performance indicator is of course, the number of trips that we have a year. So, the number the number of trips that are just one of them? And also the average occupancy. That is the key performance indicator. And, of course, the price per travelled minutes is also an indicator mean how well do we perform and in terms of the economy, because if the cars aren't planned effective effectively, then the price per minute will go up and if you can put a lot of people in the same car the price per minute will go down and otherwise the price per minute will go up because it is all things equal, it is more expensive to to one the cars with one person than to one the car with five people in it.

# Transcript Overview: Interviewee 5

## Date of Interview: 02/09/2021

**Could you explain the DRT service in your region?**

The DRT system started without the integration with the buses and the trains. So, it was a standalone project where we had a nationwide solution where we are able to pool different kinds of public transportation needs for for DRT for for people with mobility needs, physical mobility needs or mobility needs, because there is no boss no train in their area. I think one of the special special things about the Danish DRT solution is that it's it is possible to pool together all kinds of transportation needs from different authorities is in the same pool. So, we have this fine opportunity for for for optimization because we have high density of prevalence in the system. In 2013 or 14 we had an funding for a project with the Danish transport authorities for combining this DRT solution with timetable traffic in a project called the connected journey, where we would would connect this to transportation modes, so it became a multi modal transportation and it has been a pilot project since 2017 and a nationwide the year after so now we have a third year up and running nationwide. It's a regular service. So now it said it's yeah regular service well known projects integrated as part of the public transport system okay.

**What are the goals for providing the service?**

it was to offer better mobility that was a public goal and of course, we have had already the backbone of transportation needs and the taxis and the minibuses driving around in this area if they could supply other needs with putting people in a car even better, then it would be a win win situation and that's the core business idea, I think. So then it was also to provide service in areas where empty buses or low capacity for sorry lower usage better use of public resources, taxpayer resources

**For the service, who is responsible for the design of the service (information, fares, reservation system, vehicle management, marketing etc.)?**

The design of the service is done in consultation between the municipalities and the PTAs. And every area of the municipality, you can have theoretically at least to their own set business rules because we have put in the rules in a system where it's possible to to granulate it. The business rules are the service level such as where the DRT last mile first mile solution covers opening hours and how long do you have to wait with the connection bus stops? For instance, how much fare ticket price to need. And so rules crossing like are going into or leaving the one specific geographical area can be a different rules. And also within one geographical area can be a third set of rules to need to walk 800 miles or 800 meters show different transfer parameters. So, every corner of the municipality can have each service level. The rules are defined by collaborating with other municipalities and but they don't have not always have the insight or the knowledge that's typically owned by the PTA. There is of course, I'm some standardization, because it's the same IT systems. We are the IT solution. But its the Danish PTAs owns this service, and the Danish PTAs are owned by the Danish municipalities and regions. We are the IT solution that that is between the public transport authorities and the National trip planner, where the business rules are presented to the travellers. So, the traveler calls PTA call center or they booked the trips themselves, and then they that trip ends up in our system, and the system, optimizes it finds the cheapest car, and so on. And then as you say, we push that trip out to the, to the specific vehicle and driver.

**How is the DRT service contracted in your region? (Who takes the financial risk, how long is it tendered for and what is the scope, how is decision making done, how are conflicts resolved)?**

It's a kind of regular taxi model, if we don't need them, we don't pay them if we need them, we pay them and amount that is already settled upon? We know Yeah, we know who will have the give us the lowest cost.

**Can you explain how the municipalities provide the Flextrafik services?**

That's for each municipality to decide how they want to provide the service and whether or not they want to use the PTA and flex Denmark. In Danish culture, there is almost no civil society solution for volunteer driving or insurance driving, it's almost 100% tax payer solution and that's one of the things that gave us an advantage we can pool this social need together. There are those two models, either they must facilitate and tender and all that themselves, or they, they can choose to use the PTA to do it. And if they use the PTA to do it, then it's obvious, of course for that those trips that that make sense in our system to, to, to include us in that. The national government made a law that says it's okay for municipalities to

transfer some of the Flextrafik duties to the PTA. And that's why we can do the optimization. And that law has been also called put into law by, of course, the Ministry of Transportation. Volume is an advantage in the input part, and in the output part in the input part, it's the case that we have transportation needs for hospitals for other sort of treatments, school children with special needs, people living in rural areas with no buses, and no trains. And no have no driver's license That's the input part where we have multiple services, we can pull together and optimize it. And in the outer part, you have a high level of competition between the different taxi operators in competition situation where they need to have the best bid, meet the compliant with the service level, but with the lowest possible costs. So volume is an advantage in our business model in the input and output. That's important. It's it's easier to to optimize when the volume is high. It's easier to have people in the car. Yeah. And to do some actual cost savings and have 500 different operators. Nationwide's gives us more it gives us the competition situation.

**Is there a cooperation between the DRT service and the PT (Public Transport) service in your region?**

That's I think that's done the configuration of the service at the I guess that is done at the Rejseplan level. Rejseplan is a nationwide trip planner that is owned by all PTAs. It's a multi modal trip planner from HAFAS in Germany. So it's a collaboration between the municipality and the PTA on whether or how to configure the, the service through the Rejseplan.

**Standardised data formats can help in interoperability, coordination between multiple operators and help in providing knowledge of the service to a user. What do you think of data standards already in place and about data standardisation in terms of DRT data?**

The services as defined in Rejseplan is owned by the system provider. That's up until we have defined a trip the last mile trip, the last part of the trip, and the last mile or first part of the trip in the first mile trip. So, it's from A to B and from then on, it's defined using SUTI is defined as a as a tribunal system. So the I would guess the service is defined by Rejseplan and the trip is defined by our system or our interfaces Yeah, if the Rejseplan system accepts the trip says it's okay with the business rules then we accept without further discussion.

**How did the adoption of the SUTI data standard happen in Denmark?**

But maybe in the early beginning, I think I have read somewhere that the Swedish authorities paid some money to start up the corporation. And then you have taxi companies, taxi system providers, authorities, and the whole supply chain actually is collaborating on a voluntary basis to make and de facto standard for exchanging information about person transport. In Denmark, it's voluntary, but we use it because we see an advantage in having this de facto standard, which gives us the possibility to specialize in our domain. And the commercial suppliers for taxi solutions can do their thing. And it's almost plug and play because we use the same standard in almost the same way. Because it's voluntary, voluntary, how you use it, to use it, it's not always at the same level. It's very good to have an involuntary de facto standard.

And we have a taxi company, who was the leader for sort of putting equipment in one taxi, you can lend it as an app solution for about 10 euros per month, per car. So,it's a very low price to get into this market. low level of entry. Exactly. Because we have 11 or 12 commercial suppliers of solutions in our whitelist. And they do use our version of SUTI. So, we have control over the data flow in the whole supply chain from us to to the taxi to the actual taxi driver.

**Are you happy with the way this was done, and would you do anything differently?**

Yeah, I think it's just you If you think about the DRT solution and the connected journey, I think the way that is done from kind of bottom up. Yeah, that's perfect. It's organic growth and voluntary participation from the PTAs and the municipalities. Same about the organization as well. And the different responsibilities are also I wouldn't change anything. There. I think from from my perspective, I think it's mostly the technology thing that it could be. Yeah, you these are long projects, and you sometimes you have to mess with the things you would do differently half a year later. So and now it's been eight years. So that definitely the things you want to do differently. Of course, we want to do more we want to mature we want to add on we want to develop. We're not just satisfied with where we are now. We just ambitious to grow more.

# Transcript Overview: Interviewee 6

## Date of Interview: 26/08/2021

**Could you explain the DRT system that is offered in your area?**

In the US, we've had the requirement to do what's called paratransit, which is demand responsive transit for the people with disability. And that's been around for over 25 years. In Denver, it's been done even a long time before that. What's been missing or what got overshadowed by doing it for people with disabilities is the general public. Now, what about demand responsive services? Are they applicable for the general public? And I think the answer is yes. In Denver, we started doing it over 20 years ago. And the objective was to provide service where fixed route did not appear to be appropriate, was productive. In the very first one we did in the year 2000 there was a little shuttle bus circulator service and one of the outlying smaller community. And it was carrying maybe 15 people a day, running around in circles, as has happened in many other places. That's simply not a good way to provide service. Things obviously carry many riders and relatively costly. So instead, we decided to offer demand responsive service in this community, essentially using the same resources thing, same small shuttle bus with the same number of hours during the day, and ridership going up to 60 boardings per day, which is a lot more it's still not very many. But the question is, if you're going to provide service in a community, then what's the best way to do it could be a train or bus or demand responses in this case, the demand responsive service was the better bet more than the most cost effective. So, from there, we went on to expand on that in quite a few other communities. And we found that the market for these services is basically in the lower density suburban areas of our metropolitan area. And that there were two demand market which is one was just circulation within the community itself where you provide the service and the other is firstly a smile that comes to be going in today. Getting people to and from the main line service like our light rail station. And we now have, it's called Flex Ride now used to be called Call-n-Ride. We now have over 20 of those service areas with over 40 vehicles. And each community, each service for each community must be customized and planned. Just like if you were planning a bus route. What's the density on around? What are the major activity centers that you're trying to reach? know, how many buses or shuttle, you know, smaller vehicles? Do you need to cover the route? Or in this case, the service area to be attracted to customers? And in each of these 20, over 20, service areas, we have to determine then customize and it depends on is it community circulation mostly? Or is it first last mile, for example? Or is it a mix of both? And if it's, and if it's first last mile, is it regular commuting? Or is it reverse commuting? Right. So it's just like, instead, the planning becomes very important. And then what that means is you have to configure just like you have to come up with the actual route and schedule for a bus, you have to come out, come up with what Service Configuration works best for each of the service areas. And it turns out that a certain amount of structure, configuration makes it work better. And it depends on the service area characteristics and the market demand.

**For the service, who is responsible for the design of the service (information, fares, reservation system, vehicle management, marketing etc), and how was it put in the contract?**

The Denver transit agency, the Regional Transportation district decides, besides fares, whatever the fare structure is, what the services are, agrees that performance measures. Everything is done by the by the Regional Transportation district. We are a government agency, we are a political subdivision of the state of Colorado

**Who is the operator of the service, when did they start operating the service and what were the authority's expectation with operator when the service started? And How is the DRT service contracted in your region?**

It's not a different question than if you're operating, say, a bus transit service. You do whatever is most cost effective and convenient, and, and best for your agency. You can hire the drivers and buy the buses and operate it yourself with your own operating division, you can contract it out to, you know, some private company that does that sort of thing. There are lots of companies that do that. And you can do a mix of you can even do a mix of that. And in Denver, we do all of those things. But for our Flexride, we contract out all of the operation of it, although we buy all of the vehicles that they use, and also we buy the fuel, because that's convenient for us. And less costly. And also, we provide the technology, you know that the demand responsive technology, but you don't have to do it that way. You know, you've I'm sure you've heard of Via, they're out there everywhere. And they can do. They're a private company. And they can do those things as well. So, you have to evaluate what, you know, if you're a small transit agency, and you don't want to take this on, and it might or might not work. And that's what a lot of them are doing. And

then as you know, we're going to try it for a year and see how it goes. In our case, we actually helped to develop the technology starting 10-15 years ago, even before there was in anybody knew about Uber or Lyft, you know. And we basically own the technology. And we provide that to our operator. It's basically a computer platform. And it's using the internet in telephone technology and tablets and the vehicles. That's the system that makes it work. But it could be via has their own, or you could buy the technology separately, or any combination once again. When we started this over 20 years ago, it used to be that people would be able to call directly drivers in each of the service areas. And that's the way they could call and make the trip. And that's the way they had to do it 20 years ago, because we didn't have the technology to automate. But then when we got the new technology, and then you know, an app, or you could do it on from your computer at home, people then migrated to using that, and less calls went to the to the driver. And then a just like about two years ago, we eliminated the calls going to the driver, which is very distracting, not good because the drivers can't pick up the that's supposed to answer calls while driving. And so, our call center which also does information for bus or rail or whatever, we switched it to training them. So, our call center now handles all kinds of calls including the specific phone calls that come in. Now they're trained to handle a booking on our automated platform for scheduling Flexride.

**Is there a cooperation between the DRT service and the PT (Public Transport) service in your region?**

Flexride has always been used depending on the particular service area as one or either or, both. Even from 20 years ago, and one of the ways is configuring the service, for example, you can configure the vehicle to be, let's say, you have two vehicles. And you can in the service area is relatively small. And you can have it scheduled on at the station every 15 minutes they during the peak period. And then the other say 30 minutes that the vehicle has it goes out and delivers people out into the area and a reverse commute or the other way around. So that's a way to make that work. Even before we had these, the modern, automated platform, you know, now with the with the automated platform, it's all automated, it can be where it's scheduled to meet the stations, immediate to station certain time. And that is the names and the trip planner. And that helps in trip planning and helps people just know, you know, where they're going, if they're just coming in, they don't have to actually make a reservation. If they're coming to the station and going out into the service area, they just waiting and bored. You know where they're going, as an example. But when it's not scheduled, it just goes to where people want to go. Well, the other thing is that in some cases, both types of service and we have that cases can be present, you can have a fixed route bus, say cutting through, you know, or alongside a community, and also have demand responsive within the community. And they can work together as well. So, it's like we were just talking, it's one way or the other way, or you go back one, you go back to the other way. And some cases, actually, some sort of combination works.

**Are you happy with the way this was done, and would you do anything differently?**

Well, originally, these types of services were centrally dispatched, everybody just calls into a central dispatcher, who had perhaps a chalkboard or a piece of paper and recorded information, and then put out a compile the manifest, okay, and gave it to the driver when they left, you know, people had to call in advance, you know, like the day before, then, and this was probably like, around 1980 or so, cell phones became very popular. I mean, and they became actually commercially viable. And that's when we started to use it. So the question became, so now how can we improve upon this Central Dispatch system, which is not very convenient for customers at all. And so what we did was we put in the cell phones into the vehicle. And that gave a direct contact between the driver and the customer. And they could even call in like a couple an hour in advance and it. So that was a big, big deal. But then, as we move towards automation, there was a challenge because the drivers were no longer going to be in control. Okay, before the driver was in control. And if they were a crummy driver and didn't want to work, they could just say no, I'm not going to give you a ride. That's an extreme, right? But the fact is that, and this probably is the more general thing about computerization is that you move from a more manual system to a more automated system. There is a transition period that is very challenging in getting drivers to understand how this works, and to actually say that Yeah, a computer can actually schedule better, faster, you know that a person would say can so that was a real challenge, and was a challenge for customers too, because they like calling in and talking and getting what they wanted, you know, that was a challenge, which now, I don't think transit agencies need to face because they'll start off completely automated now. But there might be some challenges still in this area, because of the nature of the demand and the Service Configuration and what people are trying to do, especially now the question is how you integrate better demand response into the fixed route system, and also accommodate people with disabilities, you know,

more cost effectively than being done now. So that's a challenge. And I don't yet know how that will work out. Especially if, you know, it's, we know, it's very expensive, high costs per person per passenger carried with for are the demand responses just as a deal basically, with people with disability, you know, whether it be cognitive or physical. And we know that people like that also like to be integrated with others. But in terms of the efficiency of demand responsive service, it usually takes quite a bit longer to handle people with this ability, I'm just giving it another challenge. And if it takes five minutes, just the board and the light somebody, then that's not going to be attractive to somebody else waiting in the same, you know, trip vehicle tour, right? So how do you handle that sort of thing? And then just as you were asking, before better integrating the fixed route services with demand responsive services? And how is that doing? You know, are we you know, how what's, what's the challenges of making that work better, and getting that type of trip planner out into the public. And then integrating that with the other sorts of micro transit or services, you know, having, you know, like MaaS, you know, that whole concept, you know, sort of thing, better integration there. And that's being talked a lot about as well. So I think the hardest part was getting the public to see that, like, a flex ride service was okay, it's not a bus route. before there was any of this type of service. I just want my bus route, right? But, but now that becomes a less has become less of a problem less of a challenge. People think that it's going to be Uber. But the challenge now is, is especially for the stakeholders, for them to understand that the DRT or Flex Ride services for transit agency is not an Uber, it is not a taxi service, because it's shared ride. And that is a real challenge. Okay. And Uber, by the way, and all are not doing very well, working with transit agencies, you've probably heard that. So those are the those are the very modern challenges, you know, are, you know, new concepts like MaaS, but nobody really knows transit agencies don't know how it's really what it is and how to incorporate it. But it doesn't stop them from stakeholders saying I got to have my own without knowing it all just got to have. The idea that DRT is something that everybody ought to have, and it needs to work here or like this. I think people are now getting over that, because there's been so many failures, really, and it doesn't really work. But it's got to be a part of your whole transit system that has to be planned as part of it. And I mean, we've had Flexride services that have failed. And that's important. Failure is important. Some of the work out and some of them don't. So that's what that's the real issue, that's what you ought to be tackling is, you know, what is DRT? Where does it work? And how does it fit in? Right? And how do you measure performance? You know, and what are your objectives?

**How is the information about the DRT service provided to the passenger and how is the information provision coordinated with local PT?**

Okay, so I forget how far along let's say that 10 years ago, you know that, essentially, Google came up with the GTFS specification, which everybody just about everybody in the US anyway now uses and produces the feed is transit feed, for available for any type of trip plan, there's other trip planners out there as well. So you can put in, I want to go from here to there this day in this time, and it will give you the best route, you know, with your application. However, it was not capable of integrating demand responsive services. But now there is an extension to they get that called GTFS Flex. And so, we have created that feed for our Flexride. I don't think there's more than a few a handful of others that have done that. But we have done that. But then after you create the data, then you have to have a a trip planning app that will actually then incorporate it. And I didn't know there's hardly any that have done that as well. Except that we got together with Kyyti and DemandTrans. And we created a trip planner incorporate the GTFS Flex and that app available on our on the Denver website. And people are using that. It does two things. One is it recognizes where there's demand responsive, where a flex ride is in its configuration. And we'll include that in your itinerary, you know, for, you know, your fixed route plus that. And if you choose to use that a temporary it also allows you to directly go to the DemandTrans platform and book your ride. We also have our call center that handles all kinds of calls including the specific phone calls that come in.

**How is DRT and local public transport coordinated in terms of tickets and fares?**

Well, I think the basic thing is that the fare for the DRT should not be different from the fare for the local bus service. Because in essence, we are providing DRT instead of a local bus. Because we have decided that that's the most cost-effective thing to do. You know, a, you can go back and forth, like we talked about, but once you've figured that out, that's the service you provided. And that is the way the customer views it. No customer will view it any other way. And if you tried to charge a premium there, which was done, probably not done much anymore, but it used to be because, hey, you're getting door to door service, you know, then it can cause that to fail. Okay. The other thing is that just is that if you want to have, you know, integrated services, you can't charge for transfers. So, and if you do, in some places still do for going from one bus route to another, you've got real problems in a and that needs to be eliminated.

Otherwise, you could do not have an integrated network transit network, that encourage ridership. In the United States, fares don't cover much. Even regular transit revenue only covers a relatively small percentage of the cost In Denver, I don't think it covers even 20% of all, you know, across the board for all our types of you know, whether on the average, and it varies by the type of service. And then it depends on how you allocate fair revenue to the different services, you know, if a person uses those, Demand responsive, you know, and then they go on to your rail to go to the station, you know, rail. So where do you count the revenue? You know, a person wouldn't have gotten on the train if they couldn't have gotten to the train. Right? So, there's cost, there's cost allocation, and there's revenue allocation. In most US cities, there's so little revenue, that it doesn't really matter, you're really talking about the cost basis, you know, what's the cost per ride, which you're going to provide that service to that market? What's the most cost-effective solution, which would be the least cost per No, or subsidy per passenger? And if you have decided that DRT is the most cost-effective solution then it should be the same as your local bus service.

We use the same form of fare payment, whether the paper ticket or a case or an electronic card or through an app for all the services that we operate. We would, but not all the services we operate can use that. Yeah. Right, because it's still relatively new. But we would, yes, we would have the same brand. And same type of fare structure is least for the Denver Metro area. And some metro areas where there are multiple providers of transit servers like Los Angeles or Chicago,, it's much more difficult there. But so here, again, can generalize any of that. But for Denver, we're one agency responsible for all public transportation. And so, we have one, we can have, you know, a single approach to make it easier for customers. Years back before, you know, the modern technology, it was just using the paper transfers. And you would have to issue or accept them on all the different routes or DRT services, which is what we did. Nowadays, we're moving towards the electronic ticketing. And so that's being better integrated. Now the issue is how best do you integrate different services integrated together in fare payment. You really need to go to an account-based fare payment electronically. And that's not easy to do. And it's not definitely easy to get all the players to work together in that system either. Because, you know, we have like Uber, or a bicycle, you know, or you know, or your you know, scooter, you know, Flex scooter, they also want to play in that in this. But now you have everybody is there still has their own system and their own Charges and all this sort of thing. That's kind of the mass element that well try to work that one out. It's not easy.

**What were the challenges that the operator faced in achieving the integration components from the previous questions?**

Oh, it's always a challenge in any transit agency, especially when you introduce a new type of service change that agencies came from, from private sector, you know, that started a century ago, more than that now. And we run buses, and that's, you know, don't go bother me with anything else. And so it's taken decades, you know, when you introduce new things, and even now, where it's where you've got some board member, and it's got to just got to have, we just got to have one of these. What good is, if you just don't plan it, you don't have a way to communicate it to customers in the community. But the, but that is no different from any other train that sort of, if you introduce a new bus route, you get the same this guy. And most people in the US, only 5% of trips in the US are on transit. Not like in the Netherlands, okay. Well, you have a much higher visibility, and let's say branding, in a way people would look to use it, and maybe, oh, here's something else new, well, maybe something I could do. It's such low recognition, customer recognition to start work, that you're at the bottom, whether no matter where you're starting at. And I can't emphasize that there is that that is a difference between the US and Europe. I mean, New York City, you know, I mean, Chicago may be, you know, Boston, in some, you know, certain cities, you know, where there's that, but even once you get that this top five cities in the US, forget it, you know, there's very little very low patronage of transit, compared to probably the top 50 cities in Europe, you know, or maybe even more than 50, you know, where you're saying, you know, the public recognition, have you promoted? The branding, you know, the integration of services? It's going to be a lot different here, then in Europe, and I'm not sure. And if you go to Africa, you know, you've got the private sector that's running the sort of, right, you got probably 75% of people are using the jitneys, and private buses and all, you know, all this stuff is going along there. It's a whole different, you know, concept of how you're branding and marketing, you know, public transportation services to a particular market. So it's not, you can't generalize at all, your question cannot be generalized.

**Standardised data formats can help in interoperability, coordination between multiple operators and help in providing knowledge of the service to a user. What do you think of data standards already in place and about data standardisation in terms of DRT data?**

In a recent TCRP paper, they came up with transactional data specifications, I think you probably seeing that. And so there's a lot of there's a lot of effort to move that into use . But here, again, it's very difficult because we have all these different private players, you know, having their own technology system, and they don't necessarily want to work together, right, because then that you lose something, you know, you use competitive advantages. And that's what it's been. So coming up with the standard is not hard. Getting everybody to use the standard is quite a big effort. If you're in the Scandinavia, and the National in the federal government says you will use us that works. You know, if you want to play in our system, you have to use our data spec, we you know, have that here in the US. But it might get to that in order to make it work, you know, at least maybe at the state level.

**What key performance indicators (KPIs) do you use to evaluate your DRT system and what have been the effects on the passenger due to your DRT system? (KPIs such as travel time, travel cost, ability to transfer)?**

Well, have you seen our performance reports online, we have our annual report, and we show all the data and charts for all of our services? There's our KPIs. There, there are two main ones, okay. And we use the same two for every service that we operate, whether the demand responsive, ADA paratransit, train, buses, samples, anything that we have. And it's boardings per service, our pay per vehicle for per vehicle service our and subsidy, because that takes an account revenue, revenue minus cost equals subsidy, per boardings boarding nodes for each person trip. And that does count transfers, you know, more, so if you wanted per actual, you know, connected trip that's different, that's a little harder to get. And if you look at the charts, where we use where we plot, you know, the productivity versus the cost per person, that gives you a really good picture of where each service stands, within their own category, whether to be DRT, or bus, and how each compare to one another. And, you know, gets to the question of how do you know which to use? Well, I mean, the basics of transit is density. I mean, there's nothing, there's no way around it, right? Its density, its population and employment density. And that and the denser it is, the more viable certain forms of transit are, okay. And that gets to this subsidy per boarding and boardings per hour of getting to how well that service is doing. In that for that route coverage. And that, you know, along with the density is and everything else in each area. Now, of course, there's other measures like on time performance, right? How well schedule adhering to how well is your service? adhering to your promise to the public, you know, so we measure that sort of thing. Customer satisfaction is one. So, we do, like, every three years, we have a customer satisfaction survey. And they, they tell us, you know, how they're on time performance, safety, cleanliness, you know, capacity, you know, whatever the questions are, you know, is it frequent service, or, you know, or the equivalent of demand response. And so, we, we also measure that, and then that's a way but you can look, that's, that's, it's, that's whether the demand responsive, or bas, us the same questions of your service. And then you're able to compare, and to understand what type of service works best under what situation? I don't know of any other way to do it. I mean, why should the demand responses they have a different KPI than your bus service? You know, I mean, another thing is, you know, is your load your passenger load? Are people standing? You know, or are people waiting too long, right? We can measure that on both services and figure out which one is how each one is knowing, you know, and each service is doing in that category, and then how they are relative to one another. So, but the main economic ones are the two the boardings passengers substitute for boarding, other performance measures are more related to how well is this particular service doing to meet the customer needs and satisfaction. One of my early paper discusses some of the customer satisfaction elements. And actually, the demand responses was rated highest amongst all among higher than bus or rail. Why is that? Well, because it's customized, right, it picks you up at your door, the passenger knows the driver, you know, and, you know, you know, and that's one of the ways customers are satisfied, right, is they get good service from there, from their vehicle and the driver, whether it be a train driver, or bus driver.

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## Date of Interview: 09/09/2021

**Is there a data specification, comparable to GTFS but also for DRT services?**

There is GTFS-Flex but it's not fully adopted, but various entities are starting to use it. The GTFS Flex is what we call a discovery data specification. It just tells you, you know, like with, you know, geo JSON or whatever, here's, you know, here's where a service area is some information about the service, the hours of the service, if there's certain things like checkpoints for the service, or for our flex routes, or things like that there's information in GTFS format that describes, you know, the structure elements of the service. There is no other standard for what we would call discovery data. That's just information about what is not transactional. There has been in the latter stages a development project, put together by MobilityData Hub in Canada to create something called the GOFS, which is General On-Demand Feed Specification and I've been a part of that process, it's largely completed. And it's basically used to provide information that's non static to trip planners, and much of that it was funded in part by Transit, which of course, is a Canadian company also. So, I've been involved in that process. It's not a substitute for GTFS but it's basically taking it more in the transactional direction. So, you could find out with a trip planner that not only here is a service, but also if the service is available right now, and if I could I book a trip on the service. There'll be a lot of mechanisms that would, if all of them are implemented by a provider, then you could actually get sort of real time information about the status of the system. I'm not quite sure how that's gonna fit into the whole Google process. But it will in some way. And it's probably six months away from going through any formal process with Google itself. Let's say that it's more of the dynamic side whereas GTFS Flex is more the static side.

**Why has it not been fully adopted?**

No one understands why it's been sitting in its status for at least two years. Without Google, formally adopting it. No one, no one really has insight into the process. GTFS is not supposed to be something that's Google specific. But the reality is that it is that there is a very obscure governance. Now I've had been involved in this process in the past, there's a very obscure of governance structure for it. And if Google decides that it doesn't want to do something, it just sort of sits there. And that seems to be the situation with GTFS flex. I know, everybody has been involved in the development and no one can explain why it's it hasn't been formally adopted. Given that we still haven't got Google to approve the GTFS flex, and GOFS. It's not clear what will happen. Let's put it this way Transit wants it and they will start implementing it irrespective of whether Google says it's part of the standard or not.

**Assuming, that the standard is already there, be it GTFS, flex, or GOFS, what are the other requirements for the information integration?**

The weakness in the whole thing is that if the data is not made available, the standards are useless. If transit wants to include in its application the information for public transport services, then it's up to whoever is responsible for that service to create the data in this GOFS format. If this data is available, then Transit could use. For the public transit agency, the incentive is to make their services better known to potential riders, so they currently have an incentive to produce and publish this data. If they're working with a technology company, or an operator, then, you know, then the PTA needs to put something into their contract to reimburse the operator or technology company for making this information available. Once you've done it one time, it's routine. My company was a part of a project with RTD. In that project, we created this GTFS flex data, and we had to, you know, take it from our sources, turn it into something that went to their data repository and all that. So, we now have a way to generate data out of our own system as GTFS flex compatible, and we can do that anywhere, but somebody else who didn't take part in a project like that might not have any way to do it. So, they would have to spend some money to do it.

**The tools for converting your public transport data into GTFS format are readily available, are such tools available for GTFS Flex or GOFS as well?**

No, they are not. 10-12 years ago, nobody was producing GTFS data and GTFS data is really simple to generate. But if you weren't doing it before, then it took some work to get to that point. And it's the same thing with GTFS flex, if you're not doing it now, it's not inherently difficult. But you have to actually do something. And then once it you want to do it, it's sort of persist, and particularly, you know, for static data, it's, you know, it doesn't change. It's like bus routes, right? I mean, you got, you know, a bunch of

points. And, you know, if the, if the bus route stays the same, the data file stays the same. Same thing with GTFS. Flex, it just has to be created the first time.

**Is the GOFS standard comparable to the SUTI standard which is used in the operations of Flexdanmark?**

It's quite different. The SUTI standard is really for moving data between, say, trip reservation systems, and scheduling, and dispatching and billing systems, they can all be one system, but you know, think of it functionally. GOFS is very much focused on trip planners. And the purpose is to allow a trip planner to know that a service is there, and to be able to discover something about that service that's dynamic in nature.

**Can the national government of the state government push for the adoption of SUTI like standard?**

No, absolutely not the national government, the United States has no role whatsoever in this. We have we tried to get the public transit industry interested in these transactional data standards for demand responsive transit. And it's not that they're opposed. They're just really don't know much about it. Transit industry has been very backward. Only in the last two or three years in the United States have they started to be interested in demand responsive transportation. Again, it's been, you know, 30 years, since it fell off their radar screen, when all this thing for services for the disabled became part of their mandate around 1990. Before that, they knew about these services, but after that, they were not interested. So, it's only now that they are getting involved again. State governments probably won't do it because of a lack of knowledge and expertise. There is a huge lack of expertise in the agencies. There's probably not more than 20 agencies in the United States. And that's, that's an exaggeration. That's too many. But somewhere between 10 and 20 agencies, the United States didn't know really much of anything about demand response or transportation for the general public. So it's very small number. So, for those who have been trying to get something like a SUTI type of thing going in the United States has been very difficult to figure out what sort of governance system could come into being this thing.

**And in your opinion, Why was the national government interested in in the Scandinavia for the development and the adoption of the SUTI standard?**

Because they were paying for the services that the cities were implementing. And they understood that there would be switching costs associated if they didn't want lock in of the vendors, because they were, those systems were piggybacking on top of the services of the taxi industry. So the service provider was a taxi company, the software platform, could be that of a third party, third party technology company, in some cases, it was the taxi company's software. And so there was a serious possibility that once you had made a software selection. That would be sufficiently costly that they would basically say to the city, no, we, our software may be lousy, but you can't change it, because it's going to be too expensive. So, the national government, I guess, they were starting to see some situations like that the city would want to change the software. But there's already been an integration with the taxi company. And so, they realized that this was the potential throughout the country. So, they needed to have some standards in terms of what the data elements would be, and all this sort of stuff. So that's what started it. I mean, was this the power of purse so to speak, that the national government say, Hey, we're not going to pay for services that can't be standardized in terms of data interactions between them? So that's what got the whole thing going.

**Is the Trip Exchange Hub that was developed in Denver for the cooperation between transport services comparable to the coordination system based on SUTI standard operated by FlexDanmark?**

No, we really don't have any standards adopted there. And that's part of the problem. We've integrated our platform with the taxi dispatching system used by the operators in Denver. And the integration was based on the use of API's. So, we had to just use their API and create an interface through which an exchange of information was possible. Functionality wise, it does the same thing but with API's. We don't have any such standard as that because we don't have a national standard. So, we just chose the path of least resistance, which is to use our own API's, in essence, plug our API data into somebody else's API, which is not an ideal situation. But there's, in the absence of anything else, you know, it doesn't make sense to create something that we have no idea whether it's those beyond one such situation. If the taxi company provides us with an API call to do something, then we have to take a look, we have to then send something, take something from our API and transform it to match the requirements. There's nothing universal about them. That's, that's the problem with API integration.

**Is there a limit to the scale of operations using API integrations?**

Yeah. Yeah. So we have a, we have a certain way we, we expose, you know, lots of different things through our API's, but then we have to write some code to make sure that our API plugs into the taxi companies and, uh, but if it was Uber or Lyft, we'd have to do it, something that plugs into their stuff and gets the data back, you know, in the, you know, through their API calls. So, I mean, this is the problem with the API solutions is that it's, it's elegant. But if you have 10, systems interfacing with 10, other systems, that's what 10 times 10 minus 10, that's 90 different, you know, flavours. So, you know, interaction between 10 systems. So, there's a lot of software that has to be written. In Denver, the taxi operators are using a common taxi dispatch system called Icabbie, there's, there's only two or three or four of those that are, you know, had some a significant market share in the United States, and that's one of them. So, there's, you know, three or four of them. So, but yeah, if it was another company that didn't use, then we would have to write a new piece of software to make it work.

**What do you think is about integration of the tickets and fares between DRT and general public transport system?**

Well, I mean, there's really, from my perspective, little issue with that, DRT ticketing should be integrated with the transit ticketing. And, yeah, it just, there's no there's really not a big problem doing it.

**And do you think that the value in in achieving ticket and fare integration is of much more of interest when the DRT service acts as a complement?**

Absolutely. If DRT service is just over on its itself. Yeah, the integration is not really that big deal. Yeah, I mean, they have two separate things because people have two separate experiences. If it's designed to interface and integrate with the fixed route system, then integrated ticketing is appropriate. The issue is that the digital payment and ticketing is new and the transit industry in the USA is relatively backward.

# Appendix C: Flexride Public Transport Network