Article

Shared Mobility in Rural Contexts: Organizational Insights from Five Mobility-as-a-Service Pilots in Sweden

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Abstract: Despite a growing interest in using Mobility-as-a-Service (MaaS) as a tool to address rural transport problems, the question of how to organize such a concept remains unanswered. To address this knowledge gap, this article explores organizational elements of rural MaaS pilots. The analysis, which is based on participatory observation and interviews with actors involved in five pilots in rural areas of Sweden, reveals that the motives of the actors involved in rural MaaS both overlap with and diverge from the frequently stated objectives of urban MaaS developments. Both concepts center on complementing and extending public transport, but while urban MaaS is underpinned by the fight against climate change, congestion, and local pollution, the main objective of rural MaaS is to reduce transport poverty. The analysis, moreover, illustrates that despite the geographic differences, actors involved in rural MaaS pilots face similar organizational challenges as have been reported from urban MaaS developments. In both cases, actors struggle with finding their roles, mitigating uncertainties, distributing responsibilities, and negotiating business models. Finally, the analysis finds that rural MaaS puts higher expectations on user involvement than urban MaaS and identifies a risk that rural MaaS developments might contribute to spatial injustice since the studied pilots only supported rural communities with high social capital.

Keywords: emerging mobility services; Mobility-as-a-Service; shared mobility; governance; rural development; Sweden

1. Introduction

Rural contexts are characterized by low population densities and long distances between societal functions such as schools, shops, and healthcare facilities. These characteristics make it difficult for public transport authorities (PTAs) to provide a level of service that is both satisfactory for rural dwellers and financially reasonable for taxpayers. Consequently, rural dwellers that do not own motorized vehicles oftentimes find it difficult to reach and interact with basic social services [1–4]. In other words, the collective performance of rural land use and transport systems frequently fail to serve all rural residents with an adequate level of accessibility, which leads to social exclusion (cf. [5]).

An emerging public sector strategy for increasing the accessibility in rural areas is to complement public transport with other types of shared mobility (e.g., [6,7]). For instance, to ensure that it remains attractive to live and work in all parts of its territory, the Danish PTA Movia has pledged to develop and disseminate shared mobility services, such as car-sharing, ridesharing, and on-demand shuttles, outside the larger cities [8]. PTAs have, moreover, displayed a growing appetite for integrating shared mobility services with public transport into Mobility-as-a-Service (MaaS) products to assist citizens in piecing together individualized offerings that suit their travel needs [9,10].

MaaS is here defined as a "type of service that through a joint digital channel enables users to plan, book, and pay for multiple types of mobility services" [11] (p. 3).

The term emerged within the transport sector around 2014 [12,13]. Although the conversation initially focused mostly on urban transport problems, such as congestion, lack of parking, and excessive car use, rural MaaS has received increasing attention from both transport scholars and practitioners. Two PhD theses on rural MaaS have, for instance, been published within the last couple of years [14,15] and at least one more PhD project is underway (Jenny Milne at the University of Aberdeen).

However, despite the growing interest in rural MaaS, few of the undertaken initiatives have managed to transcend the research funding-infused pilot phase (cf. [16]). Rural contexts seem to both amplify general institutional barriers for MaaS developments (cf. [17,18]) and introduce new ones [19–21]. Consequently, how to setup business models, distribute responsibilities, and interact with citizens so that rural MaaS solutions become attractive, viable, and resilient remain open questions [14,22].

To address these knowledge gaps, this article reports on five rural pilots in Sweden in which public transport has been complemented with new types of shared mobility services: DalMaaS in Skattungbyn, FjällMaaS in Södra Årefjällen, Hämta in Torhamn, KomILand in Lundsbrunn, Timmersdala, and Broddetorp, and Mobilsamåkning in Broddetorp. Four of these pilots integrate planning, booking, and payment functionalities across public transport and new types of shared mobility services (i.e., level two MaaS products according to the MaaS taxonomy in [23]), while one only introduces a new shared mobility service. Based on 27 semi-structured interviews with the involved actors, the analysis explores organizational elements of the pilots, such as the involved actors' objectives and motives and the division of roles and responsibilities. It, moreover, reports the involved actors' views on what an ideal setup for a rural MaaS operation would be, given their experiences from the pilots.

In the following, the background to the research is first outlined, including the central problem (transport poverty in rural areas), the proposed solution (MaaS), and the addressed knowledge gaps. Thereafter, the Methods section motivates and depicts the case studies as well as the data collection and analysis processes. Next, the results from the analysis are described and discussed, and finally, the article ends by proposing policy implications and avenues for further research on rural MaaS.

2. Background

2.1. The Problem: Transport Poverty in Rural Areas

Transport poverty is a broad, overarching notion that encompasses mobility poverty (lack of transport options), accessibility poverty (difficulty of reaching certain key activities), transport affordability (lack of resources to afford available transport options), and exposure to negative transport externalities [24] (other terminologies that are used to describe transport poverty problems include transport disadvantage (e.g., [25]) and transport-related social exclusion (e.g., [26])). Hence, an individual can be said to be transport poor if at least one of the following conditions apply [ibid.]:

- There is no transport option available suited to the individual's physical condition and capabilities
- The available options do not reach destinations where the individual can fulfil daily activity needs
- The money spent on transport leaves the household with a residual income below the poverty line
- The individual needs to spend an excessive amount of time travelling to fulfil daily activity needs.
- The travel conditions are dangerous, unsafe, or unhealthy for the individual

Rural populations are, on average, older and poorer than their urban counterparts (e.g., [27]) and therefore in greater need of affordable and accessible transport options. People in rural areas, moreover, usually must travel more than urban dwellers since the

distances to schools, jobs, shops, and other social services are typically longer outside cities. Still, the low population densities and long distances in rural areas make it costly to provide public transport. Thus, rural populations are oftentimes more dependent on car travel. For instance, according to the most recent national travel behavior survey in Sweden, people in small towns and rural municipalities use cars for about 76% of their daily traveled kilometers, while the corresponding number for people in large cities and in municipalities near large cities is 48% [28].

One consequence of the high car dependency within rural transport systems is that many are forced into car ownership [29]. In other words, many rural dwellers own and use cars even though they would rather not. However, since cars are expensive and require physical and cognitive abilities, this option is not available for all, especially not for children, the elderly, and people with disabilities. Thus, although the share of the population that is exposed to car deprivation in rural areas is lower than in cities [30], the perceived consequences for those who cannot get access to or drive cars are more severe; transport poverty is more likely to be a source of social exclusion on the countryside [1].

2.2. The Proposed Solution: Mobility as a Service

A recent literature review identified three reoccurring types of proposed solutions within the scholarly body of literature on rural public transport improvements [31]: demand responsive forms of public transport (e.g., [32]) (also known as demand responsive transit, DRT, (e.g., [33]) and on-demand public transport (e.g., [34])); different forms of shared mobility, such as car- and ridesharing (e.g., [35]); and solutions for virtual travel, such as video call platforms (e.g., [36]) (i.e., services that provide people access to functions without physical travel). These types of proposed services are supposed to complement and extend the existing public transport offering. To do that, it should preferably be as seamless as possible for users to switch in-between them and between them and public transport. This is where the idea of MaaS comes into play: "The vision is to see the whole transport sector as a cooperative, interconnected ecosystem, providing services reflecting the needs of customers and seamlessly combining different transport means, such as private vehicles, public and collective transport (bus, metro, light rail, car sharing), biking and walking" [37] (p. 3). In practice, this means offering a new digital service layer, which provides users with a single point of access for finding, booking, and paying for mobility services [11]. Depending on how MaaS is conceptualized, the concept can, moreover, include that the mobility services are coordinated in time and space (e.g., [38]).

Although MaaS arguably still mostly exist in power point presentations and strategy documents, a few services are available to the public, especially in European cities. These include Jelbi in Berlin (jelbi.de), Whim in Helsinki, and Yumuv in Zürich, Basel, and Bern. However, pilot projects excluded, there are few examples of MaaS services that address the travel needs of rural dwellers.

2.3. Knowledge Gaps

Despite the material referenced in previous sections, transport poverty in rural areas is arguably an issue that has received limited attention from the research community [30,39]. Similarly, relatively little is known about the effectiveness of introducing new types of shared mobility such as car-sharing, ridesharing, and bicycle pools in rural areas [29]. Thus, there is scope for research into how shared mobility can complement public transport and mitigate transport poverty problems in rural areas.

Still, although touching upon this topic, this article primarily addresses knowledge gaps within the literature on MaaS (see [40,41] for overviews). Little is known about the effects of MaaS [16] as well as of the implications of different ways of governing MaaS [11]. In general, "there is very limited evidence to either support or contradict the many hopes projected onto MaaS" [42] (p. 23). This uncertainty has been found to stall MaaS developments [43]. A better understanding of the organizational aspects of MaaS, such as how to setup business models, distribute responsibilities, and interact with citizens,

seems to be needed to advance the concept [44]. Since MaaS primarily has been discussed and trialed in urban areas thus far, this is especially true with regards to rural MaaS [14,45].

Hence, to pave the way for rural MaaS developments and to improve the understanding of how MaaS can be used to create mutually reinforcing relationships between public transport and other forms of shared mobility in rural areas—and thereby to address transport poverty problems—this article sets out to explore the organizational elements of five rural MaaS pilots in Sweden.

3. Materials and Methods

3.1. Case Studies

The analysis reported in this article covers pilots of shared mobility and MaaS in rural areas of Sweden. Sweden was judged to be a suitable context for the study since there is a large variety of rural areas in Sweden, ranging from very remote rural regions in northern Sweden to rural regions that either attract a lot of tourism and/or have several cities within short commuting distances. Sweden has, moreover, arguably acted as a frontrunner in the MaaS space. Consequently, there are several MaaS pilots from distinct types of rural geographies to choose between.

The five pilots that were analyzed (see Table 1) were purposefully selected to achieve maximum variance in terms of organization and context as well as symmetry in terms of outcome. In other words, rather than selecting the seemingly best-practice cases, pilots that either exhibited contrasting ways of organizing MaaS and/or were set in contrasting rural areas were picked for the study. According to [46], this is an appropriate strategy for exploring the significance of various circumstances for case processes and outcomes.

Table 1. Analyzed rural MaaS pilots in Sweden.

Pilot	Location	Period	Modes	App Integration
DalMaaS	Skattungbyn	November 2018 –ongoing	Ridesharing (private car and special transport)	Search and book functionality integrated in app
FjällMaaS	Södra Årefjällen	February 2020 –ongoing	Commercial bus service, home delivery, ridesharing and public transport	Search, book, and payment functionality integrated in app, except for public transport, which is deep linked (i.e., a hyperlink that links to a specific piece of content on a website or app)
Hämta	Torhamn	March 2018 –April 2018	Ridesharing and public transport	Search and book functionality in web app and deep link to public transport
KomILand	Broddetorp, Timmersdala & Lundsbrunn	October 2020 –ongoing	Public transport, two types of car sharing, bicycle sharing, tool sharing and taxi	Search, book, and payment functionality integrated in app, except for taxi and car sharing, which are deep linked
Mobil- samåkning	Broddetorp	September 2013 –September 2018	Ridesharing	Search, book, and payment functionality in web app, which also visualized public transport schedules

DalMaaS—In 2018, a local civic organization in Skattungbyn, a rural community with about 300 residents in Dalarna, initiated a ridesharing service together with an external technology provider. Initially, this service focused on sharing private car rides, but assisted by the regional PTA and the external technology provider, it grew to include possibilities to share special transport rides offered as part of the public transport portfolio. The first function was introduced in November 2018 and the latter in June 2019. Both could be found and booked in a joint smartphone app, However, the special transport sharing service was never properly launched due to internal problem at the PTA. A joint relaunch of the services has since been planned but delayed. As of August 2021, the plan is to relaunch the app when the COVID-19 pandemic is over. According to the technology provider, 34 people registered for using the ride sharing services, but the services were used to a very limited extent prior to being paused.

FjällMaaS (this name is introduced for the purpose of this paper)—In early 2020, the association for local businesses in Södra Årefjällen, a sparsely populated tourism area in the Jämtland region, applied and received funding from the EU Rural Development Program through the Swedish Board of Agriculture for piloting a MaaS concept meant to assist tourists that arrive by train to the area and to facilitate low carbon person mobility and goods deliveries for locals [47]. In July 2020, an on-demand, commercial bus service was launched. It primarily transports tourists between the train station and the mountain lodges in Södra Årefjällen, but others are welcome to use it too. The service has been used quite a bit during holiday seasons—approximately 1′200 journeys were, for instance, made between July and September 2020 [48] with lower numbers during off-season. To accommodate for this fluctuation in ridership, the standard buses that were originally used have been replaced by minivans. Ridesharing through an app was also introduced in February 2020. A total of 125 people registered for the service, but it was soon paused, and thus sparsely used, due to the COVID-19 pandemic. A service for home delivery from restaurants and supermarkets was instead introduced in April 2020. As of August 2021, about 50 deliveries had been made according to the technology provider. All services are bookable via a smartphone app, which also presents regional public transport trips and provides a link to the regional PTA's website.

Hämta—In the spring of 2018, the regional PTA in Blekinge developed and tested a prototype of a ridesharing service for two months in the rural community Torhamn, which has approximately 600 inhabitants. The service was mediated through a custom web app that enabled users to register, search, and book shared rides. The app, moreover, included a link to the public transport app. Payment functionality was, however, not included. The aim of the test was to explore if an app can assist ridesharing and if ridesharing can complement rural public transport and thereby increase accessibility in rural areas. During the pilot, 61 people downloaded the app and 147 ridesharing trips were registered. However, only a few of these resulted in actual ridesharing trips [20].

KomILand—The KomILand concept centers around a regional platform that is meant to enable rural dwellers to put together mobility service offerings that are tailored to the needs of their communities. Following an initial, researcher led pre-study (see [49]), the ongoing pilot set out to develop and validate a functional prototype. This protype is currently piloted in three rural communities in Västra Götaland: Broddetorp, Timmersdala, and Lundsbrunn. In addition to public transport, it includes two types of car sharing services, bicycle sharing, a service for sharing of other tools (such as trailers), and taxi. Additionally, a ridesharing service has been prepared for but was never introduced due to the COVID-19 pandemic. These services can be booked and paid for through a smartphone app, except for the taxi and car sharing. Additionally, the pilot includes so called mobility coaches, which offer advice to the civic organizations that act as ambassadors for KomILand. Overall, none of the included mobility services has attracted any significant level of use from the potential test users. As of the end of June 2021, 95 persons were registered for use and 34 individual bookings and purchases had been made through the smartphone app, according to the technology provider.

Mobilsamåkning—A local civic organization in Broddetorp, a rural community in Västra Götaland, which has around 200 inhabitants, introduced a ridesharing service in 2013. The ridesharing was mediated via an externally developed web app through which users could register, search, book, and pay for shared rides. The public transport timetable was, moreover, presented as a travel option. The service, which was initially co-funded by the municipality and the regional PTA, was available for five years, but was discontinued in 2018 when the technology provider no longer was able to maintain the web app. Broddetorp has since become a demonstration site within the KomILand pilot. During the first year of the Mobilsamåkning pilot, 28 persons used the service frequently, according to the technology provider. With time, users dropped off and the ridesharing activity stalled. In total, there were approximately 80 registered users in Broddetorp.

3.2. Data Collection and Analysis

The principal data collection technique for the reported analysis was semi-structured interviews with stakeholders either involved in and/or affected by the five pilots. A total of 27 interviews were conducted with representatives for local civic organizations, local businesses, technology providers, municipalities, mobility service providers, and regional PTAs, see Appendix A (Table A1) (interviews with test users as well as with involved research institutes have been conducted as well but will be analyzed and reported in another article). The interviews were mostly conducted via online meeting platforms and were, on average, about 45 min long. Two separate interview guides were utilized, one for the FjällMaaS pilot and one for the other pilots. At a general level, both guides focused on understanding: the background to, expectations on, and objectives of the pilots; who has been involved and in what role; why the pilots were setup the way they were; how the interviewees consider that rural MaaS, ideally, should be organized; what challenges the pilots have faced; what insights the pilots have provided; and what the pilots have led to, directly and indirectly.

Nineteen of the interviews were recorded and transcribed verbatim while detailed meeting notes were written for the all the other interviews but one, which was conducted via e-mail. A thematic analysis was performed, meaning that the authors closely examined the interview documents to identify common topics, ideas, and patterns of meaning (cf. [50]). To preserve the essence of the pilots, patterns were first identified within each pilot, prior to searching for replications across them (cf. [51]), and the cross-case analysis strived towards learning from their differences as well as from their similarities (cf. [52]). Although the analysis was largely explorative and inductive, the search was guided by four themes that described the pilots (motives, distribution of responsibilities, challenges, and results) and four themes that described rural MaaS in general (prerequisites, activities, roles, and collaboration). The analysis of each pilot was performed by one of the authors, while the cross-study analysis was performed in plenum.

In addition to the interviews, the analysis was also informed by participatory observation. As detailed in the Declaration of Interest section, two of the authors (author one and author three) have been actively involved in the planning, funding, and operation of several of the analyzed pilots. The authors have therefore spent countless hours thinking about and discussing the pilots with the other involved actors. The knowledge derived from this line of work has not been used as primary data for the reported analysis. Still, it has provided a deep understanding of the pilots. This understanding has guided the search when collecting and interpreting the interview data. It has, moreover, benefited the self-assessment of the quality of the research.

4. Results

4.1. Motives and Objectives

All five pilots involved a multitude of actors with different points of departure. This section analyzes how representatives of the most frequently involved actor types define their organizations' motives in relation to the pilots. See Table 2 for a summary.

The interviewed representatives of regional PTAs described various reasons for engaging in rural MaaS developments, such as to investigate rural dwellers' mobility needs and to understand how the rural public transport offering could be developed to meet these needs. Still, across all the cases, their main motive seemed to be to explore new ways to provide accessibility in rural areas in collaboration with other actors. This motive was related to limited and shrinking budgets for rural public transport. For instance, in the Mobilsamåkning case, a budget cut led to the PTA intensifying its search for solutions outside traditional public transport lines and on-demand services. The first step along this line of work was to announce a call through which villages and municipalities could apply for funding for rural mobility initiatives. The Mobilsamåkning pilot was one of the initiatives that was granted funding. Likewise, the PTA involved in DalMaaS stated that their motive was to find new ways to increase accessibility in rural areas.

Table 2. Motives and objectives.

Actor Type	Main Motives and Objectives	Example Quotes
Regional PTAs	Explore new, cost-efficient ways to provide accessibility in rural areas; identify their role(s) in the future rural mobility landscape; use data from MaaS services to gain new insights into rural mobility needs	"I think one can almost take it all the way back to when we were ordered to cut costs substantially...and that's where the thoughts begun: how can one do something more innovative and creative, and think new, and do things in other ways."—Interviewee 25 (I25), translated
Municipalities	Explore new ways to meet the mobility demands from residents and tourists to enable inhabitants to live, work, and visit rural areas	"We want young people to be able to stay in the municipality too. So how can we solve it [mobility] now and in the future, so that this will be an interesting municipality to move to?"—I03, translated
Civic organizations	Improve the accessibility for residents and tourists within their local area	"...People here need to be able to get to work and we knew that some people shared rides, but we needed some systemacy. So, we identified that problem. And then we saw that it relates to questions that many other with similar problems have. And this is when we realized that this is not only a local question for us, but also a question for the municipality and the regional PTA and so on"—I02, translated
Local businesses	Improve the accessibility to and from, and within their local area, especially for customers; make it easier and more attractive to run local businesses	"The problem during the last two years is that it has been impossible to get a taxi, and when you do, they are quite expensive. Last spring break, we did not get any taxis at all, so the staff had to drive the guests [to the train station]"—IP07 (translated)
Technology providers	Improve rural mobility; develop and showcase their services; influence the actions of the PTAs	"In cities, there are so many delivery companies and others [service providers]. So, from a service perspective, there is no need to go in [there] and do things [for us]. So, for service reasons, we choose to start on the countryside"—I01, translated
Commercial mobility service providers	Showcase their services; explore new market segments; influence the actions of the PTAs and municipalities	"We are involved in all those [pilots] because we want to show what we can and should do"—I20, translated
Research institutes	Test their ideas; learn about the effectiveness of innovative solutions for rural mobility	Representatives for the involved research institutes were not interviewed. The findings on their motives are instead based on a combination of statements made by representatives of other types of organizations and observations made during participatory observation of the pilots, see Section 3.2
National authorities	Support rural development; finance research and development	Same as above

Several of the regional PTAs, moreover, reflected on the changing role of PTAs. According to the interviewed representatives, the PTA must adjust to societal trends such as digitalization and the modern sharing economy. This was particularly the case in the Hämta pilot. The development of Hämta was underpinned by a general notion of need for renewal at the PTA, and they judged the biggest need for reinventing themselves was in rural areas, where the public transport offering was perceived as limited. Accordingly, the objective of the Hämta pilot was to test if and how the PTA could offer ridesharing in rural areas. Similarly, in the KomILand pilot, the project leader considered the PTA's motivation to be to acquire new tools to add to their toolbox. Hence, overall, the PTAs seemed to use the pilots to identify their role in the future rural mobility landscape.

This was the case for municipalities too, although their involvement in the pilots, on average, was more limited (see Section 4.2). The municipalities' interest in the pilots was rooted in a concern about the low accessibility in rural areas. For instance, the interviewed representative at the municipality involved in the DalMaaS pilot saw the promotion of rural MaaS as a way to ensure that it would be appealing for current residents to stay and for future residents to move to the area. Similarly, the representative at the municipality in the FjälMaaS case, said that residents as well as tourists increasingly demanded innovative, smart, and climate friendly travel options, which led them to look beyond private car and/or bus-based mobility solutions. Additionally, in some cases, such as the KomILand pilot, the municipalities used the pilot as a vehicle to influence the strategies and actions of the PTAs.

Similarly, several commercial mobility service providers, technology providers, and civic organizations hoped that the pilots would lead to the PTAs strengthening their commitment in rural areas in one way or another. Still, some of the representatives of civic organizations brought forward the difficulty for them to make their voices heard, and thus to influence the PTAs, as a reason for why they wanted to develop new, more local, mobility solutions. They saw no other option. In synchrony with the local businesses, they spoke passionately about the importance of making it easier to live in, work in, and visit their local areas, even if one does not own a car. The commercial mobility service providers and technology providers shared this goal and argued that their services were part of the solution. Thus, they used the pilots to develop, showcase, and prove the value of their services, generally with the goal of convincing either PTAs and/or municipalities to pay for their services after the pilots. Comparably, the research institutes that were involved used the pilots to test their ideas empirically and to gain insights about the effectiveness of innovative solutions for rural mobility, which they then could publish in academic reports, such as this article.

In summary, all actors shared the goal of findings new, collaborative methods to improve the accessibility in rural areas and believed, collectively, that real-world pilots were needed to explore such methods. This goal seemed to be related to a belief that new tools empowered by digital technologies can contribute to renew and/or complement traditional public transport in rural areas. Additionally, several involved actors used the pilots as an arena to voice their agendas, develop their products, and showcase their services.

4.2. Roles and Responsibilities

The five analyzed pilots did not share a common way of distributing roles and responsibilities. Rather, they all represented different ways of organizing rural MaaS pilots. In this chapter, we discuss the roles that the different actor types have had in the pilots. See Table 3 for a summary.

Table 3. Division of roles in the pilots.

Actor Type	DalMaaS	FjällMaaS	Hämta	KomILand	Mobilsamåkning
Regional PTAs	Mobility service provider	Not involved	Initiator; financer; mobility service provider; project leader	Initiator; financer; mobility service provider	Financer
Municipalities	Contact point between the PTA and the involved civic organization; financer	Not involved	Contact point between the PTA and the involved civic organization	Project leader; concept developer	Financer
Civic organizations	Initiator; co-concept developer; participant recruiter	Not involved	Participant recruiter	Participant recruiter; test usage	Initiator; concept development
Local residents/ general public	Test usage; sharing private resources (ridesharing)	Test usage; sharing private resources (ridesharing)	Test usage; sharing private resources (ridesharing)	Test usage; sharing private resources (ridesharing)	Sharing private resources (ridesharing)
Local businesses & interest groups	Not involved	Initiator; financer; concept developer	Not involved	Not involved	Not involved
Technology providers	Concept developer; contracted supplier	Concept developer; contracted supplier	Concept developer; contracted supplier	Concept developer; contracted supplier	Concept developer; contracted supplier
Mobility service providers	Not involved	Contracted supplier	Not involved	Contracted suppliers	Not involved
Research institutes	Adviser; researcher	Adviser; researcher	Not involved	Initiator; concept developer; researcher	Not involved
National authorities	Financer (later stage)	Financer	Not involved	Financer	Not involved

The regional PTAs have played a role in four of the five pilots; despite being positive towards the FjällMaaS pilot, the PTA has not been directly involved in it. When involved, the role of the PTAs has ranged from merely financing the pilot, such as in the Mobilsamåkning case, to initiating and leading the project, such in the Hämta case. In the DalMaaS case, the initial initiative was taken by the local village association, while the PTA

joined first when the pilot was absorbed by a larger R&D project. In the KomILand case, the role of the PTA has evolved during the pilot project. Initially, the PTA's plan was to co-finance the pilot and to make the public transport offering available for the technology provider, but with time the PTA has doubled down on their commitment by financing a continuation of the pilot and by increasingly acting as an advocate for the concept.

Several representatives of involved technology providers, but also some of the representatives of the PTAs reflected on challenges related to the PTAs' role. These interviewees noted that the PTAs, generally, lack a culture of innovation as well as a tradition of collaborating with other actors on somewhat equal terms. A few interviewees, moreover, described variations in attitudes within the PTAs' organizations; some of the decisionmakers and officials are, according to these interviewees, less inclined to challenge the PTAs' established working models, whereas others consider it to be necessary to meet people's expectations and to leverage societal trends such as the ongoing digitalization and the anticipated rise of the modern sharing economy.

None of the studied rural MaaS pilots were initiated by municipalities. Still, municipalities have in different capacities been actively involved in all of them except for in the FjällMaaS pilot. In most cases, this involvement has been fairly limited compared to other actors, except for the KomILand pilot, where a municipal cooperation organization has acted as project leader and contributed considerably to developing and advocating for the piloted concept. In their roles, the municipalities have financed bottom-up initiatives by providing funding for local, civic organizations (DalMaaS, FjällMaaS, and Mobilsamåkning), although this funding has in most cases not been ear-marked specifically for mobility services. Municipalities have, moreover, promoted the piloted services to the locals and were by many interviewees described as a crucial link between the village associations and the PTAs.

The role of local civic organizations and residents varied across the cases as well. In Hämta, the role of locals was in the development phase limited to providing feedback to the ridesharing app, while the implementation phase was dependent on residents registering car rides to be shared with others. In Mobilsamåkning and DalMaaS, the role of local civic organizations was much more central; these pilots were initiated by village associations, which procured a service they needed and further developed it together with technology providers. In these cases, the residents also had a key role as active ridesharing between residents was an important part of the solutions. The FjällMaaS pilot was initiated and co-financed by a local organization, but in contrast to the other cases, this organization represents local businesses rather than residents.

In KomILand, locals were invited to meetings to discuss their needs, but in comparison to Mobilsamåkning, DalMaaS, and FjällMaaS, where local organizations initiated the pilots and have had a customer relation to the technology providers, the local organizations in KomILand have merely acted as facilitators and ambassadors for the pilot. In terms of involvement of locals, this puts KomILand somewhere in-between Hämta (where residents were only involved as test users late in the process) and Mobilsamåkning and DalMaaS, where residents within the local village associations initiated the pilot and procured the technology provider's services.

Two separate, but equally small, technology providers played a key role in Mobilsamåkning, DalMaaS, and FjällMaaS by developing the concepts, and the provided technologies, in collaboration with the local organizations that procured their services. This collaboration was considered necessary and advantageous by the technology providers, but also challenging as the processes became time consuming and resource intensive. In the Hämta case, the technology provider was contracted by the PTA and had more limited contact with the test users throughout the process.

The commercial providers of mobility services have participated to a very limited extent in the pilots. The only pilots that featured commercial mobility service providers separate to the technology providers (that in many of the cases have provided the technical platform and a ridesharing service) were FjällMaaS and KomILand. In the FjällMaaS pilot,

a bus operator was initially hired to operate the commercial bus service but was later replaced by a taxi company. Similarly, a car sharing service was hired to operate a minivan sharing service in the KomILand pilot. Additionally, the KomILand pilot encompassed taxis and a peer-to-peer car sharing service, but neither the taxi booking company, nor the provider of the peer-to-peer car sharing service participated actively in the pilot.

In contrast, both research institutes and national authorities have played active, yet little discussed, roles in the pilots. While national authorities mainly have used a hands-off funding approach to support rural mobility development and research, several research institutes have been involved hands-on in the pilots through activities such as co-developing, branding, advocating for, and anchoring the demonstrated concepts, writing funding applications, recruiting participants (organizations as well as test users), evaluating data, and disseminating results. As such, research institutes have rather acted as proponents of the demonstrated services and as brokers of ideas, needs, and opportunities than as distant and neutral observers.

In summary, although all the pilots focused on the needs of locals and were dependent on their active participation, the division of roles and responsibilities diverged in terms of who has been involved in the initiation, concept development, roll-out, operation, and evaluation of the piloted services. PTAs, research institutes, and technology providers have, generally, had central roles, while municipalities and commercial mobility service providers have been less involved. National authorities have provided much of the funding but have otherwise played limited roles in the pilots. The involvement and action space of locals, local businesses, and local civic organizations have varied across the pilots.

4.3. Future Roles and Activities

There were different opinions among the interviewees on how mobility services must develop to meet the needs of rural dwellers. Accordingly, their views diverged on what roles different actors should take in the future rural mobility landscape as well as on what actions needed to be taken to get to the envisioned state.

A frequent reasoning was that the PTAs should provide open, regional MaaS platforms and offer access to traditional public transport lines and on-demand services. Yet, not everyone agreed that this would be enough to create a vibrant rural mobility landscape that improves accessibility. The technology providers saw themselves as vital components in the future ecosystem. Still, a neutral and national platform that provides equal terms for all mobility service providers was suggested as a better alternative by some. The commercial ground for shared mobility services in rural areas was questioned by many, including by representatives of the PTAs. A common view, especially among the representatives of municipalities, was therefore that mobility services should be treated as part of the public transport offering in rural areas. In other words, these interviewees thought that PTAs should provide mobility services that can complement traditional public transport lines and on-demand services. To justify this argument, the interviewees typically referred to the principle of equal treatment and held that the PTA should offer a decent level of accessibility to residents no matter where they live. Since these interviewees did not think that was the case, it follows that PTAs must improve their services where the public transport offering is limited, such as in rural areas. The solutions to improve accessibility in rural areas, most frequently brought up by the interviewees, were to enhance the on-demand offering and to complement traditional public traffic with new types of mobility services. Still, some of the involved actors questioned whether one can expect a high service level in all types of areas. After all, it is much more cost-efficient to provide accessibility within and around cities, they argued.

The interviewees also disagreed about whether PTAs were fit to lead the design and diffusion of local mobility services. For example, one interviewee saw shared mobility services, such as ridesharing, and public transport as two separate systems that can coexist but should not be mixed: one local and social and one regional and public. Furthermore, these interviewees feared that if the PTA take lead, this will imply that the power and action

space is taken away from the residents and, moreover, that such a top-down perspective will lead to the mobility services becoming poorly adjusted for local conditions.

The opposing point of view, offered by a municipality representative, was that the PTA mission is to provide accessibility, not public transport per se. Hence, they should offer mobility services, or other solutions, whenever these provide more accessibility per tax coin than traditional public transport.

Regardless of the PTAs' role, there was a strong agreement among the interviewees that involvement of residents in the development and operation is key; an actionable and influential local civic organization was seen as a prerequisite for the adoption and diffusion of new types of mobility services, especially of those that require a certain level of penetration to function well, such as ridesharing. Accordingly, the civic organizations saw themselves as the ambassadors of rural MaaS towards the residents as well as the actor that can make sure that the services meet the residents' needs. Hence, it was argued that local civic organizations should be involved to a high degree already in the design phase. Comparably, the commercial mobility service providers argued that they possess the most knowledge about mobility services, and therefore should be involved at an early stage as well. This would enable them to take part in the design of the service rather than only providing the requested services, which in turn would lead to better services, they argued.

Several interviewees emphasized the important role of municipalities in rural MaaS, especially as a mediating link between the regional PTAs and the people at the grassroots level; municipalities have, according to these interviewees, better knowledge of the preconditions and needs in villages compared to the PTAs, and closer connections with the PTAs (that they jointly fund) compared to local civic organizations. The municipalities also saw themselves as a good link between the PTAs and local organizations and residents. One of the interviewed platform providers argued that municipalities should consider mobility services as basic services in the same manner they consider internet connection as a basic precondition to rural living. In this capacity, it was argued that municipalities can be both facilitators and driving forces for rural MaaS.

In terms of the highest priority actions to pave the way for rural MaaS, the interviewees mentioned updating the definition of public transport to encompass more modes of transport, including mobility services in the regional transport strategy, and to halt the direct and indirect subsidization of parking and private car use to instead stimulate mobility services by acting as first customers. The interviewees furthermore pinpointed continued exploration, testing, and collaboration as a must. At this point, none of them had a clear picture of how rural MaaS should be organized and how it could be financed.

In summary, the interviewees believed that rural MaaS can complement public transport and supposed that its introduction would mitigate transport poverty in rural areas, at least to some degree. While some argued for local solutions, others made the case for either developing on-demand services instead or integrating mobility services and MaaS with the regional public transport offering. Although the interviewees did not have a clear picture on how to distribute roles and responsibilities within rural MaaS to make the concept viable, a majority identified PTAs, municipalities, and local civic organizations to all have key roles in its development and operation. Going forward, adjustments to the basic structures of mobility are needed as well as continued exploration, testing, and collaboration, according to the actors involved in the five analyzed rural MaaS pilots.

5. Discussion and Conclusions

The expressed motives of the actors involved in the five analyzed rural MaaS pilots (see Section 4.1) partly overlap with and partly diverge from the commonly stated objectives of MaaS developments in urban geographies. Both rural and urban MaaS are framed as solutions that aim to complement public transport and to reduce the perceived need of owning and using private cars. However, while this motive is grounded in problems such as road congestion, poor air quality, unhealthy travel choices, and greenhouse gas emissions when discussed for urban context (e.g., [53,54]), the analyzed pilots were primarily

motivated by the need to better provide accessibility to rural dwellers, especially to people that either have limited or no access to private cars or people that want to reduce their private car dependency for other reasons. To put it simply, the interviewees' focus was less on environmental sustainability and more on transport poverty (i.e., social sustainability). This finding provides empirical backing to earlier notions on the differences between the objectives of urban and rural MaaS (e.g., [14,22,55]).

In terms of matches and mismatches between the involved actors' motives and the actual outcomes of the pilots, one of the most notable findings is arguably that the use of the trialed services has been limited across all the studied cases (see Section 3.1). According to the interviewees, this is largely due to aspects related to the design and timing of the pilots, such as the COVID-19 pandemic in the case of KomILand, FjällMaaS, and DalMaaS (travel activities have been greatly affected by the outbreak of the COVID-19 virus, including reduced use of public transport (e.g., [56]) and shared mobility services (e.g., [57]), and the short trial periods (especially in the Hämta pilot) but also due to general challenges associated with rural MaaS, such as attracting a critical mass of users from the start and to keep users engaged over time. In rural areas, the potential base of users is small, which makes services that require a critical mass to function well, such as ridesharing, vulnerable to external disturbances like changes in peoples' everyday life, the interviewees argued. This vulnerability was also, in some cases, linked to a high share of elderly residents who were less technology savvy. Other reasons for the limited activity in the pilots, proposed by the interviewees, included travel habits that are difficult to break, insufficient incentives to use the mobility services, limitations to the trialed systems and apps and therefore large entrance barriers for users, and an uncertainty about roles and a lack of culture of innovation within the involved organizations that led to low value service offerings being trialed in the pilots. Hence, the actors involved in the studied pilots seem to have faced similar barriers as their urban counterparts (cf. [11,16,18]).

Still, as discussed in the Introduction section, rural areas are characterized by long distances between neighbors as well as between peoples' homes and destinations such as shops, workplaces, schools, and medical facilities. Rural public transport has, moreover, decreased in many places over the last decades due to a combination of factors including urbanization and austerity measures [58]. Consequently, the levels of private car ownership, car travelling, and car dependency are typically higher in rural areas compared to the urban context. Since car ownership and habitual car use are two of the greatest barriers to MaaS adoption [59], it follows that rural MaaS faces even greater challenges than urban MaaS. Hence, even though the analyzed pilots neither prove nor disprove the potential for rural MaaS, it can be assumed that the introduction of MaaS will not mitigate rural transport problems on its own. To break car dependency and improve accessibility for non-car owners in rural areas, alterations that fundamentally change the context of rural traveling will be needed as well. As argued within the literature on sustainability transitions (e.g., [60]), and recently exemplified by the COVID-19 pandemic, fundamental transformations of practices within socio-technical systems (such as personal transport) are more often than not caused by a combination of mutually reinforcing global events (such as the spread of the virus), change processes at system level (such as the travel restrictions and working from home policies that were imposed in the wake of the virus), and break-throughs of promising technology alternatives (such as telecommuting services).

As none of the studied pilots have been successful in attracting a critical mass of users for a longer period (yet), it is not possible to identify causal links between their organizational forms and the outcomes. Nevertheless, some differences can be observed between the pilots that were initiated by local actors, such as Mobilsamåkning, DalMaaS, and FjällMaaS, and the pilots that to a larger extent were initiated by municipalities and PTAs, such as Hämta and KomILand. Keeping in mind that many factors influenced the outcome of the pilots and that the number of cases is small, it can be observed that the locally initiated services, on average, have been ongoing for longer time periods and have been more successful in attracting users. This can be reflected on in the light of that the

interviewees, more or less unanimously, stressed that rural MaaS must build on local needs and that local residents therefore should be involved in the design of the services. In particular, representatives of technology providers and local organizations emphasized a need for so called place-based solutions, instead of one-size-fits-all solutions developed at a municipal, regional, or national level. All in all, anchoring with and involving locals seem to be essential components for rural MaaS developments no matter who the initiator is, in particular to make sure that the services address real user needs and to put the services in position to attract sustained usage.

On the topic of user involvement, the analysis illustrates a clear difference between how the role of users is constructed in rural MaaS compared to in urban MaaS. Active locals who are willing to actively contribute to solving their mobility challenges are required in all the studied rural MaaS cases, and many interviewees emphasized that active locals are a prerequisite for rural MaaS since the concept largely builds on peer-to-peer sharing of private resources. This can be contrast with urban MaaS solutions, which typically are based on a combination of public and commercial mobility services. Whether rural dwellers are more willing and able than urbanites to actively participate in MaaS operations and to share private resources remain, however, unanswered questions [61]. This leads to the question of whether it is fair to have different expectations on people, depending on where they live.

Many of the trialed concepts were, moreover, dependent on capable and influential local organizations in the roles of ambassadors and facilitators. Still, few of the interviewed representatives of municipalities and PTAs reflected on the risk of contributing to increased spatial injustice between different types of rural areas if exclusively supporting communities with strong local civic organizations. Within rural studies, several researchers have pinpointed risks connected to this kind of approach. Since the most marginalized areas often lack the needed capacity to engage in innovation processes, innovation strategies building on local social capital may increase spatial inequalities as villages without social capital might be left behind by areas with higher capacity to act [62,63]. Hence, although spatial inequalities between urban and rural areas was a prime motive for many of the studied rural MaaS pilots, there seems to have been a lack of awareness of, or attention to, the risks of increased spatial inequalities between different kinds of rural areas among the interviewees. Measures may need to be taken to ensure equal opportunities across rural communities when developing and disseminating rural MaaS. Future research should, for example, explore how rural MaaS solutions can be co-created with residents in rural communities with less social capital.

In terms of differences between the division of roles in the pilots (see Section 4.2) and the views on how future developments should be organized (see Section 4.3) it is interesting to note that PTAs were pinpointed as the natural leaders of rural MaaS services by most interviewees but were not sure of their own roles in rural MaaS. This might be linked to the discrepancy between what the MaaS concept entails and the common understanding of what public transport is, and is not, and what a PTA does, and does not (cf. [11,64]). It is, moreover, notable that municipalities were considered as a central actor for enabling rural MaaS but have only been involved to a relatively small degree in the studied pilots. As proposed by the project leader of the KomILand pilot, this might be related to municipalities in Sweden having a limited role in, and thus capacity to provide, mobility services in general, especially in rural contexts. Overall, it was evident that the level of uncertainty around rural MaaS is high, and that actors are still searching for their roles in its development, diffusion, and operation (cf. [11,43]).

Finally, one can note that four of the five pilots implied a high level of dependency on small technology providers, and that the KomILand pilot was reliant on quite uncommitted commercial mobility service providers. These dependencies seem to have contributed to frequent delays in some cases as well as to a gulf between expectation and outcome with regards to the quality of the piloted services; a gulf that also has been present in many of the urban MaaS pilots to date. Despite utopian visions, such as "the single most powerful

tool to decarbonize transport for future generations" [65], MaaS is a nascent concept and most examples of MaaS are thus far merely early prototypes.

The research reported in this paper provides novel insights on how rural MaaS has been, and can be, organized. It, moreover, highlights several avenues for further investigation. More research is needed into how rural MaaS services are adopted and used, and how this affects rural dwellers and communities. The limited activity in the five analyzed pilots indicate that more research is needed into how one can motivate potential users to adopt and use rural MaaS solutions. Future studies on rural MaaS users should, moreover, investigate who benefits from rural MaaS developments, and who does not. For instance, the reported analysis identified a risk that rural MaaS solutions might increase spatial injustice between rural communities. This risk should be further analyzed. Additionally, future studies should investigate rural MaaS solutions' potential to either alleviate or worsen transport injustice along other dimensions, such as age, gender, socioeconomic status, or ethnicity. Finally, the reported research only observed a small number of relatively short and small-scale rural MaaS pilots in Sweden. Comparative case studies—preferably encompassing larger and more long-term MaaS operations in dissimilar rural contexts—are needed to assess the transferability of the reported findings and conclusions.

Appendix A

Table A1. Interviews.

Interviewee	Pilot	Type	Date	Method	Length	Documentation
I01	DalMaaS	Technology provider	20-05-15	Online	53 min	Recorded & transcribed
I02	DalMaaS	Civic organization	20-05-15	Phone	65 min	Recorded & transcribed
I03	DalMaaS	Municipality	20-12-15	Online	47 min	Recorded & transcribed
I04	DalMaaS	Regional PTA	20-10-08	Online	40 min	Recorded & transcribed
I05	FjällMaaS	Mobility provider	20-10-13	Online	~45 min	Meeting notes
I06	FjällMaaS	Local business	20-10-14	Online	~90 min	Meeting notes
I07	FjällMaaS	Local business	20-10-15	Online	~45 min	Meeting notes
I08 & I09	FjällMaaS	Local business	20-10-28	Online	~45 min	Meeting notes
I10	FjällMaaS	Local business	20-10-30	Email	-	-

Table A1. *Cont.*

Interviewee	Pilot	Type	Date	Method	Length	Documentation
I01	FjällMaaS	Technology provider	20-11-11	Online	~75 min	Meeting notes
I11	FjällMaaS	Municipality	20-11-27	Online	~60 min	Meeting notes
I12	FjällMaaS	Regional PTA	20-12-09	Online	~60 min	Meeting notes
I13	Hämta	Regional PTA	18-04-16	In person	73 min	Recorded & transcribed
I13 & I14	Hämta	Regional PTA	19-10-09	Online	40 min	Recorded & transcribed
I15	Hämta	Municipality	20-12-16	Online	57 min	Recorded & transcribed
I16	Hämta	Civic organization	21-01-07	Phone	43 min	Recorded & transcribed
I17	KomILand	Municipality	20-12-21	Online	77 min	Recorded & transcribed
I18	KomILand	Technology provider	20-12-18	Online	78 min	Recorded & transcribed
I19	KomILand	Regional PTA	21-01-22	Online	76 min	Recorded & transcribed
I20	KomILand	Mobility provider	21-02-03	Online	54 min	Recorded & transcribed
I21	KomILand	Mobility provider	21-02-03	Online	52 min	Recorded & transcribed
I22	KomILand	Mobility provider	21-02-03	Online	40 min	Recorded & transcribed
I23	KomILand & Mobil-samåkning	Civic organization	20-05-18	Phone	59 min	Recorded & transcribed
I24	KomILand & Mobil-samåkning	Municipality	21-01-11	Online	63 min	Recorded & transcribed
I25	KomILand & Mobil-samåkning	Regional PTA	20-05-26	Phone	36 min	Recorded & transcribed
I26	Mobil-samåkning	Technology provider	18-04-16	In person	86 min	Recorded & transcribed
I26	Mobil-samåkning	Technology provider	19-10-18	In person	64 min	Recorded & transcribed

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