Mobility as a Service (MaaS): An Update

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About this Document

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Carol Schweiger, President, Schweiger Consulting

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1 Introduction

Since the concept of Mobility as a Service (MaaS) was defined in 2014 by Sonja Heikkilä[1], many transportation agencies around the world have explored the potential of MaaS with a wide variety of results. Public transportation agencies and regional and local governments have been deploying technologies and creating the partnerships with mobility service providers (MSPs) that are required, in part, to provide the basis for full-featured MaaS systems. However, not only are many of the pilots and deployments in urban areas, but also have not been successful whether in urban, suburban or rural areas. The reasons for the lack of successful and long-term MaaS implementations include flawed assumptions, limited market appeal, technical and operational challenges, cultural resistance, financial unsustainability, and external factors, failing to deliver on its promises of seamless mobility[2].

This white paper, which is an update of the original N-CATT white paper on MaaS published toward the end of 2020, focuses on the current situation with MaaS and application of MaaS in small urban or rural areas. Further, this paper will provide insights into why rural MaaS has not been as successful as expected and present current promising applications that are attempting to overcome the barriers to success.

This paper will describe MaaS for rural and small urban areas:

- Reviewing the definition of MaaS and related concepts;
- Describing rural MaaS and "Universal MaaS;"[3]
- Providing examples from agencies that are deploying MaaS;
- Describing the benefits and challenges associated with deploying MaaS;
- Describing a MaaS readiness index/tool; and
- Describing a potential MaaS evaluation framework.

2 Definitions of MaaS and Related Terms

The following definitions of MaaS and two related terms are from the SAE Shared and Digital Mobility Committee - SAE JA3163, which is the Taxonomy of Shared Mobility: Ground, Aviation, and Maritime. This Recommended Practice[4] provides a taxonomy and definitions for terms related to local and regional shared mobility (including ground, aviation, and maritime services) and their enabling technologies.

- Mobility as a Service (MaaS): An integrated mobility concept in which travelers can access their transportation modes over a **single digital interface**. MaaS primarily focuses on passenger mobility allowing travelers to **seamlessly plan, book, and pay** for travel on a pay- as-you-go and/or subscription basis.
- Mobility on Demand (MOD): A concept based on the principle that transportation is a **commodity where modes have distinguishable economic values**. MOD enables customers to access mobility, goods, and services on demand. This is different from MaaS in that it is a broader concept. The similarities and differences

between MOD and MaaS are discussed in detail by Susan Shaheen and Adam Cohen at the Transportation Sustainability Research Center of UC Berkeley[5].

- Shared Mobility: The shared use of a travel mode that provides travelers with **access to a transportation mode on an as-needed basis** (including public transit, micromobility, carsharing, etc.).

Another definition that is important to include in the MaaS discussion is Mobility Management, since many people refer to MaaS as a way to provide or facilitate Mobility Management. "Mobility management is an innovative approach for managing and delivering coordinated transportation services to customers. Customers include older adults and people with disabilities. Mobility management focuses on meeting individual customer needs through a wide range of transportation options and service providers. It also focuses on coordinating these services and providers in an effort to achieve a more efficient transportation service delivery system."[6]

From the US Department of Transportation (DOT) perspective, a mobility marketplace such as MaaS should incorporate the following MOD innovation principles[7]:

- **Traveler-centric** – promotes choice in personal mobility driven by the specific needs of the traveler and utilizes universal design principles to capture the needs of all travelers.
- **Mode-agnostic** – encourages multimodal connectivity and system interoperability where all modes of travel are considered and integrated seamlessly to achieve the complete trip vision.
- **Technology-enabled** – leverages emerging and existing technologies, data connectivity, and standardization to support personal mobility choices.
- **Partnership driven** – develop and leverage unique partnerships, both public and private, to accelerate deployment of emerging mobility options.

Further, a MOD Marketplace (Figure 1) such as MaaS is a digital platform where multimodal supply for personal mobility and goods delivery services are integrated into a trusted venue for consumers to plan, reserve, and purchase services that meet their current needs. Consumer demand for these services is matched with supply provided by transportation agencies and operations managers, as well as private mobility and goods delivery providers. A Marketplace is enabled by strong data governance, integrated payment processing, and shared transactional specifications.

Another way to envision supply and demand is shown in Figure 2.

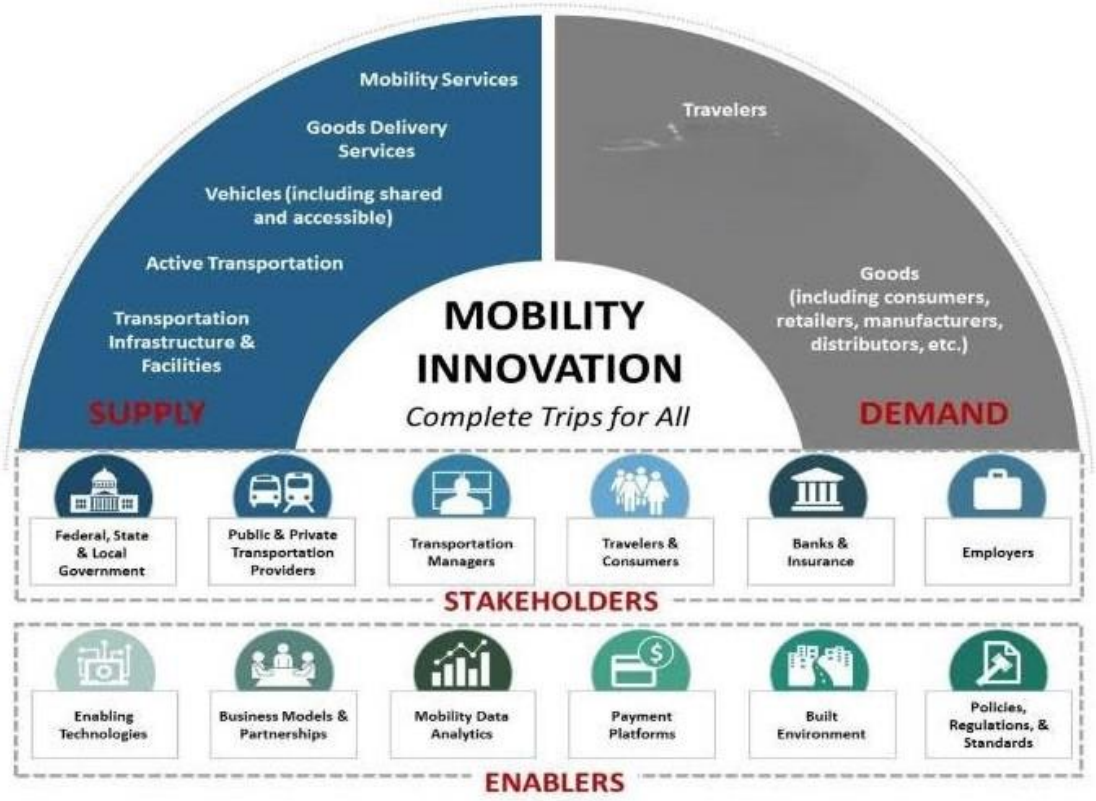

Figure 1. Mobility Marketplace Framework[8]

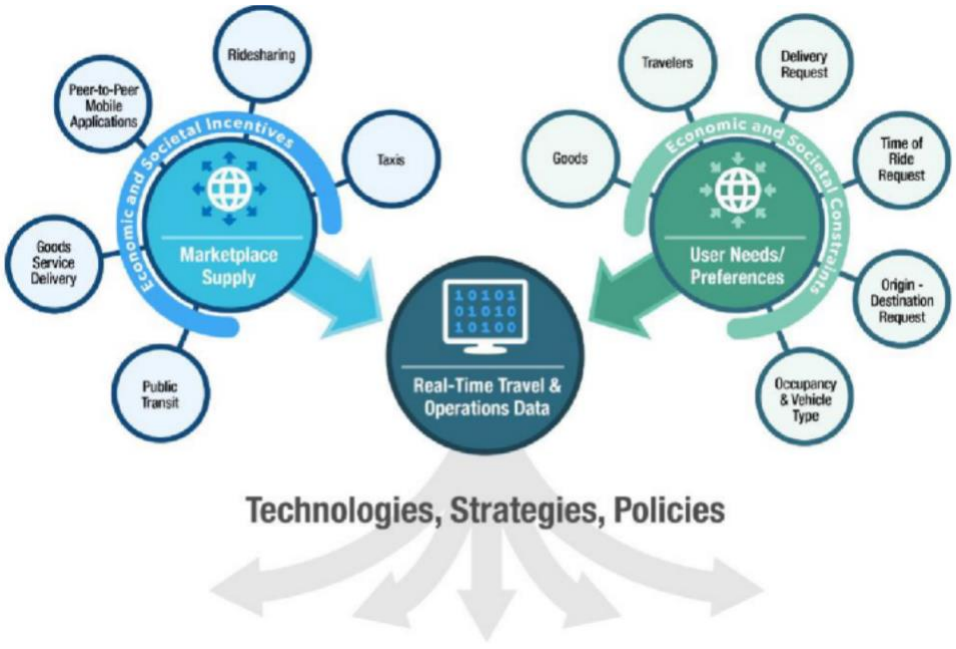

Figure 2. Holistic View and Enablers of Mobility Marketplaces[7]

The MaaS concept can best be described using Figure 3. In the upper left-hand corner, shared assets include shared mobility services such as bikesharing, carsharing and goods movement. In the middle left-hand side of the chart, personalized services that are integral to a MaaS offering include a personalized travel planner, information about all mobility services available to the traveler and a service level agreement (SLA). An SLA "defines the level of service expected from a vendor, laying out metrics by which service is measured, as well as remedies should service levels not be achieved."[9] SLA is usually associated with telecommunications services, but it applies directly to a MaaS offering. In the lower left-hand corner, items that facilitate travel are shown including personal data, traveler incentives for using specific mobility services and/or the MaaS offering, and smart payment, which allows the traveler to pay for the whole trip with either a MaaS "subscription" or one payment for the whole trip.

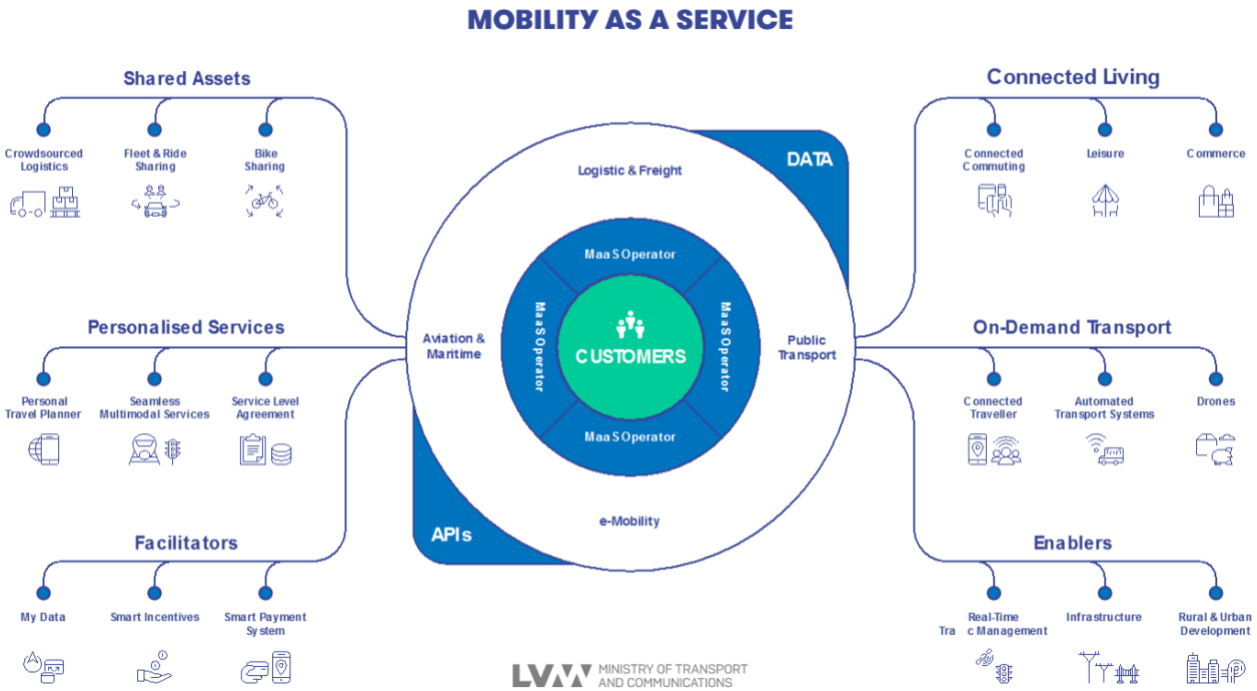

Figure 3. MaaS Concept

One aspect of MaaS that makes it very appealing besides being a one-stop shop, it can provide connections to various aspects of active living, as shown in the upper right-hand corner of the chart – MaaS can facilitate access to education, leisure activities, commerce (e.g., shopping), etc. Further, in the middle right-hand side of the chart, are specific on-demand transportation items such as automated transport and drones, as well as the capability to keep the traveler connected. The lower right-hand corner has the MaaS enablers including real-time traffic management, transportation infrastructure, and rural and urban development.

In the center of the chart is the traveler with the various MaaS providers/operators just outside of the traveler. The outer ring shows the general transportation mode categories offered in MaaS including public transit, goods movement, aviation and maritime, and mobility services

that can be accessed electronically. Two other critical parts of MaaS are the application programming interfaces (APIs) and data that drives MaaS. An API "is a software intermediary that allows two applications to talk to each other. APIs are [a] way to extract and share data within and across organizations. Every time you use a rideshare app, send a mobile payment, or change the thermostat temperature from your phone, you're using an API."[10] MaaS needs data to operate, particularly to allow trip planning, booking and payment as well as to provide the traveler with real-time information about the current status of their trip and the services that make up that trip.

3 Rural and Universal MaaS

3.1 Rural MaaS

Given the difference in the supply of mobility services in rural areas as well as several other factors, MaaS in rural areas will look different than it does in urban or even suburban areas. A study that defined MaaS services in four different geographic regions showed that rural areas "are suffering from a lack of commercial transport services, such as connections to long-haul and scheduled services. Therefore MaaS-enabled first- and last-mile services might provide significant benefits as the current service level could at least be sustained, the utilization rates could be increased and [availability] can be enhanced."[11] Further, demand-response and school transportation services could be accomplished by using shared-ride services such as carpools and vanpools. "Also, embedding other services, e.g., library services and small patch deliveries (medicine and food), as part of the MaaS package has been discussed, i.e. bringing services to customers, not vice versa. Since the demand is hard to predict and the availability of services may be more important than the price, pay-per-use will probably be the most practical way for rural customers."[12]

Another way to define rural MaaS is from Jenny Milne in her work on rural MaaS at the School of Engineering, University of Aberdeen in Aberdeen, Scotland[13]. Rural Mobility as a Service (RMaaS) is a transportation concept tailored to rural areas, integrating passenger and freight transport systems to address the unique challenges of low population density, longer travel distances, and limited infrastructure. Unlike urban MaaS, which focuses on providing a variety of transport choices, RMaaS emphasizes adding value to existing transport modes, such as buses, private cars, and demand-response transport, to improve connectivity and accessibility.

The key features of RMaaS are as follows:

- **Integration of People and Goods:** RMaaS combines passenger transport with freight delivery (e.g., prescriptions, parcels) to create a more sustainable and efficient transport system.
- **Systems Thinking Approach:** RMaaS requires a holistic approach, considering societal readiness, technology, economics, and stakeholder relationships to address rural transport needs.
- **Focus on Value:** Due to limited transport options in rural areas, RMaaS prioritizes

maximizing the utility of existing resources rather than offering extensive choices.

- **Vehicle Miles Traveled (VMT) Goals:** RMaaS aims to reduce vehicle miles traveled (VMT) and reliance on private car ownership.
- **Incentives for Participation:** Visitors and residents may be encouraged to participate in crowdshipping or cargo hitching through rewards like discounts or loyalty points. Crowdshipping is engaging individuals to deliver parcels during their regular journeys, often incentivized by financial rewards or loyalty points. Cargo Hitching is utilizing spare capacity in vehicles (e.g., buses, private cars) to transport goods alongside passengers.

RMaaS represents a shift from traditional rural transport systems by leveraging existing assets and fostering collaboration between stakeholders to improve connectivity and enhance mobility for rural communities.

RMaaS differs from traditional MaaS in several key ways, reflecting the unique challenges and opportunities of rural areas compared to urban environments. First, there is a focus on value vs. choice. Where traditional MaaS primarily focuses on offering users a wide variety of transport options, such as buses, trains, ridesharing, and bikesharing, tailored to individual needs in densely populated areas, RMaaS emphasizes adding value to existing, often limited transport modes (e.g., buses, private cars) rather than providing extensive choices, due to the constraints of rural infrastructure and lower population density. Second, freight and passenger transport can be integrated. Where traditional MaaS typically centers on transporting passengers, with freight and goods delivery rarely integrated into the system, RMaaS actively combines passenger transport with freight delivery (e.g., parcels, prescriptions) to optimize resources and address the high costs of last-mile delivery in rural areas. Finally, there are several other differences in the use of systems thinking, goals to reduce VMT, infrastructure and technology, and incentives for participating in RMaaS.

In summary, RMaaS adapts the principles of MaaS to the rural context by focusing on value, integrating freight, addressing societal readiness, and leveraging existing resources to overcome the challenges of low population density, long distances, and limited infrastructure.

Figure 4 [14] shows various aspects of a rural MaaS offering[15]. These aspects of rural MaaS will be described in more detail in Section 4, which presents a few US rural MaaS deployments.

Figure 5 (adapted from Aki Aapaoja's definition of MaaS service combinations for different geographical areas[16]) compares the objectives of rural MaaS versus MaaS in three other geographic areas. This highlights the unique characteristics of rural MaaS, particularly the potential to combine additional services such as goods delivery with mobility services, and **not** focusing on the reduction of private car ownership of use, which is a prominent goal of most urban MaaS offerings.

Any technology-enabled mobility service such as MaaS should be available to all travelers, but this is particularly true in a rural environment. The Greenlining Institute has identified modal priorities for urban, suburban and rural areas based upon "12 indicators [that] comprehensively

measure various transportation modes across their impacts on mobility and economic opportunity. Comparing the performance of modes in communities lays the groundwork for prioritizing the most [applicable] modes."[17] Examples may include demand-responsive transit and inter-city transit, park and ride lots, and safe bike and walk infrastructure.

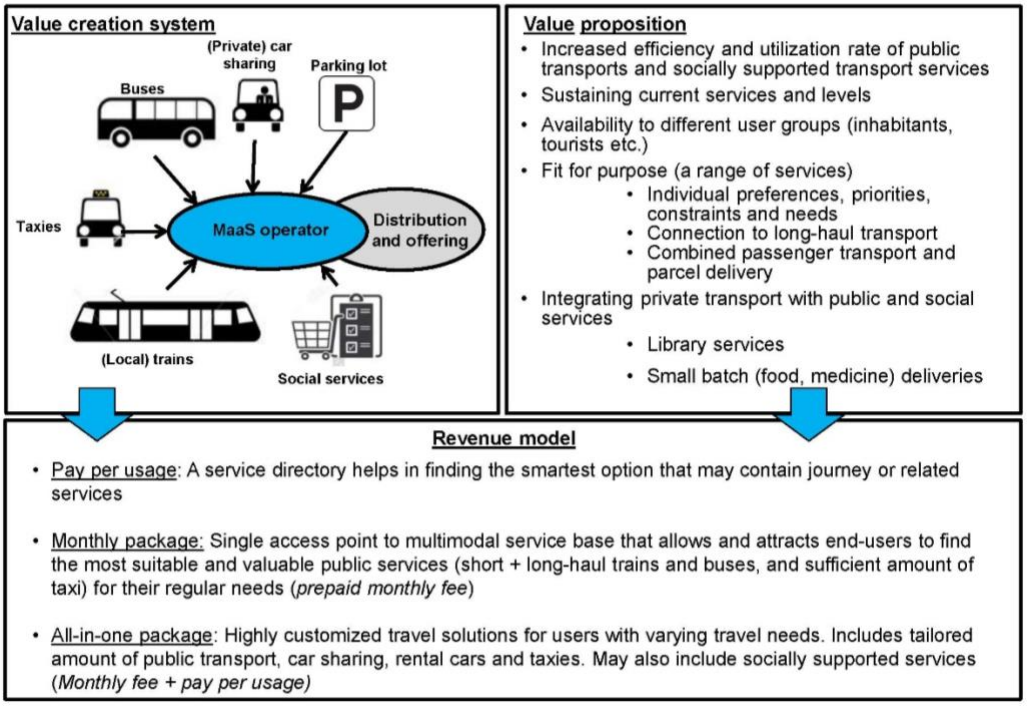

Figure 4. MaaS Services in Rural Areas

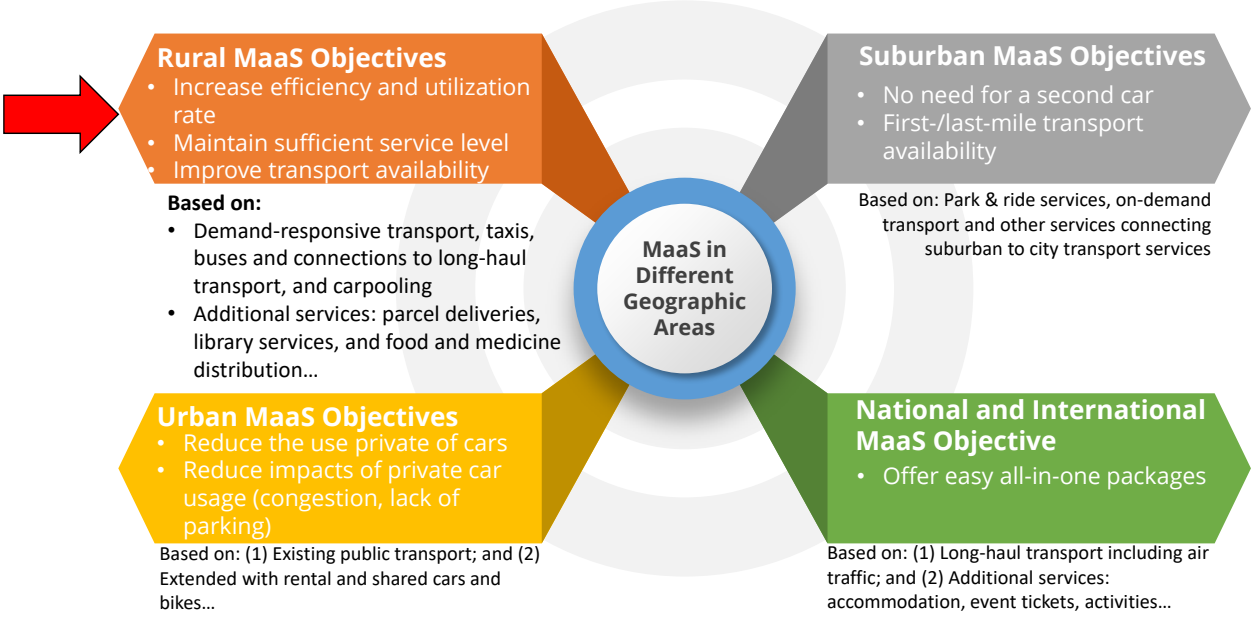

Figure 5. MaaS Objectives and Services in Different Areas

In rural areas, which have "very low population density and highly dispersed destinations,"[18] the prioritization of modes within the framework is shown in Figure 6[19]. "Caltrans' Smart Mobility Framework recommends prioritization of transportation projects and programs that:

- Create and maintain walkable rural towns and safety improvements on rural roads
- Connect networks of schools, services, and employment destinations"[20]
- Because flexible, high-occupancy modes best suit the needs of a rural community, rideshare receives high priority. Rideshare and microtransit can be easily adapted for the appropriate scale, and can increase connectivity to schools, services, and employment destinations
- Where practical, active transportation ranks as a high priority due to the need for safe biking and walking infrastructure in town centers and on rural roads.
- Personal electric vehicles receive high priority, due to dispersed housing and destinations.
- Both electric and conventional public transit have a medium priority, due to efficiency. Yet this could vary depending on the need for public transit between rural towns or to connect to cities.
- Carshare, ride-hailing, bikeshare and taxis are ranked low, mostly due to lack of feasibility"[21]

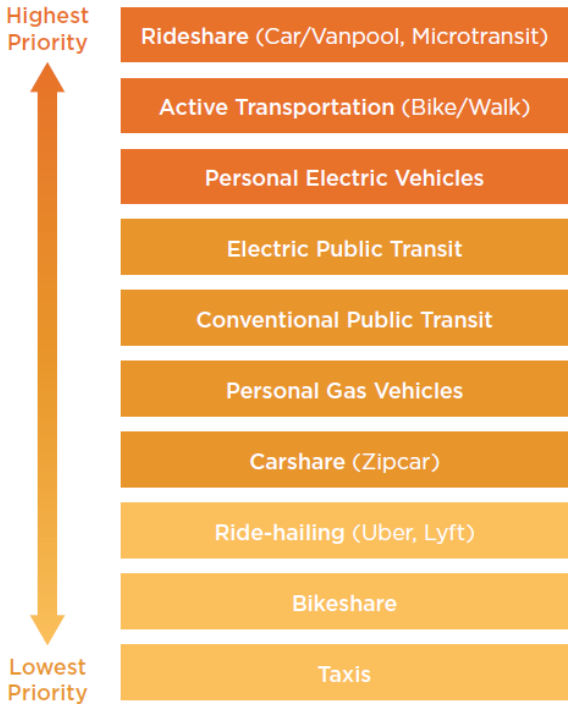

Figure 6. Rural Areas Mobility Choices Using Mobility Indicators

As mentioned earlier, the supply of mobility services in rural areas is not as large as it is in urban areas. In the development of a rural MaaS offering in Tompkins County, NY (described in Section 4), Dwight Mengel originally envisioned the potential for increasing the supply of services once mobility is improved through MaaS as shown in Figure 7[22]. Individuals can become volunteer drivers and receive benefits resulting in an increase in the supply of transportation.

On the left side of the figure, the increase in supply will eventually result in improved mobility for travelers.

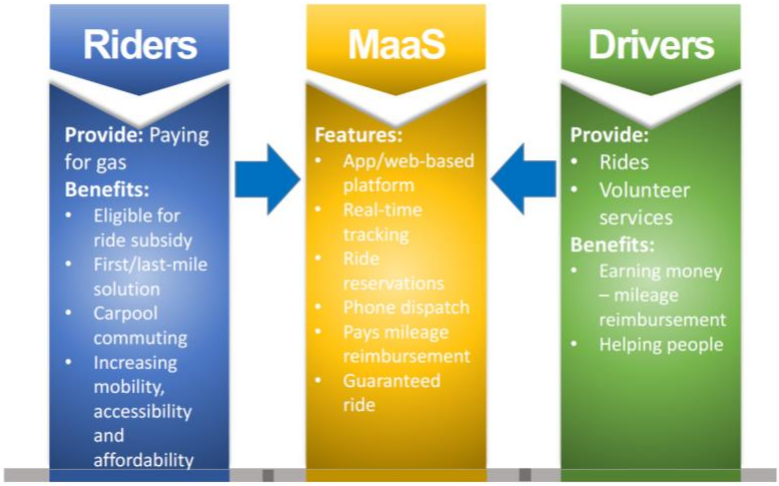

Figure 7. Shared Mobility Strategy to Boost Mobility Supply in Rural Communities

From a variety of sources[23],[24],[25],[26],[27],[28] the benefits of deploying Mobility as a Service (MaaS) in rural areas include:

1. Improved Availability:

- Enhances access to essential services like healthcare, education, and shopping, especially for residents in areas with limited or no public transport options.
- Provides tailored solutions for all traveler groups.

2. Reduced Car Dependency: Offers viable alternatives to private car ownership, reducing reliance on personal vehicles and addressing transport poverty.

3. Environmental Benefits: Promotes shared mobility and optimized routes, reducing vehicle miles traveled (VMT) and energy, contributing to sustainability goals.

4. Cost Savings:

- Reduces operational costs for transit agencies by optimizing vehicle utilization and integrating services like statutory social and health service transport (SHST).
- Provides affordable fares for users, encouraging adoption.

5. Job Creation: Creates employment opportunities by introducing new mobility services and infrastructure.

6. Energy Efficiency: Reduces energy consumption in the transport sector through optimized mobility systems and integration of self-driving vehicles.

7. Improved Passenger Experience: Simplifies trip planning, booking, and payment processes, offering real-time updates and tailored transit itineraries for users.

8. Support for Underserved Areas: Expands mobility services to remote and sparsely populated regions, addressing mobility gaps and improving connectivity.

9. Energy Reduction: Integrates passenger and freight transport to reduce energy and reliance on private cars.

10. Encouragement of Social Interaction: Facilitates out-of-home activities, fostering social engagement and interaction among rural residents.

11. Economic Opportunities: Combines passenger and freight transport systems to create new revenue streams and improve financial viability.

12. Innovative Solutions: Introduces creative approaches like crowdshipping, cargo hitching, and demand-responsive transport (DRT) to address rural mobility challenges.

13. Enhanced Resource Efficiency: Optimizes the use of existing transport modes, such as buses and private vehicles, for both passengers and goods.

These benefits collectively improve the quality of life for rural residents, enhance connectivity, and support sustainable development in rural communities.

However, according to Jenny Milne, et al[29] and other resources, the key challenges of RMaaS implementation include the following:

1. **Transport Poverty and Forced Car Ownership**: Rural areas often face limited transport options, leading to reliance on private cars, which can be costly and not available for some residents.
2. **Lack of Infrastructure**: Rural areas typically have fewer transport services and weaker digital connectivity, contributing to a "digital divide" that hinders the adoption of digital MaaS solutions.
3. **Low Population Density**: Sparse populations make it difficult to achieve economies of scale, reducing the financial viability of transport services.
4. **Limited Modal Availability**: Rural areas often lack diverse transport modes, such as shared mobility services, which are more common in urban areas.
5. **Digital Literacy and Reluctance**: Older populations in rural areas may be less comfortable with digital technologies, posing challenges for MaaS adoption.
6. **Funding and Financial Commitment**: RMaaS requires significant investment, and rural areas often struggle to secure funding due to lower farebox recovery and budgetary constraints.
7. **Stakeholder Engagement**: Collaboration among stakeholders, including users, transport

operators, and policymakers, is often limited, affecting the design and implementation of RMaaS.

8. **Integration of Modes**: Combining existing transport modes, such as school buses and public transport, is complex and can limit service availability during peak hours.
9. **Evaluation and Learning Frameworks**: Many RMaaS pilots lack robust evaluation mechanisms, making it difficult to measure success and learn from past projects.
10. **Data Challenges**: Issues with data quality, availability, interoperability, and privacy hinder the development of effective MaaS solutions.
11. **Procurement and Governance**: Differences in procurement approaches and governance structures across regions complicate the implementation process.
12. **Resistance to Change**: Cultural and behavioral resistance to new mobility solutions can slow adoption in rural areas.

These challenges highlight the need for tailored approaches to RMaaS that consider the unique characteristics of rural areas, such as geography, population density, and transport needs.

3.2 Universal MaaS

AARP defined the concept of Universal MaaS as a single, integrated network of traditional and non-traditional services that together serve everyone using universal design principles. This "one-stop shopping" platform should make it easy for anyone to plan, book and pay for a trip, as well as to navigate a trip easily (including facilitating transfers between mobility services).

"Universal MaaS, while initially a concept for urban areas, could result in expanded mobility in small towns and rural areas as well, although the shift to this new paradigm will happen at a slower pace than in cities. Public bus service will play an important role, but alternative shared-ride solutions may offer a competitively priced advantage over traditional public transportation in certain circumstances. Transportation policy should support the best mix of transportation options that facilitate broad mobility."[30]

Further, a "Universal MaaS system, where specialized transportation services are integrated into a single platform along with other means of shared-use mobility services, could be smart enough to apply the appropriate subsidy for each unique human services transportation client and trip request, while protecting the privacy of the individual. For example, a qualifying Medicaid customer's medical travel would be charged to the state or other appropriate entity such as the Medicaid nonemergency medical transportation (NEMT) broker. His or her nonmedical travel would be charged to a personal account or other subsidizing entity as appropriate. Gone, therefore, would be the days when that customer would have to go directly home rather than make a convenient stop-off at the grocery store because Medicaid only covers the medical portion of his or her trip. Beyond convenient cost allocation, MaaS could be enhanced by the addition of mobility management, which lends a human dimension to a system that is otherwise primarily tech based. Mobility managers could provide direct

assistance for complicated trip planning or even travel training—supplementary services to readily available one-click, one-call information centers."[31]

The concept of Universal MaaS is shown in Figure 8[32].

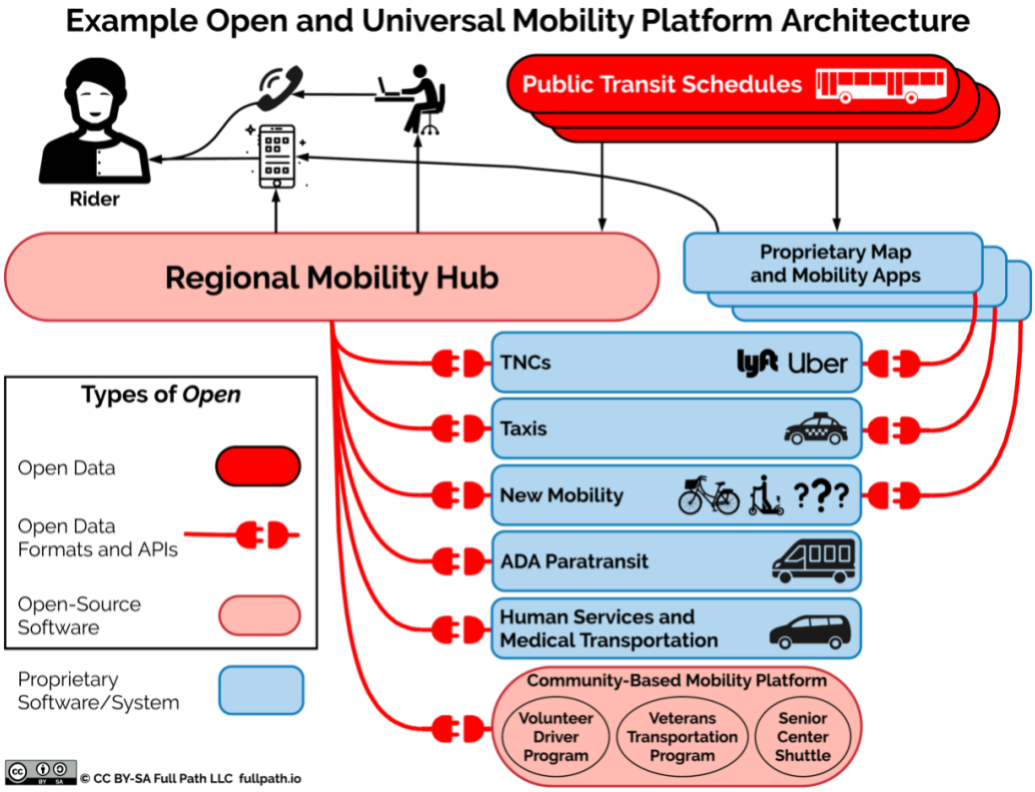

Figure 8. Open Universal MaaS Platform

4 Rural MaaS Examples

4.1 Tompkins County, NY MaaS

Tompkins County, NY, a primarily rural county with one small urban area (Ithaca, NY) faces three general mobility needs: opportunity loss to mobility operators, barriers faced by people who do not drive a car, and people desiring affordable mobility choices. These three mobility needs are driving change in how the County approaches developing and continuously improving the community mobility system. According to Dwight Mengel, the former Chief Transportation Planner at the Tompkins County Department of Social Services, fortunately, collaboration between public, private, and institutional mobility partners is part of the local culture. This culture of collaboration and innovation has encouraged "thinking outside-of-the-box" to create new mobility approaches, including MaaS. Thus, the County is beginning to create a MaaS business model and will be implementing it first in Tompkins County, then regionally. The greater objective is to provide a MaaS model for small urban and rural

communities elsewhere in the country.

The overall vision for MaaS in Tompkins County began as shown in Figure 9. Customer Service was considered a focus of this system, ensuring not only that travelers have access to all available mobility services, but also that they have access to customer service 24 hours a day, 7 days a week. The value proposition for this rural MaaS has five major elements including mobility education, financial services (e.g., individual mobility plans, coordinated fare payment among mobility operators and customers, crediting volunteer driver mileage reimbursements as revenue, credit employer subsidies as revenue), customer service, incentives/discounts and capability to adapt and innovate (e.g., increase supply of volunteer drivers).[33]

An overall mobility "menu" of all mobility services in Tompkins County was envisioned to be developed as shown in Table 1[34]. Each traveler would select from this type of menu and tailor their mobility "subscription." A sample mobility menu selection and subscription for a family that lives in the small urban area within the County is shown in Table 2 and one for a family living in the rural area of the County is shown in Table 3.

Table 1. Mobility Services Menu and Unit Costs

MOBILITY MENU	Unit Cost	Unit
Annual Adult Bus Pass	$450	Annual
Annual Youth Bus Pass	$110	Annual
Ithaca Carshare "Its my car" Plan	$8	Hour
Ithaca Carshare "Just in Case" Plan	$11	Hour
Car Rental	$55	Day
Taxi trip - City	$8	Urban Trip
Taxi trip - Rural	$20	Rural Trip
Bicycle Maintenance	$50	Voucher
Electric Bike Purchase	$2,000	HE Bike
Bike Purchase	$700	Bike
Rideshare Driver – Miles	$0.54	Mile
Rideshare Rider – Miles	$0.15	Mile
GADABOUT Paratransit	$4	Trip
Vanpool Membership	$125	Month/Seat
Guaranteed Ride	$30	Annual

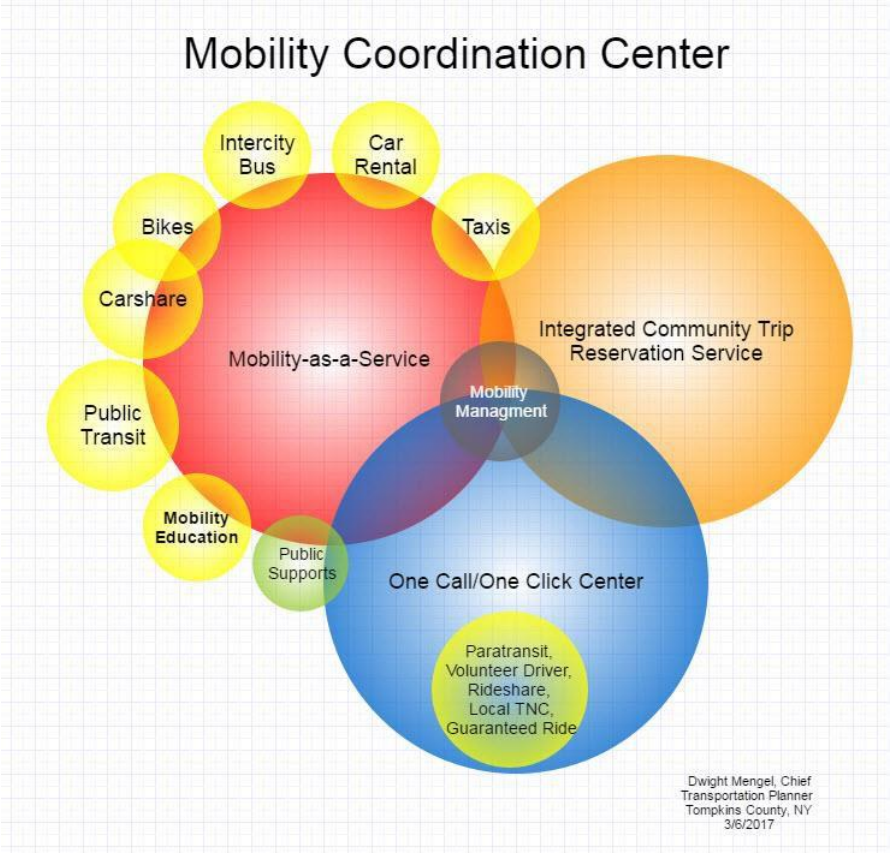

Figure 9. Tompkins County, NY MaaS Concept

Table 2. Sample Small Urban Mobility Subscription

Small City Mobility Budget (1 car, 2 adults, 1 youth, Walkscore = 96)	
Carshare	$ 900
Annual Bus Passes (2)	$ 560
Taxi	$ 192
Bicycle Maintenance	$ 100
Guaranteed Ride	$ 30
Member Support	$ 178
Annual Total	$ 1,960
Monthly Payment	**$ 163**

Table 3. Sample Rural Mobility Subscription

Rural Household Mobility Budget (1 car, 2 adults, 1 youth, Walkscore = 0)	
Vanpool Membership	$ 1,500
Carshare (Discount Plan)	$ 480
Taxi	$ 200
Guaranteed Ride	$ 30
Member Support	$ 121
Volunteer Driver Revenue	$ (400)
Vanpool Program Subsidy	$ (600)
Annual Total	$ 1,331
Monthly Payment	**$ 111**

The MaaS development in Tompkins County is taking place in two phases as shown in Figure 10, starting with the Mobility on Demand On Ramp, through the Shared Use Mobility Center, with the support of the Federal Transit Administration. "From June 2018 to November 2019, Tompkins County participated in the FTA's MOD On-Ramp Program to convert its MaaS concept into a multi-phase project. The results of their On-Ramp Program project created manageable phases and signaled the beginning of system development.

"Phase 1, which [is being] funded by [an FTA Integrated Mobility Innovation] IMI grant ($820,000 USD), consists of four major tasks: (1) develop a multimodal trip planning platform to integrate travel information from mobility providers and enable access through a smartphone app and web platforms; (2) implement a call center to answer inquiries by telephone, text and chat (by computer) 24/7; (3) deploy a guaranteed ride program for Tompkins County residents and people traveling to Tompkins County; and (4) develop a rural First-Mile/Last-Mile service pilot extending the range of Tompkins Consolidated Area Transit (TCAT) Route 43 with Gadabout demand-response service in a project area (in the rural Village and Town of Dryden)."[35]

Tompkins County completed the first step in Phase 1 as of April 2025, which is the development of a multimodal trip planner called Tompkins Transportation Scout. It is available via the website (https://my.tompkinsscout.org/), and an Android or iPhone app. Tompkins Transportation Scout is a program of Tompkins County, in partnership with GO ITHACA, the Center for Community Transportation, and the Human Services Coalition of Tompkins County. Tompkins Transportation Scout is being officially launched on April 17, 2025.

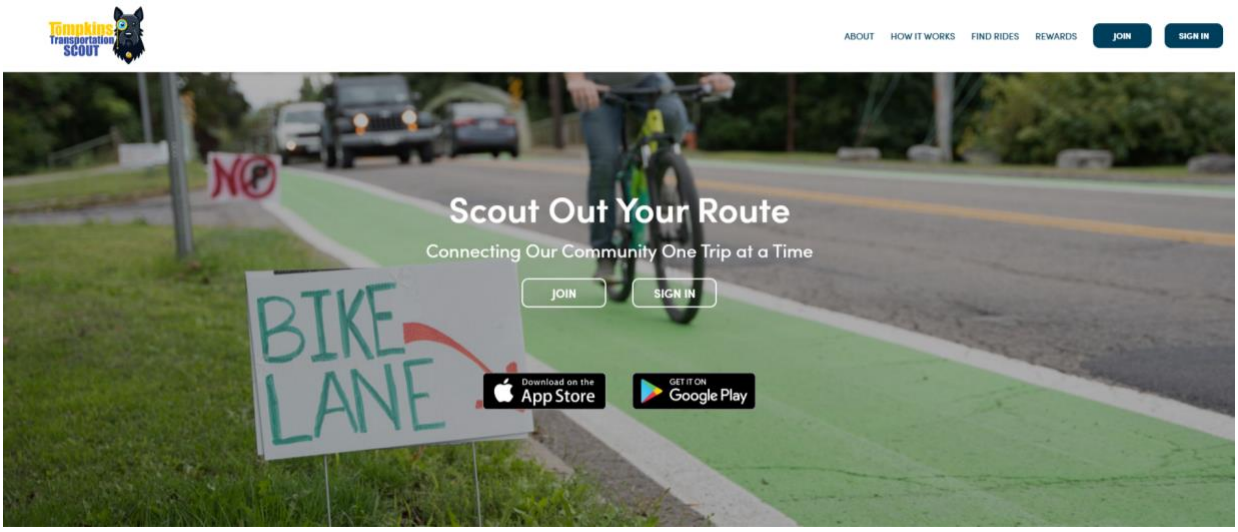

Figure 10. Tompkins Transportation Scout Website

"Phase 2, which [builds] on the foundation developed in the IMI-funded Phase 1, is expected to implement key MaaS elements including creating a member organization, deploying financial services and enhancing customer service (beyond the call center). Initially, the MaaS concept for Tompkins County [included] customizable monthly mobility subscriptions – Phase 2 [provides] the back-office infrastructure and other services needed to offer travelers these subscriptions."[27]

Figure 11. Tompkins County MaaS Development Phases[36]

4.2 Rural California MaaS[37]

Another example of rural MaaS is in the San Joaquin Valley, CA. According to Caroline Rodier, Ph.D. Researcher and Associate Director of the Urban Land Use and Transportation Center at the University of California, Davis, "it is a case study that shows how mobility as a service acts as (1) An integrator of multiple mobility services to optimize access and (2) Links people and their travel needs to these mobility services. It is becoming the backbone of expanding shared

mobility services in the San Joaquin Valley. Bounded by the Sierra Nevada to the east and the Coast Ranges to the west, the San Joaquin Valley is California's single most productive agricultural region and one of the most productive in the world, producing more than half of the fruits, vegetables and nuts grown in the United States. It is home to a number of cities including Stockton, Modesto, Fresno, and Bakersfield. However a large share of its 4 million residents live in rural areas or on the fringes of urban areas. Here residents are commonly low income agricultural workers. Almost all the census tracts in the San Joaquin Valley have been declared economically and environmentally disadvantaged communities by the state of California. This region has some of the worst air quality in the nation."

"A planning study was conducted [in the region] to examine new technology and shared mobility services to meet mobility gaps and reduce emissions. UC Davis led a community-based planning effort in partnership with the Valley which included stakeholder engagement, focus groups, and data analysis. Problems were inventoried by location and included intercity transit gaps, very high cost transit routes, services with low farebox recovery, and communities with low vehicle to adult ratios. Also new technology and shared mobility alternatives that looked promising were identified and evaluated.

"At the conclusion of the study, three pilot concepts for implementation were identified and financial support from California's Low Carbon Transportation fund was secured to implement the pilots. These pilots included:

1. An electric vehicle carsharing service (called Miocar) in affordable housing in southern Valley;
2. MaaS (called Vamos) in the northern Valley, in San Joaquin and Stanislaus Counties; and
3. A volunteer ridesharing service (called Volunteers on the Go [VOGO]) that served the areas which are highly disadvantaged rural areas with an extremely low volume of transit service.

The MaaS platform was envisioned to knit existing and new services together as they begin to expand throughout the Valley through other low carbon transportation projects. From the traveler perspective, the following are the key user questions that VAMOS should answer:

- What is the best way to get from A to B by time and cost?
- When will my ride arrive?
- Is space available?
- Can I reserve a space?
- Can I pay now?

Figure 12 shows the system perspective of MaaS. The platform integrates different services and their data, and a smartphone app is the interface between the answers and questions.

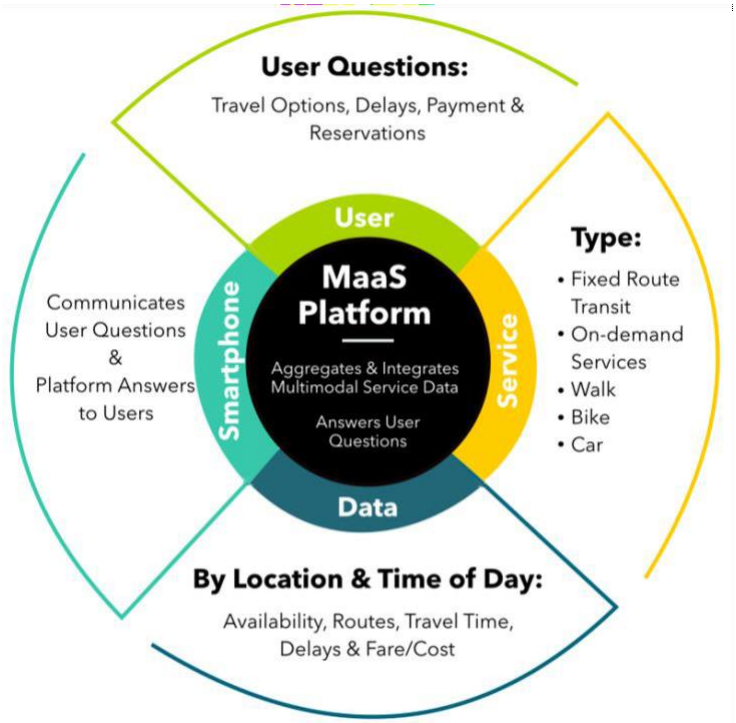

Figure 12. System Perspective of MaaS

MaaS platforms need to communicate with mobility services via application programming interfaces (APIs) and data. However, in this project it was found that many service providers do not want to connect to the MaaS because of concerns about competition, protection of software secrets, and sometimes just the lack of an existing API. If there is an existing contract, it is really tough to get them to connect to the platform. If a service provider is willing to connect to the MaaS system, because there are no standard APIs and data structures for integration, each integration is an expensive one-off– from $10,000 to $30,000, on just the MaaS side. Because of these challenges, UC Davis recommended that their program partners require a contractual agreement with subcontractors so that they will integrate and pay for the integration with the MaaS.

An open public MaaS model (vs. a MaaS model provided by a private company) would include all available services that are combined to provide more choices to more destinations and to minimize travel time and cost given the travelers' needs. This public-facing platform may lower barriers to market entry, especially to small local providers, and increase service supply and lower costs with more competition. Further, MaaS enables the creation of individual accounts and codes that would allow for promotions and easy application of subsidies for special groups.

While this is the bigger picture of MaaS, Vamos had to focus on what the project team thought were realistic short-term goals for Vamos, which included:

- Integration of transit services across transit agencies and between fixed-route, demand- response transit (DRT), and VOGO
- Reservations for VOGO and DRT
- Streamline transit payments and subsidies

As of August 2020, Vamos allows:

- Transit planning across 14 transit agencies in San Joaquin and Stanislaus Counties with
  - Turn by turn instructions
  - Real-time arrival information
- DRT is linked to fixed route transit
- Information on how to reserve DRT, but not direct reservations
- Reservations for VOGO are enabled
- Separate bicycle trip planning (not integrated to transit yet)

The transit agencies that are included in the MaaS application are shown in Figure 13.

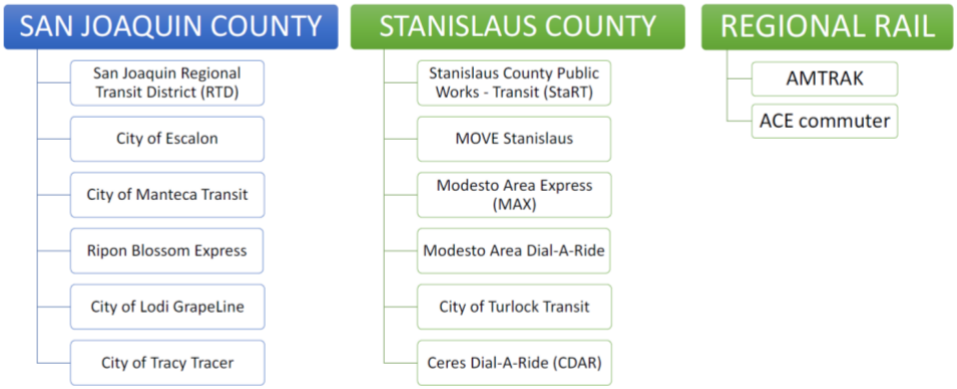

Figure 13. Transit Agencies Participating in Vamos

5 Benefits and Challenges Associated with Deploying MaaS

Since its inception, MaaS deployments and the success of those deployments has followed the Gartner Hype Cycle, which "is a framework used to visualize the life cycle of a technology or innovation, from its initial introduction to its mainstream adoption. It illustrates how expectations for a technology can fluctuate over time, moving from initial excitement to eventual disillusionment, and ultimately to a period of sustained productivity." See Figure 14.

As of April 2025, it is evident that MaaS as not been as successful as it was expected to be in terms of improving mobility. In a global synthesis of Mobility as a Service (MaaS) completed in early 2025[38], the reasons for this lack of success are described as follows:

- **Flawed Assumptions**: MaaS was built on unrealistic assumptions, such as the idea that multimodal journeys could be made seamless and that private car users would switch to

MaaS. These assumptions have proven incorrect, as car users value ownership and convenience, and public transport users are already familiar with their options.

- **Thin Market**: The target market for MaaS apps is limited, as car users and regular public transport users do not see the need for MaaS.
- **Lack of Compelling Value Proposition**: MaaS has failed to provide sufficient value to users, with mobility offers often being more expensive than alternatives and not delivering significant mode shifts or reductions in VMT.
- **Technical and Operational Issues**: Many MaaS apps faced technical bugs, outages, and integration problems, making them difficult to use and deterring adoption.
- **Behavioral and Cultural Barriers**: Cultural perceptions of car ownership, resistance to changing travel habits, and the sunk costs of owning a vehicle have limited MaaS adoption.
- **Financial Unsustainability**: MaaS projects have relied heavily on subsidies and have not been financially sustainable, with public agencies hesitant to continue funding them without clear evidence of social benefits.
- **Fragmentation and Complexity**: The integration of multiple transport modes and providers has been technically and administratively challenging, highlighting the fragmentation in urban transportation systems.
- **Limited Mode Shift and Benefits**: MaaS has not demonstrated significant mode shifts, improvements for all travelers, or energy reductions, undermining its case for further investment.
- **External Factors**: The COVID-19 pandemic and economic changes, such as reduced fuel costs, have further complicated MaaS adoption.

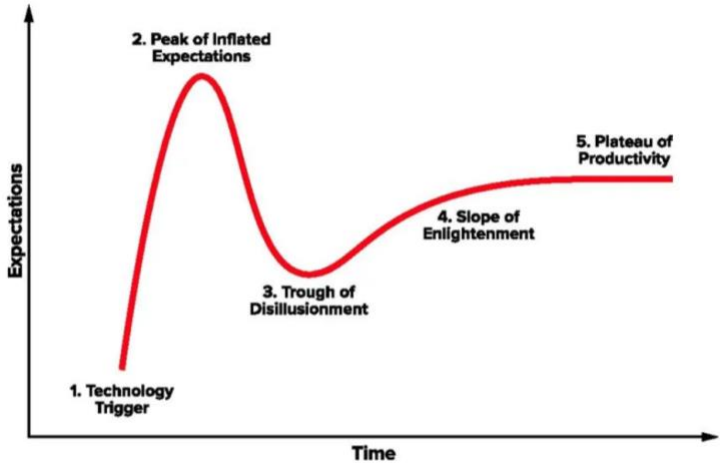

Figure 14. Gartner Hype Cycle[39]

6 MaaS Readiness

In 2023 and 2024, a new MaaS readiness index (MRI) was developed to evaluate the readiness of a specific area for implementing MaaS solutions[40]. It focuses on three key aspects: technology, coopetition, and policy.

1. Technology Features: These assess the technological maturity of the region to support MaaS solutions:

- **Routing**: Availability of static and dynamic trip planning.
- **Booking**: Online booking capabilities and external registration options.
- **Payment**: Availability of electronic payment methods, types, and options (e.g., pay-as-you-go or subscription).
- **Ticketing**: Digital ticketing and external validation options.
- **Navigation**: Real-time vehicle positions and traffic alerts.

2. Coopetition Features: These evaluate the ecosystem of collaboration and competition among stakeholders:

- **Business and Data**: Willingness of stakeholders to collaborate and share data.
- **Infrastructure and Supply**: Availability, coverage, frequency, reliability, and quality of mobility services.
- **Market Readiness**: Indicators like mobile internet penetration, willingness to pay online, and Gross Domestic Product (GDP).
- **Market Volume**: Population size, density, and early adopters.

3. Policy Features: These examine the policy environment and stakeholder experience:

- **Administration**: Presence of strategic documents, action plans, and legislation supporting MaaS.
- **Experience**: Stakeholders' experience in multimodal journey planning, cooperation, and cross-border collaboration.

The MRI provides a structured framework to assess and benchmark MaaS readiness across diverse regions including rural areas. The scoring and aggregation is as follows:

- **Technology and Policy Indicators**: Scored on a Likert scale (ready, short, long).
- **Coopetition Indicators**: Quantitative values normalized on a scale of 0–100.

The MRI highlights strengths and gaps in technology, collaboration, and policy, enabling:

- Comparison between regions and before-and-after pilot activities.
- Decision Support for prioritizing measures and evaluating smart mobility developments.

The MRI works when assessing MaaS readiness in rural areas. The methodology has been applied to pilot locations in Central Europe, including rural areas such as Saxony and Rottal-Inn. The MRI evaluates readiness for MaaS solutions by considering technology, coopetition, and policy features, and it adapts to the specific characteristics of rural regions. For example, in Saxony, the MRI assessed bus line optimization and rail connections, while in Rottal-Inn, it evaluated cross-border on-demand bus services. These applications demonstrate the flexibility of the MRI in addressing rural mobility challenges.

7 MaaS Evaluation Framework

As with other technology-enabled systems deployment, it is critical to evaluate MaaS from a variety of perspectives to determine its impact on the traveler, agency and community or region. Unfortunately, there are very few evaluation processes that have been developed for MaaS. Further, the number of actual MaaS deployments in the US, particularly in rural areas, has been very limited.

One potential MaaS evaluation framework that is beginning to be used on several MaaS deployments in Sweden has promise in the US in that it addresses the complexity associated with MaaS offerings and provides a structured approach to evaluation. MaaS has impacts on at least three of the following four levels[41]:

- Micro level – this incorporates the MaaS users including travelers and citizens of the area where MaaS is being offered;
- Meso level – this level incorporates the following:
  - Regional and local governments that determine rules and regulations, and have certain roles and responsibilities regarding the MaaS offering;
  - Public service providers that determine regulations, have specific roles and responsibilities, have organizational goals, have perceived business opportunities in offering MaaS, and have a brand image;
  - Private service providers that have to abide by certain laws, have organizational goals, have perceived business opportunities in offering MaaS, and have a brand image;
- National government level – may have legislation and regulations regarding MaaS, may have a vision of MaaS, and may provide financial support; and
- Society at large, which encompasses the prior three levels.

This core evaluation framework, called KOMPIS, is shown in Figure 15[42]. The data that would be collected in order to utilize this framework is shown in Figure 16[43]. This framework was used to evaluate at least two MaaS deployments in Sweden: LIMA (Lindholmen Mobility Arena) and MoJo (Mobility Johanneberg) projects. These projects ran from September 2020 to September 2021.

Using KOMPIS, the key results from the LIMA project are as follows[44]:

1. **Public Transport as a Backbone**: For MaaS to become a sustainable alternative, public transport must play a central role. However, private actors currently cannot resell public transport tickets, and public transport companies in Sweden have not taken on the role of MaaS suppliers. Addressing this "lock" is essential for progress.
2. **Legislative and Tax Challenges**: Current legislation and tax rules hinder the development of shared mobility. For example, the Rental Car Act limits car sharing to companies, and tax rules discourage private individuals from sharing cars. These need to

be adapted to enable a more resource-efficient society.

3. **Digital Standards for Cars**: Cars should be equipped with digital keys to facilitate easy sharing, similar to how seat belts and airbags are standard today.
4. **User Needs and Attractiveness**: While the LIMA service is considered attractive, it primarily appeals to people with existing multimodal, collective, and active mobility patterns. To broaden its appeal, more transport modes and user-friendly travel planning should be included.
5. **Interest from Property Developers**: Property developers in urban environments have shown strong interest in mobility services like LIMA, driven by municipalities' guidelines to replace parking spaces with sustainable alternatives in new urban areas.
6. **Potential Benefits**: Combined mobility can lead to reduced energy impact, easier control of employees' travel, and more efficient administration of travel. Simplifying access to shared mobility services is seen as valuable.
7. **MaaS Vision**: MaaS aims to offer a combination of shared mobility services (e.g., public transport, emission-free cars, micro-mobility) that complement each other and are easily available, potentially reducing traffic congestion and promoting sustainable travel choices.

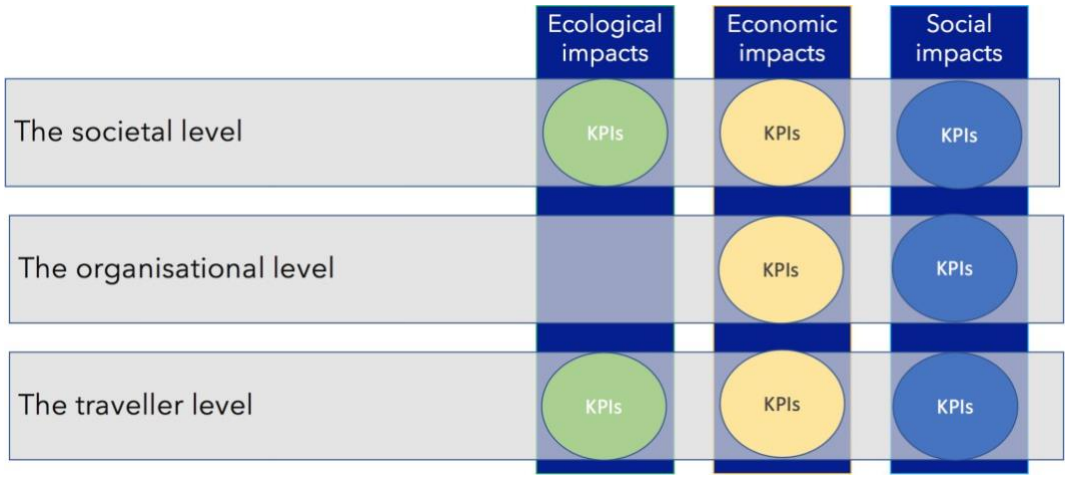

Figure 15. MaaS Core Evaluation Framework

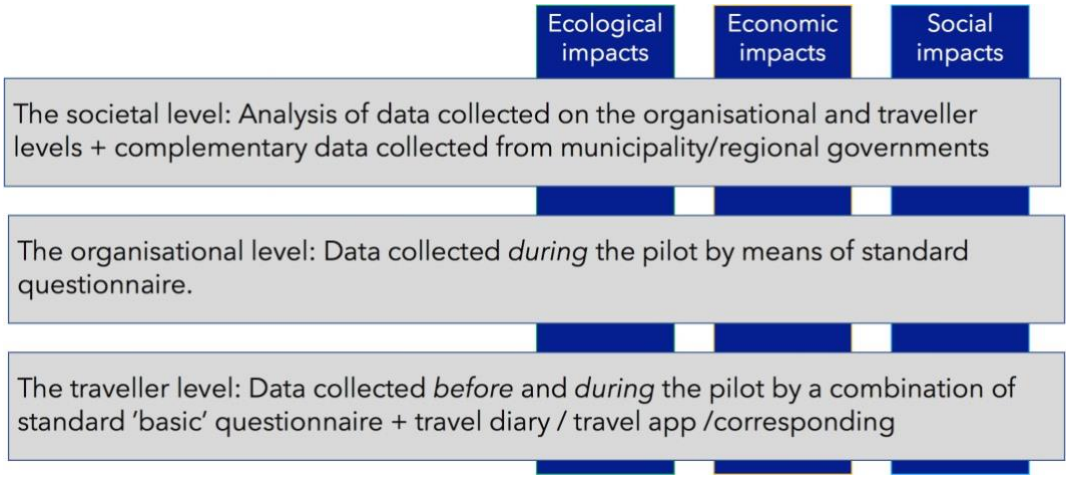

Figure 16. Data Collection for MaaS Evaluation

8 Conclusions

"Many public transportation authorities are looking to how they can enable better mobility for their citizens, in congested urban settings as well as in poorly connected peripheral communities and rural areas. MaaS is increasingly being presented as a possible solution in both contexts, although the path forward has proven far more difficult than hoped. Part of this may lie in underestimating the complexities of achieving integrated mobility services, which is often linked to a lack of practical experience in implementing and running MaaS services. [It is critical] to understand the bigger picture of MaaS primarily from the user perspective but in an interplay with the service perspective, as the service offer and design inherently affect use of the service."[45]

"Central questions remain regarding how to achieve MaaS. Regardless of the type of organization [undertaking MaaS], three such interrelated questions are: 1) What is the ecosystem? (i.e. Which organisations take what role(s) in a MaaS service?); 2) What is the business model? (i.e. What is the value offering to the customers and users? and How can this offer be achieved in an (economically) sustainable manner?), and 3) How are outcomes measured? (i.e. What are the goals? What are the KPIs? Which assessment methods and tools are most appropriate?). There are likely multiple appropriate answers which vary according to the local context and specific service, which complicates the decision-making process, particularly given the current state of affairs with services limited in number and scale, limited empirical data, and unstructured (and incomparable) evaluations, all of which contribute to uncertainty."[46]

The evaluation framework in Section 7 reflects several aforementioned items that an agency should identify in order to explore the development of MaaS:

- What are the goals and objectives of offering MaaS? These will be used to identify the types of impacts that are expected as a result of offering MaaS and will be used in the evaluation

framework, as shown in Figure 15. For example, an overall goal could be to improve the mobility of travelers in and around the area being covered. The objectives should be quantitative and can be used to define key performance indicators (KPIs) that will be used to evaluate the MaaS solution both before and after it is deployed.

- What are you providing to travelers? For example, if you have conducted a needs assessment to determine the needs of the travelers in your area, will MaaS address any of those needs? If so, which needs will be addressed by providing a MaaS solution?
- Which organizations should be involved in MaaS? The answer to this question will help to identify the "levels" as shown in Figure 15. Here, at least four types of organizations should be considered:
    - Organization(s) offering MaaS (e.g., a public transit provider, other public/ government entity such as a metropolitan planning organization, social service agency or private organization)
    - Organizations offering mobility services through a MaaS platform (e.g., public transit agency, carsharing companies, ridesourcing companies, bikesharing companies, taxi companies, etc.)
    - Organization(s) that develop MaaS platforms
    - Organizations that represent and support travelers, including social service organizations, transit riders' groups and medical providers
- What steps are required to fund the development and deployment of MaaS, and ensure that MaaS is sustainable after the initial deployment?
- How will you address the availability of a technology-enabled MaaS solution? Will individuals be able to access the MaaS platform in a variety of ways, including those that do not require a smartphone or computer?

MaaS is a complex undertaking, but has the potential to significantly benefit communities within the platform's ecosystem. These questions can help entities considering MaaS to lay the right foundation for implementing a system that serves their needs.

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