



**Tommy G. Thompson Center
on Public Leadership**
UNIVERSITY OF WISCONSIN-MADISON

**CONNECTING WISCONSIN OF TOMORROW: METHODS TO IMPROVE PUBLIC
MOBILITY UNDER FUTURE SOCIAL, ECONOMIC AND TECHNOLOGICAL
CHANGES**

FINAL REPORT

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LIST OF ACCRONYMS USED IN THIS REPORT

MaaS	Mobility as a Service
GBFS	General Bikeshare Feed Specification
NFV	Network Functions Virtualization
API	Application Programming Interface
APTA	American Public Transportation Association
AVL	Automatic Vehicle Location
CAGR	Compound Annual Growth Rate
CROWE	Center for Research on the Wisconsin Economy
DHS	Department of Health Services
DNS	Domain Name System
DoT	Department of Transportation
FTA	Federal Transit Administration
GMM	Google Mobile Maps
GPS	Global Positioning System
GTFS	General Transit Feed Specification
IMDF	Indoor Mapping Data Format
IoT	Internet of Things
IT	Information Technology
LADoT	Los Angeles Department of Transportation
MCTS	Milwaukee County Transit Service
NAT	Network Address Translation
NHTS	National Household Travel Survey
NT	North Denmark Region
ORCA	One Regional Card for All
OSM	Open Street Map
PPP	Public-Private-Partnerships
PPPP	Public-Private-People-Partnerships
RFID	Radio-Frequency Identification
SDOT	Seattle Department of Transportation
SIM	Security Module
SMP	Swedish Mobility Program
ToD	Travel on Demand
TSP	Transportation Service Provider
USDOT	United States Department of Transportation
V2I	Vehicle-to-Infrastructure
VMs	Virtual Machines
VNFs	Virtual network functions
WisDoT	Wisconsin Department of Transportation

WISPIRG Wisconsin Public Interest Research Group
WMaaS Wisconsin Mobility as a Service

EXECUTIVE SUMMARY

PROJECT OVERVIEW

Major demographic and societal economic changes are likely to have significant impacts on the mobility needs of Wisconsin citizens in the next two decades. At the same time, future technological breakthroughs may help overcome many of the obstacles to seamless mobility. This project addresses the critical challenges facing many cities and communities in Wisconsin: how to leverage the technological breakthroughs to re-think and re-design future mobility services and enable smart and connected communities. We envisioned an ambitious "Wisconsin Mobility as a Service" (MaaS) platform and proposed three separate tasks for this project: i) study demographic and technological trends and socioeconomic challenges affecting public transportation in Wisconsin; ii) study factors affecting the implementation of improved mobility services in Wisconsin, and iii) provide a description of the architectural and operational roadmap design of a MaaS platform for Wisconsin.

An Advisory Committee was established that consisted of knowledgeable individuals with skilled expertise from the transportation industry. The Committee helped to identify transportation demand in Wisconsin, brainstormed service gaps and needs, and assessed possible solutions most suitable for implementation in Wisconsin. A total of eight committee members (see Appendix A) represent an array of transportation providers and organizations throughout statewide transportation systems, including local governments, transportation planners, public transit providers, shared-ride taxi service providers, and bikeshare providers. Throughout the project timeline, three Advisory Committee meetings were held to discuss research progress during each phase. The entire process of this project is shown in Figure I.

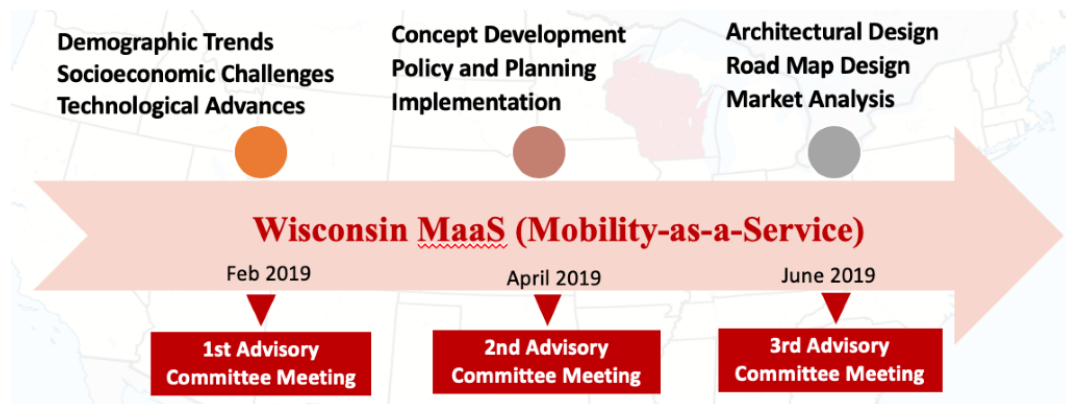


Figure I: Process of the Project

DEMOGRAPHIC, SOCIOECONOMIC AND TECHNOLOGICAL CHANGES IN WISCONSIN

A recent study from the Wisconsin Department of Administration estimated that by 2040, 23.7% of the population will be aged 65 or older, up from 13.7% in 2010. Northern Wisconsin is projected to see the most dramatic aging population shift. Meanwhile, according to the United

States Census Bureau, 11.3% of Wisconsin's population is living in poverty, which is a larger percentage than 30% of the states investigated in the United States.

On the other hand, Wisconsin is experiencing a large growth in the labor market after a decline in the unemployment rate from 2010 to 2017, according to the Center for Research on the Wisconsin Economy (CROWE). The employment-population ratio that measures the fraction of the population with a job ranked the fifth highest among all states in 2017.

Public transport systems in Wisconsin are comprised of county-wide transit systems, multi-county transit systems, fixed-route systems, shared ride taxis, shuttle and inter-city services. Three types of ridesharing services currently operate in Wisconsin, which include carshares, rideshares, and bikeshares. Public transportation is undergoing technological change and advancement that has helped achieve more efficient service and ultimately has influenced travel behaviors and trends of public transit commuters. Access of smartphones and Internet brings travel convenience for people of all age groups. Development of real-time data and information established the foundation for improving system efficiency and performance.

FACTORS AFFECTING THE IMPLEMENTATION OF MAAS IN WISCONSIN

MaaS was defined as a shift away from personally owned modes of transportation and towards mobility solutions that are consumed as a service. MaaS is an on-demand, real-time platform that can include any combination of different transport modes through a unified gateway that creates and manages the trip, which users can pay for with a single account. Since its introduction, MaaS has been applied to many countries and cities around the world. Its reported benefits include providing tailored transportation service plans for different types of customers at a more competitive price, improving the efficiency for each Transportation Service Provider (TSP) via collaboration between different TSPs, reducing transportation congestion and emissions, encouraging the growth of public health and social equity, etc. Through rigorous research, the team assessed current practical issues and possible suitable solutions for Wisconsin by reviewing best practices and MaaS system case studies around the world and consulting the adaptability and feasibility with the advisory committee. The critical issues of implementing MaaS in Wisconsin are classified into three categories: concept development, policy and planning strategies, and implementations, as shown in Figure II.

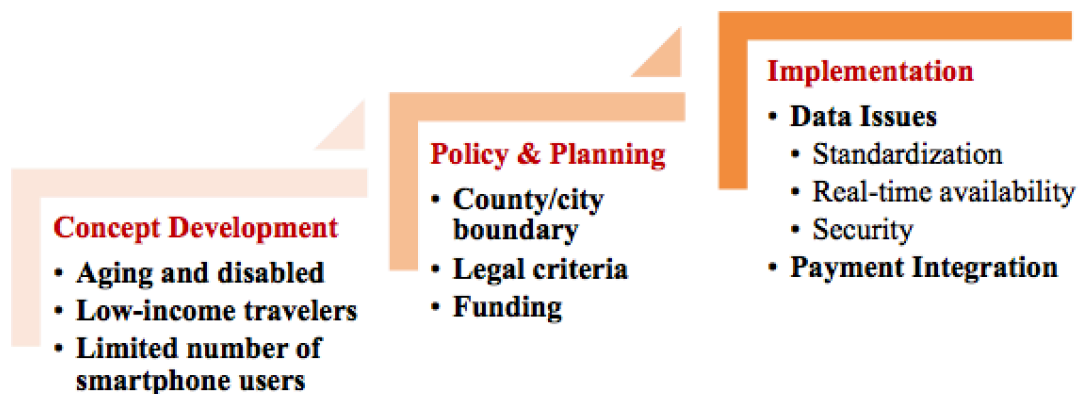


Figure II critical issues of implementing MaaS in Wisconsin

Corresponding to each of identified issues, potential solutions are summarized as follows:

Concept development

- **Aging population and people with disabilities:** To better fulfill the needs of the aging population and people with disabilities, potential measures are proposed from marketing strategy, service packages, information provision, and interface design. Regarding marketing strategy, a household-based access would be more effective than an individual-based access. MaaS companies could provide different ticket options targeting different frequency levels of people using the service. A pay-as-you-go function, a monthly ticket or a yearly membership could be offered based on the frequency of usage of customers. Certain types of service packages are also suggested for older adults such as volunteer/paid transportation service, health care trips, cross-boundary trips and paratransit service, with add-on values embedded. A user-friendly interface needs to consider vision, hearing issues, cognitive and mobility limitations that older adults and people with disabilities may have. Telephone customer service and website development would also be necessary. Moreover, to make sure it is economically feasible, collaborations among MaaS companies, Wisconsin DOT and DHS (Department of Health Services) are needed.
- **Low-income travelers:** Cost is a main concern for low-income travelers. MaaS companies could provide public-oriented trips (e.g., the combination of fixed-route transit, bike sharing and walking), and eco-friendly trips (e.g., bike sharing and walking) as tailored service packages to low-income travelers. Meanwhile, some volunteer-to-earn-trips programs could be suggested. Cost assistance might be required from federal and state governments, including employer-based programs, discounts, universal PASS, and user-side subsidy.
- **Travelers with limited smartphone usage:** MaaS is designed to be based on smart phone usage; however, the fact that there still have some travelers with limited smartphone usage in Wisconsin (e.g., northern rural areas) cannot be overlooked. MaaS could offer integrated services in low cell phone usage regions by limiting the contact number to a single phone number and a single website. Such a phone number and website should be capable of providing customer service information, answering any questions or providing support for more complicated transportation requests.

Policy and planning strategies

- **County/city boundary:** Travel needs are not limited by municipal boundaries, but transit services often are. To implement MaaS across county borders, agreements between operators and well-specified open interfaces need to be established in order to implement MaaS across county borders, targeting at the operational geographical area the transport modes that can contribute, additional resources and associated roaming costs, agreements for data privacy, boundaries on the length of time data will be held and handled, ticket reservation and cancellation policies, detailed specifications of the interface, etc.
- **Legal criteria:** Certain legislation, policies and guidelines need to be established in the future to guarantee the operation of MaaS, including legislation protecting the access of

MaaS companies to market, open data policy, API (Application Programming Interface) and data standardization, data security, rights and obligations to be claimed in detailed agreements, guidelines on building multimodal payment systems, legislation protecting passengers' safety and security, policies for facilitating technology development, guidance in the collaboration between counties and cities, etc.

- **Funding:** Little funding assistance is needed from the government for a commercial business model. In commercial business models, MaaS companies can act as a commercial reseller and a commercial integrator. Public transport operators owned by the municipality or region can act as MaaS operators by integrating additional transport services and digital services with their existing public transport. Public-Private-Partnerships (PPP, P3s) and Public-Private-People-Partnerships (PPPP, P4s) are two business models governments could follow in facilitating MaaS. In P3s, the public actor may integrate different types of actors and services into the system, which will rationalize the services the public actor is responsible for. P4s would also be considered as a way for organizing future mobility and transport in primarily rural and sparsely populated areas and regions.

Implementation issues

- **Organizational and planning issues:** We suggest that Wisconsin cities such as Madison and Milwaukee establish a Smart Public Transport Task Force to aid in the implementation of MaaS. The task force should have representatives of state and local government, public and private transport providers, academics who study, coordinate and inform participants about the integration of public transportation travel information services and associated payment systems in each region. Such efforts could be led by the regional metropolitan planning organizations or by the State DOT. Such a process could also be adapted for smaller locations and rural areas. A statewide Smart Public Transport Task Force could be used to share expertise and explore how to improve information systems and transport services in locations with limited capabilities to provide a wide range of choices.
- **Data issues:** Data standardization, real-time data availability and data security need to be considered in implementing MaaS. Data standards should be developed among all the participants. Existing data standards, including GTFS (General Transit Feed Specification), GTFS-realtime, and GBFS (General Bikeshare Feed Specification), could be used. Data standards for carsharing, dockless-bikeshare and other services need to be established in the future. Ease of data availability is the foundation to enable real time information. An Open Data Cloud is required to enable real time information in an integrated MaaS system. A trust framework or trust domain is essential for implementation of MaaS as it involves data exchange, retention, analysis, etc. The scope not only includes personal data for users, but also propriety data from various transportation service providers.
- **Payment integration:** Wisconsin is a mix of urban, suburban and rural communities and the payment system for each case is different in nature based on technological availability and user demand. For urban cases such as Milwaukee, the case of the MCTS M-CARD is

an easy, affordable and efficient way to pay for bus service. For sub-urban/rural cases, the payment system is still based on cash or coupons. Payment options include a prepaid card refilled with a balance limited by a certain minimum to maximum amount, an account credit working like a credit card, and some integrated payment options for rural or limited smart phone accessibility. Promotional offers could be made to users that may give them more points for payment discounts if they are making a suggested route choice.

SWOT ANALYSIS

To develop a fuller understanding of MaaS benefits and challenges before implementing it in Wisconsin, the research team conducted a Strength, Weakness, Opportunity, and Threat (SWOT) analysis (see Figure III), to identify MaaS’s strengths and weaknesses (S-W), as well as broader opportunities and threats (O-T) from the perspectives of all participants in Wisconsin.

Strength	Weakness
<ul style="list-style-type: none"> • User Flexibility • User Convenience • Transparency • Personalization • Promoting sustainable and health lifestyles 	<ul style="list-style-type: none"> • Technology investment requirement • Equity • Funding • Ease of Use • Wireless Connectivity Issues
Opportunities	Threats
<ul style="list-style-type: none"> • Sustainable and intermodal travel options • Young talent to Wisconsin • Complimentary services • Equity • Cross-boundary solutions 	<ul style="list-style-type: none"> • Partnership establishment Uncertainties with transportation service providers • Hard to change travel patterns and behavior • Subscription model • Privacy concerns • Government Approval Requirements

Figure III: SWOT Analysis

SYSTEM ARCHITECTURE AND ROADMAP OF MAAS IN WISCONSIN

Architecture

The system architecture for MaaS in Wisconsin is designed to show different roles of participants in the three main sections, including data, business services and user interface, as illustrated in Figure III. Data are collected from both transportation service providers and users and processed by MaaS service providers. Two types of business services are provided, tailored transportation service for travelers (users), and operation analysis and optimization for transportation service providers. System security and government regulations are established to ensure an adequate and safe MaaS system.

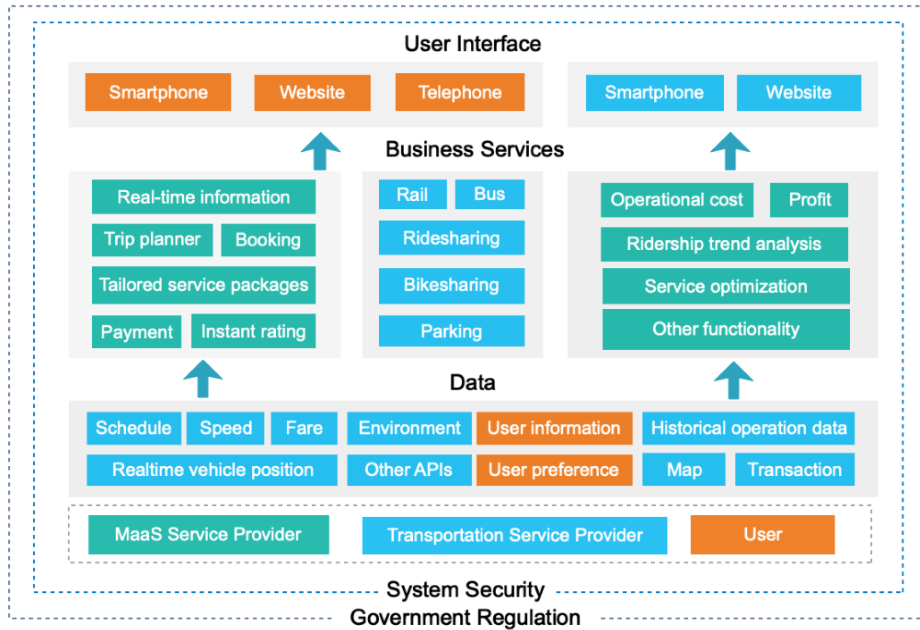


Figure IV: System Architecture for MaaS in Wisconsin

Roadmap

The roadmap for implementing MaaS in Wisconsin defines the strategic plan for participants, which consists of a set of tasks in planning, launching and implementation phases. To establish MaaS in Wisconsin, local governments need to create a suitable legal environment to encourage different service providers and startup companies to work together and implement new technology. MaaS service providers take the responsibility of integrating services together through information provision, ticket integration, payment integration, revenue allocation, etc. Tasks identified for transportation service providers are collaboration, adaptation and integration.

MaaS may possibly evolve from a large urban area, then advance towards smaller cities. However, rural areas face some challenges in adapting to MaaS but will eventually adapt to it. Although this report has recommended planning and implementation strategies for MaaS in rural areas, more efforts should still be taken to study specific travel behavior of people living in rural areas, to explore more business models, and to investigate most suitable marketing strategies. Tailored service packages need to be designed not only for older adults in rural areas, but also other population groups, after understanding their travel characteristics. Pilot projects are suggested to be established to study implementation of Wisconsin MaaS in different scenarios, such as urban or rural, inner-city or inter-city, public-funded or commercial-funded, etc. These projects would make great contributions in verifying the strategies proposed in this report and exploring new visions of MaaS.

Actors	Tasks	Phase I: Planning	Phase II: Launching	Phase III: Implementation	
Government	Legal Environment	Resolve Equity issues (e.g., Aging and disabled, low-income families, etc.)		Monitor WMaaS Operators and TSPs	
		Break out statewide cross-county barriers			
	Support Public Transportation usage	Build incentive plans to employers providing support to employees for public transportation			
		Build incentive plans to Transportation Service Providers for participating in WMaaS			
	Enhance data security and exchange technology	Set up statewide data security and open data regulations	Invest in the latest technologies for supporting MaaS		
	Finance	Identify and determine potential funding sources for support WMaaS			
Public Awareness	Build up public awareness on WMaaS	Initiate public referendum on WMaaS			
Research and Development	Conduct feasibility study on WMaaS				
MaaS Operator	Strategy	Develop WMaaS business models	Promote/Market WMaaS in public		
			Branding Plan		
	Collaboration	Build up partnership among all the participants	Establish Business model with all WMaaS participants	Initiate MaaS Pilot Project(s)	
	Service Integration		Integrate payment, routes and real time info		
	Revenue Allocation		Develop revenue allocation/share agreement		
Customer satisfaction	Conduct customer preference survey and demand analysis		Perform service evaluation		
Transportation Service Provider (TSP)	Collaboration	Establish Agreements to enable data exchange , revenue allocation, service scope and security			
	Adaptation	Upgrade technology and infrastructure for WMaaS			
	Integration	Data standardization (Open data)		Exchange data	

Figure V: Roadmap for implementing Mobility as a Service in Wisconsin

CHAPTER ONE INTRODUCTION

1.1 BACKGROUND

The transportation of goods and people play an important role in the growth of an economy. High density and connectivity of transportation infrastructure is closely related to high levels of development. However, highway-centric improvements such as expansions may increase the number of vehicles on the road resulting in more congestion. This issue can be resolved by finding a more sustainable solution that uses existing mobility infrastructure and resources to effectively move larger numbers of people from their origins to their destinations.

Wisconsin has undergone immense societal and economic development since the Great Recession in 2008. The unemployment rate is expected to be less than 2.5% due to an influx of labor force, shifts in the basic needs of the aging population, and trend changes in technology and personal habits [1]. Today's active workforce will begin to shift into older population groups in the next couple of decades and will require advanced and adequate mobility support. Building a stable, prosperous future for Wisconsin will not only require increasing the region's attractiveness for potential residents, but also improving the quality of life for current residents [2]. A recent statewide California study found that millennials are more inclined to use all shared mobility services (e.g., fleet-based car-sharing, peer-to-peer car-sharing, bike-sharing, dynamic ridesharing, and on-demand ride services) [3]. With the influx of a new labor force, mobility demand will be instrumental in connecting the workforce to locations experiencing job growth.

The Wisconsin Department of Administration estimated that by 2040, 23.7% of the population will be 65 or older, up from 13.7% in 2010. Additionally, the population between 70 and 79 will more than double in size by 2040 which will change the workforce composition dramatically [4]. An aging population has special mobility needs due to their more restricted physical conditions and lifestyles. These factors and the projected age population shift will escalate the necessity for solutions to specific transportation needs of the elderly and persons with disabilities.

These societal and demographic changes in Wisconsin will increase demands for new and different mobility solutions. Efficient and effective accessibility options can ultimately lead to positive economic and social benefits. A sustainable mobility solution can be attained through the implementation of a concept called MaaS or Mobility as a Service. As defined by Kamargianni and Matyas, Mobility as a Service (MaaS) is a new mobility model that aims to bridge the gap between public and private transport operators on a city, intercity and national level, and envisages the integration of the currently fragmented tools and services a traveler needs to conduct a trip (planning, booking, access to real time information, payment and ticketing) [5]. Implementing MaaS could help promote and boost Wisconsin's economic growth and technological advancement. This project aims to assess the feasibility of and potential ways to implement MaaS in Wisconsin.

1.2 PROJECT OBJECTIVES

Identification of current transportation service gaps and potential solutions are necessary in order to meet the mobility demands of people in Wisconsin with changing societal and demographic characteristics. Three separate tasks were proposed for this project: a) study demographic and technological trends, and socioeconomic challenges affecting public transportation in Wisconsin; b) provide a description of the architectural and operational design of a MaaS (Mobility as a Service) platform for Wisconsin; and, c) study factors affecting the implementation of improved mobility services in Wisconsin.

1.3 PROJECT METHODOLOGY

Three separate phases were conducted to achieve the project's objectives: 1) study demographic, economic and technological trends in Wisconsin; 2) identify critical issues and MaaS strategies in different phases; and 3) design the architecture and roadmap for a MaaS ecosystem in Wisconsin (Figure 1).

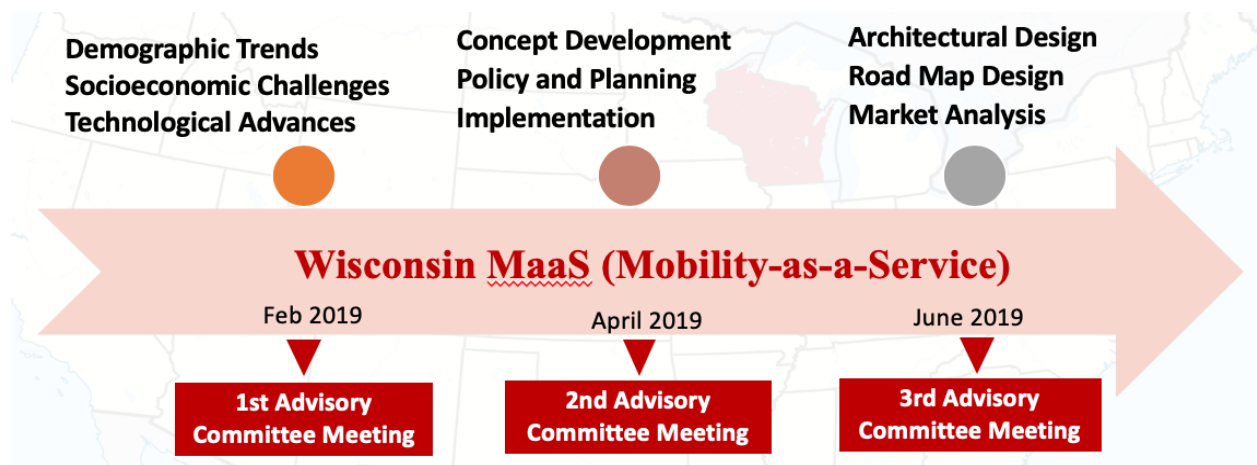


Figure 1: Process development of the project to identify current transportation service gaps and potential solutions.

An Advisory Committee was established and consisted of knowledgeable individuals with skilled expertise from the transportation industry (see Appendix A). A total of eight committee members represent an array of transportation providers and organizations throughout Wisconsin's transportation system including local governments, transportation planners, public transit providers, shared-ride taxi service providers, and bikeshare providers.

Throughout the project timeline, three Advisory Committee meetings were held to discuss the research team's progress during each phase. Initially, the research team gathered summary statistics indicating demographic, economic, and technological trends in Wisconsin, and found new research and applications discussing MaaS. During the first Advisory Committee meeting in February 2019, the research team shared their findings on demographic, economic and technological trends in Wisconsin. Committee members expressed their interests and concerns with the information shared that served as the foundation for identifying critical issues to address in the next project phase. The second phase occurred between February and April and involved identifying critical transportation issues and MaaS strategies to address these issues. The critical

issues were categorized into groups focused on concept development, policy and planning, and implementation issues. Each of these identified issues were then further analyzed by their ability to answer the following two questions: 1) Do these issues exist in Wisconsin, and if so, to what degree? And, 2) How can these issues be fully considered and solved by the envisioned MaaS framework? Through rigorous research, the team assessed current practices and possible suitable solutions for Wisconsin by reviewing best practices and MaaS system case studies where successful implementation occurred either nationally or globally. These findings were then packaged into proposed solutions that were discussed at the Second Advisory meeting in April. Finally, the third phase consisted of developing an architectural design, roadmap design, and market analysis for WMaaS (Wisconsin MaaS). These items were then introduced at the last Advisory Committee meeting held in June with the intention of receiving concluding feedback for drafting of the final report.

1.4 ORGANIZATION OF REPORT

This report has been organized into 7 chapters. Chapter 1 includes the introduction, background, project objectives, project methodology and a description of the overall organization of the project. Chapter 2 focuses on the demographic, economic, and technological changes in Wisconsin. In this chapter, the primary issues like aging population, labor shortage, spatial and job mismatched and needs of low-income travelers have been highlighted. Chapter 3 examines all the transportation modes and operations in Wisconsin and identifies potential service gaps by investigating the locations and service availability of each transportation mode in different parts of Wisconsin. Chapter 4 describes the four-case study performed for Mobility as a Service (MaaS) in different parts of the world to evaluate the strategies and the mobility solutions implemented in each case. Chapter 5 identifies the barriers associated with implementing MaaS in Wisconsin which was based on the feedback of the Advisory Committee members. The chapter also covers potential solution suitable to a Wisconsin scenario for each of the barriers identified by the committee members. Chapter 6 designs a system architecture for MaaS in Wisconsin that identified all the participants involved in MaaS and how they are connected;;develops two sets of mechanism, i.e., one for MaaS customers, and the other for MaaS service providers, for MaaS operations in Wisconsin ; and proposes a road map to define each step needed to be taken to implement MaaS in Wisconsin. Chapter 7 summarizes the overall finding from the research and makes recommendations for the future implementation of MaaS in Wisconsin.

The appendices in the report include: A) List of WMAAS advisory committee members; B) Meeting minutes for the three advisory committee meetings; and C) A Pilot Project Concept of Campus MAAS.

CHAPTER TWO DEMOGRAPHIC, ECONOMIC AND TECHNOLOGICAL CHANGES IN WISCONSIN

2.1 DEMOGRAPHIC CHANGES

2.1.1 Aging population and people with disabilities and their travel patterns

Wisconsin's population is aging and is occurring faster in rural areas. According to the Wisconsin Department of Administration's Demographic Services Center's 2013 Report [6], the population of people aging between 65 to 84 is projected to nearly double from 777,500 in 2010 to 1,535,500 in 2040. Additionally, people 85 years or older are estimated to increase 140% from 118,500 in 2010 to 283,500 in 2040, as shown Figure 2. From 2010 to 2040, the number of people in the 0 to 17 and 18 to 64 age groups will decrease 10% (from 86% to 76%), while the 65 and over age group will increase 10% (from 14% to 24%), as illustrated in Figure 3. It is interesting to note that all of the population growth in Wisconsin between 2010 and 2040 will be of people over the age of 65. Such statistics suggest that an aging population will become a major concern for Wisconsin over the next 30 years.

"all of the population growth in Wisconsin between 2010 and 2040 time period will be of people over the age of 65."

Source: Wisconsin Department of Administration [6].

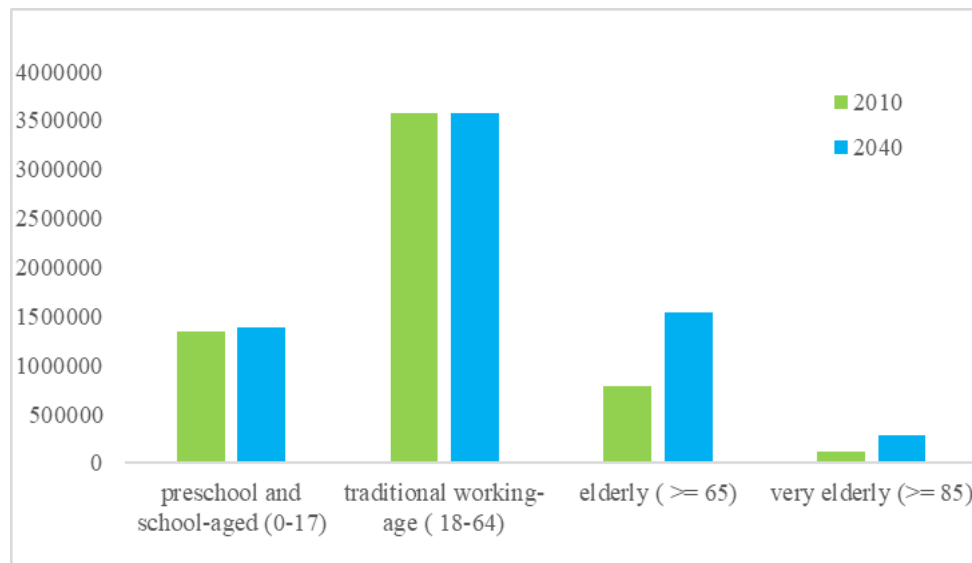
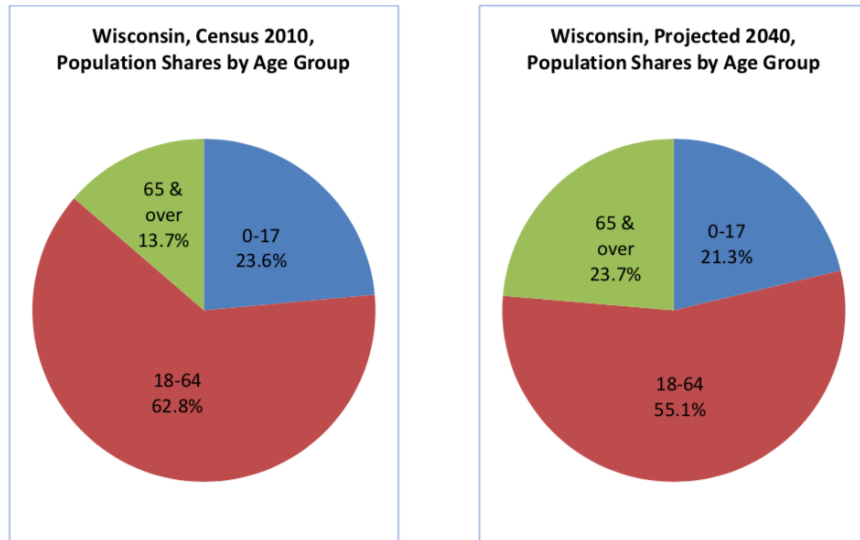


Figure 2: Population of Different Age Groups in Wisconsin from 2010 and 2040 [6]

Noticeably, in comparison to other Wisconsin cities and counties, Northern Wisconsin is projected to see the most dramatic aging population shift. As shown in Figure 4, estimates predict that 3 out of every 10 residents in each Northern Wisconsin county will become a senior (age 65 or older). Age or disability can contribute to social isolation and often present obstacles to reaching healthcare appointments, school, work, the grocery store and more [7].



Wisconsin Population, 2010 - 2040, by Broad Age Groups							
Age Group	Census 2010	Projected 2015	Projected 2020	Projected 2025	Projected 2030	Projected 2035	Projected 2040
0-17	1,339,492	1,311,425	1,338,370	1,366,010	1,385,735	1,390,055	1,381,310
18-64	3,570,180	3,576,670	3,602,780	3,580,325	3,565,855	3,577,580	3,574,960
65 & over	777,314	894,920	1,063,930	1,257,515	1,424,320	1,508,635	1,535,365

Figure 3: Population Comparison between Different Age Groups [6]

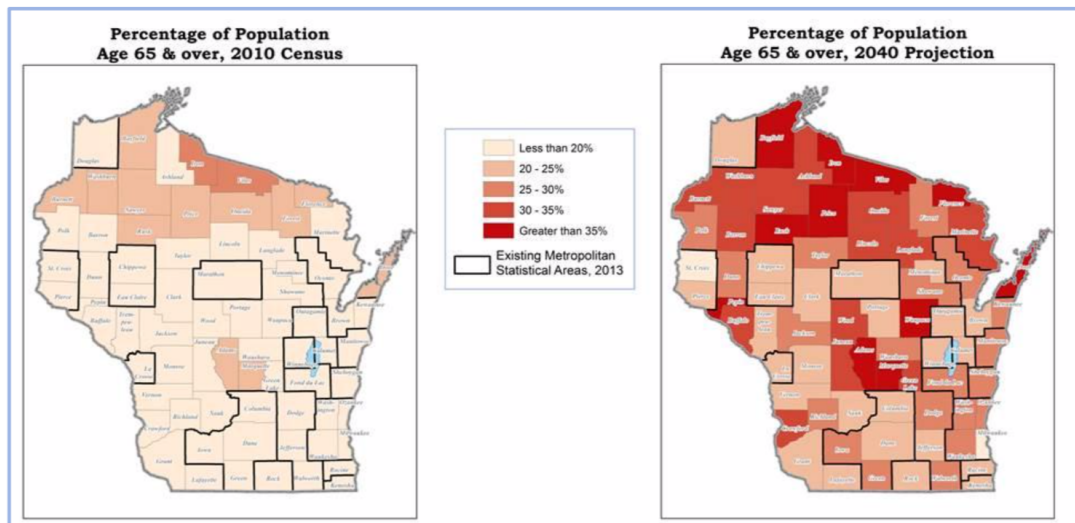


Figure 4: Percentage of Population Age 65 and over between 2010 and 2040 [6]

According to a survey targeting Wisconsin residents age 65 and over, the preferred daily mode choice for older adults in Wisconsin is a personal vehicle, with just about half favoring driving by themselves (46%) compared with being driven by others (9%). Between public and specialized transit choice, bus had the most frequent usage (3.36%) by this age group, as shown in Table 1 [8]. However, as this population ages, their ability to drive themselves for essential trips may be less feasible. The top five mobility barriers, in order of the most prohibiting, are: no/limited access to a car, no/limited access to public transit, long distances to destinations, cost issues, and other health challenges. These barriers may be restricting travel for older adults with mobility difficulties to get to their main destinations such as going to medical appointments, buying essential living items, attending community or civic events, and visiting friends or friends [8]. While the majority of seniors in Wisconsin have access to the internet, the majority use a personal computer to access the internet.

Table 1: Respondents by Modal Choice [8].

Question	Rarely or Never	A Few Times Per Month	A Few Times Per Week	Every Day
Private auto (you are the driver)	26.08%	5.50%	22.56%	45.86%
Private auto (you are the passenger)	28.41%	35.81%	26.87%	8.91%
Bus	81.74%	8.41%	6.49%	3.36%
Taxi (you are the only passenger)	88.69%	8.11%	2.59%	0.61%
Taxi (shared ride with other passenger)	90.13%	6.20%	2.98%	0.69%
Mini-bus	89.00%	7.47%	2.63%	0.89%
Paratransit service	91.76%	4.14%	3.27%	0.83%
Biking	87.77%	7.20%	3.89%	1.14%
Personal motorized device	92.48%	2.19%	2.12%	3.21%
Walking	37.38%	19.97%	19.76%	22.89%

According to 2017 National Household Travel Survey (NHTS) data, 25.5 million Americans age 5 and older have self-reported travel-limiting disabilities. Of these, 13.4 million are age 18 to 64 and 11.2 million are age 65 and older. That is, the aging population makes up 45.5% among all American adults with disabilities. Most of these disabilities are long-term: 79.1% report having a disability for more than 6 months and another 13.8 percent report having a life-long disability. Over half of all respondents with disabilities use one or more medical devices, including walking canes, walkers, wheelchairs, motorized scooters, motorized wheelchairs, crutches, white canes for visual impairments, and seeing-eye dogs [9].

Since there is a high percentage of older adults in people with disabilities, characteristics and barriers to mobility for essential trips of older adults can be mitigated with services bundled can provide access to the most cost-efficient and fastest modes available to both older adults and people with disabilities in their area. Besides, special medical devices and care should be given to people with disabilities [9].

2.1.2 Younger Generation Lifestyle and Travel Trends

Millennials tend to own fewer cars, prefer to commute by alternative non-motorized means of transportation, and prefer to drive less in comparison to members of older generations.

Source: WISPIRG [8]

Younger individuals generate a significant impact on travel trends and can be a persuasive demographic group because of their stage in the general lifecycle. Their influential ability is a result of lifestyle, consumer preference, and travel behavior differences compared with previous generations. Nationally, travel behavior and customer preferences are changing with millennials directly influencing these shifts. Millennials use multiple modes to commute and are generally less interested in car ownership than other age groups.

Many millennials favor transit-oriented living and consider public transit the backbone of a multi-transit lifestyle [10]. In APTA's 2018 Mobility Survey, 74% of millennials said they would use a Mobility as a Service app to coordinate and pay for different types of transportation [10]. Additionally, APTA's Millennials and Mobility study showed millennials tend to pick the best mode for every trip. For example, 69% of millennials surveyed said they used multiple modes to reach a destination several times a week or more [10]. Shifts in travel trends nationwide echo similar trends experienced in Wisconsin. For example, a NHTS survey from 2017 showed that, in Wisconsin, the number of drivers aged 20 to 54 drove significantly fewer miles than comparable age groups in 2009 [11].

A study conducted by WISPIRG in 2014 found that college-aged students in Wisconsin are more inclined to want to experience a multimodal transportation future. The availability of multimodal transportation options is a major deciding factor when determining where to live after graduation. Additionally, a survey from the WISPIRG study showed that 75% of students preferred to live in a place with non-driving transportation options after graduation, and 55% of students would reside in Wisconsin after graduation if they could live in a place where trips for work, recreation, and errands were not dependent on a personal vehicle [10]. In Wisconsin, 45% of the population is 35 years or younger, with almost a fourth (23%) of those in this age group living in the two largest Wisconsin cities, Milwaukee and Madison [12]. People in younger age groups in Wisconsin tend to have similar travel patterns and preferences as the national trend discussed above. The study by WISPIRG Foundation found that millennials in Wisconsin find it important for them to live in a place with non-driving transportation options and would be more likely to stay in Wisconsin if they could live in a place where trips for work, recreation, and errands did not require a car. Survey participants also said that the availability of multimodal transportation options – or the lack thereof – may factor into their decisions about where to live and work in the future indicating how Wisconsin MaaS could be an important innovation to fill this desire [12].

Younger generations are increasingly preferring to live in denser, urban areas to match their lifestyle preferences and to use a commute mode that allows them to optimize their time or multitask. This shift has been supported by WISPIRG's finding that showed that 85% of the survey respondents preferred to avoid driving to reduce costs associated with having a car, such as maintenance, repair, gas, insurance, and parking. About 63% of them stated that they would

like to engage in other activities (like working/doing homework, reading, using social media, using their smartphone for fun etc.) while traveling [10].

The study by WISPIRG also suggested that new technologies and services, often linked to smartphone apps, are facilitating Wisconsin’s younger generations’ car-free or car-lite lifestyles. Smart phone and technological use have become an essential part of the life for younger generations. The Pew Research Center found that more than 92% of millennials and 85% of Generation X own smartphones (see Figure 5). The majority of the millennials are also very dependent on access to and use of social media (Facebook, Instagram) [13]. These nationwide trends indicate that millennials may be more adaptive to using technology for their commuting choices and more supportive of MaaS due to their aversion to owning or driving a personal vehicle. Millennials are reported as the most frequent users of these emerging transportation options as shown by a study performed by ZipCar (Zipcar 2013). Real-time bus tracking and route-mapping on smartphones have made navigating public transportation more convenient helping to shift the travel preferences of younger generations. Additionally, an internet MaaS platform does not seem to be a barrier for this group since adults younger than age 45 were equally divided between using a personal computer and using a smartphone as their primary way to access the Internet.

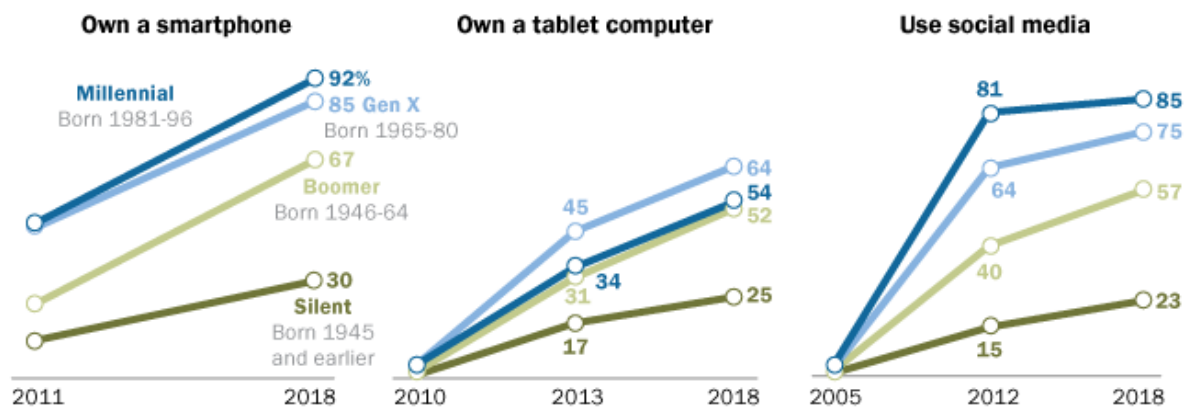


Figure 5: Percentage of adults in each generation who own a smartphone, tablet computer or use social media [11]

Younger generations’ adaptability to shared mobility services could be a result of many factors such as residential location choice, comfort with technology use, and higher engagement rates in “travel multitasking” during their commute. Millennials are more inclined towards residing in central and urban areas and are more open to using alternative modes of transportation. These lifestyle and travel preferences classify them as a potential high-adapting market for shared mobility services [7].

2.1.3 Low-Income Travelers Travel Trends

Nationally, members of low-income households take fewer trips per day and travel shorter distances. People in low-income households walk, bicycle, or use public transit to complete trips significantly more than those in households with higher incomes. They use privately-owned vehicles less and are more likely to not own a personal vehicle at all. The mode used by trip

purpose also differs except for work trips when a personal vehicle is available for use. Otherwise, low-income households tend to complete shopping/errand trips and social/recreational trips more often through walking, bicycling, or using public transit. Additionally, those in low-income households in denser, urban areas use public transit more than in areas with less density due to an absence of attractive, reliable, and affordable alternative transport options [14]. According to a survey among US families in 2017, the lowest income group in this survey (annual household income of less than \$40,000) was most likely to identify affordability as the biggest challenge of traveling [15].

According to the United States Census Bureau, 11.3% of Wisconsin's population is living in poverty which is larger than 30% of the states investigated in the United States [12], and 30.1% of households earn less than \$35,000 annually [12]. In 2017, Menominee County and Milwaukee County had the highest poverty rate in Wisconsin (27.6% and 19.1%, respectively) [15][16]. While the percentage of people below the poverty line is decreasing (Figure 6), a significant portion of travelers with low income still exist and it remains imperative that their travel demands, and concerns are addressed in any policy and planning considerations.

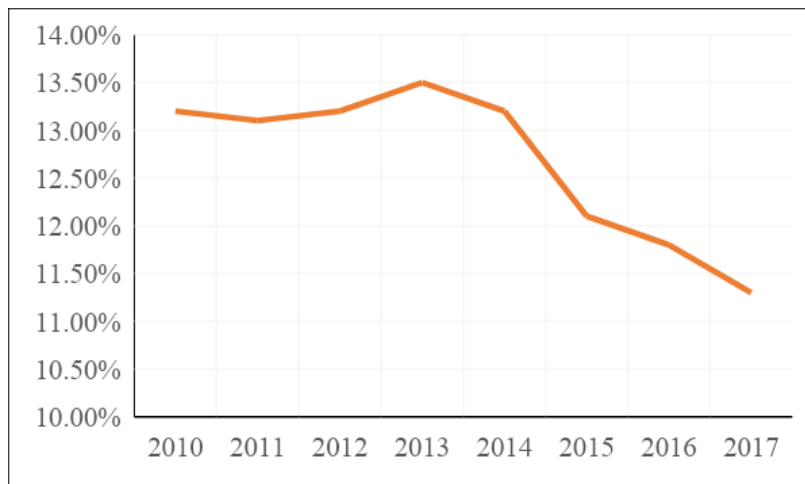


Figure 6: Estimated percent below poverty level in Wisconsin, 2010-2017 [11]

Low-income households in Wisconsin exhibit a similar travel pattern and behavior as the national findings. Low income Wisconsinites, who are often people of color, face a significant financial barrier to owning a car or for maintaining their vehicle. Some low-income individuals who are unable to drive or afford a car have limited dependable transportation options, while others who live in cities with public transit options are not adequately served [17].

Barriers to travel for low-income people can be mitigated by offering tailored service packages that accommodate the financial investment capacity or desire and preferred methods of travel of people in low-income households.

2.2 SOCIOECONOMIC CHANGES

2.2.1 Spatial Mismatch

The job location of an individual can often be contradictory to their place of residence for commute purposes. This misalignment generally leads to the generation of more car trips, that could be across city or county borders, and usually results in more personal vehicle ownership in households. Figure 7 shows a statewide comparison between the number of housing units and employment numbers for each county [18]. A spatial mismatch can be observed by comparing the housing and employment densities. Housing density in the southeastern region of Wisconsin is relatively low compared with employment. Similar low housing density trends can be observed in other counties such as Douglas, Taylor, Lincoln, and Clark which also have a relatively high employment availability.

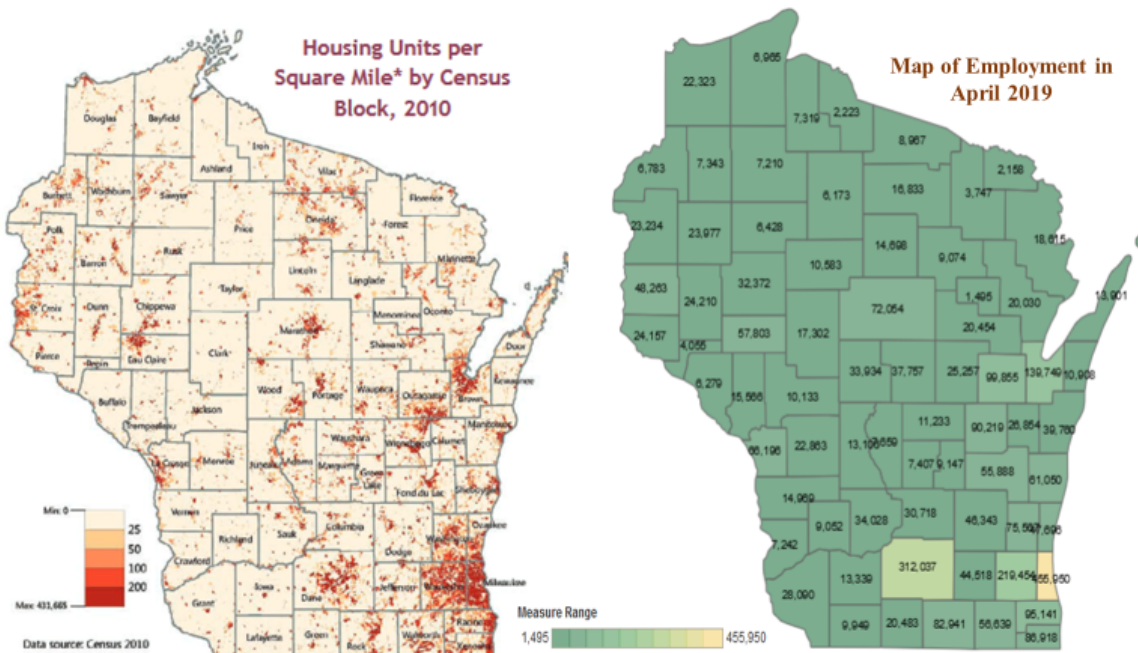


Figure 7: Comparison between housing location and Employment location in Wisconsin [18]

This observation indicates that the population employed by those jobs is commuting to those areas from elsewhere. The work-home trips generated will typically be completed through a personal vehicle if adequate public transportation options are not available. Using Milwaukee County as an example, the green municipalities in Figure 8 have larger populations that commute, and presumably work, during the day than at night. The City of Milwaukee attracts the most workers—about 125,000 in total, yet nearly 95,000 people leave the city for work every day. Similar travel patterns can also be observed from Figure 8 which traces commute flows between each of the 100-plus cities, towns, and villages in the five-county Milwaukee region. The red lines depict commuters entering or leaving communities outside the region highlighting that many labor force commuter's cross county boundaries for work purposes [1] [2].

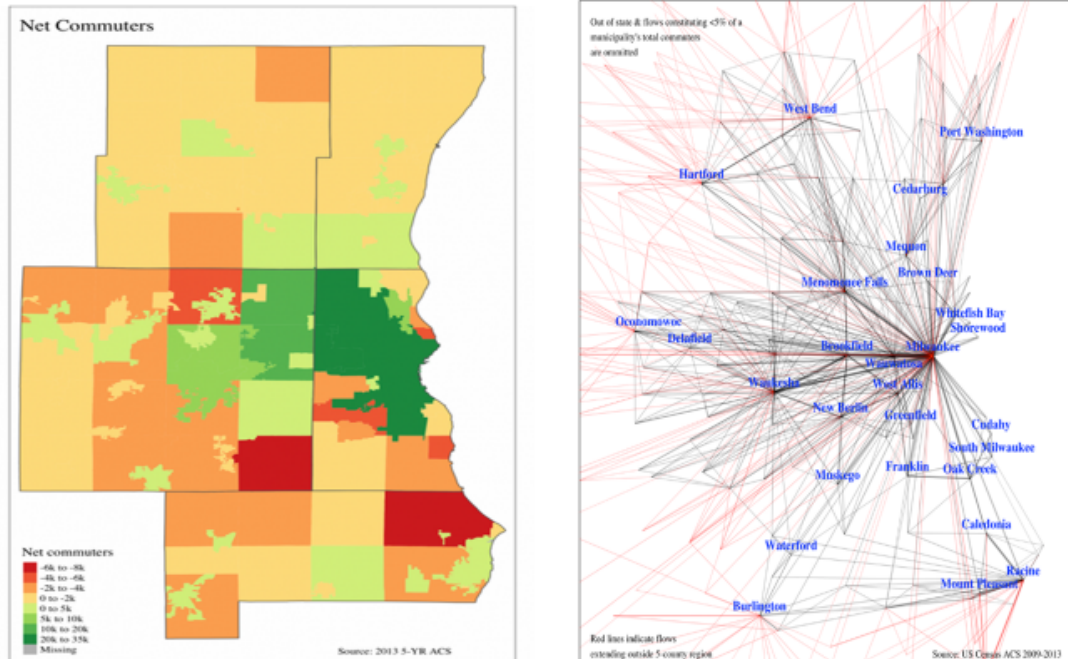


Figure 8: Net commuters and commuting flows in Milwaukee [2]

An individual’s decision on employment or housing location could be based on many factors such as job suburbanization, inadequate public transportation options, social factors, racial segregation, or housing cost. If an individual resides in a specific location further away from their employment location, their commute travel demand could be met by private vehicle ownership, public transportation, or private shared mobility operators. Mobility as a Service (MaaS) acts as a choice multiplier and solution to bridge the gap between commuter choice and public transportation. MaaS can increase and ease mobility by optimizing routing options, integrating payment systems, and reducing travel costs.

2.2.2 Labor Shortage

According to the Center for Research on the Wisconsin Economy (CROWE), Wisconsin’s economy has witnessed its greatest unemployment rate decline which has decreased from its peak of 9.2% (January 2010) to 3.2% (November 2017), just above the 3% all-time low (Figure 9). This change demonstrates a large growth in the labor market since a decline in the unemployment rate is a result of increasing job opportunities. The employment-population ratio, which measures the fraction of the population with a job, combines the employment and participation rates. In November 2017, the ratio in Wisconsin was 66.7%, which is the highest ratio since early-2008 and ranks the fifth highest among all states. Wisconsin added about 59,000 jobs between January 2010 and November 2017 with a cumulative gain over 14%. This increase in job opportunities allows for more potential for incoming labor to enter the Wisconsin economy. The majority of the incoming labor force would fall under the working age group [1].

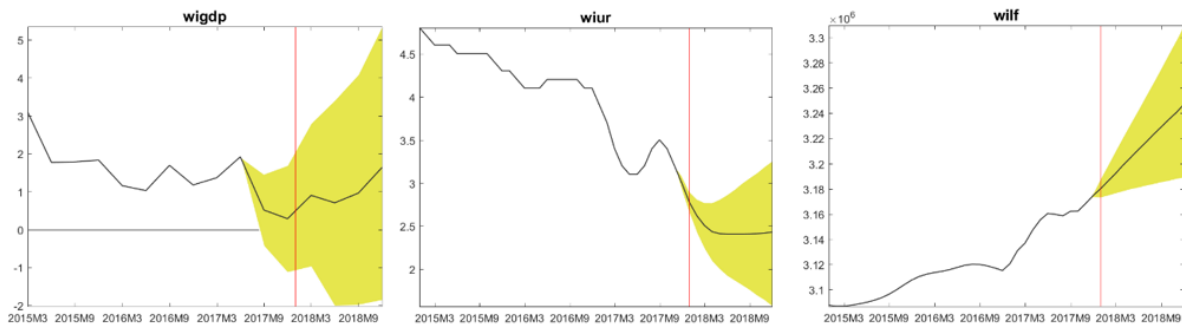


Figure 9 : GDP growth rate, unemployment rate, labor force in Wisconsin [1]

The majority of the labor force entering Wisconsin is within the age group of 25 to 54 (working age group) and prefer to avoid driving. Efficient public transportation options make urban living more cost effective and time efficient. Retention of this young labor force in Wisconsin will require prioritizing sustainable, accessible, and adaptable public commute mode options [1], [2].

2.2.3 Sharing Economy

The sharing economy is an economic model often defined as a peer-to-peer (P2P) based activity of acquiring, providing, or sharing access to goods and services that are facilitated by a community based online platform [19]. In recent years, the sharing economy has become a new opportunity for suppliers and users to use. The Pew Research Center found that usage of these platforms varies widely across the population. In total, 72% of American adults have used at least one of eleven different shared and on-demand services. Some incorporate a relatively wide variety of these services into their daily lives: Around one-in-five Americans has used four or more of these services, and 7% have used six or more [20]. Wisconsin has experienced a similar trend as the nation where residents have embraced shared and on-demand services. Shared and on-demand transportation services such as Zipcar, Lyft, and Uber (sharing rides and renting cars) have entered the Wisconsin market over the past several years and have increasingly been added to Wisconsin customer's list of accessible transportation alternatives.

2.3 TECHNOLOGICAL CHANGES

Mobility as a Service (MaaS) is not only an option for younger generations but is also a necessity for aging populations and persons with disabilities to provide them with mobility independence. MaaS involves a combination of various transport modes such as car, bus, and bicycles readily available at the press of a button. The deployment of MaaS and service integration requires technological service availability. As discussed in Section 2.1.2, technology has already become an essential part of daily life for younger generations. Thus, for MaaS to become a reality in Wisconsin, identifying existing technological infrastructure is necessary since it can be a starting point of positioning for MaaS development.

2.3.1 Public Transportation Technology

Trip planning and passenger communications (bus route and schedule) are major barriers for public transit users; however, new emerging technologies are developing rapidly to help address these challenges. Nowadays, schedule and route plans are not only just available on websites but

have also been made to be compatible with smartphones that are quickly outperforming traditional computers for navigational activities [21].

Emerging technologies allow passengers to conveniently perform trip planning, minimize wait

Public transportation is undergoing technological change and advancement that has helped achieve more efficient service, and ultimately has influenced travel behaviors and trends of public transit commuters

Source: Oregon Department of Transportation [21].

times, and to make smooth transitions between modes and to coordinate transfers. In urban areas such as Milwaukee County, the Milwaukee County Transit System (MCTS) app allows users to save most frequently used stops for easy access for directions and has the option to save as many stops as desired to track real-time bus arrival information. The app offers an electronic payment option with built-in Google street views of every bus stop and an easy navigation home screen that includes tools to track buses, find stops, and customize by adding favorites [22]. In

suburban/rural areas, however, travelers make reservations via phone. Taking Ozaukee County shared ride taxis as an example, dispatchers arrange the scheduling by using a software called Route Match. Drivers then pick up, transport, and drop-off commuters while keeping in touch with the control center using the driver's version of the software on the tablet equipped in the vehicle.

Real-time information systems in public transit can include next stop audio systems as well. These audio systems aid passengers in unfamiliar areas to reach their destinations. This feature along with the availability of real time information on mobile devices or websites can help improve public transit users' trip experiences by informing their trip plan, minimizing wait times, and improving transfers [21]. In urban settings such as Milwaukee County, MCTS buses consist of a next stop audio system that update passengers with the next upcoming stop on the route. MCTS uses GTFS data, scheduled information, and a GPS tracking system to estimate the possible arrival time of the bus based on its last location and helps passengers predict the real-time arrival time of the bus at the stop. The company, Clever Devices, extracts clean data from raw data and broadcasts it to a website (RideMCTS.com), mobile devices, and phone system. Riders can choose the option most convenient to them to retrieve real-time information including texting, calling, or by going online. Two viewing options are available to the mobile user or computer users. One option displays the list of routes and estimated bus arrival times, whereas the second option is a map displaying chosen routes with bus icons revealing real-time locations of the buses. The customers can also be updated with estimated arrival times by texting or calling an information line [23].

Google Maps are also available for commuters to use where they can view maps, real time navigation, and access scheduling tools for transit systems, Uber, and Lyft. Google map uses GTFS, GTFS-Realtime, and Google's Complete Map Content Specifications. Data sources used by Google Map include transit agencies (e.g., MCTS, Washington County Commuter Express in Milwaukee) and crowdsourcing data.

With increased technology adoption by individuals and companies, electronic ticketing and fare collection systems are becoming popular among commuters. The electronic fare collection system can be enabled by smart card, smart phones, or magnetic stripe technologies. This allows customers to maximize convenience and minimize time consumption which increases efficiency and safety in money operation [24]. MCTS currently has the M card that uses an electronic ticketing and fare collection system (see Chapter 5 for more details).

2.3.2 Smartphone Technology

According to the U.S. Census Bureau, fewer than 60% of households own smartphones in half of Wisconsin counties (Figure 10), at least 30% of all households in nine counties lack any internet access, and in 10 counties fewer than half of households have some sort of wired broadband service. Households in the upper area of northern Wisconsin have the lowest number of smartphone use (50 % to 60%). The highest percentage of smart phone usage is in Dane county, Saint Croix, and Pierce Counties (~75%). Smartphone use in households is moderately high in the northeastern and southeastern regions of the state. A higher density of the aging population resides in the northern part of the state which is also a very rural area. Individuals who are part of the aging population group have special mobility needs that indicates a need for improving the technological service gap in order to efficiently mobilize Wisconsin’s growing aging population.

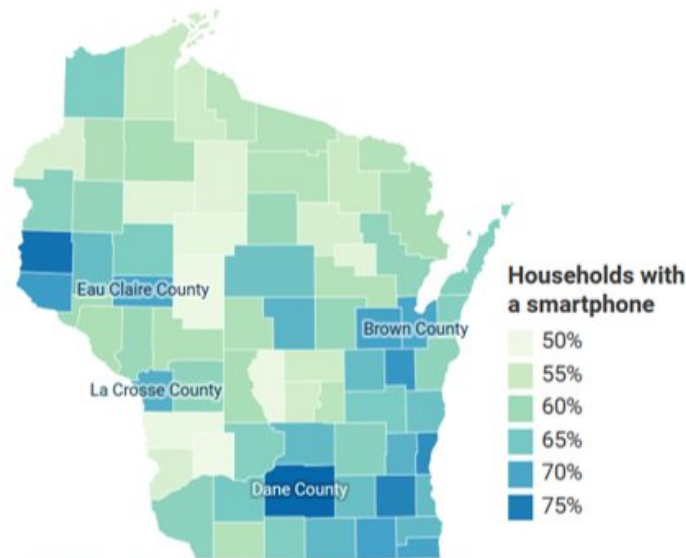


Figure 10: Percentage of households with a smart phone in each county in Wisconsin (U.S. Census Bureau)

The Wisconsin Department of Health Services (2014) indicated that about 77% of adults aged 65 to 74 and 43% of the adults aged 75+ have access to the internet (Figure 11). However, most adults aged 45 and older prefer to use a personal computer to access the internet. This finding suggests that older adults may be less adaptive to smartphones compared with personal computers. Therefore, MaaS solutions for older individuals considered to be in the aging population age group should be accessible in alternative methods other than a smartphone [25]. From the trends of the study it seems that smart phone access is still rapidly growing which also

includes the late adopters. Over time as the population ages, the percentage of smart phone users will continue to grow, and approach close to 100%. However, there will always be some percentage who is unable to use a smartphone which will require alternatives.

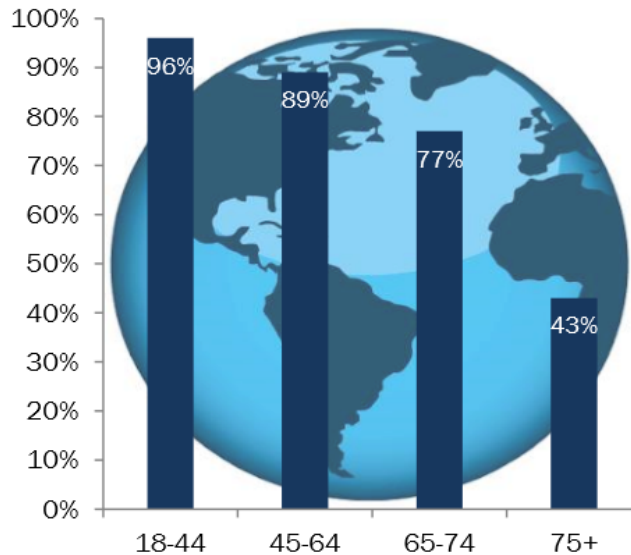


Figure 11: Internet access amongst Wisconsin adults based on different age group [25]

The Pew Research Center found that millennials are the highest users of smartphones even if they do not own broadband service at home [13], and the national trend of individuals owning desktop or laptop computers has slightly decreased between 2016 to 2018 from 78% to 73% [13]. The dip in desktop or laptop computer ownership may be indicative of a shift to a greater usage and ownership of portable mobile devices (e.g., tablet, smartphone) [13]. Acceptance and usage of smartphones varies based on the age range. The analysis above shows that older individuals are less adaptive to smartphone use whereas younger generations have embraced smartphones and intertwined them into their daily life patterns. Therefore, the approaches to implement MaaS for each age group should be different with the younger generation's MaaS solution more smartphone oriented.

2.3.3 Real Time Data

Real-time data and information are important factors to improve system efficiency and performance. For public transit, most real-time information relies on Automatic Vehicle Location (AVL) and Global Positioning Systems (GPS) in order to estimate approximate arrival times for passengers and transit system operators. Passengers access real-time arrival and departure information through dynamic signs at stops and stations, or through home or smartphone internet connections [26]. GPS technology also guarantees real-time data and information for other transportation modes such as taxis, cars, or bikes.

As smartphones become more prevalent, real-time data and information can also be transferred to users through apps (e.g., Transit, MCTS) in Wisconsin. Transit is an app that integrates the information of different modes to give travelers multimodal dynamic traveling information,

which helps them plan their trips anytime and anywhere. MCTS also developed their own app to provide information such as bus arrivals, departures, and schedules for their passengers.

2.3.4 Summary

The younger generation's disposition towards multimodal transportation in Wisconsin also highlights their supportive attitude towards the use of public transportation. The reason for this attitudinal shift may be due to changes in lifestyle preferences that influence the demand for more or better public transportation options. Conversely, it has been identified that Wisconsin has a large low-income traveler group and people in low-income households walk, bicycle, or use public transit to complete trips significantly more than those in households with higher incomes. The findings from Chapter 2 also highlights the significant existence of a spatial mismatch between job and housing location. All these factors will require the adequate supply (transportation modes and options) for each of these groups based on their needs. Suppliers are considered as any transport organization who wants to integrate their transportation services with a broader network of transport options to expand their customer reach and base. Generally, suppliers aim to provide service that is attractive to current and future customers by offering optimal levels of accessibility, efficiency, reliability, and flexibility. Often, each supplier must navigate trade-offs between their service offerings due to varying constraints (i.e. financial, geographical, etc.).

Under a MaaS scheme, users can access transportation services through a unified service that manages their trip across modes with one payment [9]. This aligns with users' desires to have access to quick, reliable, on-demand transportation options for their travel needs. The integration of payment into the MaaS scheme makes the process more seamless and the overall experience easier to understand. The implementation of a statewide Wisconsin MaaS system has the potential to make traveling within the state a much more enjoyable and stress-free experience.

Conceptually, MaaS requires a relatively easy transition and adoption for users and suppliers, although barriers exist for users and suppliers to implement and adopt the technology exist. Barriers to adoption for users include access to the internet to use the MaaS platform, an aging population and the potential for less willingness to adopt new technologies, and the difficulties to change travel behavior (e.g., still large use of personal vehicles for travel statewide). As identified in Chapter 2, Wisconsin currently has some of the technology required for MaaS (M-Card, Real time information, Electronic Fare System). However, Wisconsin also has technological gaps (low smart phone use areas). With evolution of time and government initiatives these gaps can be filled to facilitate supply for the users. Once users have access and the willingness to adopt the technology, the MaaS usage has a relatively low long-term commitment given the potential for flexible payment and service bundle options.

CHAPTER THREE PUBLIC TRANSPORT OPERATION IN WISCONSIN

Implementation of Mobility as a Service requires technological resources and public transportation infrastructure. MaaS provides an integrated transportation system offering carpool, rideshare, shared ride taxi, and transit services. Identifying the modes of transportation and services offered in Wisconsin will help to understand the foundation that is available to use for the future creation of a statewide Mobility as a Service. The section will also discuss the availability of each transportation service, their operational terms, and the location of each facility around the state. This chapter describes transportation services in Wisconsin including public transportation, intercity travel routes, shared ride taxi, ridesharing, and park and ride systems. After comparing the transportation systems with traveler demand in Chapter 2, this chapter gives an overall view of transportation service gaps in Wisconsin.

3.1 PUBLIC TRANSPORT

As defined by the Wisconsin Department of Transportation (WisDOT), public transport systems in Wisconsin are comprised of county-wide transit systems, multi-county transit system, fixed-route systems, shared ride taxis, and shuttle and inter-city services (Figure 12).

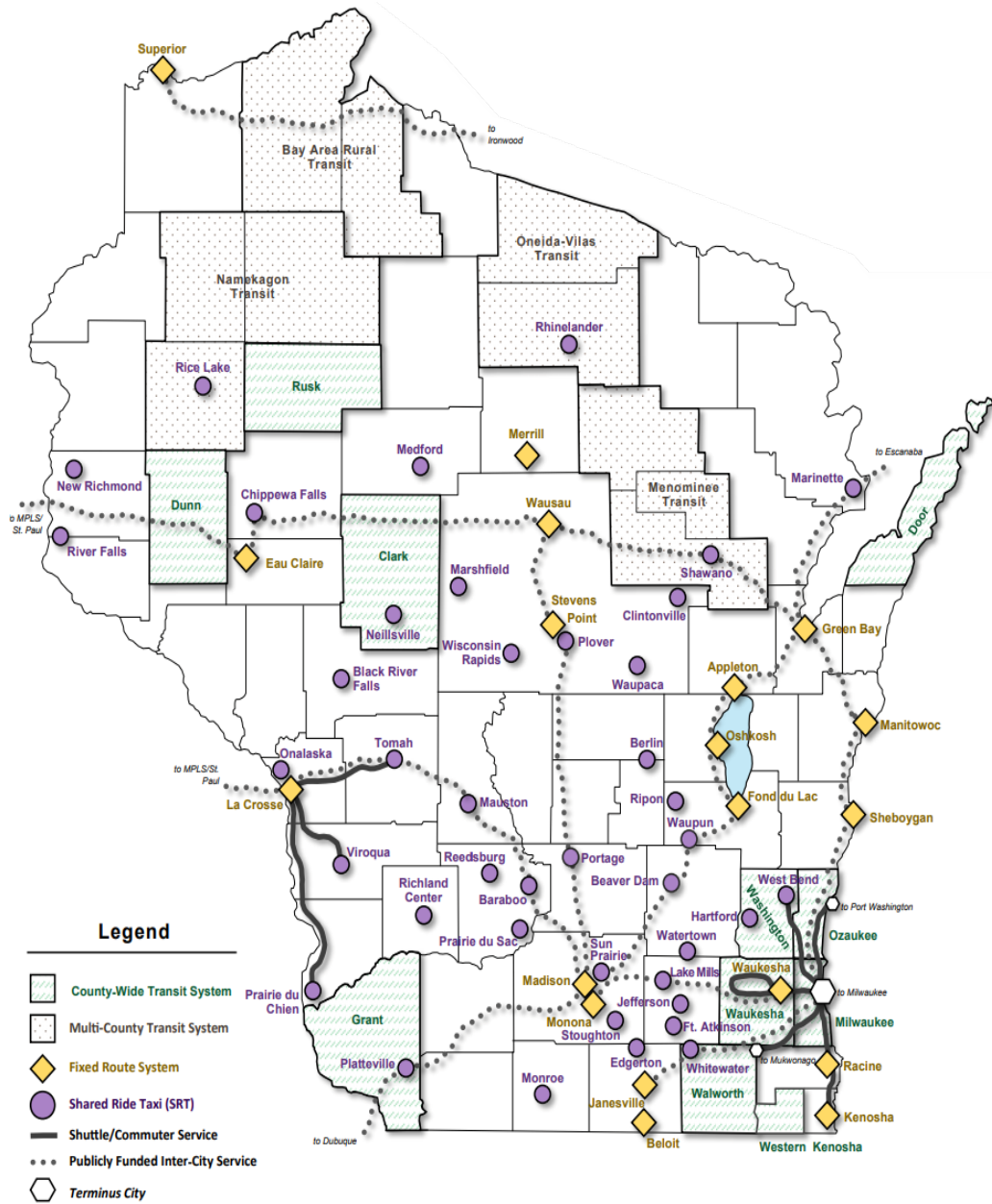


Figure 12: Wisconsin Public Transit System 2019 [27]

3.1.1 City and County-wide Transit System

Many Wisconsin counties have their own transit systems, including Rusk County, Dunn County, Clark County, Grant County, Door County, Washington County, Ozaukee County, Waukesha County, Milwaukee County, Walworth County and western Kenosha County. These systems provide a transportation network at the county level offering transit services for people who travel within county boundaries.

3.1.2 Multicounty Transit System

Multi-county transit systems primarily operate in the northern region of Wisconsin and include Bay Area Rural Transit, Namekagon Transit, Oneida-Vilas Transit System and Menominee Regional Public Transit. These systems provide transit service between two or more counties through a collaborative partnership [28].

3.1.3 Fixed Route Transit System

The fixed route services in Wisconsin are either a combination of fixed route and Paratransit services or fixed route, Paratransit, and demand responsive services. Fixed route services have a fixed schedule and the schedules vary from one county or system to another. The fare structure has different rates for base or standard rides, senior/disabled riders, and youth/student rides. The majority of fixed route services in the state are in the regions of roughly 30,000 or more. Additionally, while an aging population lives in the northern region of the state, fixed route service is only available in the northern county of Douglas. For example, the city of Appleton has a fixed route service that runs Monday through Friday from 5:30am-10:30pm, Saturday from 7:30am-10:30pm, and Sunday from 7:30am-2:00pm. The base fare for the service is \$2.00, \$1.00 for seniors or persons with a disability, and \$0.75 for youth or student riders [29].

Shared ride taxi services operate in many counties throughout Wisconsin and are generally operated by private companies. A shared ride taxi may pick up and drop off passengers enroute to a different passenger's destination. They typically use a flat fare or zone fare system. While open to all users, their usage is dominated by the elderly and persons with disabilities. This type of service usually needs to be scheduled one day before the intended travel takes place. Shared ride taxis are eligible for financial assistance from state and federal sources while conventional exclusive use taxis are not. Eligibility for funding requires that operators comply with federal and state regulations such as the Americans with Disabilities Act. A reduced fare is offered to seniors, students, and persons with disabilities. Figure 13 provides a map created by WisDOT displaying the shared ride taxi services in Wisconsin [27], [28]. One example is Washington County's Shared Ride Taxi Service. The Washington County Shared Ride Taxi Service provides public shared-ride services throughout Washington County and into the northern portion of Menomonee Falls (Menomonee Falls service area boundaries include Maple Road to the west; Pilgrim Road to the east and Menomonee Avenue to the south, with the exception to include Community Memorial Hospital and Gloria Dei Day Care). The service operates Monday through Saturday from 5:00 am to 11:00 pm. In order to use their service, the rider's origination or destination must begin in Washington County. Additionally, all fares are distance-based by 5-mile increments.

A similar form of demand responsive service exists in most of the rural areas of Wisconsin, especially in the northern region. While the northern part of Wisconsin has a large population of individuals 65+, Rhinelander SRT and Rice Lake City Cab are the only shared ride taxi systems in northern Wisconsin (Figure 13). This service gap highlights a disparity in northern Wisconsin between viable and accessible transportation options for individuals who may not have the ability to operate or own a personal vehicle for traveling. Shared ride taxi services are more common in the central and southern part of the state[27], [29].

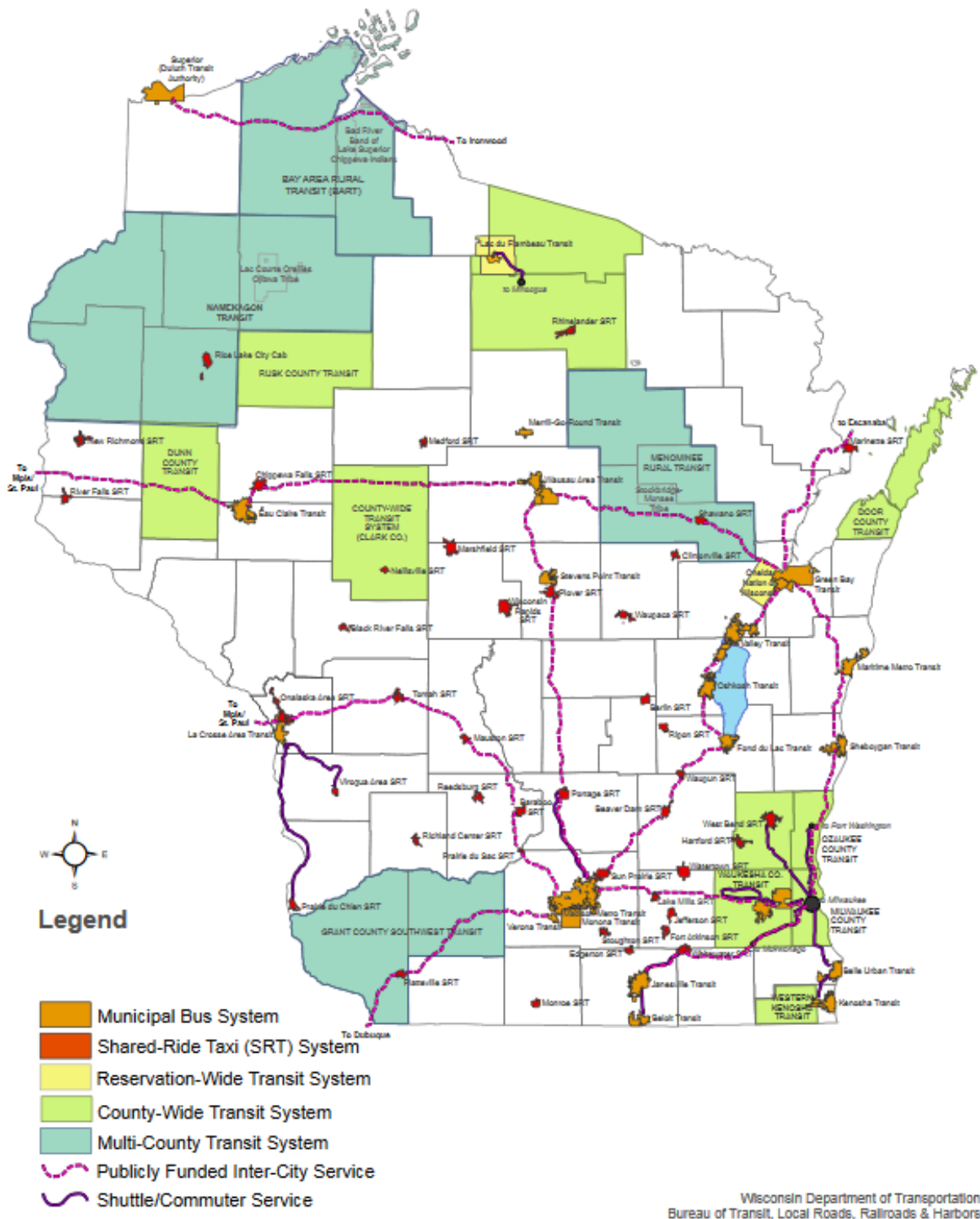


Figure 13: Wisconsin Public Transit System 2019 [27]

3.1.4 Shuttle/ Commuter Service

Shuttle service is offered in a limited number of locations throughout Wisconsin. The counties with shuttle bus service in the southeastern region are Racine, Kenosha, Walworth, Milwaukee, Washington and Ozaukee, and in the western region are Onalaska, Tomah, Viroqua and Prairie du Chien. An example of shuttle service is Commuter Express which is operated by Riteway Bus Service, Inc. This service travels between Washington County and Milwaukee County. Kenosha County also offers commuter service to the Chicago Metra station in Antioch, IL, and is scheduled to run three times per day on weekdays and four times per day on Tuesdays and Thursdays [27].

3.1.5 Intercity Service

Railroads in Wisconsin serve passengers through Amtrak passenger rail service and Metra. Two Amtrak routes serve Wisconsin, i.e., the Hiawatha Service, a corridor service operating seven round trips a day between Chicago and Milwaukee, and the Empire Builder, a long-distance train operating one trip a day each way between Chicago and Seattle/Portland. METRA serves a total of 11 train lines primarily located in Illinois, and a few in Wisconsin (Union Pacific North in Chicago to Kenosha in Wisconsin) [30]. Besides Amtrak and Metra service, most of the intercity travel routes in Wisconsin are daily intercity bus routes provided by Indian Trails, Lamers Bus Lines, and Jefferson Lines. A few commuter bus routes are provided by Ozaukee County Express and Wisconsin Coach in the Milwaukee area and SMRT bus in southwestern Wisconsin (Table 2). Figure 14 shows a map of intercity travel routes in Wisconsin, including railroads and buses [30].

Table 2: Public Transportation Options in Wisconsin Cities [30]

PUBLIC TRANSPORTATION OPTIONS IN WISCONSIN CITIES					
CITY	LOCAL TRANSIT (Urban Bus)	RAIL	INTERCITY BUS	FERRY	AIRPORT (with passenger service)
Ashland	BART		Indian Trails		
Appleton	Valley Transit		Lamers Bus Lines		Outagamie County Regional
Beloit	Beloit Transit System		Van Galder (S. Beloit)		
Columbus, Portage, Tomah, Wis Dells		Amtrak	Lamers Bus Lines, Greyhound		
Duluth/Superior	Duluth Transit Authority		Indian Trails, Jefferson Lines		
Eau Claire	Eau Claire Transit		Greyhound, Jefferson Lines		Chippewa Valley Regional
Fond du Lac	Fond du Lac Area Transit		Lamers Bus Lines, Greyhound		
Green Bay	Green Bay Metro		Indian Trails, Jefferson Lines, Lamers		Austin Straubel International
Janesville	Janesville Transit System		Van Galder, Wisconsin Coach		
Kenosha	Kenosha Transit	Metra	Wisconsin Coach		
La Crosse	Municipal Transit Utility	Amtrak	Jefferson Lines		La Crosse Municipal Airport
Madison	Madison Metro		Badger, Jefferson Lines, Greyhound, Lamers Bus Lines, Megabus, Van Galder		Dane County Regional
Manitowoc	Maritime Metro Transit		Indian Trails, Jefferson Lines	S.S Badger	
Menomonie	Dunn County Transit		Jefferson Lines		
Milwaukee	Milwaukee County Transit System	Amtrak	Badger, Greyhound, Indian Trails, Jefferson Lines, Lamers Bus Lines, Megabus, Wisconsin Coach	Lake Express	General Mitchell International
Oshkosh	Go Transit		Lamers Bus Lines		
Racine	Belle Urban System	Amtrak (Sturtevant)	Wisconsin Coach		
Rhineland					Rhineland-Oneida County
Sheboygan	Shoreline Metro		Indian Trails, Jefferson Lines		
Stevens Point	Stevens Pt. City Bus		Lamers Bus Lines		
Waukesha	Waukesha Metro		Badger, Wisconsin Coach, Lamers Bus Lines		
Wausau	Metro Ride		Lamers Bus Lines, Jefferson Lines		Central Wisconsin (Mosinee)

3.2 SHARED MOBILITY SERVICES

Most governmental authorities actively promote ridesharing and carpooling. These transportation alternatives are a communal use of transportation and serve as an effective and sustainable way to combat single-occupancy commuting, traffic congestion, and environmental issues. Three types of share services currently operate in Wisconsin which include carshares, rideshares, and bikeshares.

Zipcar is an example of a carsharing service in Wisconsin. The company provides vehicle reservations for paying members. The membership options include payments by the minute, by the hour, or by the day, which is in addition to the monthly or annual membership fees. Members can view vehicle availability and reserve a self-service car in increments of 30 minutes via the internet, Android and iPhone apps, or by telephone. Members pay only for the time they reserve [31] [32]. Zipcar vehicles report their position to a control center using in-car technology such as RFID (Radio-Frequency Identification), presumably via cellular [31]. The company was originally founded in 2000 and was based on existing German and Swiss companies. Currently, the University of Wisconsin-Madison has 14 Zipcar stations and Milwaukee has seven.

Uber is a ridesharing company in business since 2009 and has been operating in Wisconsin since May 21, 2015. Their services cover Milwaukee, Green Bay, Waukesha, Racine, Kenosha, Lake Geneva, Madison and Wisconsin Dells. Lyft, a similar service as Uber, operates in Appleton, Eau Claire, Fond du Lac, Green Bay, Janesville, La Crosse, Madison, Milwaukee, Sheboygan and Waukesha.

Madison, Milwaukee, and Wauwatosa are cities that have an established bikeshare program. BCycle is currently providing bikeshare operations in Madison offering over 35 stations with 350 bikes throughout the downtown. A membership can be purchased online or at the station. Riders can select a bicycle, then ride the bicycle before returning it to any of the docks. The usage fee is \$3 per every 30 minutes. If the riders need to extend their ride beyond the allotted 30 minutes, then they need to dock the bike and check out the bicycle again [32]. Bublr Bike is the nonprofit bikeshare operator in Milwaukee, Shorewood, West Allis, and Wauwatosa. Bikesharing is a short-term transportation system in which individuals can purchase access that allows them to “share” a bike from any bike station and ride it to any other bike station within 30 minutes. Stations are typically located within a quarter- to a half- mile distance of each other, creating an easily navigable network. The system is open to anybody 14 years or older. Bublr currently has around 100 bike stations with plans to expand in the upcoming year [33].

Although currently illegal in Wisconsin, electric scooter systems have been implemented in many cities elsewhere. These electric scooters provide services similar to bike share programs and often they do not have fixed docking locations.

3.3 PARK AND RIDE SYSTEMS

Park and rides lots offer free parking in several counties throughout Wisconsin (Figure 15). Many allow for overnight parking in designated spaces, secure bicycle racks, shelters, and lighting. Several park and ride lots in Milwaukee, Waukesha, and Madison Counties are served by public transit [34].

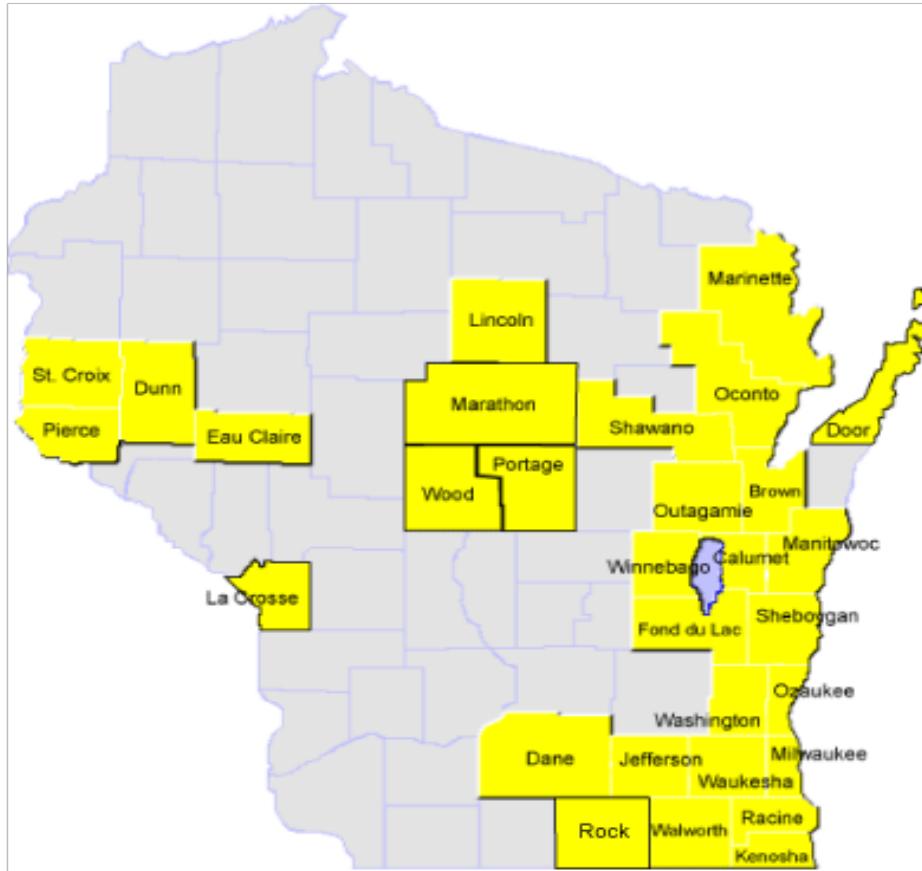


Figure 15: Park and Ride Services in Wisconsin [34]

3.4 IDENTIFYING SERVICE GAPS

In Chapter 2, an analysis on the demand of transportation needs in Wisconsin was conducted based on socio-demographic factors, economic factors, and technological factors. The analysis highlighted concerns about the existence of spatial mismatch, a projected growth of an aging population in certain areas of the state, technological adaptability among different age groups, and the available technological resources. This chapter identified the available transportation services and infrastructure in Wisconsin. The information from these two chapters can be used to identify the existing service gaps in Wisconsin and is discussed below.

3.4.1 City County Boundaries

As identified in Chapter 2, many individuals commute across city-county boundaries to access jobs and fulfill their duties. Publicly funded intercity service and multicounty transit systems in Wisconsin can provide transportation services for these types of commuters. In the Milwaukee area, Milwaukee County Transit System also operates vehicles for Ozaukee County. The service has been integrated into the MCTS system using the same fare system. However, publicly funded intercity service is only available in a few counties statewide, and several other counties only have access to multi-county transit service for cross county travel. This disparity highlights a service gap for publicly funded intercity service and multicounty transit systems in many counties in the northern part of the state (Taylor, Rusk, Price, Forest, Florence).

3.4.2 Service for Aging Population

The higher concentration of an aging population in northern Wisconsin calls for a transportation concern given the limited availability of shared ride taxi service in the region. The only shared ride taxi service available in northern Wisconsin is in Oneida County and Rice Lake. This service gap is of even greater concern for the northwestern region of the state due to their even lower access to most forms of public transportation options.

3.4.3 Payment Systems

An integrated payment system is an important component of MaaS; however, the payment systems in some rural regions of Wisconsin are primarily based on coupons/vouchers. For example, Ozaukee County Shared Ride Transit Service transactions are made by paying the bus operators by cash, check, or coupon. An electronic payment system has not been established in many areas. The gap in existing payment technology provides a challenge for MaaS implementation statewide.

CHAPTER FOUR MAAS AROUND THE WORLD

This chapter reviews applications of MaaS around the world. Definitions and benefits of MaaS are introduced first and followed by classification of MaaS into different geographic level categories. After that, four case examples (two from urban areas, and the other two from rural areas) are discussed in detail from the perspectives of visions, strategic planning, collaboration, and service integration.

4.1 CONCEPT OF MAAS

A UK study conceptualizes MaaS as using a digital interface to source and manage the provision of a transport related service(s) that meets the mobility requirements of a customer [35]. A European MaaS White Paper from 2017 says MaaS is the integration of various forms of transport services into a single mobility service accessible on demand [36]. Since its introduction, MaaS has been applied to many countries and cities around the world (Figure 16).

Mobility as a Service (MaaS) has been defined by different organizations since its emergence. Wikipedia defines MaaS as a shift away from personally owned modes of transportation and towards mobility solutions that are consumed as a service.

Source: MaaS Alliance [36].



Figure 16: “MaaS” applications throughout the world by 2018.

The growth of MaaS is beneficial to all participants: governments, transportation service providers, and travelers.

Governments

MaaS helps reduce the ownership of cars and encourage more people to use shared transportation services. MaaS is an ideal strategy to solve urban parking issues and congestion issues. MaaS implementation and adoption can help to reduce transportation emissions, encourage the growth of public health and social equity, and build better urban-urban, urban-suburban, and urban-rural connectivity.

Transportation Service Providers

MaaS advocates for the collaboration between different transportation service providers, which highly improves the efficiency for each participant in running their own service. By having MaaS components embedded in each type of service offering, the number of users for each service can potential grow due to the benefits from collaboration. MaaS can help fill the service and connection gaps since it combines different transportation modes in one, cohesive platform (e.g., It offers the flexibility of ridesharing services and the reliability of fixed-route transit). MaaS also has the potential to benefit other service providers (e.g., food delivery, freight transportation).

Customers

MaaS provides more choices of transportation services at a more competitive price. Tailored transportation service plans for different types of customers (e.g., commuters, seniors) can be provided that cater to their actual needs. Additionally, MaaS can help alleviate safety and security concerns that may exist for certain traditional transportation modes. After completing a trip, MaaS also allows customers to give instant feedback to providers which can help continuously improve their overall travel experience.

4.2 CLASSIFICATION OF MAAS GEOGRAPHIC LEVELS

The European MaaS White Paper classifies MaaS into different geographic level categories: cities, suburban areas, rural areas and long-haul transport (Figure 17). Developing MaaS in each geographic area type creates different challenges to be considered. In urban areas (cities), a well-functioning and organized MaaS can address congestion, parking, and emissions and air quality issues. Cities can implement MaaS based on existing public transport systems and incorporated with rental and shared systems (e.g., cars, bikes). In suburban areas, MaaS can offer a solution to first- and last-mile and accessibility issues. MaaS suburban developers might focus efforts on park and ride services, on-demand transport, and other services that connect suburban transport services to city transport services. In rural areas, MaaS aims to increase efficiency, maintain sufficient service levels, and improve accessibility.

The foundation of the MaaS ecosystem would be demand-responsive transport, taxis, buses with connections to long-haul transport and car-pooling. These services can also link to, parcel deliveries, library services, grocery, and medicine distribution as add-on services. For long-haul transport, MaaS can offer easy all-in-one packages by integrating existing long-haul transport services and terminal access systems services. Accommodation and event tickets can potentially be purchased as add-on values to long-haul transport.

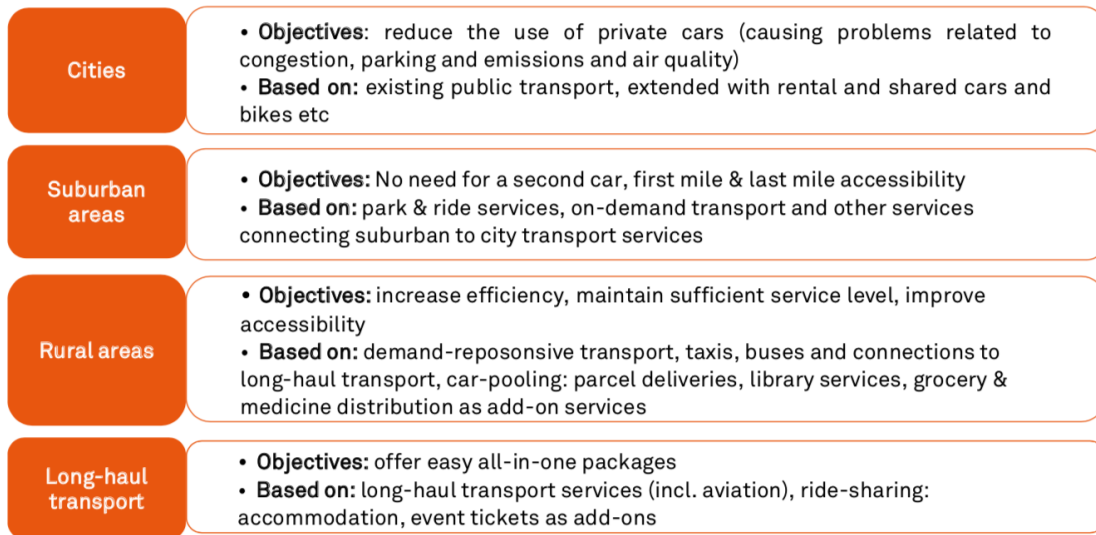


Figure 17: Classification of MaaS Geographic Levels [37]

The following sections introduce four case studies that have been successfully applied at different geographic levels. We will discuss MaaS vision, their strategic planning, collaboration, service integration, and current project status for each of the cases.

4.3 MAAS IN URBAN AREAS

The increase in transportation infrastructure and number of vehicles on the road has exacerbated congestion which has consequently led to people migrating back to cities. Congestion and the trend towards more urban living is only expected to grow around the world in the next decade. With an increase in urban density, MaaS provides a transportation solution for moving people faster and more efficiently in urbanized settings. MaaS can transform the current transportation system into a significantly more flexible system by integrating transportation modes and creating more seamless travel options [37].

4.3.1 Sweden

Sweden has a population of over 10 million people. The country is ranked as the fourth most competitive country in the world with a rapidly growing economy and an even income distribution [38]. Stockholm and Gothenburg are Sweden’s two largest cities.

MaaS Vision

Sweden is actively trying to improve their transportation system and to reduce commuting time in a safe, easy, and efficient way. The increase in the number of residents living in

MaaS is considered a national prominent issue for the Swedish Ministry of Enterprise and Innovation and is considered a key mechanism to solve some of their transportation challenges. MaaS aims to facilitate efficient transport in a variety of ways, including, connected public transit, rideshare services, carpools, bike rentals and driverless vehicles.

Source: Government Offices of Sweden

Stockholm, the capital of Sweden, has caused the average commute time to increase by about 20% between 1995 and 2013.

According to Statistics Sweden and the City of Stockholm’s Office of Research and Statistics, about 54% of Stockholm’s total population live within the city limits; 22% live in one of the ten adjoining municipalities, 16% commute from the county’s other 15 municipalities, and only 8% commute from another county. The total population growth in Stockholm was nearly 18% between 2005 to 2015 and is projected to increase 25% by 2030. Considering these factors and growth projections, the City of Stockholm set a goal to have 75% of all trips happen via public transport, bicycle or foot by 2025, especially for people living within the city limit or adjoining municipalities for their day-to-day commute [39].

The efficiencies and integrated system created by MaaS provides a viable way to reduce car ownership considering its competitiveness with providing faster, more reliable, and greater commuter comfort for the users (Figure 18).

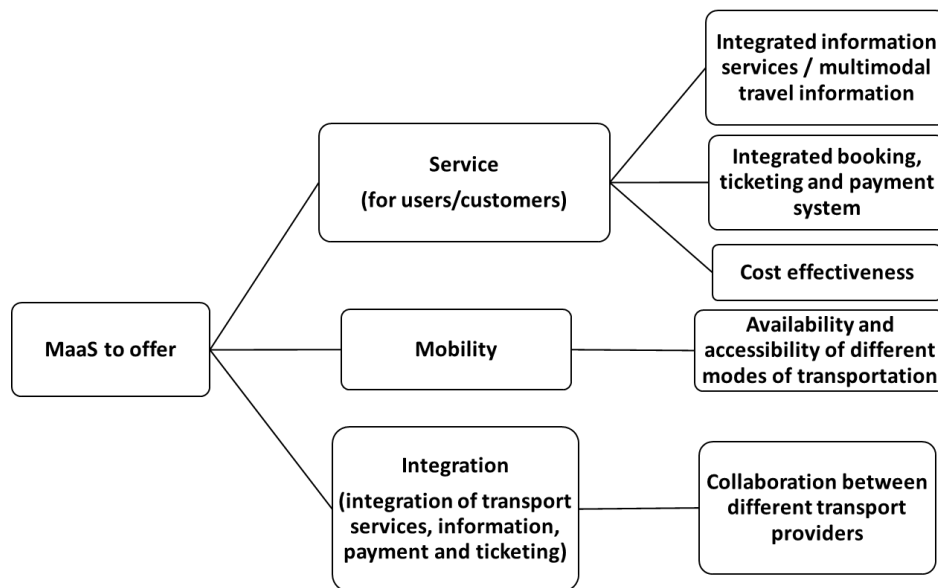


Figure 18: Concept of MaaS to implement in Sweden

Proper implementation of MaaS, requires attention on developing cooperation between public and private players, different services, and a business model. Sweden’s public transport sector has set a goal of doubling the number of public transport trips between 2006 and 2020. The Swedish government earmarked €200 million in 2015 for development of new and smart public transport to reach this target which included investing in a passenger-centric multimodal transportation system that is easier to access, is more efficient, and lowers environmental impact.

Strategic Planning

The City of Stockholm has started to implement their 2030 urban mobility vision by increasing high-capacity public transport, bicycles and pavements for walking short distances between destinations (e.g., metro stations, business center) [40]. One of the first efforts was to integrate public transport with existing connected transportation infrastructures (e.g., traffic lights, traffic

monitoring, parking). For example, the inner-city buses in Stockholm can communicate with traffic lights to grant signal priority if they are running late. Additionally, information boards now provide travelers with updated information about delays and alternative routes. Since mobility is a core MaaS concept, Stockholm has started to address transportation pain points by increasing traffic flow while providing more freedom of choice between reliable modes of transport (e.g., bus, tram, ferry).

MaaS implementation in Sweden began with a goal to shift travel behavior from the “car as the norm” to “mobility package options as the norm”. In their first phase, the city developed policies, regulations, agreements, and technology to establish the baseline needed for combine mobility services. Ultimately, this helped to enable collaboration between different transport provider and to encourage startup companies produce new technologies. The next phase involves the development of new services and the upgrade of existing services to ensure good regional accessibility and creation of a competitive public transport system.

Collaboration

The Swedish Mobility Program (SMP) is a national integration platform that enables and promotes combined mobility services on a large scale and offers public transport services via a national access point. The Swedish Transport Administration has been collaborating with public transportation agencies in different cities to increase regional connectivity, foster service integration (e.g., ticketing, scheduling), and improve mobility [41].

Samtrafiken, established by SMP, is a business-to-business company that supports the coordination of all public transportation in Sweden through cooperation between players on the public transportation market [42]. Västtrafik, (a public transport agency for services involving buses, ferries, trains, and the Gothenburg tram network in the county of Västra Götaland, Sweden) has collaborated with other regional Public Transportation Authorities in the Swedish Mobility Program (SMP) to develop a national level integration platform for transportation related services. This platform was comprised of a portal that which provided MaaS operators access to transport service data and tickets to be included in their MaaS services [43].

Service Integration

One of the most successful MaaS projects in Sweden is UbiGo, which offers mobility subscriptions for urban households to use as an alternative to owning a car. Their app includes mode options such as public transport, taxis, bikes, car rentals and carsharing services based on an individual’s travel requirements and charges a single bill for the whole household. The project started in Gothenburg as a pilot program and has since expanded to Stockholm. Samtrafiken is another successful project in Sweden that developed the National Ticket and Payment Standard within the Swedish Public Transport market to integrate services and to link together the ticket and payment systems from different transportation service providers [44].

4.3.2 Seattle

The city of Seattle has a population of 608,660 and represents about 20% of the urbanized region. The city of Seattle consists of several mixed-used urban centers with a population density of 17 persons per acre and employment density of 13.2 jobs per acre. Seattle is considered a high

technological connected city. An annual tech survey found that 85% of residents have internet at home and 58% are smartphone users [45].

MaaS Vision

Seattle has been nominated as the United States' premier, and United States Department of Transportation (USDOT)'s signature Smart City. The city is making substantial investment in public transportation and campaigns, shared mobility, electrification, transportation demand management, parking, bikeshare, and transit communications.

The Seattle Department of Transportation (SDOT) has started to implement the "Move Seattle" initiative to improve safety for all commuters, expand maintenance and improvement of streets and bridges, and increase investment in affordable and reliable travel options for commuters. The project has set a target to establish urban automation, connected vehicles, intelligent sensor-based infrastructure, and urban analytics. Thus, the initiative ensures secured shared computing and data storage platforms, user focused mobility services and choices, urban delivery and logistics and allows the data platform to optimize the mix of all delivery services, and smart land use. The USDOT established a vision for Smart Seattle – Development of Mobility Market Place project that includes launching a data platform to optimize capacity, user experience and societal goods across all travel modes, connecting public and private sectors, and establishing a single payment gateway.

Strategic Planning

Move Seattle is a 9-year strategic plan for transportation system improvement in Seattle, approved by voters in November 2015. City residents committed to a levy of \$930 million over nine years for investing in an improved, reliable, and convenient transportation system.

The Seattle Department of Transportation (SDOT) has developed the "New Mobility Playbook" with five major "plays" to adapt to the new technologies to implement in the transit system. An adaption strategy is emphasized rather than reshaping the city to ensure that a fair, safer, and just transportation system is achieved for all. A main goal is to set up safer data structures to be integrated with stakeholder collaboration. A single-point, user-friendly payment system is also planned to be implemented, as well as, encouragement for shared, electric, connected, and automated vehicles. Some of their initiatives include citywide 3-minute passenger loading zones; for passenger pick-up and drop-off by ride-sourcing and micro-transit services, the installation of sensors and a communication system to accumulate real-time data on buses and light rail trains; and the implementation of traffic signals, electric charging stations, parking spaces, streetlights, and shared vehicles to provide a smart transportation system. The Mobility Market Place aims to provide a platform for all transportation providers with a place to securely distribute their apps, data, or services to users with an option to compare and optimize travel cost. The development plan also includes expansion of the network of sensors at intersections and multiply vehicle-to-infrastructure (V2I) communications citywide. To collect real-time data, smart sensors and communication systems need to be installed on buses and light rail trains, traffic signals, electric charging stations, parking spaces, streetlights, and shared vehicles in the city and by King County Metro [45].

Collaboration

The Smart Seattle – Development of Mobility Market Place project is the result of collaboration between the Seattle Department of Transportation, University of Washington research team, Microsoft, and King County Metro.

The project intends to create a data platform which will consolidate and optimize all transportation modes in one place. The project initiates collaboration between transportation service providers and system operators to enable optimized service offerings.

Source: Smart Seattle- A Prototype for the New Century's Digital City
[46]

The Seattle DOT in partnership with Outdoor for all Foundation is creating adaptive recreation opportunities for children and adults with disabilities, which will not only open opportunity for individuals with disability but will also promote bike sharing for all [46]. Seattle has also set an example of a payment integration system through its ORCA card. The ORCA card was first initiated in 2009 and is managed by the Central Puget Sound Regional Fare Coordination Project. The card is valid in the Seattle metropolitan area and for Sound Transit, local bus

agencies, Washington State Ferries, King County Water Taxi, and Kitsap Fast Ferries. Initially, the Central Puget Sound transit agencies collaborated to work towards a region wide fare system in 1991. In April 2003, seven transit agencies in the Central Puget Sound Regional Fare Coordination Project (Sound Transit, King County Metro, Community Transit, Everett Transit, Pierce Transit, Kitsap Transit, and Washington State Ferries) collaboratively signed a \$43 million contract that was awarded to ERG Transit System who acted as the integrator of the project [47].

Service Integration

A contactless, stored-value smart card system known as the ORCA card (One Regional Card for All) was developed for the public transit system in the Puget Sound region of Washington State. The payment integration system made for the ORCA card is an all-in-one transit pass, which can be used on most transit systems in the Seattle metropolitan area. The ORCA card can be loaded with monthly passes, as well as, an "e-purse" value that is similar to a debit card where passes and transfers can be purchased. ORCA cards can be purchased with an initial \$5 payment, and then the user has the option to buy preloaded values between \$5 to \$300. The card is available to purchase and reload through the ticket vending machines at transit stations, customer service centers, participating grocery stores, and online. The key benefits of ORCA are the automatic apportionment of fare revenues between the different transit companies based on actual use and the reduction of noticeable fares for the transit users. The Figure 19 explains how the fare is distributed between the two different transit companies, Metro Bus and Sound Transit [48].

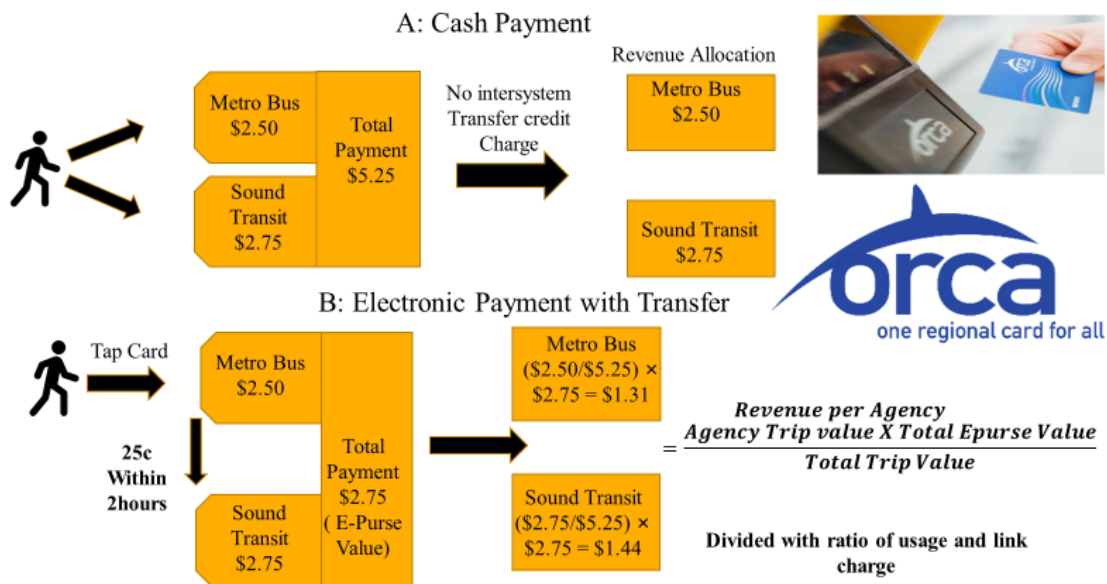


Figure 19: ORCA (One Regional Card for All) payment structure

4.4 MAAS IN RURAL AREAS

4.4.1 Finland

Finland is characterized by its very sparsely populated areas with long distances to municipality centers, especially in areas such as Lapland which has a population density of 180,000 persons per 100,000 km² [49].

Finland has two projects focused on determining how to promote mobility services in rural areas. One initiative was a one-year project called “MaaS concept – promoting service and livelihood development in rural areas” that occurred from 2016 to 2017. The project aimed to create a national vision for MaaS in rural and sparsely populated areas focusing mainly on recognizing emerging and potential business models for both commercial and publicly supported transport services. The project also improved awareness of the MaaS concept in rural areas and provided metrics and recommendations for the development of mobility regulations and technical aspects of the new mobility services. The second project is a rural MaaS pilot program called “VAMOS!”, which incorporates Ylläs Tiketti as the mobile ticketing and payment application and Shareit Blox Car as the peer-to-peer car sharing service.

MaaS Vision

Finland has three different perspectives on mobility services:

- Business: Includes tourism and last-mile deliveries.
- Inhabitants: Includes those who pay for their mobility services. Trip purposes are varied and could include commuting, hobbies, and shopping journeys. The sharing economy was also considered, along with what services would be practical to offer the customer and which services the customer would use.

- Publicly supported and subsidized transportation: Includes statutory social and health service transportation and school transportation.

The Rural MaaS project in Finland defined the rural mobility vision as: “Ensuring for everyone adequate mobility services and accessibility relative to well-being, cost-efficiently with an appropriate service level” [50], [51] . Other important aspects of the vision include maintaining the vitality of rural areas and offering reasonably priced services to everyone regardless of their place of residence [52].

Strategic Planning

Combining the mobility of people is the project goal. Legislation and decision-making that support mobility services are needed, as well as transparent procurement. Innovative procurement is recommended since it concentrates on problems and objectives instead of a predefined solution.

Related to publicly subsidized social and health service/care transportation, the possibility of a personal mobility budget should be studied. The user would have more flexibility to organize transportation based on individual needs and preferences within the allocated budget according to the extent of support needed. However, how to encourage car- and ride- sharing needs to be addressed and solved. Sufficient information on the number of customers and their mobility needs would also be required for organizing and procuring the services.

Service levels do not necessarily have to be the same in all areas. For example, kilometer-based zones with different service levels would mean that a municipality, when granting building permits, could tell which subsidized mobility services are available in that zone. The most rural areas do not necessarily have to have the same services as areas closer to a municipal center.

The capacity of private cars (including cars owned by municipalities and companies) could be used for sharing services. Air traffic should be analyzed based on the number of passengers and demand. For example, some airports could remain open only during the peak season when there is sufficient demand. When they are closed, transit could be organized from other airports to these areas. Commuting should be analyzed in relation to transit schedules and park and ride lots. The pricing structure also requires careful planning to be successful, for example, how to assign a price if a taxi ride includes both people and a parcel [52].

Collaboration

The project details the collaboration needed between municipalities, social and health services/care, ELY Centers (Centre for Economic Development, Transport and the Environment) and Kela (The Social Insurance Institution, i.e., a Finnish government agency in charge of settling benefits under national social security programs), and the desire for mandatory collaboration by the public sector. Combining the services would require a national system or database where all the relevant information is available to all involved stakeholders. The Public-Private-People Partnership (PPPP, 4Ps) is proposed in planning and implementing MaaS (Figure 20). The project details the collaboration needed between municipalities, social and health services/care, ELY Centers and Kela, and the desire for mandatory collaboration by the public

sector. Combining the services would require a national system or database where all the relevant information is available to all involved stakeholders. The Public-Private-People Partnership (PPPP, 4Ps) is proposed in planning and implementing MaaS.

In Finland, health and social services along with regional government reformation are currently ongoing with transport and mobility as a cross-cutting theme playing a vital role within the established regions. A growing need for integrating publicly compensated transport methods (i.e., statutory social service transportation) and self-paid transport exists. Public expenses on statutory social service transportation in Finland are very high reaching about one billion euros annually. However, the accessibility of public transport should be improved in order to provide appropriate service levels through reorganized and complimentary transport services for citizens in rural areas. Another factor to consider is that many regions may have seasonal demand (e.g., tourism) which increases the demand for the accessibility to public transport. Since flows of passengers and goods are relatively small in rural areas, the PPPP model suggests the integration of private, public, and commercial transport services.

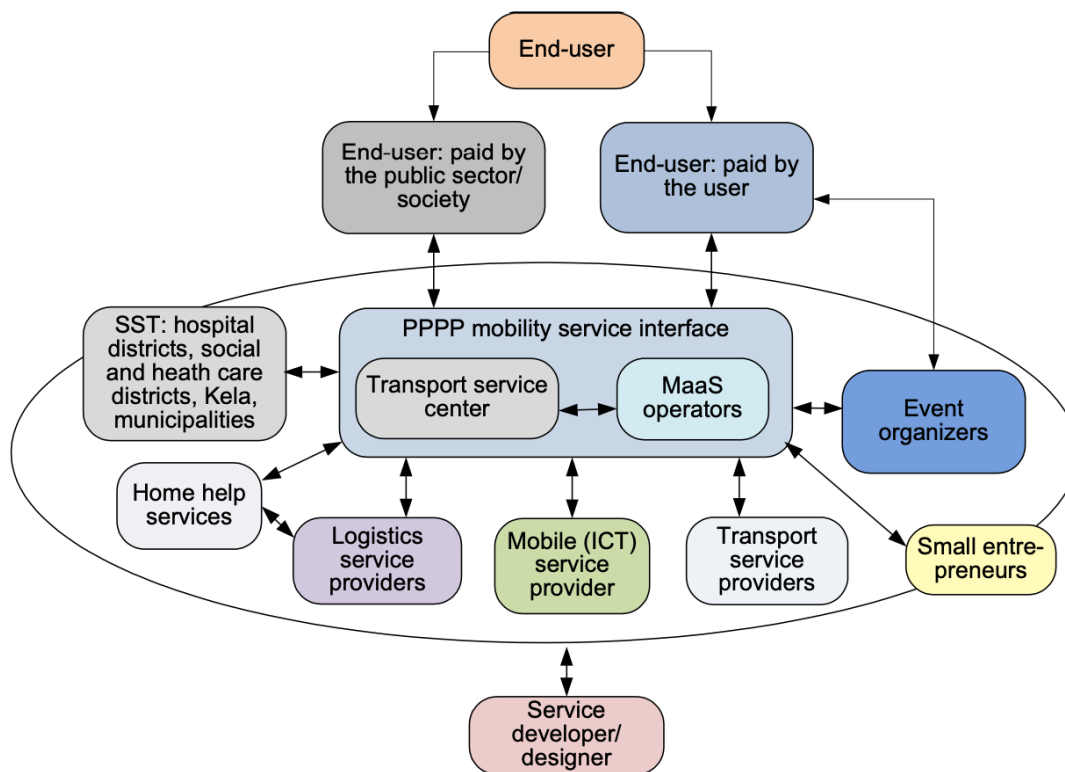


Figure 20: The PPPP model in Finland

Service Integration

Two pilot services are currently occurring in rural areas of Finland. One service is Ylläs Tiketti which is an application with embedded mobile ticketing and payment capabilities (Figure 21). In the Ylläs Tiketti app, users can buy Ylläs's tickets and services from a comprehensive range of service providers. For example, buying tickets in advance for bus travel and events in the Ylläs area, including bus transfers to and from the airport and train station, ski-bus, and chartered bus services. For local transport operators and other service providers, Ylläs Tiketti helps to meet the travelers' needs by serving as a mobile sales channel but it does not necessitate any payment terminal. The app facilitates payments safely and securely with debit or credit cards, SVEA, or MobilePay [53]. The other service is Shareit Blox Car. It is a peer-to-peer car renting platform where anyone can rent out their own cars or get a car from nearby to complete their trip [54].

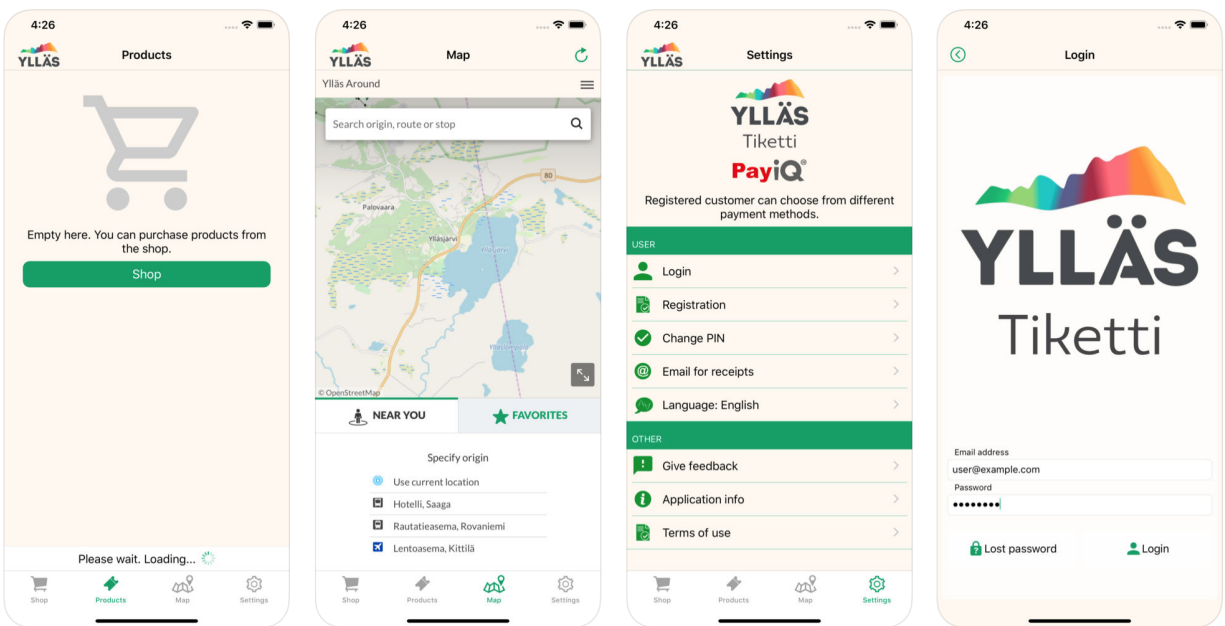


Figure 21: Ylläs Tiketti, a pilot project in Finland [55]

4.4.2 Denmark

The northern Denmark region is an area with a relatively low population density and only a few larger towns. Aalborg is the only city with more than 100,000 residents.

Two projects are underway in northern Denmark. The mobile application 'MinRejseplan', or My travel plan, is a combined mobility solution currently being developed by the Transport Authority of Northern Denmark (Nordjyllands Trafikselskab). In addition to MinRejseplan, a Travel on Demand (ToD) solution called Plustur is now available across Northern Jutland [56].

MaaS Vision

For the past 15 to 20 years, Nordjyllands Trafikselskab/North Jutland's Transport Company-traffic company in North Denmark Region (NT) has been working to improve mobility in their

rural areas by focusing on responsive solutions for the elderly and for others. These mobility solutions are also working to better coordinate with public transport. Another issue is transporting users for the last mile of their trip (e.g., to and from the main bus routes and stops from people’s homes). A long-standing goal was to increase public transport as a share of the total number of rides in the region and to reduce CO2 emissions. The goal has since evolved to include enhancing residents’ mobility options by offering more and smarter mobility services. By increasing mobility options, the region can potentially increase their livability attractiveness. By developing MinRejseplan, NT aims to make it easier for users and residents to plan their trip while also increasing the availability of transport options – both public and private. Another vision is to develop an app where users could pay all parts of a trip in a singular place.

Strategic Planning

Characteristics of MinRejseplan include: 1) Strengthening mobility in rural areas; 2) Educating people on their ability to have access to the “main network” of public transport (grey/dotted lines); 3) Ensuring Demand Responsive Transport plays a central role in the network (Figure 22) [56].

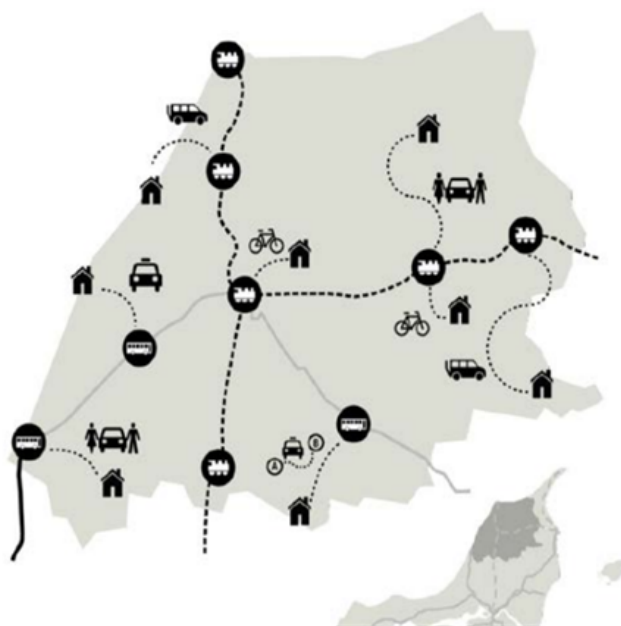


Figure 22: Pilot Network of MinRejseplan [57]

Collaboration

The main barrier is the development of a common payment system due to a lack of interest among the different transport providers in customer data sharing and difficulties in pooling payment systems between private and public entities. The Northern transport company will need to convince these stakeholders that competition will not increase by being a part of a fully-

fledged MaaS solution. Instead, participation in MaaS will likely increase the total number of travelers, and thus potential customers, by creating a platform that can combine different travel modes. In other words, participation in MaaS is not a zero-sum game, and it is believed that the customer base that transport providers will be sharing will grow over time.

Resources are another barrier since it can be very expensive for a single transport authority to develop a MaaS system. The budget for MinRejseplan is ten million DKK. Therefore, all the regional transport authorities in Denmark have founded a company, Rejseplanen A/S, which will own and run the future application after its launch. This model also ensures that MinRejseplan will be available across Denmark by the end of 2019.

Service Integration

A digital ticketing function and payment solution have been incorporated into MinRejseplan. Additional options besides regular public transport were ToDs (e.g. Flextur, Plustur), taxis, and GoMore, a carpooling company.

4.5 SUMMARY

A case study of MaaS at different geographic level has been performed as a part of this study and included both urban and rural cases. Sweden and Seattle are the two cases studied for Urban areas. Sweden considered MaaS as a national prominent issue and designated MaaS as a key mechanism to solve some of their transportation challenges. The approach used by Sweden moves towards shifting travel behavior from “car” as a norm towards “mobility packages” as a norm. To enable this shift, Sweden has adapted to a series of collaborations between players in the public transportation market, performed service integration and initiated several pilot projects in some of their major cities to promote the successful growth of MaaS.

Seattle, who has been nominated as USDOT’s signature smart city, is working towards establishing urban automation, connected vehicles, intelligent sensor-based infrastructure, urban analytics ensuring secured shared computing and data storage platform, user focused mobility services and choices. To establish MaaS, Seattle has both support from it’s dwellers as well as initiative from its public transportation service providers and SDOT. To achieve this goal, Seattle has developed a “New Mobility Playbook” with five major “plays” to adapt to the new technologies to be implemented in the transit system. The city is also working towards establishing a digital platform through Smart Seattle – Mobility Market Place.

The two urban cases focus on different goals for implementation of a MaaS environment. For the case of Sweden, the goal is to reduce commuting time in a safe, easy, and efficient way. On the other hand, Seattle focuses on using their public support, technological and competitive public transportation resources to build a technologically advanced mobility solution. Therefore, comparing the two cases studied not only shows the reasons for implementing MaaS in an Urban setting, but also provides a path towards achieving it.

The two cases of MaaS in rural areas were studied in two European countries: Finland and Denmark. Finland established a PPPP business model for rural areas, developing two apps for mobility services in rural areas. One is mainly based on public transit and, the other one is a peer-to-peer car renting platform. Denmark had a built-in rural service functionality from an

existing widely used app that helped in accessing the market, with demand responsive transport playing a central part in their transportation service network. The two cases of rural MaaS have suggested possible business models that can be used for a rural MaaS scenario. The case studies also set examples on the nature of the app that can be developed through their application development pilot projects. Therefore, MaaS in rural areas of Wisconsin can use these case studies as benchmarks in acquiring collaboration, strategic planning, service integration in the potential establishment of MaaS in rural Wisconsin.

CHAPTER 5 FEASIBILITY STUDY OF MAAS IN WISCONSIN

MaaS is a concept with multiple possibilities for practical implementation. However, the possibilities for implementation may vary based on the specific area – city, demographics, social conditions, etc. Similarly, Wisconsin has its unique case and possibility that needs to be identified in order to enable a localized MaaS solutions that will effectively work with the public sector, transportation service providers, the private sector and legal boundaries of each county and state. In the previous sections, the socio-demographic characteristics, legal boundaries, the existing technological infrastructure assets, local population needs and demands, possible barriers and limitations, and industry expertise feedback have been identified. In the following section, the the feasibility study of MaaS in a Wisconsin context will be performed based on the research findings and possible solutions suitable to Wisconsin will be proposed. The proposed solutions based on a feasibility study will not only include technological solutions, but will also consider other factors such as funding, resource allocation, legal criteria, cross county options, data security, etc.

5.1 CLASSIFICATION/STRUCTURE OF CRITICAL ISSUES

During the First Advisory Committee meeting, a group of six highly skilled, knowledgeable experts from the transportation industry joined the WMaaS research group to provide their feedback on the various critical issues associated with deploying MaaS in Wisconsin.

The critical issues identified by the first Advisory Committee meeting have then been further classified into three types: concept development, policy and planning, and implementation. Concept development includes the issues associated with aging populations and people with disabilities, low-income travelers and the limited number of smart phone users. Issues under Policy and Planning include county/city boundary, legal criteria, and funding. Finally, the Implementation section covers areas related to data, which includes standardization, real-time availability, and security and payment integration (Figure 23). The issues are discussed in detail in the next section.

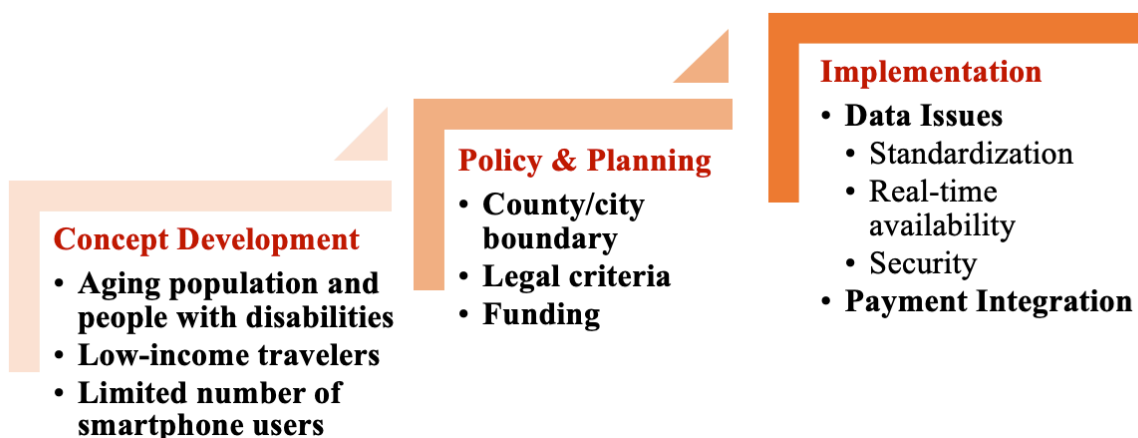


Figure 23: Classification and structure of critical issues

5.2 CONCEPT DEVELOPMENT

5.2.1 Aging population & people with disabilities

As described in Section 2.1.1, the aging population is a major concern in Wisconsin. People with disabilities are also a group that needs to be considered in MaaS.

To better fulfill the needs of the aging population as well as people with disabilities, potential measures are proposed from four aspects: marketing strategy, service packages, information provision, and interface design.

Considering marketing strategy, it is not easy to determine the extent of willingness and habits of older adults and people with disabilities in embracing new technologies, so a household-based access would be more effective than an individual-based access. That is, booking, paying and rating the service for each trip could be made by family members or care givers of older adults who may not be able to make these arrangements by themselves, to complete trips in MaaS solutions. This strategy provides more convenience and reliability for both older adults and

“The service area is rural and 80% of population is aging or disabled.”

Source: Running Inc.

“More growth of aging population in rural communities has been observed.”

Source: WisDOT

“Special service is needed for people with special disabilities, for example cognitive disorder, visual disorder etc.”

Source: SEWRPC

people with disabilities during their traveling than traditional transportation modes. At the same time, it would greatly help the market penetration for MaaS companies, especially at the very start. As for pricing strategy, MaaS companies could provide different ticket options targeting different frequency levels of people using the service. For non-frequent users, a pay-as-you-go function could be offered. For users with high times of access, by selling a monthly ticket or a yearly membership, MaaS companies would keep the current customers and attract more potential users in the meantime.

Service packages are essential components in MaaS solutions. People would be willing to use MaaS service only when existing service packages are consistent with their preferences, which include price, accessibility, reliability, speed, with or

without caregivers, etc. There are certain types of service packages suggested for older adults and people with disabilities such as volunteer/paid transportation service, health care trips, cross-boundary trips and paratransit service. Figure 24 shows the temporal efficiency, spatial efficiency and cost of each transportation mode. The yellow circles are mode recommendations for older adults and people with disabilities. MaaS companies could consider either one specific mode or the combination of them as solutions.

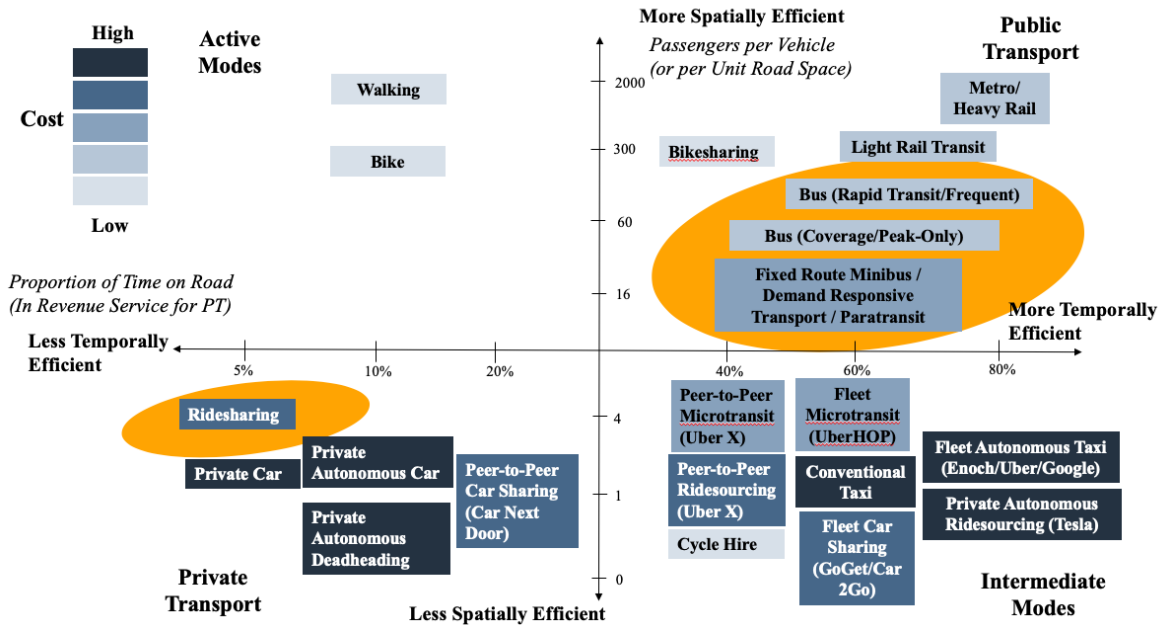


Figure 24: Recommendations for transportation modes of older adults

Information provision is a fundamental function in MaaS solutions. Information of health centers, shopping discounts and community activities could also be provided to older adults and people with disabilities in the MaaS interface. It is important for MaaS companies to provide more add-on values than transportation information because the ultimate objective of MaaS would be changing people’s lifestyle. Meanwhile, as the survey indicated, most older adults in Wisconsin prefer driving themselves (45.86%) to being driven by others (8.91%) every day[8]. Thus, for older drivers, park and ride information is also needed in MaaS solutions.

Older adults and people with disabilities may have limitations with vision, hearing, mobility, cognition, etc. A user-friendly interface needs to take these features into consideration. Tips for developing apps for older adults and people with disabilities include: (1) increase contrast between text and background, (2) label icons to avoid miscommunication, (3) format fonts, icons and interactive elements, (4) avoid complex navigational elements, (5) provide cues, noises and reminders [58]. Telephone customer service and website development would be necessary because a portion of older adults and people with disabilities is used to smartphones.

Besides, special attention should be paid for MaaS in Wisconsin in providing adequate service for people with mobility, circulatory, respiratory, or neurological disabilities. According to the requirements of ADA (Americans with Disabilities Act), wheelchairs and manually powered mobility aids, such as walkers, crutches, canes, braces, or other similar devices designed for use by individuals with mobility disabilities should be accepted and provided for free. Other regulations in ADA should also be followed [58].

To ensure that it is economically feasible, collaboration among MaaS companies, Wisconsin DOT and DHS (Department of Health Services) are needed. DHS is one of the largest and most diverse state agencies in Wisconsin, with an annual budget of roughly \$11.5 billion and more

than 6,100 employees. DHS is committed to protecting and promoting the health and safety of the people of Wisconsin, making sure everyone can live their best life [59]. Wisconsin DOT also has programs in addressing elderly mobility issues. MaaS companies could seek financial support from Wisconsin DOT and DHS [60].

5.2.2 Low-income travelers

Cost is a main concern for low-income travelers. MaaS companies could provide public-oriented trips (e.g., the combination of fixed-route transit, bike sharing and walking), and eco-friendly trips (e.g., bike sharing and walking) as tailored service packages to low-income travelers. Meanwhile, some volunteer-to-earn-trips programs could be suggested. For example, they could provide care for trips of older people and people with disabilities. They can also help by

“Any change cannot have a disproportionate impact on minority and low-income populations.”

“Funding or User side subsidy for the low-income traveler must be determined based on the income threshold.”

Source: WIPTA/City of Fond du Lac

regularly evaluating the MaaS system and giving valuable feedback. Some low-income travelers could also be selected as volunteer drivers after passing background tests. Cost assistance might be required from federal and state governments, including employer-based programs, discounts, universal PASS, and user-side subsidy. The yellow circles in Figure 25 are mode recommendations for low-income travelers that MaaS companies could consider as potential service options.

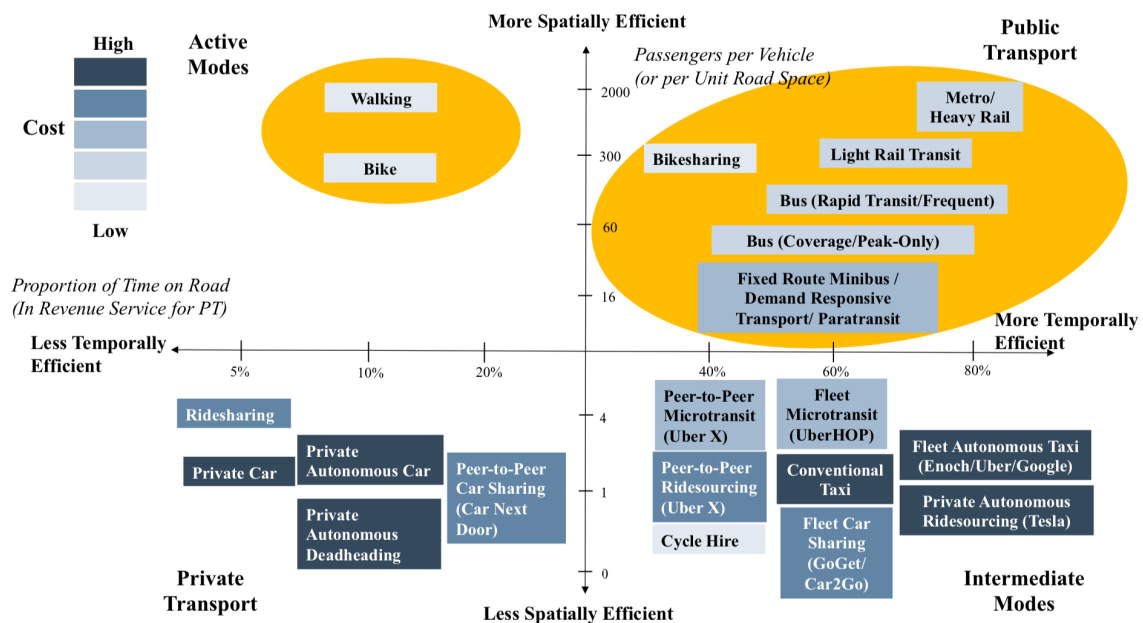


Figure 25: Recommendations for transportation modes of low-income travelers

5.2.3 Travelers with limited smartphone usage

MaaS is designed to be based on smart phone use. However, many areas of Wisconsin either do not have access to smart phones or have low smart phone use. Therefore, methods of implementation of MaaS with minimal or no smart phone use have been suggested. The problem could be solved by using web based and call center-based ordering. There will be signup procedures that should have a minimum timeline within which the booking should be completed. MaaS could offer integrated services in low cell phone usage regions by limiting the contact number to a single phone number and a single website. The single phone number should also provide customer service information, answer any questions or provide support for some more complicated transportation requests [61].

5.3 POLICY & PLANNING ISSUES

5.3.1 County/city boundary

Travel needs are not limited by municipal boundaries, but transit services often are. Spatial and skill mismatch means that many commuters travel across county borders to reach their job destination. However, most public transportation services are limited to county borders. Therefore, a MaaS system that is effective across county borders is needed to ensure an effective mobility solution that allows commuters to use MaaS service across county border using the same application.

“Service is often limited to a boundary (city/county) but jobs can cross these lines so how do you serve these types of cross-boundary trips?”

Source: SEWRPC

“Same app should be used across county boundary, so user’s familiarity and convenience increase.”

Source: Bublr Bike

Implementing MaaS across county borders is similar to the mobile roaming concept. MaaS services exceeding the limit of county or municipal borders means using the transport services of other MaaS operator(s) rather than the operator to which one subscribes. Across county borders, one MaaS operator will not be able to satisfy all the mobility necessities of all subscribers and therefore demands cooperation between the different MaaS operators. This facilitates expansion of their service coverage as well as business possibilities. MaaS in a region

requires contracts between the MaaS company and the different transportation service providers; Therefore, to implement MaaS across county borders, connections need to be established between each MaaS operator across county borders [62].

In addition, MaaS can overcome one of the key barriers to cross county services by providing acceptable ways to allocate costs and revenues between government sponsors because of the availability of the detailed trip information.

Process

Implementing a Cross County Border MaaS system requires detailed study of the county that will participate in the MaaS system. This can be initiated beginning with a case study of existing communications between partners, for example, studying the case of My Corridor (Europe) and

comparing it with the Wisconsin scenario. Then strategies for further development can be formulated. This step can be followed by program development plans that should be discussed and negotiated with local and state level agencies; this step should then go through monitoring and evaluation (Figure 26). Once the process phase is over, expert technical input (engineer, IT specialist) is required to develop the physical infrastructure and the information infrastructure required to deploy a Cross County Border MaaS system [5] [63].

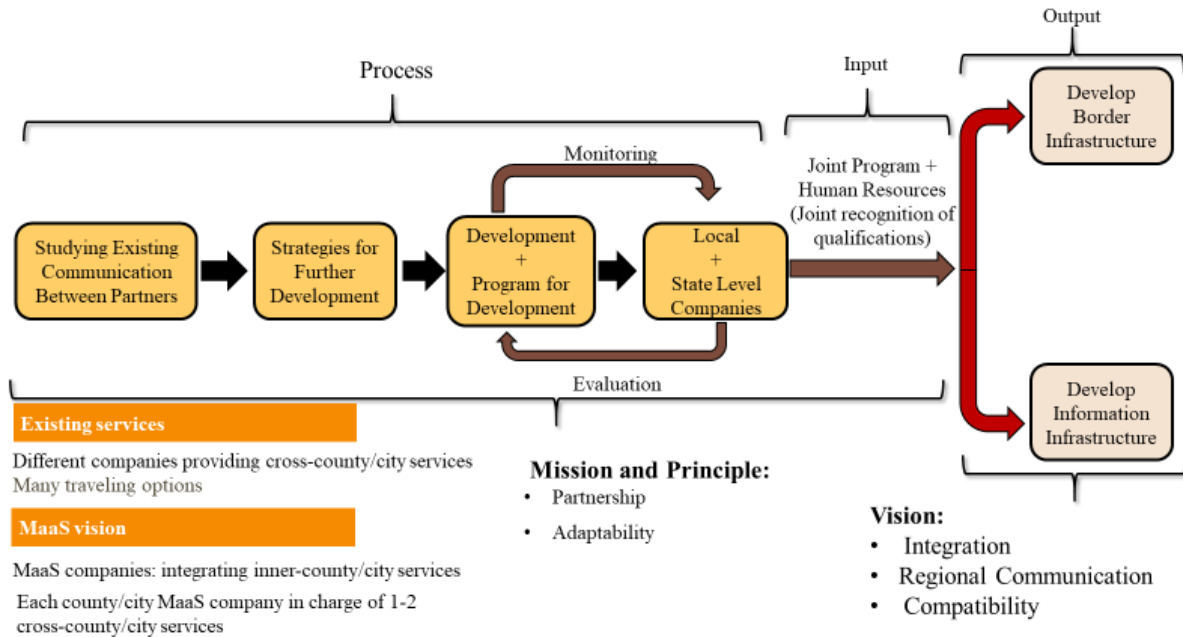


Figure 26: Steps towards setting up a Cross County Border MaaS system [5]

Cross County Border MaaS Architecture

Figure 27 shows the Cross-County Border MaaS Architecture framework, which is bounded by and based on a set of agreements. This kind of framework is only successful if all participants under each connection abide by the agreement, which is symbolized by the arrow flow and the moving gear. Movement in one direction makes all the other connections move in a specific direction. The figure below also illustrates some of the existing Wisconsin transit service that already fits into the framework [29], [36], [64], [65].

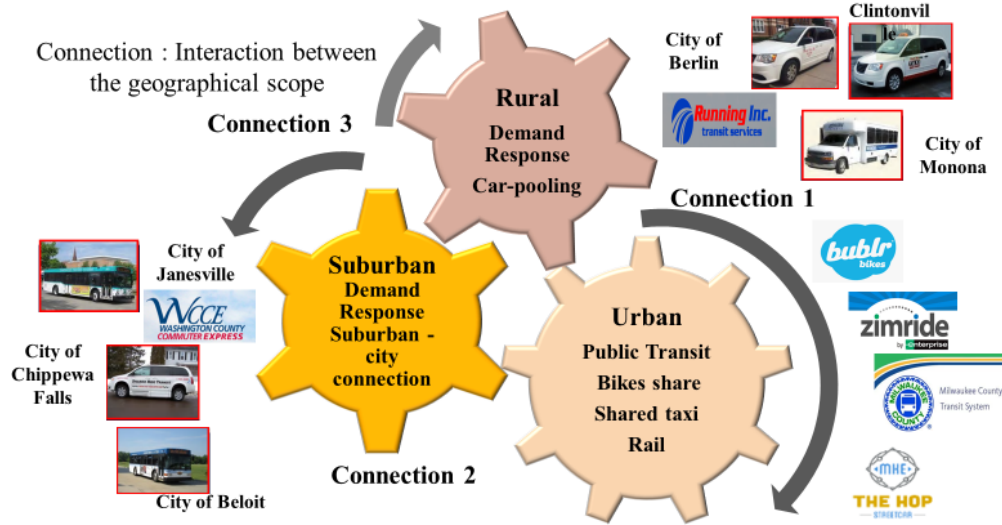


Figure 27: Cross County Border MaaS Architecture [29], [36], [62], [64], [66]

Agreement

“Finding employees who meet criteria such as passing a drug test; an alcohol test; passing vehicle inspection is a challenge; satisfies city’s requirements by working in collaboration with police department.”

Source: Running Inc.

“Service providers are willing to provide the service. However, many of them do not want to deal with federal regulations.”

Source: WIPTA

“Between two counties, many agreements already exist. Although politically divergent, the two counties will agree for integration purpose.”

Source: City of Waukesha

Each connection in Figure 27 represents the interaction between the geographical scope. All the corridors are bound by operational agreements and must work collaboratively to function effectively. Agreements between operators and well-specified open interfaces need to be established in order to implement MaaS across county borders. The agreements that form the basis of cooperation to be established in a Cross-County Border MaaS system are defined as follows:

- It is necessary to define the operational scope of each MaaS operator while implementing a Cross County border MaaS system. Hence, the operational geographical area of MaaS operators involved in the agreement needs to be specified and agreed upon.

- Each county has specific transportation systems active only within

that region and all available transport modes in a county may not be eligible to be included into the cross county MaaS scenario. Therefore, the transport modes that can participate in Cross County Border MaaS when roaming needs to be identified for each county border.

- Establishing connectivity across county borders may require some additional resources and will have associated costs. Any possible additional roaming costs will need to be specified for each county case by case [66].
- Data exchange will occur between MaaS operators from different counties participating in the Cross-County border MaaS system. Agreements for data privacy need to be established, identifying all the stake holders affected by the data exchange process [66].
- Once exchanged, data will be held by operating companies under a MaaS operator. Thus, set boundaries need to be established for length of time data will be held and handled [62], [64], [66].
- Ticket reservation and cancellation policies need to be specified for smooth service delivery from start to end.
- Detailed specifications of the interface, which allows connecting to the services of the partner operator [66], need to be created.
- Revenue and cost allocation formulas need to be agreed upon based on MaaS data. Experience elsewhere can be used to help this process

5.3.2 Legal issues

Current legal criteria to be considered include all the legislation, regulation, policy, guidance and information from the Federal Highway Administration [67], as well as the administrative code from the Wisconsin State Legislature [68]. However, there are certain legislation and policies that need to be established in the future to guarantee the operation of MaaS:

- Legislation needs to be set up to protect the access of MaaS companies to market, e.g., permission to resell tickets;
- Open data policies are crucial in the MaaS market to encourage and legalize data interactions among different participants, e.g., FTA Open Data Policy Guidelines;
- To guarantee the efficiency of data transmission, guidelines about API (Application Programming Interface) or data standardization need to be established, e.g., LADOT Guidelines for Handling of Data from Mobility Service Providers;
- Data security is a key issue for stakeholders who share their data with someone else. Detailed agreements need to be reached. Legislation needs to be established to guarantee their rights and obligations;
- Guidelines about how to build multimodal payment systems are required for service providers;
- Legislation about protecting passengers' safety and security while using MaaS service is necessary;
- A policy for facilitating technology development needs to be established; and

- Guidance in the collaboration between counties and cities is of great important because inter-city transportation or cross-border traveling is currently limited in Wisconsin.

5.3.3 Funding

“Costs increase annually but funding isn’t. Balancing with demand is a challenge. The balance is mostly achieved by reorganizing the staff or operations structure.”

Source: MCTS

“Funding is a problem. Urban and sub-urban area operators need to collaborate. Majority of the expenses are resulting from transit operation and a balance is hard to maintain with limitation on federal Grants.”

Source: SEWRPC

Key organizations in a MaaS ecosystem include transportation service providers, governments, MaaS service operators/integrators, travelers, logistics service providers, etc.

In review of successful practices, five business models in Finland are described to deal with the shortage of funding [66], as shown in Figure 28:

(1) The first business model suggests MaaS company as a commercial reseller. In this case, a reseller supplies transport services of different transport modes; a travel agency is a good example of a reseller.

(2) The second business model indicates MaaS company as a commercial integrator. An integrator in addition combines the services of several modes with digital services, e.g., an application for mobile ticketing and/or travel

planning. For some integrators, MaaS is the main business; for some commercial operators, MaaS is a complement to their service offering.

(3) Public transport operators can act as MaaS operators by integrating additional transport services and digital services with their existing public transport, see flow chart (3) in Figure 28. The public transport operator may be owned by the municipality or region.

(4) Public-Private-Partnerships (PPP or P3s) is another business model in which the public actor may integrate different types of actors and services, which will justify the services the public actor is responsible for. These may include legislated special transport services and freight/delivery.

(5) Public-Private-People-Partnerships (PPPP or P4s) are considered as a way for organizing future mobility and transport in primarily rural and sparsely populated areas and regions. In Finland, health and social services along with regional government reformation are currently ongoing in which transport and mobility as a cross-cutting theme present a vital role within the established regions. A growing need exists for integrating publicly compensated transports (i.e., statutory social service transportation) and Self-paid transport Public expenses on statutory social service transportation transport in Finland are too high and have reached 1 billion euros annually but simultaneously the accessibility of public transport should be improved in order to provide a sufficient service level through reorganized and complimentary transport services for the citizens in rural areas. It is also worth noting that many regions may have seasonal demand factor (e.g., tourism) that increases the demand for accessible public transport.

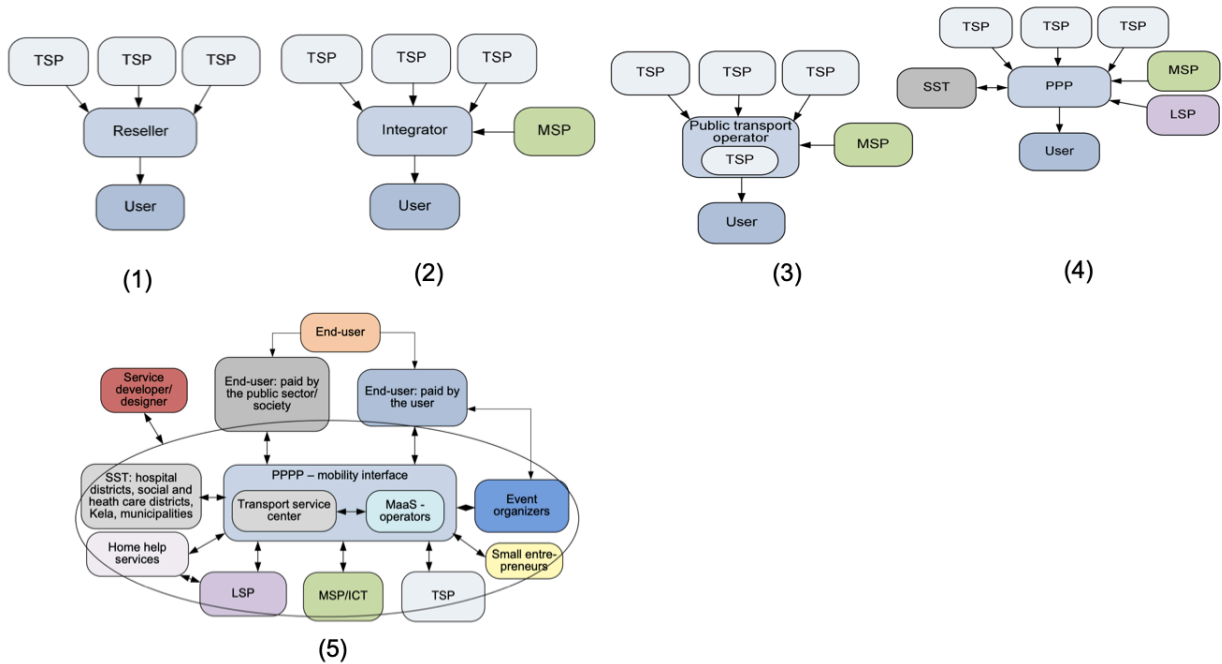


Figure 28 : Business models recommended in Finland MAASiFiE project

5.4 IMPLEMENTATION ISSUES

5.4.1 Data issues

Data Standardization

Data standardization is an important element in a well-operated MaaS system. The transfer structure of operation data is shown in Figure 29. Two sets of data standards need to be developed in the procedure, one between the Transportation Service Provider (TSP) and MaaS service operator and the other between the MaaS service operator and governments. At the current stage when there is no standard for certain types of data, an Application Programming Interface (API) can be used instead.

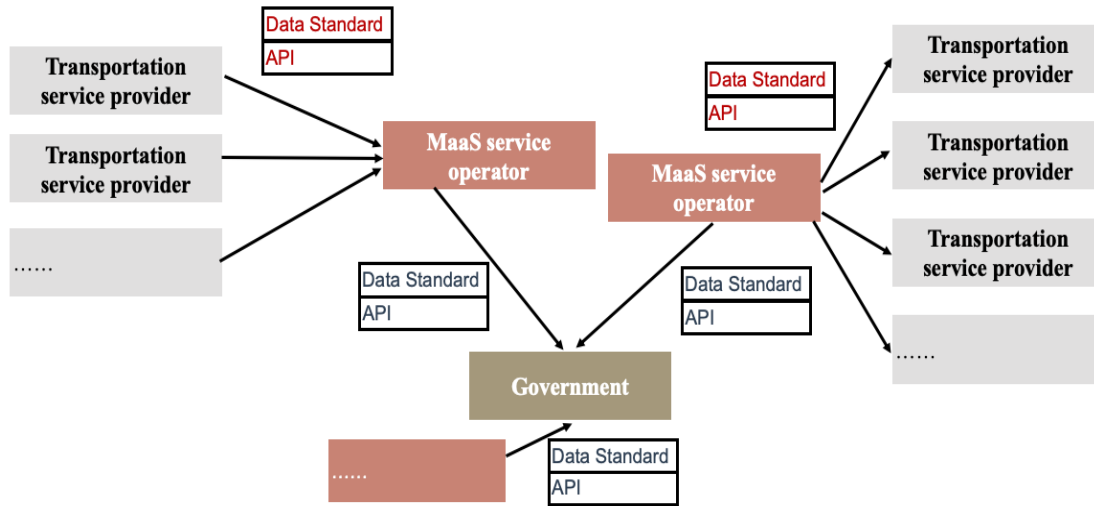


Figure 29: Structure of the data transfer between TSP, MaaS operator and the government

“Operation cannot be performed on state level unless standardized information has not been made available. Formation of such a system will require infrastructure to support it.”

Source: SEWRPC

“Leaders have a greater role in standardization of information, policy making and allocation of funding.”

Source: Ozaukee Transit

Table 3 shows three general transit apps that are currently present in the United States, including City Mapper, Transit, and Moovit, whose features, modes included, data source and data formats are summarized here. These apps have intensive trip-chain-based functions in information provision and can be seen as the first stage (information integration) of MaaS. Table 4 shows existing other apps such as Google Maps and Apple Maps that provide navigation functions and static schedule information of transit modes. Taking MCTS’s app as an example,

Table 5 shows the information that is provided by the transportation service providers’ app in Wisconsin, which includes the dynamic and static

information of routes operated by themselves. Moreover, MCTS’s app has payment option embedded.

Table 3: Existing General Transit Apps

App	Features/Characteristics	Modes	Data Source	Data Format
City Mapper	Maps, Real time information, Routes comparison by time, cost, fitness and weather, guides top commutes with Get Me Home or Get Me To Work features, Teleporter	Dockless bikeshare and scooters, walking, train, bus, bicycle, subway, ferry, taxi, Uber, Lyft	Open Data from transport authorities	GTFS, GTFS-realtime
Transit	maps, step-by-step navigator (GO), real-time trip planning	Transit, Uber, Lyft, bikeshare, dockless bikeshare, taxi, walking	OSM (Open Street Map), Metro, DoT, transit, Streetcar, shuttle, local transit, railway, taxi, crowdsourced live transit data, ...	GTFS, OSM
Moovit	Crowd sourced mapping, live arrival & departure times, updated line schedules, local station maps, service alerts and advisories that affect users' trips	Public Transit, Hailing Service, Taxi, On-Demand Service, Walking, Bike	Azure Maps (Microsoft Azure), crowdsourced data, public transit schedules	GTFS, Amazon CloudFront, GTFS-realtime

Table 4: Existing other Apps

App	Features/Characteristics	Modes	Data Source	Data Format
Google Maps	Maps, real-time navigation, time and schedule	Transit, Uber, Lyft, walking	Transit agencies (e.g., MCTS & Washington County Commuter Express in Milwaukee), crowdsourcing data	GTFS, GTFS-realtime, Google's Complete Map Content Specifications
Apple Maps	proactive routing suggestions, third party apps used inside of maps, indoor and outdoor navigation-Traffic, time and Schedule	Subways, buses, trains, and ferries; Transit; Indoor service;	Automotive Navigation Data, Hexagon AB, Intermap Technologies, OpenStreetMap, and Waze; Google Mobile Maps (GMM) service (used by Mapkit), TomTom NV	GTFS, Indoor Mapping Data Format (IMDF) is a new data model developed by Apple for indoor positioning

Table 5: An example of Existing Transportation Providers' Apps in Wisconsin

App	Features/Characteristics	Modes	Data Source	Data Format
MCTS	Real-time bus tracker, trip planning, payment, alerts	Transit	MCTS	GTFS

Table 6 summarized the existing data formats of different transportation modes. GTFS and GTFS-Realtime, GTFS-flex, and GBFS can be used for transit, demand-responsive transportation and bikeshare, respectively. TNCs and other carshare services only provide their custom APIs, that need to be standardized in the future.

Table 6: Data Types and Formats

Type	Format	Developer
Transit	GTFS (General Transit Feed Specification, static)	Google & TriMet, 2006
	GTFS Realtime (realtime public transit data)	Google & Transit Developers, 2011
Demand-responsive transportation	GTFS-flex	Google, Trillium, etc., 2016
Bikeshare	GBFS (General Bikeshare Feed Specification)	NABSA (North American Bikeshare Association) with bikeshare operators, 2015
TNCs (e.g. Uber, Lyft)	Custom API (Application Programming Interface) s	
Carshare (e.g. Zipcar, Car2Go)	Custom API (Application Programming Interface) s	
Streets	OpenStreetMap, SharedStreets, Open 511, Datex	

Real Time Information

Ease of data availability is the foundation to enable real time information. An Open Data Cloud with standardized, open formats accessible to app developers, city staff, and researchers is required to enable real time information in an integrated MaaS system. Data to be derived from public or semi-public transportation sources will also be hosted in the Open Data Cloud. Open and standardized Application Programming Interfaces (APIs) must be established to support real-time trip planning and mode choice analytics and should be made available in accessible format.

Real time data requires data from various transportation mode services. These services could be private, public or third party and will require collaboration in data sharing. The city can contract with private transportation providers to access their systems through open APIs, and to the extent possible, share anonymous trip data via the Open Data Cloud.

Real information can be provided by third party organizations. One example of the currently operating MaaS third party service provider companies include OMNI Modal which provides

services to Smart Cities, DOTs, public transit agencies and alternative mobility providers, 3rd party app developers, and planning and engineering firms.

Data Security

A Digital Identity Trust Frameworks define the 'rules of the road' for interactions between organizations when handling identity, authentication and authorization. A trust framework or trust domain is essential for implementation of mobility as a service as it involves data exchange, retention, analysis etc. The scope not only includes personal data for users, but also propriety data from various transportation service providers [69]. There are three major components of an application domain. The Carrier Application represents applications that are under direct control of the operator. The Partner Application block represents applications where the operator is involved with a resulting partnership with the Internet of Things service provider. If a relationship exists between a network operator and an application partner, it means that some level of trust exists between these entities. Both the carrier provided/hosted applications and the partner applications may be able to access services from the carrier network. Finally, internet and 3rd party applications do not have a strong trust relationship with network operators and typically access data through open data sources (Figure 30) [70].

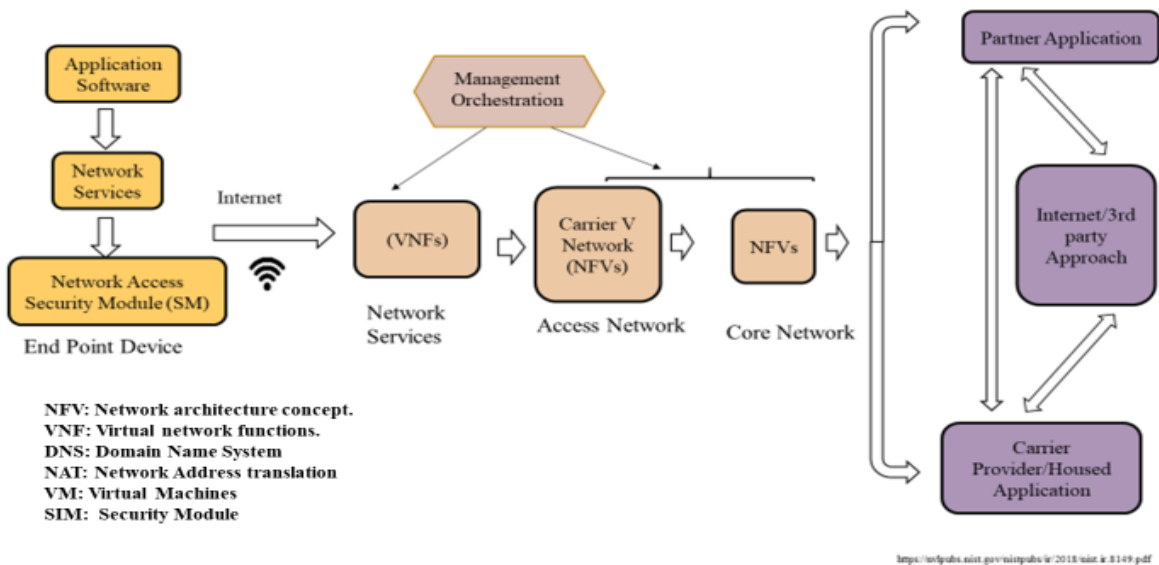


Figure 30: Trust boundary and Trust Domain for data handling [69]–[71]

Network Function Virtualization (NFV) is a network architecture concept that uses technologies of IT virtualization to virtualize an entire class of network node functions into building blocks that connect to create a communication service. Virtual network functions (VNFs) are virtualized tasks formerly carried out by proprietary, dedicated hardware. VNFs move individual network functions out of dedicated hardware devices into software that runs on commodity hardware. These tasks, used by both network service providers and businesses, include firewalls, Domain Name System (DNS), caching or Network Address Translation (NAT) and can run as Virtual

Machines (VMs). The device Security Module (SIM) shown in the model is a piece of a hardware module under the control of a network operator [69]–[71] (Figure 30).

The Internet of Things (IoT) is increasing the connectivity of the world and is an essential part of a MaaS system. It enables data generation, exchange and analysis to bring new insights to better mobility solutions. However, an effective IoT solution also refers to deploying it safely so that the information is only available to authorized personnel [72]. Thus, the following point lists some security features required for an IoT Platform:

- Data encryption to prevent eavesdropping.
- Data integrity protection to prevent data tampering.
- Access control covering access to software facilities and data.
- Authentication and authorization control to prevent identity spoofing.
- Credential management to allow security credentials to be managed and securely stored [45].

5.4.2 Payment integration

A vision for MaaS includes a focus on the customer experience by providing one application that includes integrated routing, booking, payments and credits/offsets. Using this application, a traveler inputs a travel destination, and the application returns all available options along with the amount of time it will take to get to the destination and each option's cost. Once an option has been selected, the application provides the opportunity to reserve and pay for the trip and provides the routing services [73].

Wisconsin is a mix of urban, suburban and rural communities and the payment system for each case is different in nature based on technological availability and user demand. For urban cases such as Milwaukee, the case of the MCTS M-CARD is an easy, affordable and efficient way to pay for bus service. The card can be loaded online and can be used at over 90 locations with stored Cash Value or a 1-, 7-, or 31-Day Pass. The card can be easily used by tapping on an orange target on the farebox. The transaction information is displayed on the screen and the transaction will make a beeping sound [22]. For rural cases, such as Ozaukee County, the payment system is still based on cash or coupons. The rides must be booked by phone at least 24 hours ahead of time. Currently Ozaukee County Transit Service is planning to move towards a real time information system.

Based on research findings and Advisory Committee feedback, integrated payment solutions possibly suitable to a Wisconsin context both for urban and suburban cases have been proposed (Figure 31). The Prepaid Card option allows transfers between certain mode choices (for example, MCTS and HOP). The prepaid option can be refilled with a balance limited by a certain minimum to maximum amount. This option will have no monthly invoice. The Account Credit option works like a credit card. This system will require a web-based account registration or smart phone application. The account will be updated on the balance per use. The user will be updated with email notification on transactions made and the account will show updates on new payment information. This service will provide monthly invoices to the users as well as allow

use of Electronic Card Payment. The MaaS system can also offer some integrated payment options for Rural or Limited Smart Phone Accessibility Payment Options. One of these options can include Direct Cash Payment to a Service Provider. However, payments can also be initiated through a registered web-based account that will show the balance accumulated per use. The users can be updated by email notification and they can receive a monthly invoice such as a credit card. Promotional offers could be made to users that may give them more points for payment discounts if they are making a suggested route choice.

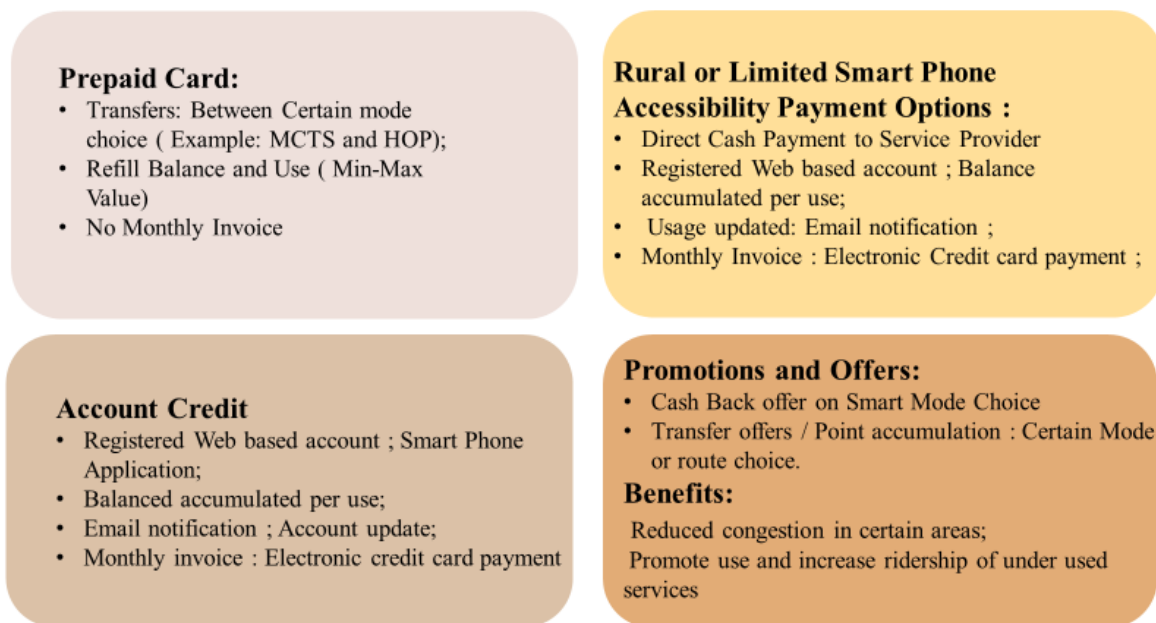


Figure 31: Integrated Payment for future MaaS users in Wisconsin [74]

5.4.3 Revenue allocation

Revenue allocation in a MaaS system will depend on whether the MaaS system is publicly operated or is a commercial business model (Figure 32). When the MaaS operator is a public entity, then one of the options of revenue allocation could be rate of return model. It allows firms to recover costs and earn a “fair” return by setting a regulated price, which is calculated by establishing the rate base and the value of all fixed assets used to produce the infrastructure at the agreed upon rate of return [75]. For the availability payment approach the public agency MaaS operator seeks competitive proposals from teams. The public MaaS operator commits an annual payment to the winning team over a specific period of long-term agreement; however, the agreement is subject to the private company meeting the performance requirements [76].

Public sector MaaS revenue allocation could also be subscription based in which the user will pay a fixed amount to the public sector that will in turn pay for the assets required to operate and manage the MaaS system. In an agreement-based revenue allocation system, the user will pay a fixed agreed price to the public section. The public sector will then distribute the revenue to the transportation service provider. Other revenue allocation methods for MaaS could be applicable to the private sector. One of them is the commission-based model in which the user pays for services received to the transportation service provider. The transportation service provider pays

a commission to the Private MaaS Operator. Finally, a shadow tolls revenue allocation system allows users to pay based on their usage of services to the private MaaS company [66], [75].

Existing revenue allocation systems in areas such as Los Angeles or Seattle with multiple transit operators can be used for models to allocate revenues between agencies.

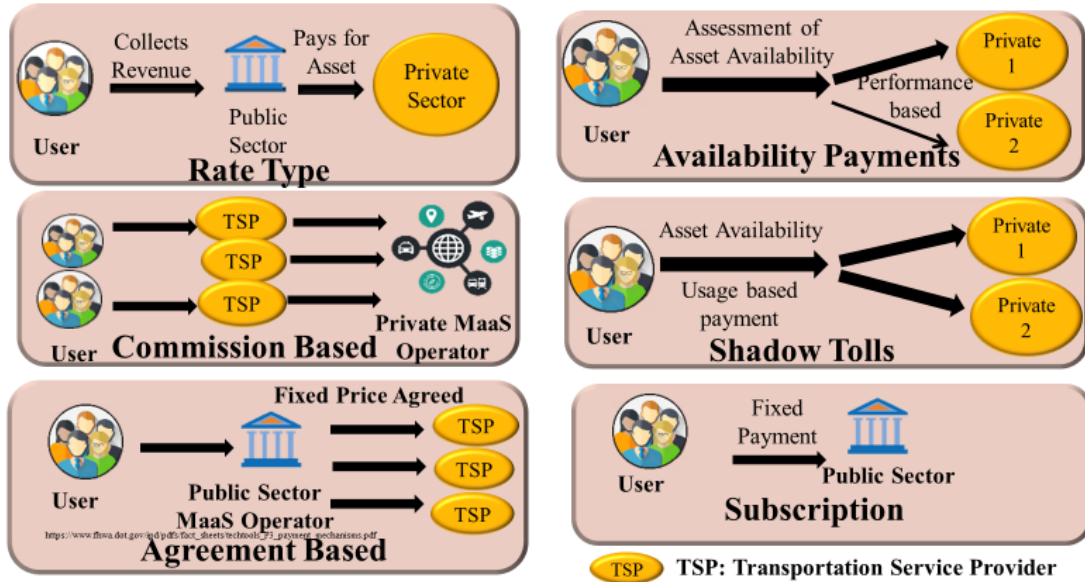


Figure 32: Different type of revenue allocation options for MaaS in Wisconsin [66], [75]

5.5 MARKET ANALYSIS

5.5.1 SWOT Analysis

Piloting and adoption of MaaS programs has been more prevalent in Europe; however, the concept and practice has recently been introduced and loosely implemented in the United States. The MaaS Topology, developed by ITS World Congress, details five levels of MaaS and highlights that the U.S. has only taken part in the first two levels, Level 0 and Level 1 (Figure 33).

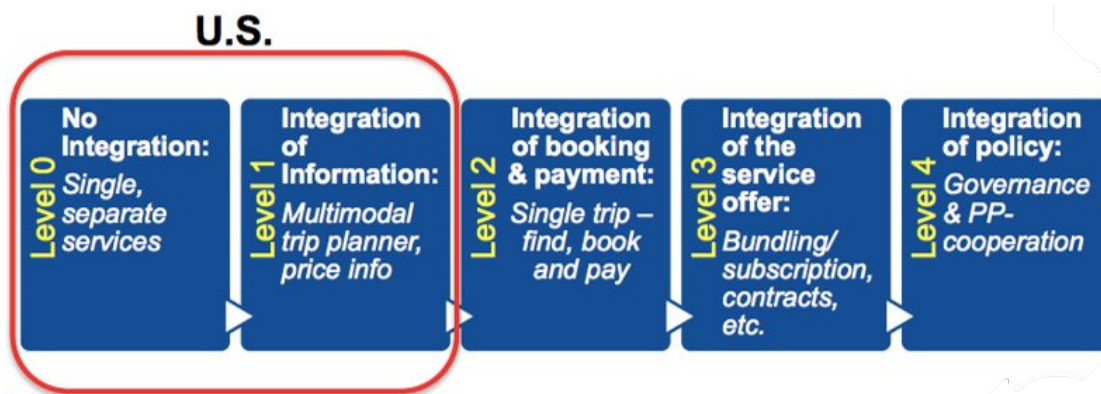


Figure 33: The topology of Mobility as a Service (MaaS) [77]

According to a Market Research Future's (MRFR) report, the global Mobility as a Service market is expected to reach about \$253.16B by 2023 growing with a 36% compound annual growth rate (CAGR compound annual growth rate) over a five-year period.

Source: MRFR [86]

In the state of Wisconsin, there is a wide variety of population densities and land uses. These differences require a MaaS model that could serve rural, suburban, and urban mobility needs. Globally, rural MaaS pilot programs are being rolled out in Finland and Denmark, and more are being implemented and piloted programs currently exist in urban areas. As MaaS is a relatively new concept and these programs are new, not much information is available to evaluate successes or opportunities for improvement. However, MaaS implementation statewide aligns with the Wisconsin Department of Transportation's mission, vision, and values to "provide an efficient transportation system"

and "finding innovative and visionary ways to provide better products and services" [78].

MaaS has just began to gain traction especially in the United States. To fully understand the impacts of MaaS on all of the participants such as MaaS service providers, transportation service providers, and users, SWOT analyses were conducted here to describe strength, weakness, opportunity, and threat faced by different participants in the Wisconsin MaaS system.

Strengths

- **User flexibility:** Wisconsin MaaS offers a transportation solution that provides more seamless travel journeys and on-demand service. Ultimately, this allows for a more flexible transportation experience.
- **User convenience:** The MaaS scheme calls for a single platform for all transportation needs which simplifies the travel process by integrating all the necessary travel procedures in one place including payment integration for all the participating service providers.
- **Transparency:** The goal of MaaS is to provide real-time data and give a variety of trip options (no matter the form of transportation) so that the user is as informed as possible about routes that best suit their needs.
- **Personalization:** Wisconsin MaaS may have the ability to show best travel route options based on individual preferences (e.g., cheapest trip, shortest distance, most active).
- **Promotes Sustainable and Health Lifestyles:** MaaS offers users transportation options that are separate from personally owned vehicles. This allows for more opportunities to become aware of and use more active and sustainable modes of transportation to complete their travel trips.

Weaknesses

- **Technology Investment Requirement:** All participating transportation providers need to have their data in a standardized format so the MaaS platform operator can properly work with the consistent information. Some providers throughout the state may not already have

data in the proper formats needed which would require a time and resource investment that may not be readily available.

- **Equity:** Smartphone internet access is crucial to fully use MaaS platforms, and thus the inability for mobile internet access is a barrier for potential adoption of WMaaS for rural Wisconsin residents and for suburban or urban residents. However, the areas with the densest transportation offerings (i.e., urban and suburban) have much greater smartphone internet usage in which to access a WMaaS platform.
- **Funding:** Sustaining a MaaS business platform could require significant long-term investment in order for it to remain high-quality for users. Potential partnerships and businesses models could help mitigate this burden.
- **Ease of Use:** If the MaaS app user interface is not intuitive or unreliable, there is risk that users will not adopt it or will stop using the service and technology.
- **Wireless Connectivity Issues:** In rural areas or in densely, built up downtowns, wireless connectivity can be hard to find. This issue presents a problem for MaaS given its heavy reliance on wireless technology and connectivity to properly function.

Opportunities

- **Provides Sustainable and Intermodal Travel Options:** Since MaaS integrates a variety of different transportation options such as walking, bicycling, and transit, users have many sustainable and active mode choices that may align more with their preferences and values (e.g., healthy lifestyle, environment-friendly). Additionally, this could potentially help reverse transit ridership decline felt by many public transit agencies.
- **Attract Young Talent to Wisconsin:** Retaining and acquiring young talent across the State of Wisconsin is a priority, and MaaS can act as a tool to attract a younger workforce as their travel preferences align with the goals and service provided by MaaS.
- **Complimentary Services:** MaaS can offer an affordable and accessible solution to the first/last mile issue by offering options to users to make these short-distance connections.
- **Equity:** The more transportation providers that participate in Wisconsin MaaS can potentially lower costs for users through market competition.
- **County and City Boundary Issue Solutions:** Many transportation providers service are bound by geographic borders resulting in a lack of accessible options to get to and from destinations that cross jurisdictional borders. MaaS can help provide users with the information they need to make these cross-border transportation connections possible.

Threats

- **Partnership Uncertainties:** Transportation Service Providers have different market structures, goals, and expertise which results in varying perspectives regarding their potential interest in joining Wisconsin MaaS.

- **Hard to Change Travel Patterns and Behavior:** Routine travel behavior is difficult to change, and many people can be averse to changing the way they travel especially if they have established a travel pattern over many years. Changing people's travel behavior may be more difficult in less dense, rural areas and for different demographics (e.g., older populations) particularly when fewer transportation options may be available to use.
- **Subscription Model:** If this type of model was employed in the Wisconsin MaaS platform, many Wisconsin citizens may not be ready to allocate a monthly budget towards non-private vehicle owned transportation, although, many transportation providers already have the option to purchase time-bound passes (e.g., monthly, annual).
- **Privacy Concerns:** Since Wisconsin MaaS will involve some personal information sharing by users, privacy concerns will likely be an issue for many potential users. It will be key to determine how the MaaS operator will use personal information and data, and to communicate to suppliers and users on how their data will be used and kept safe.
- **Governmental Approval Requirements:** Many government-based transportation service providers require governmental approval by local municipalities or counties for any major service change or technology investment. This approval requirement may make MaaS adoption difficult for various transportation service providers across the state given the risk adverse nature of governmental agencies.

5.5.2 Implementation Issues

Past work at the university involved an examination of issues that relate to adoption of innovation for transit agencies and elsewhere.[79] The feasibility of implementation of an innovation such as MaaS depends of factors related to the innovation and to the potential users of the innovation. Technology is likely to be adopted when it has a significant advantage over current methods, when it can be easily tried without a long-term commitment, when results can easily be observed and when the consequences of failure are small.

Table 7: Implementation analysis of MaaS

<i>Technology Assessment</i>
<ul style="list-style-type: none"> • Relative Advantage: MaaS provides real time information, alternative choices, payment systems. This should remove barriers for choice users and reduce uncertainty.
<ul style="list-style-type: none"> • Trialability: difficult to try, all or nothing system
<ul style="list-style-type: none"> • Observability: Benefits (i.e. usage) may be difficult to quantify
<ul style="list-style-type: none"> • Complexity: Easy to understand if a user-friendly platform, technology is complex behind the system
<ul style="list-style-type: none"> • Cost to implement: Will require supporting infrastructure AVL, GPS, communications system
<ul style="list-style-type: none"> • Impact of failure: Public agencies are risk-averse and avoid early adoption

<i>User Assessment</i>
<ul style="list-style-type: none"> • Target users: small urban area and rural public transport systems, 80 + systems in Wisconsin
<ul style="list-style-type: none"> • User characteristics: Customer focus, budget concerns, regulatory constraints, geographic limits, high visibility in public sector
<ul style="list-style-type: none"> • User Attitudes: generally open to change, trialability is important, budget limits prevent risk taking, avoid early adoption
<ul style="list-style-type: none"> • User Capabilities: Need help in implementing complex technology, staff shortage for innovation

<i>Factors that favor implementation</i>
<ul style="list-style-type: none"> • Potential benefits for users that may increase ridership
<ul style="list-style-type: none"> • Concept is easy to understand
<ul style="list-style-type: none"> • Users are generally open to change

<i>Factors that discourage implementation</i>
<ul style="list-style-type: none"> • Difficult to try, all or nothing system
<ul style="list-style-type: none"> • Staff and budget shortages
<ul style="list-style-type: none"> • Regulatory constraints
<ul style="list-style-type: none"> • Public agencies avoid risk and potential for failure
<ul style="list-style-type: none"> • Internal technology is complex

An assessment of MaaS on these factors is given in Table 7. For MaaS, the advantages are clear and relatively easy to understand but it would be difficult to implement on a trial basis. Benefits may be more difficult to measure and quantify. Implementation over the long term will require supporting infrastructure of vehicle location systems, real time information and communications

systems. Implementation would involve public agency support and would have to overcome risk and consequences of failure. For MaaS we also looked at users from smaller cities and rural areas in Wisconsin (Figure 35 middle) These users are very customer focused and operate with significant budget constraints in a very visible public arena. They are generally open change but budget limits, staff shortages and consequences to failure can be significant barriers.

User characteristics that need to be considered are budget and staff shortages, regulatory constraints, the difficulty of 'giving it a trial', and risk-taking climate and fear of failure in a public arena.

For MaaS to be implemented, it will be important to clearly explain its potential benefits and to estimate their potential value. Staff and budget shortages as well as the risk-taking climate suggest a strategy of trial systems in the way of demonstration projects where consequences and implementation issues are worked out. A key element of implementation will be the development of supporting infrastructure over time that can be used to support MaaS.

5.5.3 Competitive Analysis

Since MaaS is a newer concept that integrates all the components of what different transportation organizations provide into one platform, a direct competitor does not necessarily exist. However, these transportation organizations can instead be evaluated on how they could be unified into the Wisconsin MaaS scheme as a collaborative partner or as an operating MaaS competitor.

Public or Public-Adjacent Transportation Companies

The types of companies that fall into this category are fixed transit providers such as Milwaukee County Transit System, bicycle sharing operators such as BublR and Madison BCycle, and shared ride taxi companies like Running Inc. or by varying counties statewide. Many different factors affect each of these providers' drivers of demand such as price, quality and add-on services, so each metric varies by company across similar service providers and all public facing service providers.

These transportation companies face budgetary, geographical, labor resources (e.g., availability, expertise) constraints that ultimately can positively but more often negatively affect pricing for their service and the level or quality of service they provide. Additionally, the varying socio-demographics, land use characteristics, and varying travel behavior routines makes it hard to evaluate each company in a statewide context. However, these companies would likely be the biggest opportunity to become a Wisconsin MaaS collaborative partner rather than a competitor.

As governmental agencies or with closer ties to government regulations, the proper resources needed to manage a MaaS system internally may be more difficult to accomplish and sustain long-term. They are more suitable as a collaborative partner where their role in the partnership would be less demanding. These companies can help to provide the necessary standardized data for MaaS platform operation but would not need to worry about the actual managing and operation aspects of the platform. One caveat is the investment that may be needed by some agencies to standardize their data in the proper format. This partnership would also be less risk averse since they would not be in charge of day-to-day monitoring of MaaS.

Private On-Demand Ridesharing Companies

Examples of companies in this category include transportation network companies such as Uber and Lyft. These companies are typically privatized, and data information sharing is not common. They are able to have tighter control on their pricing making it very cost-competitive with public transportation and private vehicles. Additionally, these companies have a large network of drivers who can make travel accessible, fast, and reliable. However, internet connection is needed to use their service and service is generally only available in more dense, urban or suburban areas. Private companies like these could either be a competitor or a collaborative partner.

As a competitor, these companies would be the sole operator of the Wisconsin MaaS platform and would likely monetarily benefit from owning the platform. In order to succeed as a competitor, they would need to acquire data from all transportation providers which may not be an easy or feasible task. However, if data collection is possible, little collaboration would be necessary, which could potentially be harmful to other transportation providers. There is also a danger that they could bias user information to benefit specific organizations and push users towards advertisers and sponsors.

As a collaborative partner, these companies would lend their expertise as the operator of the MaaS platform, but their ownership of the MaaS platform would be limited and a more mutual partnership with open communication and greater benefit sharing would occur.

Multimodal Transportation App Providers

The providers in this category do not actually provide a physical transportation service, but instead are transportation information providers that help users evaluate different travel options to get to their destination.

City Mapper

Features and characteristics of this app include maps, real-time information, routes comparison by time, cost, and fitness and weather. Dockless bicycle share and scooter, walking, train, bus, bicycle, subway, ferry, taxi, Uber, and Lyft are modes users can evaluate. The data source is open data from transport authorities' data format that is provided in GTFS and GTFS-real-time.

Currently City mapper is only available in very large cities and not in Wisconsin. However, there is a future possibility that City mapper may extend its service towards Wisconsin and hence be a competitor to WMaaS.

Transit

Features and characteristics include maps, step-by-step navigator (GO), and real-time trip planning; Modes offered in this app are transit, Uber, Lyft, bicycle share, dockless bicycle share, taxi, and walking. The data source is from OSM (Open Street Map), Metro, DoT, transit, streetcars, shuttles, local transit, railways, taxis, and crowdsourced live transit data, and the data format is provided in GTFS and OSM.

Currently Transit is available is available in Wisconsin. However, its service is currently limited to Milwaukee.

Moovit

Features and characteristics include crowd sourced mapping, live arrival and departure times, updated line schedules, local station maps, and service alerts and advisories that affect users' trips. Public transit, ride hailing service, taxi, on-demand service, walking, and bicycle are modes offered in the app. The data source is from Azure Maps (Microsoft Azure), crowdsourced data, and public transit schedules, and the data format is GTFS, Amazon CloudFront, GTFS-real-time.

Google Maps

Features and characteristics in the app include maps, real-time navigation, traffic updates, and time and schedule information. The modes offered for evaluation are transit, Uber, Lyft, walking, and bicycling. The data source is from transit agencies and crowdsourcing data, and the data format is GTFS, GTFS-real-time, and Google's Complete Map Content Specifications.

Apple Maps

Features and characteristics include proactive routing suggestions, third party apps used inside of maps, indoor and outdoor navigation, traffic updates, and time and schedule information. Modes in the app are subways, buses, trains, ferries, walking, and bicycle. The data source is Automotive Navigation Data, Hexagon AB, Intermap Technologies, OpenStreetMap, Waze, Google Mobile Maps (GMM) service (used by Mapkit), and TomTom NV, and the data format is GTFS and Indoor Mapping Data Format (IMDF) for indoor positioning.

Similarly, to public and public-adjacent transportation companies, app providers are likely best positioned to be a collaborative partner for Wisconsin MaaS since they do not provide a physical transportation service component to their service. Their transportation and technology integration expertise could be leveraged as they could be the platform operator. They already have the knowledge and resources and would be a more neutral operator since they do not provide an actual physical transportation service. According to an APTA study, 80% of millennials consult with either Google or Apple Maps for transportation planning, suggesting that partnerships with the two companies may be both fiscally and practically the easiest path. Optimizing existing dominant platforms should involve improved trip aggregation, centralized payment systems and real-time travel information [80].

Several caveats currently exist with app providers. One caveat is that sometimes their public transit information is not the most up to date, but as a collaborative partner with Wisconsin MaaS, these data would likely be current since they are directly in contact with the public transit agencies. Another caveat is their potential inexperience with payment in-app integration, although companies such as Google and Apple have this expertise outside of their map apps.

Privately-Owned Vehicles

While private vehicles offer autonomy and flexibility, users are also subject to the cost of car ownership and variability in quality of travel service (e.g., from congestion, from crash risk,

parking availability and costs). According to the Bureau of Transportation Statistics, the average total cost per mile of owning and operating a car is 59 cents which equates to an average total cost per 15,000 miles of \$8,849, a significant amount of money [81]. Car ownership can be cost-prohibitive for many individuals increasing their reliability on available options such as public transit, shared-ride services, and safe bicycle and pedestrian infrastructure.

5.5 SUMMARY OF FINDINGS AND PRELIMINARY CONCLUSIONS

Based on the feasibility study, MaaS in Wisconsin can benefit users of different age groups from different geographic locations. The aging population and people with disabilities in Wisconsin can benefit from user-oriented solutions that will require federal and state level support. Low-income MaaS users can use MaaS by using tailored service packages, volunteer to earn trips and obtain cost assistance. Service options for MaaS for areas with limited accessibility to smart phones include web-based and telephone service booking and a payment integration solution. The proposed solution for MaaS in Wisconsin also includes methodology, requirements and proposed options for MaaS across county borders.

- In this chapter the scope of agreements required between MaaS operators and transportation service providers has been identified; finally, possible Wisconsin Cross County MaaS system Architecture has been proposed that considered all the existing transportation infrastructure available in Wisconsin. Implementation of MaaS in Wisconsin would require adaptation of the MaaS system in future regulations. Thus, the issues associated with a MaaS system that are required to be covered in future regulations have also been identified.
- Apart from technological need, one of the major factors affecting feasibility of MaaS in Wisconsin is the funding availability and this is a concern that was raised by the Advisory Committee members. A case study with respect to other MaaS systems has been performed and has been compared within a Wisconsin context to propose potential business models to combat a funding deficiency. Data standardization enabling all transportation modes to have a similar data format is the key component of successfully operating MaaS and therefore stakeholder interaction, resulting in identifying data exchange and essential data formats required for MaaS.
- The study also highlighted the importance of the data availability and collaboration support required among different stakeholders providing MaaS service. Data security is another important component in MaaS that has been brought to light through this study and hence identified the possible areas of alert, introduced a Trust Boundary framework for data exchange and identified the legal permission required for data security.
- Payment integration is an essential component of MaaS and hence the study proposed a possible payment integration for Wisconsin for different service users. Since MaaS involves service integration and integrated payment options, therefore revenue allocation is an essential factor and different revenue allocation structure options for the Transportation Service Provider (TSP) suitable for Wisconsin context have been proposed.

- Several barriers have been identified in Chapter 5 and the barriers consist of the initial investments needed (e.g., costs of technology, data restructuring), lack of resources or expertise needed for MaaS implementation, geographic boundaries of service, regulatory constraints, and market structures and organizational goals. While MaaS can be implemented using different business models (e.g., private, public-private), each transportation service provider will be required to continually and actively provide the most up-to-date required data regardless of the chosen organization managing the MaaS system. Observability of Wisconsin MaaS should be easy since data will be readily available to analysis once the appropriate metrics for success are defined.

Deployment of MaaS in Wisconsin is a strong future possibility; hence MaaS may happen, possibly evolving from a large urban area. MaaS will then advance towards smaller cities. However, rural areas will face some challenges in adapting to MaaS but may eventually adapt to it. To implement MaaS in Wisconsin, standardized data systems, formats and interchange protocols will be needed to make the system operable. Real time information availability is essential for MaaS and real time vehicle locations systems will be required. A MaaS system could be publicly managed or operate as a public private partnership (PPP) and implications of each case need to be assessed. MaaS requires collaboration among different stakeholders (public entity, transportation service provider) and hence standard agreements will need to be established. The business model for MaaS could be both private and government regulated. In either case, leadership at the state level will be needed to coordinate activities. For effective operation of MaaS, agencies are suggested to move from transit being providers to becoming mobility aggregators to meet the growing and changing needs of the consumer.

CHAPTER 6 SYSTEM ARCHITECTURE, MECHANISM AND ROADMAP FOR WMAAS

The findings from Chapters 2 and 3 along with feedback from Advisory Committee members were used to identify barriers and possible solutions to the envisioned ‘Mobility as a Service’ system in Chapter 4. However, establishing a successful ‘Mobility as a Service’ system in Wisconsin will require the development of a MaaS system architecture for Wisconsin with the boundaries and modularity of the system, a proposal of possible mechanisms for operating a MaaS system (from a service request to completion and how it will function in a MaaS system), and the creation of a structured roadmap of how the different phases will be accomplished.

6.1 MAAS SYSTEM ARCHITECTURE

The system architecture for MaaS in Wisconsin (Figure 34) shows the relationship between different participants in the MaaS system, where MaaS service providers, transportation service providers, and users are considered the three main participants in the system. Each of the participants plays different roles in the three main sections: data, business services, and user interface.

The participants in the Data section ensure that smooth operation of the system occurs. Data are to be collected from both transportation service providers and users to then be processed by MaaS service providers. The two types of business services offered by MaaS service providers targets travelers (users) and transportation service providers. Smartphones, websites, and telephones are the main channels of user interfaces for users. Through interactions with users, MaaS service providers will offer real-time information, trip planning and booking capabilities, tailored service packages, and payment and instant rating options for users to customize and optimize their trips. Meanwhile, transportation service providers will own the functionality aspect of transportation services for users. Smartphones and websites will be the channels for transportation service providers to access the service provided by the MaaS service providers. Ultimately, this partnership will help transportation service providers to improve their transportation services for users. This service needs to have the capability to investigate operational cost, calculate profit, and analyze ridership trends and service optimization. Static information and real-time data will be needed to provide efficient service for users, while historical operation and transaction data are required to provide service for transportation service providers. System security and government regulation are important aspects to consider for ensuring an adequate and safe MaaS system.

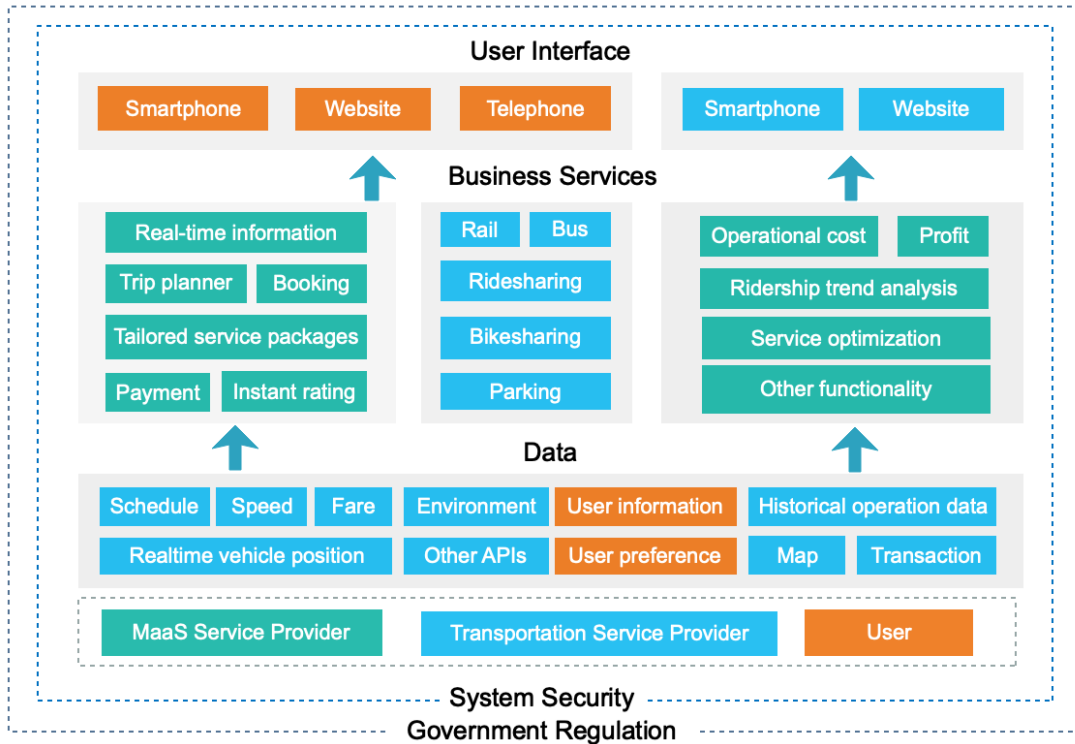


Figure 34: System Architecture for MaaS in Wisconsin.

6.2 MECHANISM

With regard to the operational mechanism of a MaaS system, the key elements include service registration, real-time information, route optimization, data analysis, payment integration, and customer feedback for future service improvements. To operate a MaaS system smoothly, a specific sequence needs to be maintained and the participating service providers will need to perform in an effective manner. For example, some of the elements, such as the registration platform (mobile app or website), are the functions to be performed by the MaaS operator themselves, while other elements, such as the external payment processing systems, will require external contributions. Conversely, some of the functions such as data analysis, matchmaking, and routing options can be performed by either the MaaS company if it has the resources or to a contracted third-party company. Two sets of mechanism, i.e., one for MaaS customers, and the other for MaaS service providers, have been proposed for MaaS operations. Each of the mechanisms demonstrate how transportation services can be linked, travel route options can be optimized, and payment systems can be integrated in a MaaS system.

As an end user in the MaaS system, customers will go through a series of interactions with the MaaS operator interface to complete a service request (Figure 35). Customers will first go through the registration phase before completing the service request phase. After generating a service request, customers will need to choose their preferred service. Finally, after their service has been completed, customers will need to make a payment after receiving an invoice from the MaaS operator. A detailed description of the entire mechanism, from service request to service completion to payment, is discussed below.

1. Users register to use service and share their information to create a personal data account. This step has three parts: Registration, Personal data entry, and Service request entry.
2. Demand Hub receives service request and user profile from the app.
3. Demand Hub sends information for Match Making.
4. Match making:
 - Evaluates the information received from the Demand Hub based on the Business Rules established by the MaaS operator, past user feedback on preferences, and the service supply from service provider (from Chart 2).
 - Match making creates Routing options to be sent to the customer.
 - Routing selection:
 - Routing options are sent back to the user via the Demand Hub for selection.
 - If selection is made by user, the next step goes to Token generation.
 - If selections are rejected by user, then the process between the Demand Hub and Routing option is reassessed (an iterative process).
5. After a route choice is selected in the match making phase, a notification is sent to the token generation phase. Token generator sends a notification to user (which also goes to the service provider in Chart 2).
6. Meanwhile, the Demand Hub sends information for Data Analysis that is also forwarded to Transportation Management Services.
7. Service delivery and completion:

The service is delivered to the user by the Transportation Management Services and Service providers. The service delivery can also be performed solely by the MaaS operator if they have all the required technology and resources available.
8. Payment notification and completions:
 - Once the requested service has been completed, the token generator sends a notification to Payment API and a voucher is generated and sent to the user.
 - The user completes payment through Payment API and external company processing payment.
9. User provides feedback for future service reference [62] [64] .

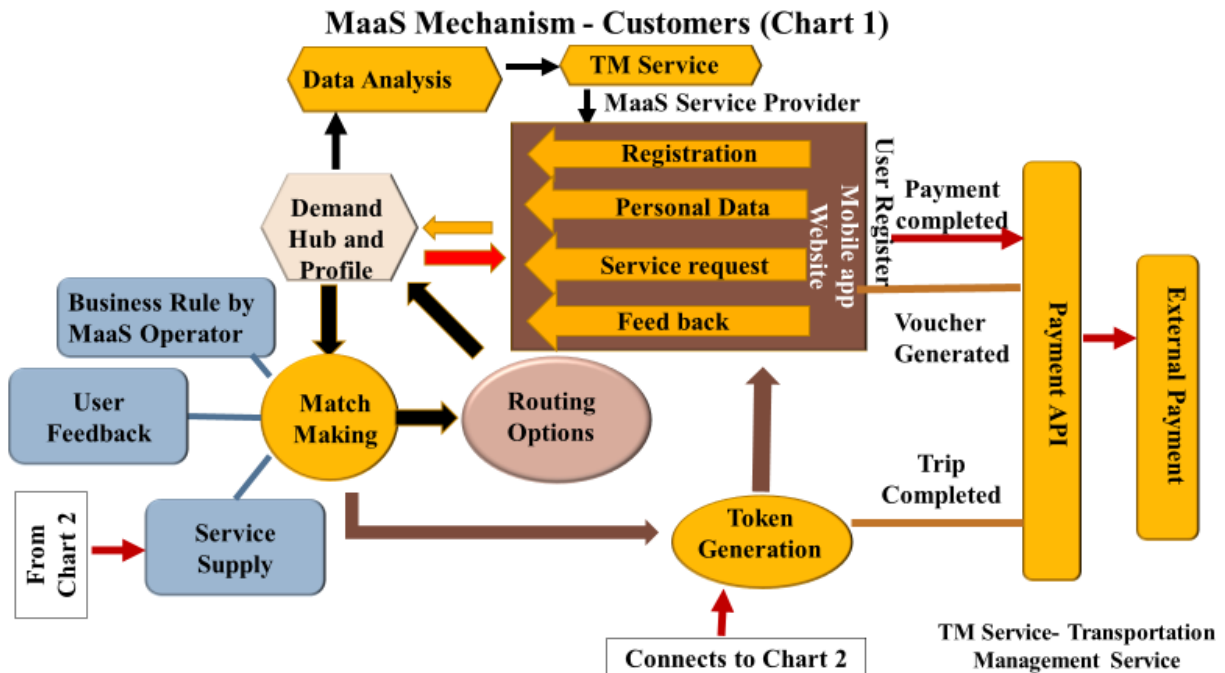


Figure 35: Mechanism for MaaS operation – Customer [62], [64]

The MaaS service provider will need to perform a series of actions to successfully deliver a service request to the customer (Figure 36). Each of the transportation service providers participating in the MaaS program will have to first register with the MaaS operator. After registration, transportation services will then be available to customers in the form of various routing options. If a service provider receives a service request through the notification system, it will then complete the service and notify the MaaS operator. This step will then prompt the customer with a payment notification that eventually completes the entire service process. The proposed MaaS service mechanism is described in more detail below.

1. Service Provider registers on the MaaS provider account. The service provider then inputs service information and data information into the Demand Hub.
2. The Demand Hub receives the service availability (supply) and data information from the Service provider.
3. The Demand Hub sends service information to Match Making.
4. Match Making:
 - Evaluates the information received from the Demand Hub based on the Business Rules established by the MaaS Operator, past user feedback on preferences, and the service request received from user (from Chart 1).
 - Match making creates some routing options.

5. After selection of route choice in the match making phase, notification is sent to the Token generation phase. The token generator sends a notification to the service provider (which also goes to the user in Chart 1).
6. Payment system initiation: Once a trip is completed, the token generator sends a notification to Payment API which updates the status of the trip completion and then triggers a voucher/invoice to be sent to the user from Payment API.
7. Payment completion: After receiving a voucher, the service provider collects payment after the user completes their transaction [62], [64] .

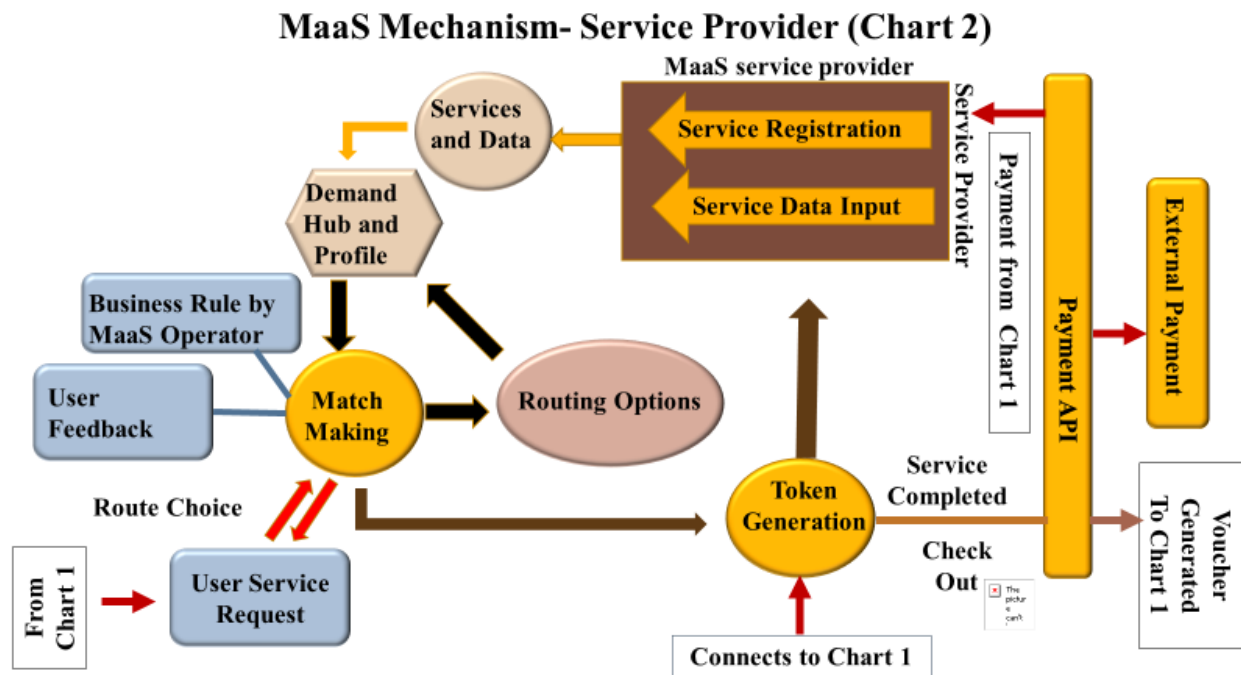


Figure 36: Mechanism for MaaS operation - Service Provider [62], [64]

6.3 ACTION PLAN/ROADMAP

The development of Mobility as a Service is a multifaceted process and the barriers identified may be different for each geographic location based on the respective socio-demographic, economic, and environmental situations. To implement MaaS in Wisconsin, a road map is proposed that defines the strategic plan to meet the goal or desired outcome of MaaS in Wisconsin. The road map will serve as a high-level flowchart that will assist in articulating the strategic thinking and highlight the major steps and milestones required to successfully implement MaaS statewide.

Based on our work we suggest that Wisconsin cities such as Madison and Milwaukee establish a Smart Public Transport Task Force to aid in the implementation of MaaS. The task force should have representatives of state and local government, public and private transport providers, academics who study, coordinate and inform participants about the integration of public transportation travel information services and associated payment systems in each region. Such

efforts could be led by the regional metropolitan planning organizations or by the state DOT. The Seattle model would be a good basis for this process. The task force would expand upon the traffic control systems active in the state for much more integration of public transport modes.

Such a process could also be adapted for smaller locations and rural areas. A statewide Smart Public Transport Task Force could be used to share expertise and explore how to improve information systems and transport services in locations with limited capabilities to provide a wide range of choices. This would be more in line with the Finland example.

The first step is to create a successful roadmap to identify the key actors who play the most significant role in the development of a MaaS system. Several case studies and literature reviews were conducted on examples from around the world and three major actors were identified: Government, MaaS Operator, and Transportation Service Provider (TSP). Each of the actors have specialized roles to play that entail a set of tasks. The required tasks consist of multiple steps, each of which needs to be completed in order to start the next steps. Each phase of the tasks performed by each actor have been divided into Planning, Launching and Implementation phases.

The government plays the most important role in the road map and help the other participators establish MaaS into the system. The tasks and the corresponding phases for each task has been divided as Phase I, Phase II and Phase II based on its stage in the entire process of the roadmap. The identified required phases and tasks are based on several analyses such as a literature review of economic and sociodemographic studies of Wisconsin, case studies of similar scenarios, and an evaluation of how MaaS has resolved transportation issues. The Advisory Committee members helped to identify legal regulations and the transportation funding structure in Wisconsin which helped discover the potential barriers in establishing MaaS in Wisconsin. The feedback from the Advisory Committee member was important to consider in order to establish: 1) a set of actors driving MaaS, 2) the tasks each provider is required to complete, and 3) the necessary measures needed for each phase to accomplish their goals (Figure 37)[82].

6.3.1 Government

Government plays a significant role in promoting MaaS development by tailoring regulations to allow for implementation of a MaaS system. Eased regulation also helps to break the barrier between transportation service providers and other MaaS stakeholders and facilitates new business models. Properly reforming regulation is a critical task since the regulations cannot be too lenient, but rather just amended enough for sustainable and efficient MaaS implementation [82].

To establish MaaS in Wisconsin, local governments need to create a suitable legal environment to encourage different service providers and startup companies to work together and implement new technology. Aging populations, mobility of low-income travelers, and retention of a younger labor workforce to address a labor shortage in Wisconsin are some of the equity issues identified in this research. Governmental entities need to establish regulations in order to resolve these issues with MaaS as a potential solution. The role of government in MaaS implementation will start in the planning phase and will last through the launching phase. Another major MaaS barrier is the lack of connectivity of public transportation across city and county borders. To

create a supportive environment for WMaaS, regulation needs to be tailored to allow for cross-border connectivity throughout the planning and implementation phase. The applicability and adequacy of implementation of the revised regulations must be ensured by monitoring the Wisconsin MaaS operators and transportation Service providers in Phase III (or Implementation phase) (Figure 37).

MaaS is reliant on public transportation so the government will need to amend policy to support public transportation usage. To promote public transportation usage, governmental agencies can offer incentive plans for employers to pass onto employees for subsidized access to public transportation. The government should also build incentive plans for transportation service providers for participating in MaaS starting from Phase I (Planning) and throughout Phase II (Launching). As MaaS requires data sharing and exchange, the government can enact policy for better data security and increased technology availability. To accomplish these tasks, the government would first need to set up statewide data security and open data regulations in the Planning Phase (Phase I). Once the regulations have been established in the launching and implementation phases, the government can invest in the latest technologies required to operate Wisconsin MaaS.

Funding is an important factor emphasized by the WMaaS Advisory Committee because establishing a new mobility solution system requires consistent funding sources. The government plays a major role in identifying and determining the potential source of funding during the Planning (Phase I) to the Launching (Phase II) phases when WMaaS is ready to be implemented. Implementation of WMaaS requires broad political support that can be achieved by public support. Since MaaS is a relatively fresh concept, especially in the American Midwest, the government should initiate public awareness so they can become familiar with the MaaS concept. Once familiarized, a referendum in the launching phase will project the potential user demand that will then help determine the potential acceptability of the MaaS concept.

6.3.2 MaaS Operator

The MaaS operator is a major player in the transportation market that acts as an intermediary between transport operators and users by integrating services, creating optimized routing options, and providing customers with bundled service packages [83].

The first task of the MaaS operator in Wisconsin will be to establish a strategy to implement MaaS. The strategy will include establishing a business model in the first phase and then will move towards the launching phase. The core of the MaaS concept is service integration and collaboration amongst different participants. Collaboration will need to be initiated in the planning phase of the MaaS process. In the next step, a finalized business model for operating Wisconsin MaaS will need to be established that includes the WMaaS operator and the transportation service providers. Investment in new technology and startup companies will need to be considered as well. As previously discussed, the next step towards implementing MaaS is service integration which starts in the Launching (Phase II) phase of MaaS. The integrated services provided by the MaaS operator includes integrated payment options for all participating modes of transportation.

As discussed in Chapter 5, the integrated payment services include options for all categories of users (e.g., web-based or telephone-based services for low internet users or aging population, smart card payment options for regular users). Integrated routing options will perform route optimization for all available modes of transportation participating in MaaS services. The route optimization option will provide multiple route choices based on multiple factors such as cost, route, and efficiency. Real-time information is another integrated service the MaaS operator will provide for the users. This service requires collaboration between all MaaS participants who will convert their available data into one standardized form, and then exchange data to provide optimized and real-time information service to its users.

Revenue allocation is one of the important tasks to be integrated for a successful MaaS system. Since service integration involves combining services of all transportation modes, the revenue collected by the integrated payment system must be adequately assigned to each of the MaaS participants. Therefore, a revenue allocation model or strategy must be determined along with establishing a business model as a part of Phase II (Launching phase). This demands collaboration in order to create a bilateral agreement between the MaaS operator and transportation service providers that will define the scope of fee, revenue allocation, data exchange, and security [5].

The concept of MaaS is new and is based on a digitization and platform approach. It is a new way of thinking that demands more time for acceptance from the users' side. Finding the correlation between customers' needs and an available solution is very important as MaaS operators function between the interface of customers and service providers [5]. Throughout the entire process of planning, launching, and implementation of MaaS, a major task of the MaaS operator is to continually gauge customer demand and satisfaction. As a result, this task has not only been proposed in the primary strategy building task in the launching phase where MaaS is promoted in public, but also in a later task of achieving customer satisfaction.

Public involvement has also been suggested during all three phases so that customer preferences, demand analysis, and performance evaluation are best understood. In the planning phase, customer preferences must be determined in order to identify their customer needs and demand. This process must be started in the planning phase so any findings can then be incorporated in the Launch phase where the MaaS operator will offer service based on customer demand. A part of the planning phase also includes branding. This phase involves promoting a potential name or branding plan for WMaaS. A branding plan may encourage more public usage of MaaS. Once MaaS service is launched, continual service evaluation will need to be conducted. Continual service evaluation not only gauges customer satisfaction with the current service provided, but also involves exploring customer demand for any emerging technologies that may be available but have not been adapted by Wisconsin yet. Conducting service evaluations in Phase III (Implementation phase) will enable continual improvement by addressing service gaps and increase the efficacy of mobility solutions provided by MaaS in Wisconsin (Figure 37).

6.3.3 Transportation Service Provider

The third important actor in a MaaS system is the transportation service provider that is a participant in the operation of a MaaS system. The majority of tasks for Transportation Service Providers encompasses compliance with government regulations or synchronization with the

strategy adopted by the MaaS operator. The tasks identified for transportation service provider are collaboration, adaptation, and integration.

Transportation service providers need to collaborate with other service providers and the MaaS operator in order to enable data exchange, revenue allocation, and payment integration. Before the above services are launched, the first phase is to collaboratively establish agreements with other TSPs and the MaaS operator to allow for proper data exchanges, revenue allocation, service scope, and data security. Operating MaaS in Wisconsin is a new outlook on mobility solutions and requires collaboration and integration. This means that transportation service must adapt not only to services offered by other TSPs, but also with the business model and agreements established by the MaaS operator. Every transportation service provider operates with the technology required to provide service within their scope. Applying MaaS in Wisconsin will demand service integration that may require adapting to technology used by another TSP or by a service offered by the MaaS operator. For example, the standardization of data to GTFS-Real time to enable real-time information, offering smart phone application service when the initial service was only web based, or establishing a new route to areas where shared transportation is not available (more shared ride taxi service in the northern areas of Wisconsin to facilitate cross-county Border MaaS service). Adapting to new technologies may not only require technological upgrades, but also infrastructure upgrades during the planning (Phase I) and launching (Phase II) phases in order to successfully implement MaaS in Wisconsin. The third task identified for TSP is integration which includes data standardization and enabling open data throughout the planning and launching phases. Once data standardization and open data have been implemented, then data exchanges can be performed in the implementation phase (Phase III) of the process. Data will be used in the mechanism to operate MaaS (Figure 37) and make optimized service available to its users.

Figure 37: Roadmap for implementing MaaS in Wisconsin

Actors	Tasks	Phase I: Planning	Phase II: Launching	Phase III: Implementation
Government	Legal Environment	Resolve Equity issues (e.g., Aging and disabled, low-income families, etc.) Break out statewide cross-county barriers		Monitor WMaaS Operators and TSPs
	Support Public Transportation usage	Build incentive plans to employers providing support to employees for public transportation Build incentive plans to Transportation Service Providers for participating in WMaaS		
	Enhance data security and exchange technology	Set up statewide data security and open data regulations	Invest in the latest technologies for supporting MaaS	
	Finance	Identify and determine potential funding sources for support WMaaS		
	Public Awareness	Build up public awareness on WMaaS	Initiate public referendum on WMaaS	
	Research and Development	Conduct feasibility study on WMaaS		
	Strategy	Develop WMaaS business models	Promote/Market WMaaS in public Branding Plan	
	Collaboration	Build up partnership among all the participants	Establish Business model with all WMaaS participants	Initiate MaaS Pilot Project(s)
	Service Integration		Integrate payment, routes and real time info	
	Revenue Allocation		Develop revenue allocation/share agreement	
MaaS Operator	Customer satisfaction	Conduct customer preference survey and demand analysis		Perform service evaluation
	Collaboration	Establish Agreements to enable data exchange , revenue allocation, service scope and security		
	Adaptation	Upgrade technology and infrastructure for WMaaS		
	Integration	Data standardization (Open data)		Exchange data
Transportation Service Provider (TSP)				

CHAPTER 7 CONCLUSIONS

This project addresses the critical challenges facing many cities and communities in Wisconsin: how to leverage the technological breakthroughs to re-think and re-design future mobility services and enable smart and connected communities. This project investigates the feasibility and implementation of MaaS (Mobility-as-a-Service) in Wisconsin by conducting three separate tasks: i) study demographic and technological trends, and socioeconomic challenges affecting public transportation in Wisconsin; ii) study factors affecting the implementation of improved mobility services in Wisconsin, and iii) provide a description of the architectural and operational roadmap design of a MaaS platform for Wisconsin.

During this project, an Advisory Committee was established that consisted of knowledgeable individuals with skilled expertise from the transportation industry. The Committee helped identify transportation demand in Wisconsin, brainstormed service gaps and needs, and assessed possible solutions most suitable for implementation in Wisconsin. Throughout the project timeline, three Advisory Committee meetings were held to discuss research progress during each phase.

Major Findings

The research team assessed current practical issues and possible suitable solutions for Wisconsin by reviewing best practices and MaaS system case studies around the world and discussing the adaptability and feasibility with the advisory committee. A summary of the key findings follows:

Key roles in MaaS system

- Key roles in a MaaS ecosystem include users, MaaS service providers, transportation service providers, and governments. Other participants such as logistics service providers and statutory social service providers are also necessary to provide add-on values in the system.
- In general, users are travelers who have the need to travel from one place to another, who are also the most important target customers for MaaS service providers.
- MaaS service providers are major players in the transportation market that acts as an intermediary between transport operators and users by performing integrated service, optimizing routing options and providing customers with bundled service packages.
- Transportation service providers are participants mostly in the operation of a MaaS system. The majority of the tasks associated with the transportation service providers involve complying with government regulations or synchronizing with strategies adopted by MaaS service providers.
- Governments play the most significant role in promoting MaaS development by tailoring the regulations to make them suitable to implement a MaaS system. Governments also help to break the barrier between transportation service providers and other MaaS stakeholders and facilitate new business models.

Concept development

- More efforts need to be taken to provide better transportation service for older adults and people with disabilities. An aging population will become a major concern for Wisconsin over the next 30 years. In comparison with other Wisconsin cities and counties, Northern Wisconsin is projected to see the most dramatic aging population shift. To better fulfill the needs of the aging population and people with disabilities, potential measures are proposed for marketing strategy, service packages, information provision, and interface design. For marketing strategy, a household-based access would be more effective than an individual-based access. MaaS companies could provide different ticket options targeting different frequency levels of people using the service. A pay-as-you-go function, a monthly ticket or a yearly membership could be offered based on the frequency of customers' usage. Certain types of service packages are suggested for older adults such as volunteer/paid transportation service, health care trips, cross-boundary trips and paratransit service, with add-on values embedded. A user-friendly interface needs to consider features of vision and hearing issues that older adults and people with disabilities may have. Telephone customer service and website development would also be necessary. Moreover, to ensure it is economically feasible, collaborations among MaaS companies, Wisconsin DOT and DHS (Department of Health Services) are needed.
- Specific MaaS solutions are recommended for low-income travelers. According to the United States Census Bureau, 11.3% of Wisconsin's population is living in poverty, which is a larger percentage than 30% of the states investigated in the United States. In 2017, Menominee County and Milwaukee County had the highest poverty rates in Wisconsin. A significant portion of travelers with low income still exists and it remains imperative that their travel demands, and concerns are addressed in any policy and planning considerations. Cost is a main concern for low-income travelers. MaaS companies could provide public-oriented trips (e.g., a combination of fixed-route transit, bike sharing and walking), and eco-friendly trips (e.g., bike sharing and walking) as tailored service packages to low-income travelers. Meanwhile, some volunteer-to-earn-trips programs could be suggested. Cost assistance might be required from federal and state governments, including employer-based programs, discounts, universal PASS, and user-side subsidy.
- MaaS is designed to be based on smart phone use; however, the fact that there is a limited number of smartphone users in Wisconsin cannot be overlooked. Many areas of Wisconsin either do not have access to smart phones or have low smart phone use. Therefore, methods of implementation of MaaS with minimal or no smart phone use have been suggested. The problem could be solved by using *Web based and Call center-based* ordering. MaaS could offer integrated services in low cell phone usage regions by limiting the contact number to a single phone number and a single website. The single phone number should also provide customer service information, answer any questions or provide support for more complicated transportation requests.

Policy and planning

- Travel needs are not limited by municipal boundaries, but transit services often are. A MaaS system that is effective across county borders is needed to ensure an effective mobility solution that allows commuters to use MaaS service across county borders using the same application. To implement MaaS across county borders, agreements between operators and well-specified open interfaces need to be established, targeting the operational geographical area, the transport modes that can contribute, additional resources and associated roaming costs, agreements for data privacy, boundaries on the length of time data will be held and handled, ticket reservation and cancellation policies, detailed specifications of the interface, etc.
- Certain legislation, policies and guidelines need to be established in the future to guarantee the operation of MaaS, including legislation protecting the access of MaaS companies to market, open data policy, API (Application Programming Interface) and data standardization, data security, rights and obligations to be claimed in detailed agreements, guidelines on building multimodal payment systems, legislation protecting passengers' safety and security, policies for facilitating technology development, guidance in the collaboration between counties and cities, etc.
- Little funding assistance is needed from the government for a commercial business model. In commercial business models, MaaS companies can act as a commercial reseller and a commercial integrator. Public transport operators owned by the municipality or region can act as MaaS operators by integrating additional transport services and digital services with their existing public transport. Public-Private-Partnerships (PPP, P3s) and Public-Private-People-Partnerships (PPPP, P4s) are two business models governments could follow in facilitating MaaS. In P3s, the public actor may integrate different types of actors and services in the system, which will supplement the services the public actor is responsible for. P4s is considered as a way to organize future mobility and transport in primarily rural and sparsely populated areas and regions.

Implementation issues

- Data are the cornerstone for achieving multiple functions in a MaaS system; implementation issues related to data standardization, real-time data availability and data security need to be considered. Data standards should be developed both between the Transportation Service Provider (TSP) and the MaaS service operator and between the MaaS service operator and governments. Existing data standards on public transit and bikeshare, which are GTFS (General Transit Feed Specification), GTFS-realtime, and GBFS (General Bikeshare Feed Specification), could be used. Data standards for carsharing, dockless-bikeshare and other services need to be established in the future. Ease of data availability is the foundation to enable real time information. An Open Data Cloud is required to enable real time information in an integrated MaaS system. A trust framework or trust domain is essential for implementation of MaaS as it involves data

exchange, retention, analysis, etc. The scope not only includes personal data for users, but also propriety data from various transportation service providers.

- Payment integration is a vital component in the MaaS system. Wisconsin is a mix of urban, suburban and rural communities and the payment system for each case is different in nature based on technological availability and user demand. For urban cases such as Milwaukee, the case of the MCTS M-CARD is an easy, affordable and efficient way to pay for bus service. For rural cases, such as Ozaukee County, the payment system is still based on cash or coupons. Payment options include a prepaid card refilled with a balance limited by a certain minimum to maximum amount, an account credit working like a credit card, and some integrated payment options for rural or limited smart phone accessibility. Promotional offers could be made to users that may give them more points for payment discounts if they are using a suggested route choice.

System architecture, operational mechanism, and roadmap

The system architecture for MaaS in Wisconsin is designed to show different roles of participants in the three main sections, including data, business services and user interface. Data are collected from both transportation service providers and users and processed by MaaS service providers. Two types of business services are provided, a tailored transportation service for travelers (users), and operation analysis and optimization for transportation service providers. System security and government regulations are established to ensure an adequate and safe MaaS system.

To operate a MaaS system smoothly, a specific sequence needs to be maintained and the participating service providers will need to perform effectively. Therefore, two sets of mechanism, i.e., one for MaaS customers, and the other for MaaS service providers, have been proposed for MaaS operations. Each of the mechanisms demonstrates how transportation services can be linked, travel route options can be optimized, and payment systems can be integrated in a MaaS system.

In addition, the roadmap for implementing MaaS in Wisconsin defines a strategic plan for participants, which consists of a set of tasks in planning, launching and implementation phases. To establish MaaS in Wisconsin, local governments need to create a suitable legal environment to encourage different service providers and startup companies to work together and implement new technology. MaaS service providers have the responsibility of integrating services through information provision, ticket integration, payment integration, revenue allocation, etc. Tasks identified for transportation service providers are collaboration, adaptation and integration.

Future Research

Travelers in rural areas

MaaS may possibly evolve from a large urban area, then advance towards smaller cities. However, rural areas face some challenges in adapting to MaaS but will eventually adapt to it. Although this report has recommended planning and implementation strategies for MaaS in rural areas, more efforts should still be made to study specific travel behavior of people living in rural areas, to explore more business models, and to investigate the most suitable marketing strategies.

Tailored service packages need to be designed not only for older adults in rural areas, but also for other population groups, after understanding their travel characteristics.

Collaboration with current mobility services

Currently, several mobility services in Wisconsin are competitors or an early form of MaaS, categorized into public or public-adjacent transportation companies, private on-demand ridesharing services, and multimodal transportation apps. Public or public-adjacent transportation companies such as Milwaukee County Transit System, Bublr, and shared ride taxi companies have their own apps that provide service information. Some even have an embedded payment system. Private on-demand ridesharing companies such as Uber and Lyft have expertise in operating real-time data and services. Transit App is a multimodal transportation app in Wisconsin whose features include maps, a step-by-step navigator (GO), real-time trip planning, etc. Multiple modes are included, such as transit, Uber, Lyft, bikeshare, dockless bikeshare, taxi, and walking. It is necessary to study how to combine or collaborate with these existing mobility services to implement MaaS in Wisconsin.

Pilot projects

Pilot projects need to be established to study implementation of Wisconsin MaaS in different cases, such as urban or rural, inner-city or inter-city, public-funded or commercial-funded, etc. These projects would make great contributions in verifying the strategies proposed in this report and exploring new visions of MaaS.

Vehicle specifications

Conventional transport vehicles are replaced on a 12-year cycle. Each replacement provides an opportunity to upgrade the vehicles and infrastructure. Work is needed to assure that new vehicles and other systems have the capabilities to work with MaaS. Their effects should survey practices in other studies and countries to provide recommendations for vehicle specifications.

Revenue and Fare collection system

Revenue allocation and improved fare collection system are two areas that will need further research before implementation of MaaS. Several revenue allocation methods have been suggested in the report based on the regular practices adopted by transportation agencies. In future, a deeper look can be taken into different ways of potential revenue breakdowns by service provider; determine whether WMaaS users opt-in to monthly or annual subscription fees and how the revenue accumulated will directly translate to revenue for each transportation service providers.

Further research can be performed towards improved verification, which means upgrading to digitized modes of user verification versus traditional mode of visual verification. The findings of this study could help observe how improved verification system should lead to quicker boarding times and less dwell times. Hence, the findings of this study would further encourage public transit providers accept the WMaaS concept.

REFERENCES

- [1] “An Outlook for the Wisconsin Economy in 2018,” *CROWE*. [Online]. Available: <https://crowe.wisc.edu/an-outlook-for-the-wisconsin-economy-in-2018/>. [Accessed: 17-May-2019].
- [2] “Commuting and Migrating in the Milwaukee Area – Marquette University Law School Faculty Blog.” [Online]. Available: <https://law.marquette.edu/facultyblog/2017/10/27/commuting-and-migrating-in-the-milwaukee-area/>. [Accessed: 17-May-2019].
- [3] D. G. Circella *et al.*, “What Affects Millennials’ Mobility? PART I: Investigating the Environmental Concerns, Lifestyles, Mobility-Related Attitudes and Adoption of Technology of Young Adults in California,” p. 119.
- [4] Annie Zaleski, “The ins and outs of Wisconsin’s changing demographics,” *Green Bay Press Gazette Media*, St. Norbert College, 16-Jul-2018.
- [5] Maria Kamargianni and Melinda Matyas, “The Business Ecosystem of Mobility-as-a-Service,” Jan. 2017.
- [6] David Egan-Robertson, “Wisconsin’s Future Populationn 2010-2040,” Wisconsin Department of Administration-Demographic Services Center, Projections for the State, Its Counties and Municipalities, 2010 -2040, Dec. 2013.
- [7] Carrie Porter, “Testimony for information relating to AB21/SB21,” Greater Wisconsin Agency on Aging Resources, 2015.
- [8] J. Bittner, Patrick Fuchs, Tim Baird, and Adam Smith, “Addressing Elderly Mobility Issues in Wisconsin,” Wisconsin Department of Transportation Research & Library Unit, Final Report No. 0092-10-19, Sep. 2011.
- [9] Stephen Brumbaugh, “Travel Patterns of American Adults with Disabilities,” *Bureau of Transportation Statistics, U.S. Department of Transportation*, p. 10, Dec. 2018.
- [10] Darnell Chadwick Grisby *et al.*, “The Transformation of the American Commuter,” *Transportation Research Board (TRB)*, 2018.
- [11] P. Hu, “Summary of Travel Trends 2001 National Household Travel Survey,” U.S. Department of Energy, Office of Scientific and Technical Information, ORNL/TM-2004/297, 885762, Jan. 2005.
- [12] U. S. C. Bureau, “American FactFinder - Results.” [Online]. Available: https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_17_1YR_S1701&prodType=table. [Accessed: 27-May-2019].
- [13] Paul Hitlin, “Use of internet, social media, digital devices plateau in US,” Pew Research Center, Washington, DC, Sep. 2018.

- [14] “2018 National Household Travel Survey Workshop,” Number E-C238, Nov. 2018.
- [15] Lynn Minnaert, “US Family Travel Survey 2017,” *Jonathan M. Tisch Center for Hospitality and Tourism, New York University, School of Professional Studies*, p. 46.
- [16] U. C. Bureau, “SAIPE State and County Estimates for 2017,” *United States Census Bureau*. [Online]. Available: <https://www.census.gov/data/datasets/2017/demo/saipe/2017-state-and-county.html>. [Accessed: 28-May-2019].
- [17] ““Arrive Together: Transportation Access and Equity in Wisconsin’ Release!” *Sierra Club*, 22-Oct-2018. [Online]. Available: <https://www.sierraclub.org/wisconsin/blog/2018/10/arrive-together-transportation-access-and-equity-wisconsin-release>. [Accessed: 06-Jun-2019].
- [18] “Index - WisConomy.” [Online]. Available: <https://jobcenterofwisconsin.com/wisconomy/query>. [Accessed: 27-May-2019].
- [19] W. Kenton, “Sharing Economy,” *Investopedia*. [Online]. Available: <https://www.investopedia.com/terms/s/sharing-economy.asp>. [Accessed: 27-May-2019].
- [20] Pew Research Center, “The New Digital Economy: Shared, Collaborative and On Demand | Pew Research Center,” May 2016.
- [21] “Public Transportation Technology White Paper,” *Oregon Public Transportation Plan*, Jan-2017. [Online]. Available: <https://www.oregon.gov/ODOT/Planning/Documents/OPTP-Public-Transportation-Technology.pdf>. [Accessed: 16-May-2019].
- [22] MCTS, “Ride MCTS | Fares and Passes,” *Milwaukee County Transit Service*, 2019. [Online]. Available: <https://www.ridemcts.com/fares-passes/ride-mcts-app>. [Accessed: 27-May-2019].
- [23] “MCTS to beta test real-time bus info technology: The Bay View Compass.” [Online]. Available: <https://bayviewcompass.com/mcts-to-beta-test-real-time-bus-info-technology/?print=print>. [Accessed: 27-May-2019].
- [24] “PROOF OF CONCEPT: GTFS DATA AS A BASIS FOR OPTIMIZATION OF OREGON’S REGIONAL AND STATEWIDE TRANSIT NETWORKS.” .
- [25] “Online in Wisconsin Findings from the Wisconsin Family Health Survey, 2015 Release,” p. 2.
- [26] Rabi Abonour *et al.*, “Real-time information - TransitWiki,” 02-Feb-2018. [Online]. Available: https://www.transitwiki.org/TransitWiki/index.php/Real-time_information. [Accessed: 27-May-2019].
- [27] Wisconsin Department of Transportation (WISDOT), “Wisconsin Public Transit Systems Map 2019 - Wisconsin Department of Transportation,” 2019. [Online]. Available: <https://wisconsin.gov/Documents/travel/pub-transit/system-map.pdf>. [Accessed: 27-May-2019].

- [28] Wisconsin Department of Transportation, “Wisconsin Public Transit: Briefing for the Wisconsin Congressional Delegation,” 2017.
- [29] Wisconsin Department of Transportation, “Wisconsin Transit Report 2016,” *Wisconsin Department of Transportation*. [Online]. Available: <https://wisconsindot.gov/Documents/doing-bus/local-gov/astnce-pgms/transit/annual-report.pdf>. [Accessed: 30-May-2019].
- [30] Wisconsin Department of Transportation, “Travel by Rail: Wisconsin Department of Transportation.” [Online]. Available: <https://wisconsindot.gov/Pages/travel/rail/default.aspx>. [Accessed: 27-May-2019].
- [31] “Zipcar: World’s Largest Car Sharing and Car Club Service - an alternative to traditional car rental and car ownership.” 26-Feb-2014.
- [32] “About Us | Zipcar.” [Online]. Available: <https://www.zipcar.com/about>. [Accessed: 26-May-2019].
- [33] “Bublr Bikes In Milwaukee,” *VISIT Milwaukee*. [Online]. Available: <https://www.visitmilwaukee.org/plan-a-visit/getting-here-and-around/bublr-bikes/>. [Accessed: 17-May-2019].
- [34] Department of Transportation, State of Wisconsin, “WisDOT Park and Ride Lots.” [Online]. Available: <https://wisconsindot.gov/Pages/travel/road/parknride/default.aspx>. [Accessed: 17-May-2019].
- [35] James Datson, “MOBILITY AS A SERVICE EXPLORING THE OPPORTUNITY FOR MOBILITY AS A SERVICE IN THE UK,” *Transport Systems Catapult*, Jul-2016. [Online]. Available: https://ts.catapult.org.uk/wp-content/uploads/2016/07/Mobility-as-a-Service_Exploring-the-Opportunity-for-MaaS-in-the-UK-Web.pdf. [Accessed: 31-May-2019].
- [36] MaaS Alliance, “MaaS Alliance White Paper- Guidelines and Recommendations for a thriving MaaS Ecosystem,” Sep. 2017.
- [37] W. Goodall, T. Dovey, J. Bornstein, B. Bonthron, and I. T. Daberko, “The rise of mobility as a service- Reshaping how urbanites get around,” *Deloitte Review*, no. 20, p. 20, 2017.
- [38] “Sweden Population 2019 (Demographics, Maps, Graphs),” *World Population Review*. [Online]. Available: <http://worldpopulationreview.com/countries/sweden-population/>. [Accessed: 31-May-2019].
- [39] “Google Translate.” [Online]. Available: <https://translate.google.com/translate?hl=en&sl=sv&u=http://www.stockholmsforsoket.se/&prev=search>. [Accessed: 27-May-2019].
- [40] D. Firth, “© 2012 City of Stockholm, the City of Stockholm Traffic Administration,” p. 72.
- [41] Adam Laurell, “The Swedish Mobility Program (SMP),” Jan. 2017.

- [42] Samtrafiken, “Samtrafiken-We create the world’s best public transport.” [Online]. Available: <https://samtrafiken.se/>. [Accessed: 27-May-2019].
- [43] “Combined Mobility as a Service (MaaS) in Sweden, 2018 - Shared Mobility Policy Database.” [Online]. Available: <http://policies.sharedusemobilitycenter.org/#/policies/976>. [Accessed: 15-May-2019].
- [44] “How does it work? - BoB - National Ticket & Payment Standards for Public Transport - WIKI.” [Online]. Available: <https://samtrafiken.atlassian.net/wiki/spaces/BOB/pages/110985249/How+does+it+work>. [Accessed: 27-May-2019].
- [45] SDOT, “A Prototype for the New Century’s Digital City,” *Smart Seattle*. [Online]. Available: <https://cms.dot.gov/sites/dot.gov/files/docs/WA%20Seattle.pdf>. [Accessed: 15-May-2019].
- [46] “FREE adaptive cycle rentals through a new partnership with Outdoors for All.” [Online]. Available: <https://sdotblog.seattle.gov/2019/05/07/expanded-bike-access-for-all-free-adaptive-cycle-rentals-through-a-new-partnership-with-outdoors-for-all/>. [Accessed: 27-May-2019].
- [47] “Department of Transportation, King County.” [Online]. Available: <https://www.kingcounty.gov/depts/transportation/news-archive/archive.aspx>. [Accessed: 27-May-2019].
- [48] King County Department of Transportation, “What to pay - Fares & ORCA passes - Metro Transit - King County,” *King County Metro*, 08-Feb-2019. [Online]. Available: <https://kingcounty.gov/depts/transportation/metro/fares-orca/what-to-pay.aspx>. [Accessed: 27-May-2019].
- [49] “Statistics and Publications, Regional Council of Lapland.” [Online]. Available: <http://www.lappi.fi/lapinliitto/en/statistics>. [Accessed: 27-May-2019].
- [50] “Projektiesittely,” *Lappeenranta University of Technology*. [Online]. Available: <https://www.vtt.fi/sites/maaseutumaas>. [Accessed: 27-May-2019].
- [51] J. Eckhardt, L. Nykänen, A. Aapaoja, and P. Niemi, “Mobility as a Service as an enabler for livelihood and accessibility of rural areas,” Finland, VTT-R-03429-17 (2017), 2017.
- [52] J. Eckhardt, L. Nykänen, A. Aapaoja, and P. Niemi, “MaaS in rural areas - case Finland,” *Research in Transportation Business & Management*, vol. 27, pp. 75–83, Jun. 2018.
- [53] “VAMOS! - An app with transportation service with API (Application Programming Interfaces) in Finland.” [Online]. Available: <https://vamosapi.com/case-yllas/>. [Accessed: 27-May-2019].
- [54] Paul Nyberg *et al.*, “Asset Optimization of the Private Passenger Car,” *Share It*. [Online]. Available: <http://shareit.fi/>. [Accessed: 27-May-2019].

- [55] “Ylläs Tiketti - app for easy and safe way to buy Ylläs’s transportation tickets and services.” [Online]. Available: <https://www.yllas.fi/en/area-info/yllas-tiketti.html>. [Accessed: 07-Jun-2019].
- [56] Å. S. Hildestrand, “MinRejseplan and Plustur – two ways to maximise mobility in rural, Northern Denmark,” Feb. 2018.
- [57] C. Hvid, N. B. Sørensen, N. Trafik, and S. Rasmussen, “The story of ‘MinRejseplan’ – a major step towards MaaS,” 2018.
- [58] “Designing Apps for Elderly Smartphone Users | Clutch.co.” [Online]. Available: <https://clutch.co/app-development/resources/designing-apps-for-elderly-smartphone-users>. [Accessed: 27-May-2019].
- [59] Department of Health, “Wisconsin Department of Health Services,” *Wisconsin Department of Health Services*, 01-Apr-2019. [Online]. Available: <https://www.dhs.wisconsin.gov/>. [Accessed: 27-May-2019].
- [60] Department of Justice, “Americans with Disabilities Act: Title III Regulations,” p. 267, Sep. 2010.
- [61] Tompkins County, New York, “Tompkins County to Receive Federal Assistance to Support Mobility Innovation Concept,” *Tompkins County NY.gov*. [Online]. Available: <http://tompkinscountyny.gov/news/tompkins-county-receive-federal-assistance-support-mobility-innovation-concept>. [Accessed: 19-May-2019].
- [62] D. König, E. Piri, M. Karlsson, J. Sochor, and I. Heino, *Deliverable 5: Technology for MaaS. MAASiFiE project funded by CEDR*. 2017.
- [63] N. F. Ogneva, “Features of the Organization and Development of Cross-border Cooperation between Regions,” *Social and Economic Geography*, vol. 1, no. 1, pp. 23–30, Jan. 2015.
- [64] R. Palacin, “‘Mobility as a Service’ (MaaS) in a multimodal European cross-border corridor,” p. 15.
- [65] D. König, E. Piri, M. Karlsson, J. Sochor, and I. Heino, “Technology for MaaS - Deliverable Nr 5,” 2017.
- [66] David König, Jenni Eckhardt, Aki Aapaoja, Jana Sochor, and MariAnne Karlsson, “Business and operator models for MaaS Deliverable 3,” *Conference of European Directors of Roads*, Jul-2016. [Online]. Available: https://www.vtt.fi/sites/maasifie/PublishingImages/results/cedr_mobility_MAASiFiE_deliverable_3_revised_final.pdf. [Accessed: 19-May-2019].
- [67] “Legislation, Regulations and Guidance - Resources | Federal Highway Administration,” *Federal Highway Administration*, 01-Apr-2019. [Online]. Available: <https://www.fhwa.dot.gov/resources/legsregs/>. [Accessed: 31-May-2019].

- [68] “Department of Transportation (Trans).” [Online]. Available: https://docs.legis.wisconsin.gov/code/admin_code/trans. [Accessed: 27-May-2019].
- [69] D. Temoshok and C. Abruzzi, “Developing trust frameworks to support identity federations,” National Institute of Standards and Technology, Gaithersburg, MD, NIST IR 8149, Jan. 2018.
- [70] ATIS, “ATIS, Smart Cities - Data Sharing Framework,” Mar. 2018.
- [71] ATIS, “Securing Internet of Things (IoT) Services Involving Network Operators,” May 2017.
- [72] “IoT Security - A Safer Internet of Things (for 2018) | Gemalto.” [Online]. Available: <https://www.gemalto.com/iot/iot-security>. [Accessed: 27-May-2019].
- [73] Carol Schweiger, “Mobility as a Service White Paper,” National Aging and Disability Transportation Centre.
- [74] “CTA How-To Guide: Buying Fares (Tickets),” *CTA*. [Online]. Available: <https://www.transitchicago.com/howto/buying-fares/>. [Accessed: 19-May-2019].
- [75] “Revenue Risk Sharing for Highway PublicPrivate Partnership Concessions,” *U.S Department of Transportation*, Dec-2016. [Online]. Available: http://www.financingtransportation.org/pdf/p3-toolkit_risk_sharing_white_paper_1216.pdf. [Accessed: 17-May-2019].
- [76] R. W. Poole, “Availability Payment or Revenue-Risk P3 Concessions? Pros and Cons for Highway Infrastructure,” p. 48.
- [77] J. Sochor, H. Arby, and M. Karlsson, “The topology of Mobility as a Service: A tool for understanding effects on business and society, user behavior, and technical requirements,” *24th World Congress on Intelligent Transportation Systems, Montreal, October 29-November 2, 2017*, 2017.
- [78] Wisconsin Department of Transportation, “Mission statement: Wisconsin Department of Transportation.” [Online]. Available: <https://wisconsin.gov/Pages/about-wisdot/who-we-are/dept-overview/mission-statement.aspx>. [Accessed: 06-Jun-2019].
- [79] “Center for Urban Transportation Studies | Just another UWM Campus Press WordPress Sites site.” .
- [80] “Millennials on the Move | WISPIRG.” [Online]. Available: <https://wispirg.org/reports/wip/millennials-move>. [Accessed: 06-Jun-2019].
- [81] “Average Cost of Owning and Operating an Automobile | Bureau of Transportation Statistics.” [Online]. Available: <https://www.bts.gov/content/average-cost-owning-and-operating-automobile>. [Accessed: 06-Jun-2019].

- [82] J. Eckhardt, A. Aapaoja, L. Nykänen, J. Sochor, M. Karlsson, and D. König, *Deliverable 2: European MaaS Roadmap 2025. MAASiFiE project funded by CEDR*. 2017.
- [83] “MaaS4EU – Mobility as a Service for European Union.” .
- [84] DARNELL CHADWICK GRISBY *et al.*, “The Transformation of the American Commuter,” American Public Transportation Association.
- [85] “The Everything as a Service (XaaS) Model | Linux Magazine.” [Online]. Available: <http://www.linux-mag.com/id/7197/>. [Accessed: 05-Apr-2019].
- [86] “Mobility as a Service Market - Global Forecast 2023 | MRFR.” [Online]. Available: <https://www.marketresearchfuture.com/reports/mobility-as-a-service-market-3109>. [Accessed: 04-Apr-2019].
- [87] M. Kamargianni and M. Matyas, “The Business Ecosystem of Mobility-as-a-Service,” *96th Transportation Research Board (TRB) Annual Meeting, Washington DC, 8-12 January 2017*, p. 14.

APPENDICES

APPENDIX A: LIST OF WMAAS ADVISORY COMMITTEE MEMBERS

APPENDIX B: MEETING MINUTES FOR THE THREE ADVISORY COMMITTEE MEETINGS

APPENDIX C: A PILOT PROJECT CONCEPT OF CAMPUS MAAS

APPENDIX A: LIST OF WMAAS ADVISORY COMMITTEE MEMBERS

(In alphabetical order by name of organization)

ORGANIZATION	NAME	WEBSITE
Bublr Bikes	James Davies Senior Director of Operations & Planning	https://bublrbikes.org/about/
City of Fond du Lac/Wisconsin Public Transit Association (WIPTA)	Lynn Gilles Transit Manager/Chair	https://www.fdl.wi.gov/ http://wipta.org/agenda/
Milwaukee County Transit System (MCTS)	Jeff Sponcia Manager of Planning	https://www.ridemcts.com/
Ozaukee County	Jason Wittek Transit Superintendent	http://www.ozaukeetransit.com/
Running Inc.	Justin Running Vice President	http://runninginc.net/
Southeastern Wisconsin Regional Planning Commission (SEWRPC)	Kevin Muhs Executive Director	http://www.sewrpc.org/SEWRPC.htm
Waukesha Metro Transit	Brian Engelking Metro Transit Supervisor	https://www.waukesha-wi.gov/
Wisconsin Department of Transportation (WISDOT)	Ian Ritz Transit Section Chief	https://wisconsindot.gov/Pages/home.aspx

APPENDIX B: MEETING MINUTES FOR THE THREE ADVISORY COMMITTEE MEETINGS

B.1: 1st Advisory Committee Meeting Minutes, February 11th, 2019

B.2: 2nd Advisory Committee Meeting Minutes, April 8th, 2019

B.3: 3rd Advisory Committee Meeting Minutes, June 13th, 2019

**Project: Connecting Wisconsin of Tomorrow:
Methods to Improve Public Mobility under Future Social, Economic and Technological
Changes**

First Advisory Committee Meeting

UWM Kenwood Interdisciplinary Research Complex, Room: 2035.

Meeting Minutes, 11th February 2019

Time: 1:30pm-3:30pm.

Attendees: James Davies (BublR Bike), Justin Running (Running Inc.-Shared Ride Taxi), Ian Ritz (WisDOT), Jeff Sponcia (MCTS), Lynn Gilles (City of Fond du Lac-WIPTA), Chris Hiebert (SEWRPC), Dr. Edward Beimborn (UWM), Dr. Jie Yu (UWM), Shamsi Mosharraf (UWM), Xinyu Liu (UWM), Josie Willman (UWM).

1. Agenda overview

2. Introduction: Dr. Edward Beimborn and Dr. Jie Yu.

3. Presentation

3.1. Project objective

3.2. Discussion

3.2.1. Running Inc., Shared ride taxi service:

a. Background:

Consists of 100% business contracting to state and abides by the state regulations. The service area is rural and 80% of population is aging or disabled;

The city has very good broad service. Recently many people move to the city from larger cities like New York due to the ability to be working from home and avoid the congested city life in such cities.

b. Service demand:

No UBER currently in service as well as there is no demand for UBER in the area. The demand for shared ride taxi is on the rise. A rough statistic for demand would be 40000 trips generated in a town of 6000people. It is easier to get support in rural communities for this kind of shared ride taxi.

c. Resources:

Currently 4 mini vans in total are made available based on the demand during the peak times of the day versus slow times.

d. Cost and revenue:

Cost to municipality decreases with increased ridership until operation goes to 100% capacity then investment is made on a new vehicle. The cost for users per trip runs between \$2.85 to \$4.85. The price is a set fee established within the municipality. The fee structure is not variable based on age. However, service beyond the boundary of the municipality its more expensive which is \$1.50 a mile.

e. Wait time:

Wait time for the service depends on the time of the day. Standard wait time is somewhere between 30 minutes or more. This due to limitation of the number vehicles on the road (limited resource). However, the wait time varies based on the demand. The schedules are often manipulated by putting taxis in off peak hour in peak hour offering more service during peak hours.

f. Challenge:

Meeting legal criteria:

Finding employees who meet criteria such as passing drug test; alcohol test; passing vehicle inspection is a challenge; Satisfies city's requirements by working in collaboration with police department

Funding:

With increasing demand for shared ride taxi there is demand for increased service. Increased service demand cannot be freely implemented due to the constraints. The services are dependent on Grant from WISDOT. Therefore, any significant change to increase or decrease service requires approval from the Grant.

g. Feedback on MaaS:

Concerned about the mechanism of the cash flow to make the shared ride taxi service work. The city will have to be paid regardless of whether the service provider has money or not. The shared taxi services report monthly revenue from billing. Then the bill is subtracted from the revenue and hence an invoice is submitted.

3.2.2 WIPTA-City of Fond du Lac

a. Background:

The population is conservative with respect to accepting the services provided by the city. However, the city does have an automatic vehicle location system.

b. Challenges:

Meeting Legal Criteria:

Service providers are willing to provide the service. However, many of them do not want to deal with Federal Regulations. Service providers are not up to speed with respect to meeting requirements of regulations such as drug or alcohol test. Service providers such as Uber and Lyft do not have to take regulations into consideration.

Funding:

Any technological update to Fond du Lac system is dependent upon the availability of Federal Grants. If private technology world was more flexible it would have helped meeting these needs.

c. Feedback on MaaS

Rider pays for a small percent of the actual cost. New technology will mean putting aside more investment for technology. This will mean putting less investment for services on the road and more on technology. Many customers do not have smart phone in several areas in Wisconsin. Ticketless fares are not yet completely applicable statewide due to limited number of smart phone users. Disproportionate effect on the minority (Low income) may result if there is an imbalance of technology users.

3.2.3 WisDOT

a. Challenges:

Ageing population:

The percentage of population falling under ageing population group is rising. WISDOT performed demographic analysis for next 25 years. More growth of aging population in rural communities has been observed.

Lack of Integration of Service Providers:

All services are limited to geographic boundaries of the counties. On the other hand, trip purposes go across state and county (job; medical purpose etc.). The concern is how to full fill the trip purpose by public transit when the service providers across county borders do not communicate with one another. All the system operators need to connect and integrate. Users should be able to easily connect from one mode to another and should be covered by one app.

State Funding Structure:

State has a tired funding structure. Federal and State funds are combined to provide an equal percentage of fund, hence providing an equitable percentage. This causes the large level of service to still get the same proportion of money.

b. Feedback on MaaS

- MaaS is more applicable to Urban setting rather than rural environment. Wisconsin has variation of population distribution. Application of statewide MaaS is more suitable for more densely population regions.
- A public entity will not bear the cost of similar kind of initiative like MaaS. Implementation of MaaS will possible have to be taken care of by private entities.
- WISDOT is willing to support the initiative of implementing MaaS if the payment aspect is taken care of.

3.2.4 Bublr Bike:

a. Background:

The demand for Bublr Bike depends on the targeted user accomplishment – whether for mobility or recreation. Eighty percent of the Bublr Bike stations are located near other transit options. A decent number of Bublr Bike riders take transit in combination. MCTS tracks bike use demand every time someone attaches a personal bike on the transit bus. This aids in determining the demand and hence a station is allotted to the location based on the bike use and statistics. Currently Bublr Bike uses BCycle – app. It allows sharing information, platform and supply and the app is active in 40 other cities.

b. Challenges:

Funding:

Federal fund is limited and hence have limited access to Grants. Bublr Bike is not defined as transit which is a limitation to accessibility to funding. Boundaries based on service (Assigned fund for each purpose).

Meeting Supply vs Demand:

One challenge is finding a good system for placing bikes at right place at the right time. Best places to start are areas with maximal population density.

c. Feedback on MaaS:

- There are no congestion or parking issue in rural area. So, while considering MaaS in rural area it's important to know whether they are willing to pay for the service as congestion is not an issue.
- Same app should be used across county boundary, so user's familiarity and convenience increase. Example: MCTS app is great in Milwaukee but not in Chicago.
- All public entities need to have the same data standard.

3.2.5 MCTS:

a. Challenges:

b. Funding:

Costs increasing annually but funding isn't. Balancing with demand is a challenge. The balance is mostly achieved by reorganizing the staff or operations structure.

c. Ridership:

One major reason for declining ridership is working from home and online university courses. MCTS NEXT is an initiative to increase ridership. The routes must be redesigned to maximize efficiency. A complete redesign of the transit system is being implemented to meet this objective. Biggest challenges faced in the project is relating higher cost versus less funding and maximizing service versus efficiency.

d. Feedback on MaaS:

- Google does a lot of the services offered by MaaS. Users will question "Why investing into MaaS is worth it?"
- MaaS will become a need in future, however it's a matter of user familiarity and time.
- Public transit operators must adapt the same fundamental system. The project will need expertise from all background i.e. engineer, planner, coder etc.
- Need real time information will become essential; All agencies need to have a standardized output; Any third-party website and app can import information and have it available for use (GTFS – General Transit Feed specification).

3.2.6 SEWRPC:

a. Challenges:

Service limited by boundaries;

Travel needs cannot be limited by municipal boundaries, but transit services are limited by boundary. Having different level of service in rural to suburban to urban area is a limitation. Employers do not consider where the pool of employees are coming from. However, employees have difficulty commuting due to limited transit connection. Often SEWRPC is contacted with such inquiries by transit users. This drives people towards owning a car hence adding an additional driver on the road and therefore leading to loss of a transit rider.

Integration of systems:

Municipality doesn't want to integrate as no one wants to give up control of their own system. As a result, there is no form of regional government.

Funding:

Funding is a problem. Urban and sub-urban area operators need to collaborate. Majority of the expenses are resulting transit operation and a balance is hard to maintain with limitation on Federal Grants.

MaaS:

- Need to know the average increase in cost increase for using the service for the users.
- More applicable to urban area and to travelers coming from out of state.

- Need an efficient payment system.
- Real time data availability needed.

3.3.MaaS concept

3.4.Wisconsin Context

3.5.Suggestions for future meetings:

- a. Requirements for building a MaaS system in Wisconsin. For example: Data, Electronic System, Payment system etc.
- b. How MaaS can fit into the general funding system?
- c. Can uniform fare collection system be implemented?
- d. All agencies need to have a standardized output of data; Any third-party website and app can import the data and have it available for use (GTFS – General Transit Feed specification).
- e. The next committee meeting to have someone from rural transit providers.

4 Meeting adjourns

**Project: Connecting Wisconsin of Tomorrow:
Methods to Improve Public Mobility under Future Social, Economic and Technological
Changes
Second Advisory Committee Meeting**

UWM Kenwood Interdisciplinary Research Complex, Room: 2035.

Meeting Minutes: 8th April 2019

Time: 1:30pm-3:30pm.

Attendees: Brian Engelking (City of Waukesha), Jason Wittek (Ozaukee Transit), Ian Ritz (WisDOT), Jeff Sponcia (MCTS), Lynn Gilles (City of Fond du Lac-WIPTA), Kevin Muhs(SEWRPC), Dr. Edward Beimborn (UWM), Dr. Jie Yu (UWM), Shamsi Mosharraf (UWM), Xinyu Liu (UWM).

1. Introduction:

Dr. Edward Beimborn and Dr. Jie Yu Introduced three new members of the advisory committee.

2. Project progress overview:

Progress of the project so far is on schedule. Took a quick look at the future progress yet to be accomplished.

Worked over a quick reminder of the upcoming meetings (**26th April 2019-Tommy G. Thompson Meeting; Third Committee Meeting – Early June**).

3. Meeting objectives today:

- To discuss the issues identified in the 1st advisory meeting; and
- To discuss the solution proposed for the problems identified in the first advisory meeting.

4. Presentation and Discussion

4.1 Presentation

An introduction of the presentation topics to be discussed has been made. The advisory committee meeting members have been given choice amongst the topics to nominate the most significant topics of discussion. The topics were then discussed in the original sequence as represented by the presentation as they were equally vital.

4.2 Discussion

4.2.1 WIPTA-City of Fond du Lac

a. Low income travelers

- Funding or User side subsidy for the low-income traveler must be determined based on the income threshold. This work can or probably already has been done by some other

government entity. This means that the work may not need to be redone as some other government entities have already divided people on whether they are eligible for user side subsidy. A good example for that is eligibility for Medicare can possibly automatically make the individual eligible for half fare.

4.2.2 WisDOT

a. Aging and disabled

- Funding: The funding programs offered by WISDOT for aging and disabled population are still similar. However, the dollar amount designated towards the programs have changed and have increased in most cases. WISDOT will provide an updated information on the amount assigned to each program.
- Customized smart phone for seniors may be a way to assist the ageing population.

b. Low income travelers:

- The method of payment or the nature of payment by the low-income travelers will determine the type of services offered to them.
- A User side subsidy may be involved
- What may be a good way to assess whether an individual fall under the low-income range? Would this issue be addressed by reviewing the tax-return of the individual? Who will be fulfilling this role of reviewing the financial information of the individual under assessment?

c. Comments on MaaS:

- A study of the user's perspective will be extremely beneficial. No clear indication is currently available on what WISDOT may want to avail at this point.
- There is a possibility that large banner companies like Apple or Google may take the first initiative and the rest of the companies at the local level will participate from there onward. This may help avoid the initial investment required for start of such initiatives like Wisconsin MaaS.
- However, there will be a panel from WISDOT at the Tommy Thompson conference. Thus, the information gathered from the committee meeting will be shared there.

d. Questions (Addressed in subsection 4.1.9.4.)

- Have any monetary figures been found regarding the expense, revenue allocation, funds?
- Is there any maintenance cost?

4.2.3 MCTS

a. Visually impaired:

- Availability of mobility application for the visually impaired may help the population's mobility condition.

b. Low income travelers:

- The eligibility for low income travelers can be determined by using the same data used to determine their eligibility for availing food stamps.
- Bublr Bike have different set price range and may be able to suggest possible funding sources.

c. Data standards:

MCTS initiatives:

- It's important to know the sources of data used by Google.

d. Feedback – MaaS Implementation Needs:

- Feed of data used is importation in successful implement of MaaS system.
- Consultation with different form of expertise is required: The technological specialist; Companies building similar kinds of application;
- Knowledge and technical background of how these things can be combined is required.
- Bublr Bike case: MCTS has information regarding integrated stops with Bublr Bike. The information is available for use and MCTS provides it to anyone requesting it. The information available is obtained manually by labelling all the stops next to a Bublr Bike station. It is stationary information, however MCTS also has available real time information for use.

e. Comments on MaaS:

- Budget is a primary constraint in for this scenario. There is a need for inclusion of MaaS initiatives in the following year's budget. If the Political county board act with a sense of urgency, it would not be difficult to find a source of funding.

4.2.4 SEWRPC

a. Ageing and Disabled:

- Special service is needed for people with special disabilities, for example cognitive disorder, visual disorder etc. These facilities may have special fee associated with it. GoGoGrandparent app is an example of service for senior citizens. However, the application is not very reliable and relies on Uber or Lyft.

b. Standardized information and payment

- Operation cannot be performed on state level unless standardized information has not been made available. Formation of such a system will require infrastructure to support it. It is necessary to first determine the sources of payment of such infrastructure and how it can be established.

c. Data standards

- Data standardization is the foundation of a MaaS system. There is need for standardization of data for services like Lyft and Uber. Although effort has been made for this process, but no positive results have occurred so far

d. Payment and Revenue Allocation

- Monthly pass is not a feasible option for increasing transit ridership. This may result into a series of unnecessary services.
- How does MaaS promote Public Transit with respect to Uber? If commuters are given choice between Uber and Public Transit with a monthly pass, they will possible choose Uber (Answered in Subsection 4.1.10.6.).

e. Comments on MaaS

- Transit system in Wisconsin is not empowered by mobility aggregator. The areas who have successfully implemented MaaS system have a better grip on information, data

standardization and authority (LADOT). This enables them to allocate resources in all the appropriate areas if mobility system as needed.

- Establishing an infrastructure for a MaaS system requires authority over decision making and resources. Government interaction and funding has always been the primary issue. In current scenario, Wisconsin does not have a political framework which could empower an initiative such as Mobility as a Service. A good example is the case of London, UK, who have a control over their policies and hence can work towards building a successful MaaS system.
- Milwaukee county's mobility management system is primarily based on MCTS and normally grows along that line. However, implementing MaaS statewide may be a challenge given the current scenario of the political and financial constraints. Thus, Milwaukee may be a starting point for such a system.

4.2.5 Ozaukee Transit

a. Recent development

- Ozaukee Transit has recently improved to newer technologies like vehicle locator, on board mapping etc. They are also working towards establishment of a new application.

b. Comments on MaaS:

- The recent trend shifts towards racing technological innovation and profit from those innovations.
- Leaders have a greater role in standardization of information, policy making and allocation of funding.
- There is better potential of MaaS involving public transit than at a state level due to constraints on funding and allocation of resources.

4.2.6 City of Waukesha

a. Ageing population

- Familiarity of the volunteer drivers are very important when it comes to Uber, Lyft or similar services. Aging population are more comfortable with familiar drivers and is also needed to protect personal safety of the users. Completion of background check for similar scenario is often an issue. As time passes and MaaS has been implemented, later generations will be more accustomed to it.

b. Data Standards

- Google are the earliest innovators of similar technological options like mapping, travel direction etc. It is about time that methods are identified to integrate private companies into it.
- Data sharing, open data, data standardization is necessary for establishing such a system. Although there is a need for expansion of this box, the political barriers associated with it acts as a limitation.

c. Comments on MaaS:

- A MaaS system may take an urban setting like Milwaukee as an epicenter and move towards smaller communities like Waukesha and then so on into more rural areas.

- Collaboration and integration are essential parts of MaaS. Collaboration is something that is desired by everyone and political bodies may agree to it as well. However, availability of resources seems to be the greater hurdle.
- Between two counties, many agreements already exist. Although politically divergent, the two counties will agree for integration purpose.

4.2.7 Dr Beimborn

a. Aging population

- The caregiver plays an important role and are often the media for exchange of information for various needs of the senior citizen receiving the service.

b. Low income travelers

- The eligibility of the individual receiving the service will be first verified. Once the process is past the verification phase the system will automatically process the revenue allocation procedure.
- User side subsidy: If an individual is eligible for food stamp then he/ she may be also eligible for transit stamp facility. This will help determine the low-income service range.

c. Cross county border MaaS

- If Europe has a successful MaaS system across countries – Wisconsin should be able to implement this strategy across county borders.
- Many of the county services may be similar or overlapping and it's a matter of forming agreements to establish the system.
- Standardization of data (GTFS and open data) is essential for all transportation service providers in order to integrate the data.

d. Questions addressed (Subsection 4.1.4.)

- Companies like Google acts as an advertising company and their revenue structure is different and hence their funding structure is different too.
- Cost implications of the technical system are often dependent on the nature of the data used as well as the states regulations on data standards.
- However, the overall figures for cost, funds or revenue varies case by case. The monetary aspects are often highly dependent on the Business Model followed.

4.2.8 Dr. Jie Yu

a. Covered majority of the presentation materials.

b. Aging population

- Sometimes knowing how to use the application appropriately may be the main concern. For example, a senior citizen might have preliminary knowledge about the application, however, they may not know the methodology for use of Shared Ride Taxi.

c. Business Model

- PPPP is a new concept that combines PPP (Public Private Partnership) with society (people) to become a public-private-people partnership (PPPP). PPPP concept involves the current PPP financing scheme and societal participation, whether in terms of legal aspects and policies or institutional matters. This new concept can help the society (people) to have prosperous welfare together with the institution under PPPP, as well as

to not depend on the state budget, as it increases private equity. For the case of aging population, the fourth P(People) refers to caregivers in the rural area taking care of aging population.

d. Differences between existing commercial apps and MaaS

- Existing commercial apps do not include the payment integration options or even address any user specific needs. In this case user specific needs refers to the special needs of users, with special physical or mental conditions – aging or disabled;

e. Comments on MaaS

- MaaS is a step towards a multimodal environment. This can be achieved by accomplishing integration of mobility aggregators with transit providers. MaaS will eventually attract more commuters towards using public transit.

f. Questions answered (Subsection-4.1.6.4):

- The route options provided by MaaS will mainly suggest Public Transit as primary option. The monthly pass option will only be available for public modes. However, the payment system for modes like Uber will be Pay as you Go.

5. Meeting adjourned.

**Project: Connecting Wisconsin of Tomorrow:
Methods to Improve Public Mobility under Future Social, Economic and Technological
Changes
Third Advisory Committee Meeting
UWM Kenwood Interdisciplinary Research Complex, Room: 2035.**

Meeting Minutes: 13th June 2019

Time: 2:00pm – 4:00pm

Attendees: Jason Wittek (Ozaukee Transit), James Davies (BublR Bike), Jeff Sponcia (MCTS), Lynn Gilles (City of Fond du Lac-WIPTA), Kevin Muhs (SEWRPC), Dr. Edward Beimborn (UWM), Dr. Jie Yu (UWM), Shamsi Mosharraf (UWM), Xinyu Liu (UWM), Josie Willman (UWM).

1. Introduction: Dr. Jie Yu

- Provided project progress and research update for Market analysis, System architecture and Roadmap
- Provided updates on the Tommy Thomson conference feedback.

2. Meeting objectives: Provide updates on the report; Gather feedback on report and any possible improvements

3. Presentation introduction: Revisit of the demographic changes in Wisconsin (Chapter 2): Young generation; Aging population; Low income travelers, Spatial mismatch; Low smart phone usage; Key findings of the project;

4. Discussion

4.1 WIPTA-City of Fond du Lac

a. First step towards MaaS:

- We are inherently conservative because it isn't our money (public money); We don't want to waste anything; We cannot be the first person to bus an electric bus ; we are really conservative to try something new and have to follow someone else who will take the first step.
- If we could implement MaaS smaller steps but all working towards the same goal, then it would be an easier goal to reach.

b. Usability: The app should be easy to use. For example: Uber app

c. Sharing and standardization: If companies want to do business, they need to share the standards and propriety information

4.2 WisDOT

a. Future research grants on MaaS:

- Haven't worked directly with university and have typically worked with transit systems;
- There is additional follow-up required for looking into MaaS as an opportunity in Wisconsin
- If we find continued benefit to do research in this area, then we will look at it going forward.
- In general funding out there available to invest in this area.
- We are handing application on a rolling basis (semiannual)
- FTA- innovation technology grants available

4.3 MCTS

a. First step towards MaaS:

- Public agency is risk averse. Any time a new tool or software is adopted, the experience and lessons faced by other clients; There is very little innovation in transportation industry in the case of Milwaukee.

b. Input for SWOT analysis:

- Governing body overseeing public agency who will want to adopt it; Governing body funding is a threat if the objective is not clearly visible enough; Getting funding approved at the county board or several different level will be hard to achieve if we are not clear on the benefits. Questions such as why we need it and how soon will it happen, needs to be answered;
- Opportunities SWOT analysis: MaaS will be an additional reason to look at the regional transportation opportunity

c. Future Research

- Suggested research on similar topics to My Corridor case;
- Fare collection system ideas; how this could work

4.4 Bublr Bike:

a. Input on SWOT analysis:

- Many parts of Wisconsin have bad cell phone service (no signal) and it's the case in the rural areas; that will affect the efficiency of MaaS; Technology plays a huge role in MaaS

b. Usability:

- The final interface must be user friendly. Apps easy to use acts as an opportunity – If the its not usable then even the millennials won't use it.

c. Future research

- There are newer data standards coming up; Therefore, recommendation for fare system is needed for MaaS. Questions needed to be answered such as: 1) What kind of replacing technology needed compatible to the future system? 2) Structure of a standard fare collection system.

4.5 SEWRPC:

a. Sharing and standardization

- Proprietary information is no longer related to standard, it's mainly regarding the visa Mastercard info (Not standards);
- Universal communication standards are coming up soon, it's just a matter of time.

4.6 Ozaukee Transit

a. First step towards MaaS

- Car ownership is driving the trend in decline in ridership. Sharing economy came as a result of 2008 recession and will continue till the next recession. MaaS works in certain places and it's not a bad idea to make it work in those certain places. It may be a good idea for pilot project in Milwaukee

b. Sharing and standardization

- All companies have their own proprietary interest; Hence, they may not want to share their information as they have different systems (MCTS uses one whereas Ozaukee uses another form of system).

c. Future Research

- There are always risks associated with investment. For example, government will invest so much behind trying to make the technology work but then someone in the basement will come up with something better. We invested so much trying to get an app for MCTS work but then Google came up google transit which works perfectly fine.

4.7 Dr. Beimborn

a. Technology assessment

- For any innovation to be adapted there must be relative advantage. Greater the relative advantage greater chances of implementation; and
- Trialability: Problem with MaaS is that it's difficult to trial; You either have it or you don't.

b. User assessment

- There are many customer-oriented agencies with limited staffing and staffing capability; People and groups are open to change have severe budget limitations

c. User capabilities

- AVL and GPS are needed; once infrastructure is in place the rest will follow us.

4.8 Dr. Jie Yu

a. Usability

- Go Go grandpa was created for convenience of the aging population; However, the app was not convenient to use so received a lot of bad reviews.

b. Future Research

- Traveler characteristics: Most MaaS systems are working in urban areas; There is a need for study for traveler in rural area. Although our report put some light on it, but

for implementing MaaS in Wisconsin we need deeper look into their preference, travel habits, demand and need to understand them better; and

- Business model: We only study the case of Finland for business model. Can we borrow their business model from Finland, or do we need a new business model for the case of Wisconsin? We need Wisconsin specific marketing strategies – travelers in rural are used to their traditional travel habit.

5. Meeting Adjourned

APPENDIX C: A PILOT PROJECT CONCEPT OF CAMPUS MAAS

Smart Mobility, Smart Campus: From MaaS (Mobility as a Service) to M.A.A.S. (Mobility, Accessibility, Adaptability, Safety)

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EXECUTIVE SUMMARY

Managing urban mobility is one of the greatest challenges of our time. Today, new transport options like Transit, Car Share, Bike Share, Ride-hailing, Shared ride taxi, Rail transport are available enabling us to create an urban mobility model which addresses the emerging needs of cities. Leading educational institutions understand the role of interoperability of transportation infrastructure and technology as a key differentiator in emerging transportation system, technologies and changing student travel behavior.

A smart mobility platform has focus on two major areas: 1) a multimodal transportation system, and 2) an integrated planning and payment. The existence of a multimodal transportation environment is a living reality at the University of Wisconsin-Milwaukee (UWM) with the presence of private vehicle parking, public transit, campus shuttle (Prowl line), On-demand van service (B.O.S.S), shared bike (BublR bike), car sharing (Zimride), Taxi (Uber) and so on. New technologies like 5G, AI, IoT (Internet of Things) can connect all these new mobility transportation infrastructure and payment technology through an application. The Smart Campus MaaS will provide student with the option of optimization of transportation mode choice based on their class schedule, budget, time frame and personal preference. They will also be able to use the convenience of an integrated payment system which will save both time and money. Finally, with its security features students will benefit from the assurance of constant availability of security surveillance and service. This will not only influence student's commute decision but also relief campus congestion and improve campus safety hence taking the overall campus culture to a new level. If student Mobility around the campus is Accessible, Affordable and Safe then fewer people will incline towards car ownership. Mobility is attained through available transportation infrastructure, Accessibility through having all multimodal transportation and integrated payment system on user's fingertip, Adaptability by being able to mold our mobility decision based on our schedule or financial needs and Safety is having an assurance of immediate assistance and constant surveillance.

Smart Campus MaaS is therefore a new innovative approach and an emerging business opportunity connecting technology and infrastructure through industry demands. The goal is attained by designating service as an ultimate product amalgamating latest transportation infrastructure and technical knowledge from industry with the business model as a platform. The business model established has been validated by identifying the market and competition, potential revenue sources, initial funding sources, a projection of the potential revenue starting from UWM projecting all the way till all Wisconsin campus and then Nationwide.

The feasibility study and projections indicate that introduction of Smart Campus MaaS will benefit both the supply and demand sides. The implications of the concept will redirect mobility trends towards the establishment of the future vision of a Smart City.

1 FUTURE RELEVANCY

1.1 Service is the future

An interesting event occurred in the March Spring Apple Event. The world's most famous hardware design company and one of the major customers of Foxconn - Apple, announced three new products[84]: 1) Apple News Subscription Service, 2) Streaming Television Service, and 3) Apple Arcade with no hardware expected.

1) Apple News+ will offer unlimited access to stories from the subscription paywalled areas of the major news sites.

2) With Apple TV+, Apple would provide the ability for viewers to sign up for premium services such as Showtime, HBO, and Starz and may also offer channel bundles providing access to content from multiple cable channels at a reduced price.

3) Apple Arcade would be the world's first game subscription service for mobile, desktop and the living room.

It can be perceived that majority of the features are preexisting and is nothing new. However, upon integrating them under one application under a specific scenario, to prudently design a mechanism, by putting emphasis on customer experience and by taking sky as the limit, "traditionally localized services" [85] can be given a new dimension.

1.2 Mobility as a service

Apple integrates digital content productions to enrich people's life. Similarly, we are exploring solutions to improve people's mobility through three phases.

- Equip old vehicles and facilities with IoT devices to make them smart
- Attract transportation providers from various modes into our platform
- Provide flat rate transportation options with a premium experience

The idea was initiated by our transportation research team, is cultivating on UW-Milwaukee Campus and will thrive in the entire nation based on well tested solutions. This is not only a trend but a unique direction to a huge business possibility.

2 PRODUCT CONCEPT & PROCESS DESCRIPTION

Mobility as a Service (MaaS) is a major trend for developing next-generation transportation systems [1]. In terms of MaaS implementation, campuses generally outperform other major activity centers in executional and operational feasibility, market penetration, and technical and economic opportunities. Younger generations typically strive to attain economic, ecologic, safe and efficient benefits [2,3]. Using the University of Wisconsin-Milwaukee (UWM) as an example, this product would make commuting more convenient for students, faculty, and staff by integrating all diverse transportation modes, including private vehicle parking, public transit, campus shuttle (Prowl line), on-demand van service (B.O.S.S), shared bike (BublR bike), car sharing (Zimride), Taxi (Uber) etc., under one application [4]. The proposed application will offer Mobility as a Service on campus to facilitate Mobility, Accessibility, Affordability and Safety (Figure 1).

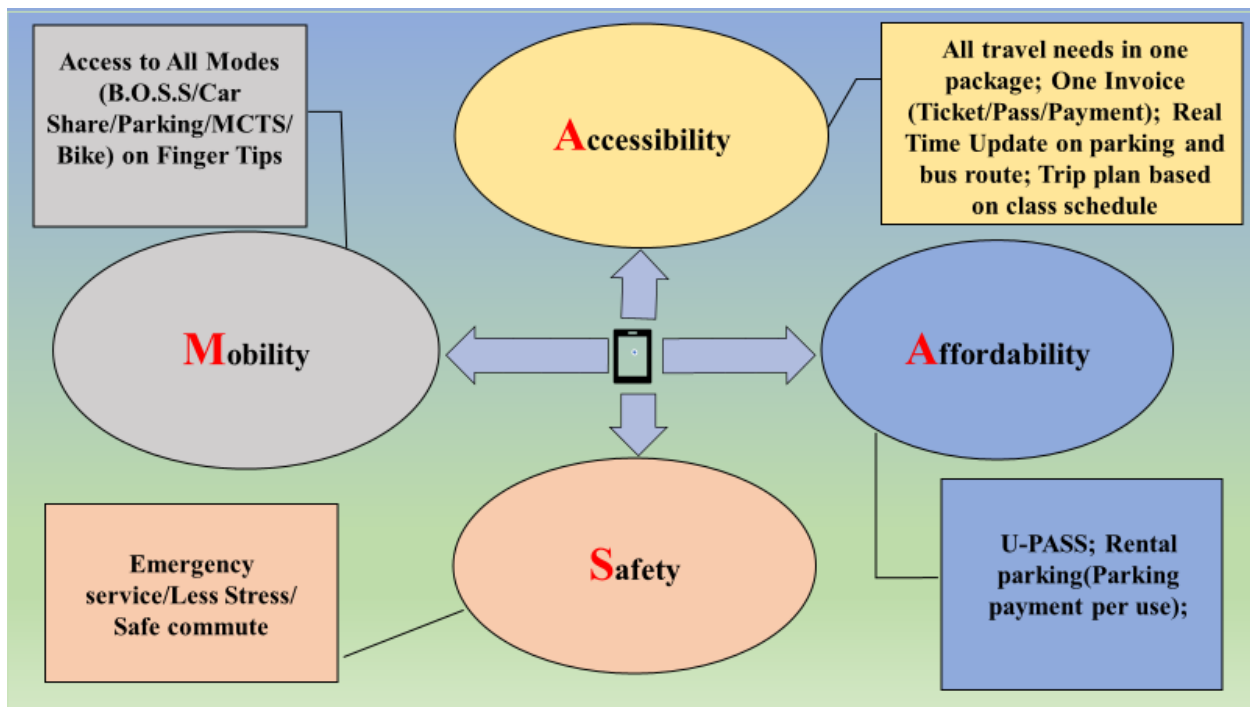


Figure 1: Implementation chart for MaaS (Mobility as a Service) to facilitate M.A.A.S. (Mobility, Accessibility, Affordability, Safety).

2.1 Usefulness: for user

The proposed solution can benefit users from six main areas which are explained in following paragraphs. All the areas shown in Figure 2 are the functions that can be integrated in a smart phone application available for passenger's use.

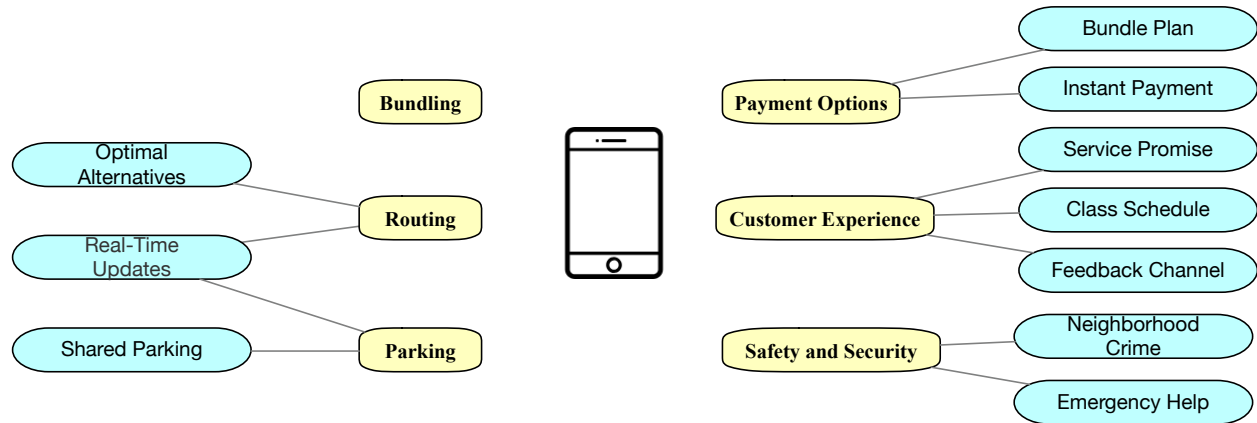


Figure 2: The benefits to users of Smart Campus application.

2.1.1 Bundling

By integrating multi-modal options, bundled traveling packages can seamlessly be provided for each trip (Figure 3).

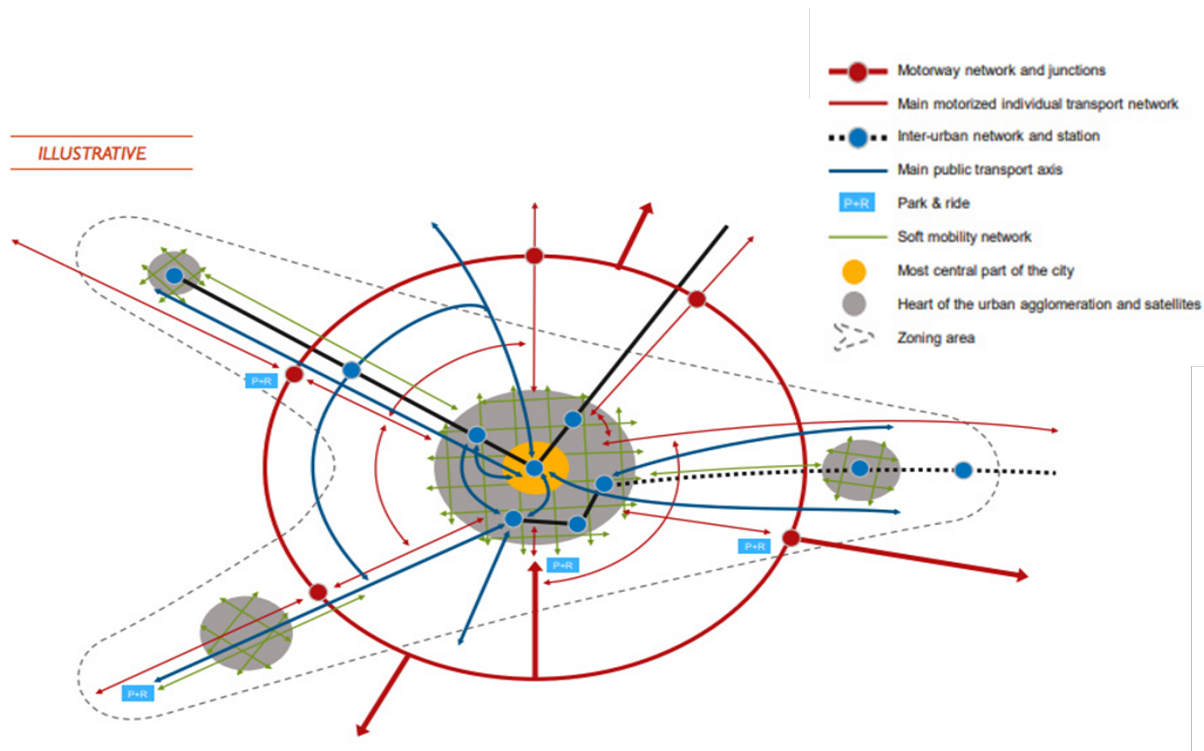


Figure 3: Illustrative Layout of a multimodal transport hub.

2.1.2 Routing

2.1.2.1 Real-Time Updates

The availability of real-time updates (i.e. schedule and location) for variable-serviced campus transit modes will allow users to make optimized trip decisions.

2.1.2.2 Optimal Alternatives

An optimization module will provide users with fast, economic, and ecological alternatives to users decision-making preferences.

2.1.3 Parking

2.1.3.1 Real-Time Parking Updates

The application offers a tab providing real-time updates on parking availability for each parking lot on campus.

2.1.3.2 Shared Parking

Residents living near the university's campus may rent out their personal parking spaces to students, faculty, and staff through the MaaS application. Parking space owners can register in the application, update the price, location and schedule making the spot available for rent. Subsequently, end users can log into their registered account and book an available spot after making an electronic payment for a specific allotted time. Users who fail to sign out of a parking spot upon leaving will be fined an additional charge at the end of the rental period. The product

helps to facilitate the optimal use of resources on- and off-campus which expands parking availability. This optimization helps balance supply and demand constraints.

2.1.4 Payment Options

2.1.4.1 Bundle Plan

The university's current transportation plan already has some successful options available for use in the bundle plan, i.e. U-Pass.

2.1.4.2 Instant Payment

The application offers users the ability for instant electronic payment and an all-in-one invoice for the services offered making payment hassle-free.

2.1.5 Customer Experience

2.1.5.1 Service Promise

Provides users with ease, serviceability, and reliability with optimal scheduling and transportation mode choice.

2.1.5.2 Class Schedule Integration

For primary customers like students, faculty, and staff, timeliness for class is the prime serviceability objective. The application enables students to upload their class schedule, and then combines the schedule with mode choice information using backend optimization methods. This ability allows the product to help users optimize mode choices that align with their schedules.

2.1.5.3 Feedback channel

A feedback channel is included in the application interface which lets operators have instant access to address customers' needs in real-time.

2.1.6 Safety and Security

Safety and security are major concerns when using public transit (especially at night). This application will help resolve these concerns.

2.1.6.1 Neighborhood Crime Map

A real-time neighborhood crime map will provide transit users with updated information on crime zones and density. This feature will help transit users to implement strategies to mitigate safety risks by rerouting around certain paths at late hours, switching transportation modes, or rescheduling the trip to their destination.

2.1.6.2 Emergency Help

The application will be equipped with an emergency help button that will instantly trigger a call to the police department and provide them with updates on the user's exact location.

2.2 Usefulness: for Transportation Service Providers

Transportation service providers are the second group who can benefit from our product. Based on the agreement of our MaaS platform, they will send their operational data to the agreement

data base. Campus MaaS company can help those providers improve market competitiveness and increase profit by realizing professional functions like operational dashboard, optimal vehicle dispatching, dynamic pricing etc. A preliminary integration plan and functions of current transportation modes on campus and other service providers has been created which will be updated after further study. Figure 4 shows the integration plan and the functions proposed by Smart Campus MaaS to each provider.

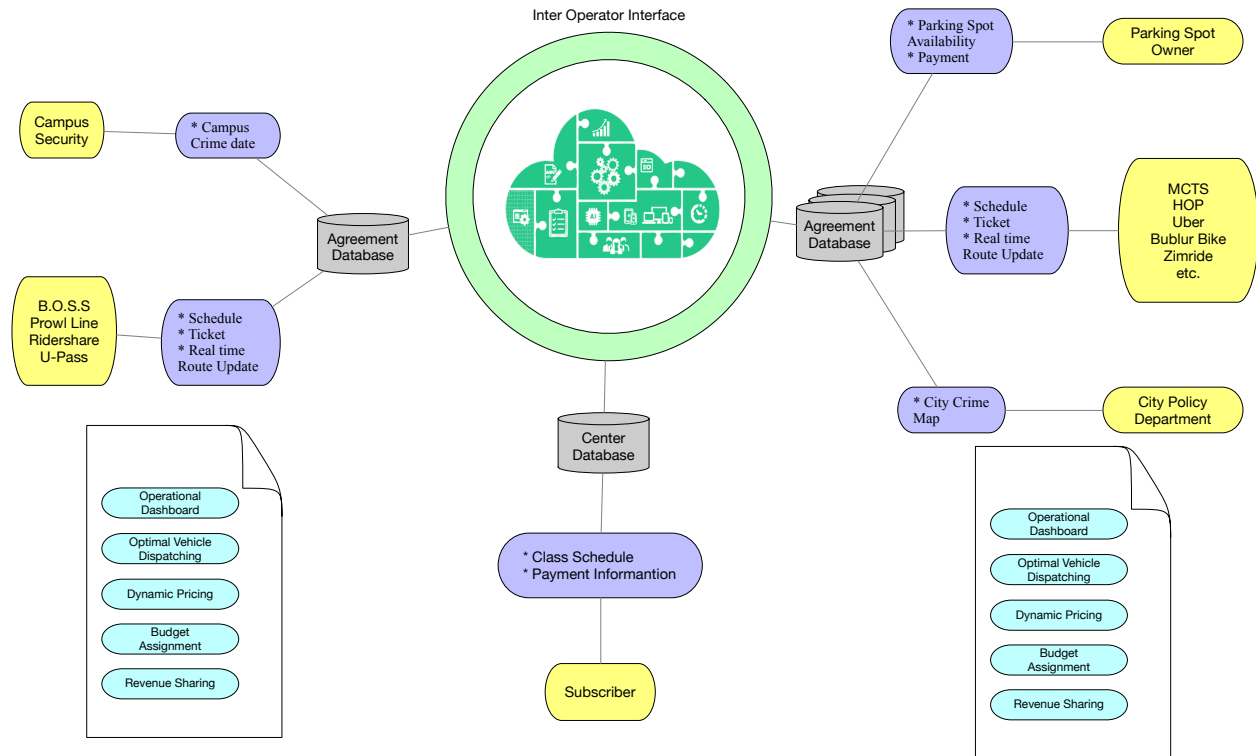


Figure 4: Integration plan of current transportation modes on campus and service providers.

3 BUSINESS MODEL

3.1 Business

With the advancement of new technologies like 5G, AI, IoT and with the help of our expertise these technologies can be brought to the fingertips of users as a regular application. The business plan has been established – like giants like Apple. In simple words, the Smart Campus MaaS company sells hardware, but it is also a software company. The business strategies in different phases can be referred to from Figure 5.

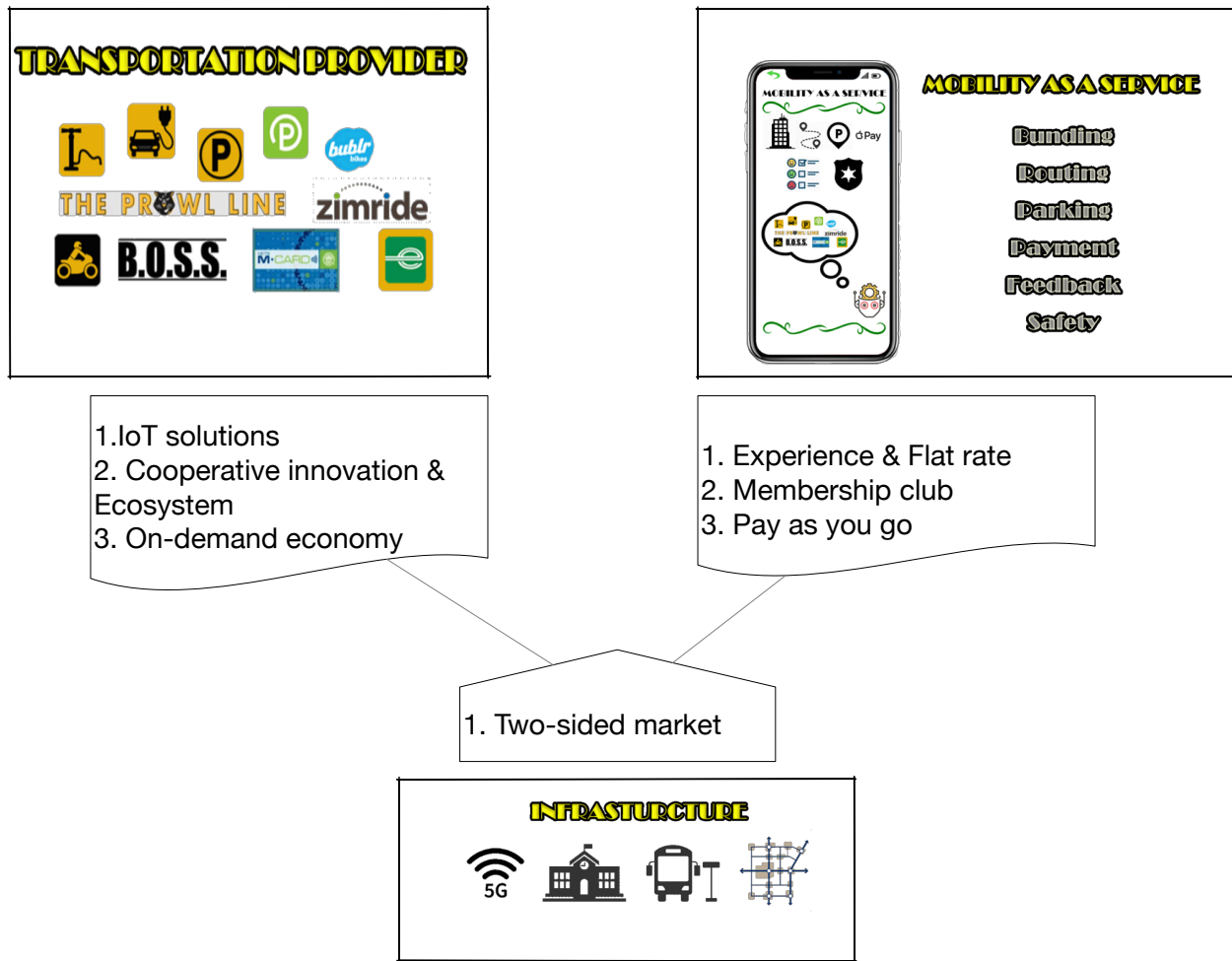


Figure 5 Business Strategy for Smart Campus MaaS.

3.1.1 Two-sided market

The proposed Smart Campus MaaS is a two-sided market. The MaaS company not only acts as a services integrator but also as a service provider. As a Smart Campus MaaS company, we cooperate with local transportation providers to better serve passengers and hence earn revenues from both.

3.1.2 Revenue from local transportation providers

1) IoT solutions 2) Cooperative innovation & Ecosystem 3) On-demand economy

The Smart Campus MaaS company will design, test and sell IoT solutions to transportation providers making some profits. This means that based on the Smart Campus MaaS company mechanism, transportation providers who are willing to cooperate and build a transportation ecosystem will be able to transform their business into an on-demand economy by improving their efficiency and effectiveness.

3.1.3 Revenue from users

1) Experience & Flat rate 2) Membership club 3) Pay as you go

Users will have more options which provide them with a greater customer experience and stable flat rate. The payment is flexible, enabling subscribers to form a membership club as well as 'Pay as you go' to attract new customers.

3.2 Business Impact

Using the business strategies established as a foundation, the business steps can be categorized into three phases with a different role assigned to each phase as shown in Figure 6. The Smart Campus MaaS company will lead as a coach to help local transportation providers improve their competitiveness and earn more profit. After building collaborations with several key players, Smart Campus MaaS company would endeavor to maximize the full potential of more transportation providers according to their unique features by building a team. Once a local team has been successfully run, Smart Campus MaaS company will seek to spread this template across the United States. The transportation service providers in each locality would buy IoT solutions and software services from Smart Campus MaaS company. Smart Campus MaaS company will help them build a local team designated as a Mobility-as-a-Service (MaaS) team. As the number of MaaS teams increases, a MaaS league will be formed. In this final stage, Smart Campus MaaS company performs like a league commissioner--and earn profit from Smart Campus MaaS company's value-added services.

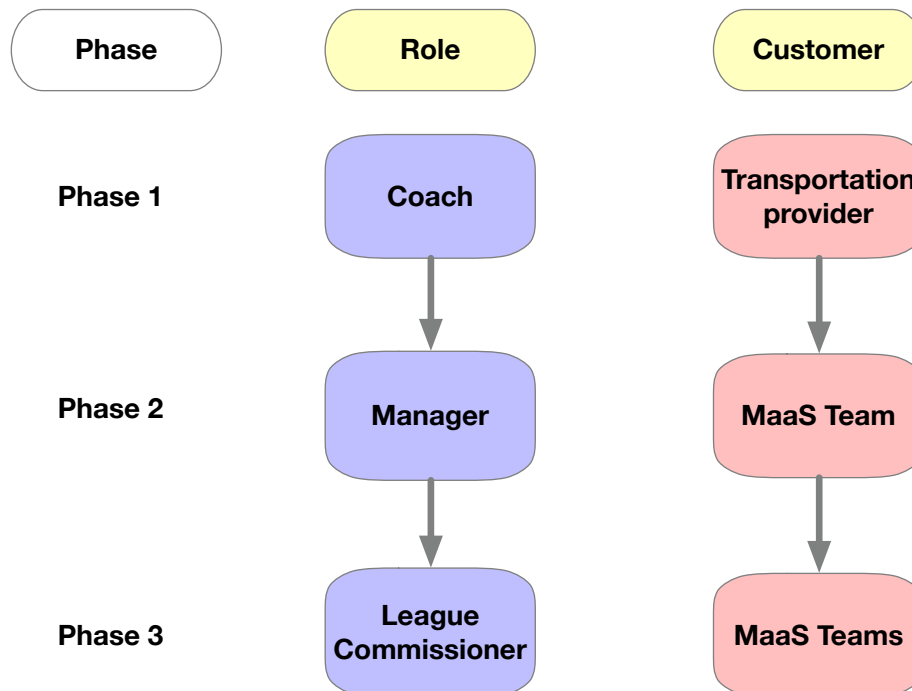


Figure 6:38 The roles and target customer in different phases.

4 MARKET OPPORTUNITY

4.1 Size & Positioning

4.1.1 MaaS Market Size

According to MRFR (Market Research Future Reports), the Global Mobility as a Service market is expected to reach approximately USD 253.16 billion by 2023 growing with a 36% CAGR (Compound Annual Growth Rate) over the forecasted period, 2017-2023.

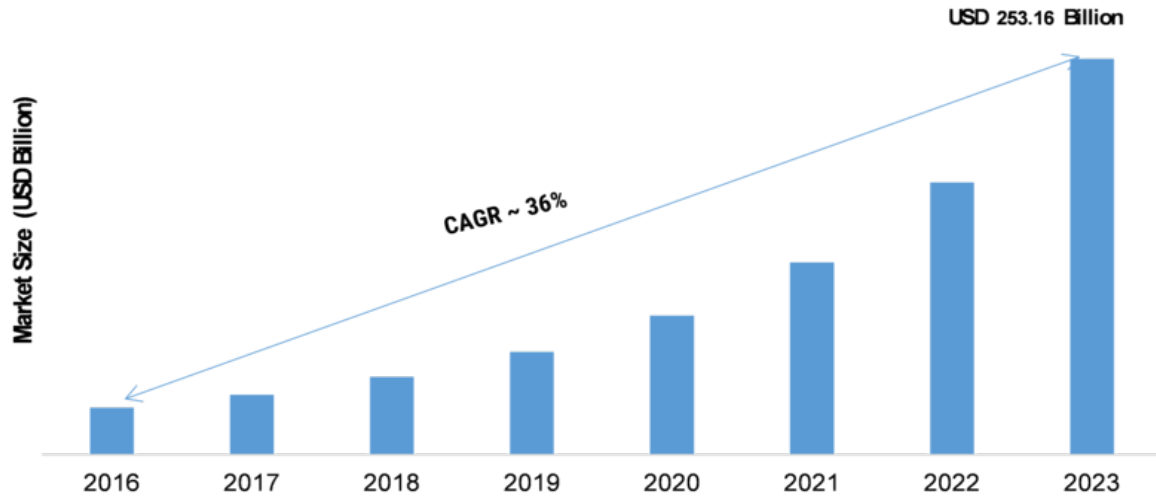


Figure 7: Market Research Future. Global Mobility as a Service Market Research Report, 2019 [3].

4.1.2 IoT Market Size

As illustrated in the IoT Market Research Report by Market Research Future[86], the global IoT market is expected to grow with a CAGR of 19.75% and which is expected to have a growth of 2488 billion USD by the end of 2022.

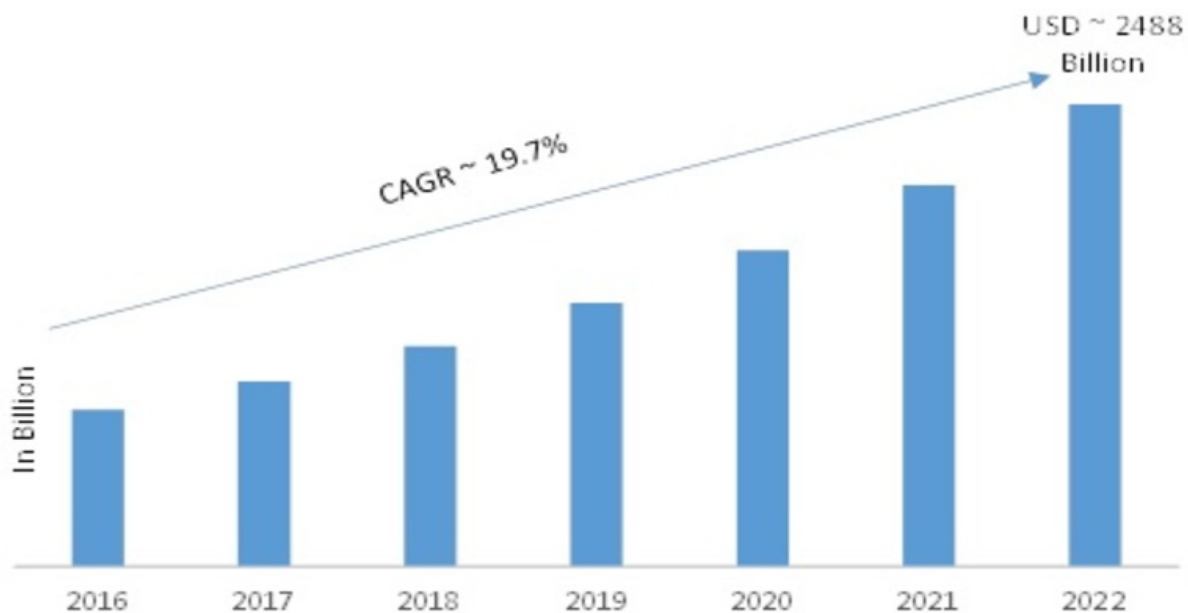


Figure 8: Market Research Future. Internet of Things (IoT) Market Research Report- Global Forecast 2022 [4].

4.1.3 Positioning

As a MaaS provider, Smart Campus MaaS company provides trip reservation, generation and instant feedback service to travelers through an application as well as optimization services bundled with IoT software and hardware to transportation service providers. The target market are universities, which is different from other current MaaS providers around the world (e.g. Whim in Finland, UbiGo in Sweden, etc.) who focus on urban areas. Campuses have strengths in developing MaaS because of its spatial accessibility, temporal stability (Classes starting at the same time every day) and diversified existing transportation modes (e.g. B.O.S.S, U-Pass, MCTS, Bubl'r bikes in UWM).

4.2 Target Customer

As a MaaS mobility provider, our product provides our mobility service to college students, faculty and staff. At the same time, smart operation solutions are offered to transportation service providers and other MaaS companies.

4.3 Competition

	Mobility Users			Transportation Service Providers & MaaS Providers			Market
	Pay-as-you-go	Tailored service package	Service Optimization	Data Analytics	Service Optimization	Smart Hardware	
Our company	✓	✓	✓	✓	✓	✓	Campus, US
Moovit	✓	×	×	✓	×	×	Urban, US
UbiGo	✓	✓	×	×	×	×	Urban, Sweden
Whim	✓	✓	×	×	×	×	Urban, Finland

Figure 9: Comparison between Campus MaaS and similar services available.

Compared to other MaaS companies, UbiGo and Whim only target their products to mobility users, with the function of Pay-as-you-go and tailored service packages. Moovit provides pay-as-you-go to users and data analytics to transportation service providers and MaaS providers. However, they do not provide service optimization solutions and smart hardware. The Smart Campus MaaS company team has highly skilled technical and research expertise, which guarantees extensive functionality such as service optimization algorithms in routing, scheduling and dispatching to both mobility customers and transportation service providers, together with smart hardware (e.g. chips, detectors, etc.) in traffic detection, information transmission and data computing to help better optimize their operation. Besides, this product places campuses as the target market, which is a brand-new market segment with much opportunities.

5 REVENUE POTENTIAL & FINANCIAL RETURN

5.1 Key Revenue Streams

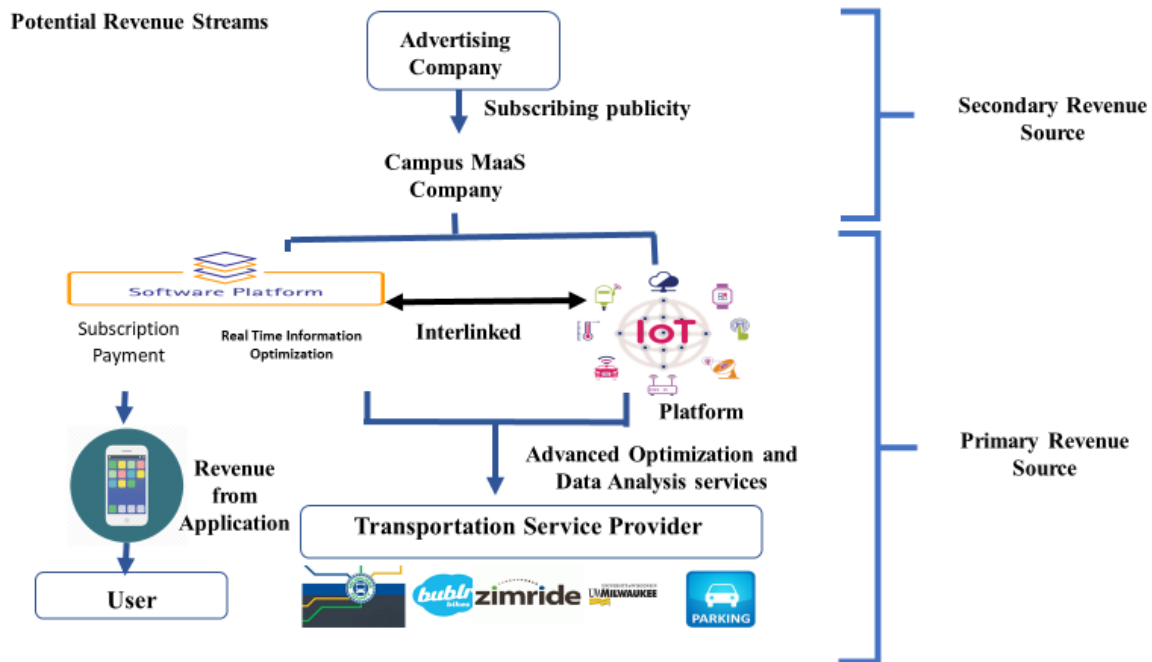


Figure 10:39 Potential Revenue Stream.

MaaS ecosystems consist of four different levels: 1) public and regulatory level; 2) transport and logistics service providers' level (i.e., supply side); 3) mobility service level (mostly acting as a MaaS operator), and 4) end-user level. Revenue Streams are the various sources from which a business earns money from the sale of goods or provision of services and is reliant on the types of activities carried out by the business. The revenue stream for Smart Campus for UWM have been categorized into four groups, i.e. MaaS service provider, Transportation service provider, Third party and End user. For case of UWM, the transportation service provider for campus MaaS will include University of Wisconsin-Milwaukee Transportation Services, MCTS, BublR Bike, Zim Ride, University Transportation Service, Home owner offering rental space etc.[87]. Campus MaaS service will have mobile app or will have service Kiosk screen around the campus. Advertising agency or small business subscribing to advertise their products on our platform is considered as a secondary source of revenue. The principal revenue source for campus MaaS system is from the user and from the transportation service providers. The revenue sources from the users will be based on the subscription cost which will cover the application and the associated services offered with the application (real time information, optimized routing information, crime map, optimized route options avoiding crime zone, parking booking platform, class schedule integration etc.). The user revenue will also be generated from the small percent of revenue share on the payment made for each mode choice. The revenue stream from the transportation services will be based on a combination of software subscription service and Internet of Things (IoT) service. The combination of the two will provide transportation service with optimized route and service choice [87].

5.2 Revenue Potential

By the year 2025 Internet of Things (IoT) could represent an economic value of \$19Trillion and will serve as key component for Research, Education and Smart communities [1]. This supports the fact that Internet of Things (5G, 8K) technology will be a part of our daily lives [1]. Hence the demand of efficient service with 5G and 8K technology will be essential part of transportation services in order to meet the market competition. According to study by APTA, 88% of the millennials say that the length of their commute is important and 65% of the millennials would use public transportation if it is made more convenient and accessible [2]. APTA's study also shows that 74% of the millennials would use a Mobility as a Service application. These statistics shows a strong support for the use of application created [2].

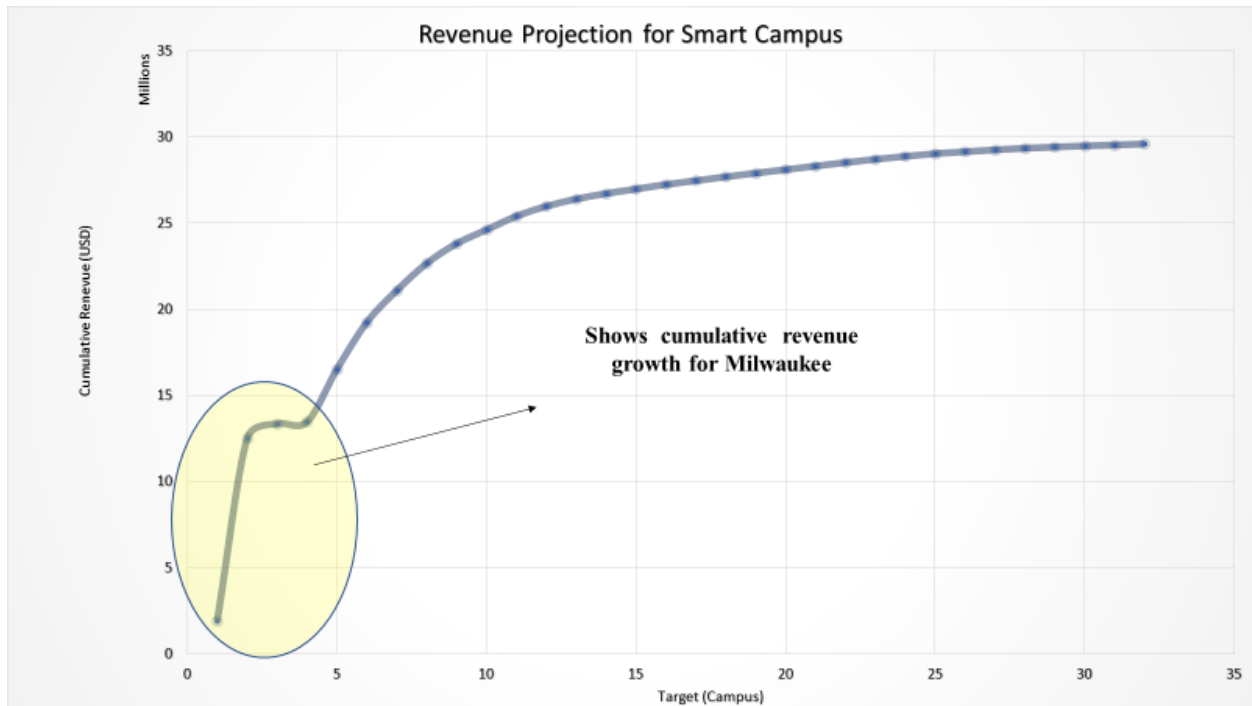


Figure 11: Cumulative Revenue Growth and Potential for Smart campus in Wisconsin.

An analysis has been conducted on 32 major colleges and university population and a sales projection has been made based on enrollment. A cumulative graph for potential revenue has been plotted to analyze the potential revenue trend for smart campus. The cumulative trend in Figure 11 shows an increasing trend in revenue potential from smart campus application. The increase in trend is based on attaining of each Target area of the Growth strategy as shown in Figure 12. Business and advertising agencies needing publicity of their product can use the walls of Kiosk as advertisement platform or post their advertisement on the side bar of the mobile application.

An estimation of the projected revenue potential has been calculated as shown in Figure 12. The potential revenue has been based on the total population of the campus and the number of

transportation modes available per campus. An assumption of 5 transportation modes per campus has been assumed based on Transit bus, Campus shuttle, Shared taxi and home rental parking owners. UWM is the only case which has an exception as the number of available transportation modes on campus is already known. The prediction of revenue potential for Target 1, Target 2, Target 3, Target 4 and Target 5 are 1,927,019.5 USD, 1,250,4500 USD, 1,925,1139 USD, 2,541,4206.5 USD and 2,960,8872.5USD respectively as shown in Figure 12.

5.3 Product Positioning & Sales/Growth Strategy

The growth strategy of the product has been based on fixed Target zones. The Target zones extend between Target 1 to Target 5 and beyond Target 5 United States wide market growth has been presumed. Target 1 covers UWM campus. Target 2 extends towards all UW-System campuses. Target 3 assumes that after UW-System possibly all the colleges and universities in the Milwaukee region will be the primary market where the growth will occur. Therefore Target 3 covers all universities and colleges within Milwaukee. It has been assumed in the next step of Growth Strategy, that larger university (population > 10,000) will demand Smart Campus MaaS in order to increase enrollment as well as meet the demand for the student population which mainly consists of millennials and younger population. Therefore, Target 4 projects towards all large colleges and universities (population >10, 000). Finally, Target 5 projects towards all the remaining smaller colleges and educational institution. Once all targets till Target 5 has been achieved, the future projection of growth can be made towards campuses across United States.

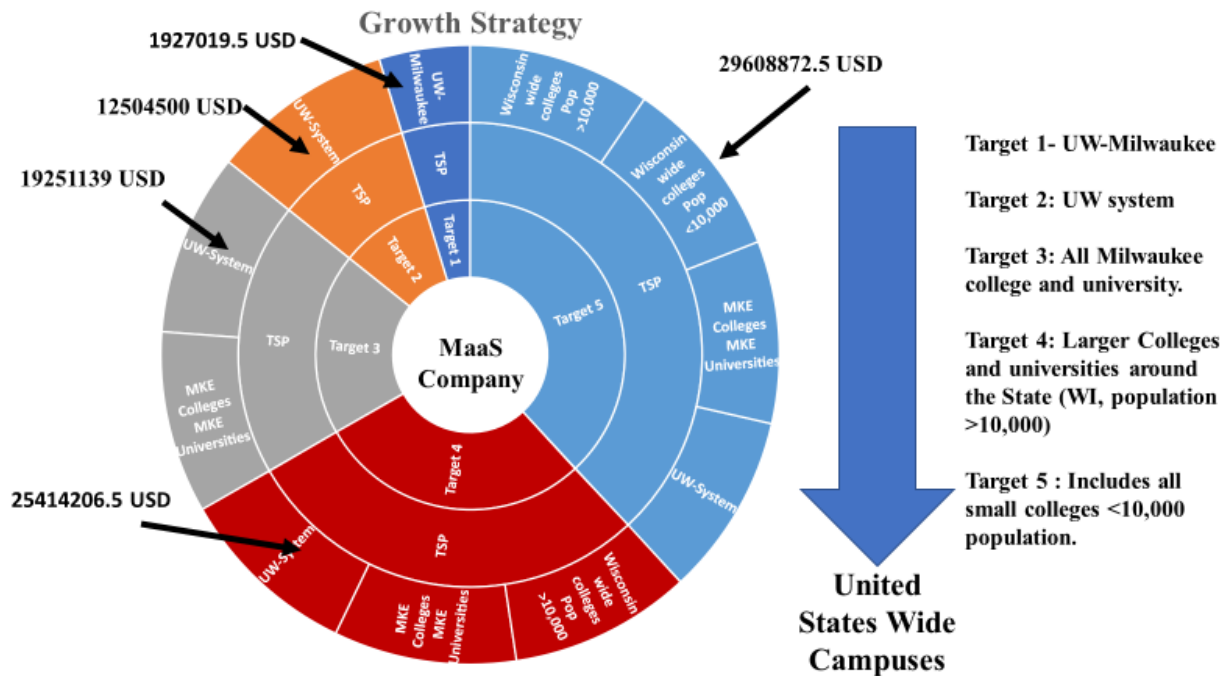


Figure 12: Growth Strategy Framework [3].

6 INITIAL FINANCIAL RETURN

The initial pilot project for the Smart Campus will be based on UWM. Campus MaaS will promote more use of transit service and is structured to reduce the use of privately-owned car. The Campus MaaS will also benefit the university area with reduction in congestion hence providing safer pedestrian crossing zones. Therefore, campus will benefit both the University, by reducing congestions and promoting safer pedestrian ecosystem for students, and the government will benefit by increasing transit ridership. Therefore, the primary initial return could be based on funding from government and university to help promote both their goals. Another source of initial financial revenue will be investment from transportation service provider who demand desire increased ridership and Campus MaaS will provide them with more publicity by promoting their service to the campus users. The fourth initial source of revenue will come from the students, faculty members and the staffs who commutes to campus on daily basis and Campus MaaS will give them a cheaper and efficient solution. The initial financial return from UWM based on the campus population and all current transportation service provider for UWM campus, is projected to be 1,927,019.5 USD.

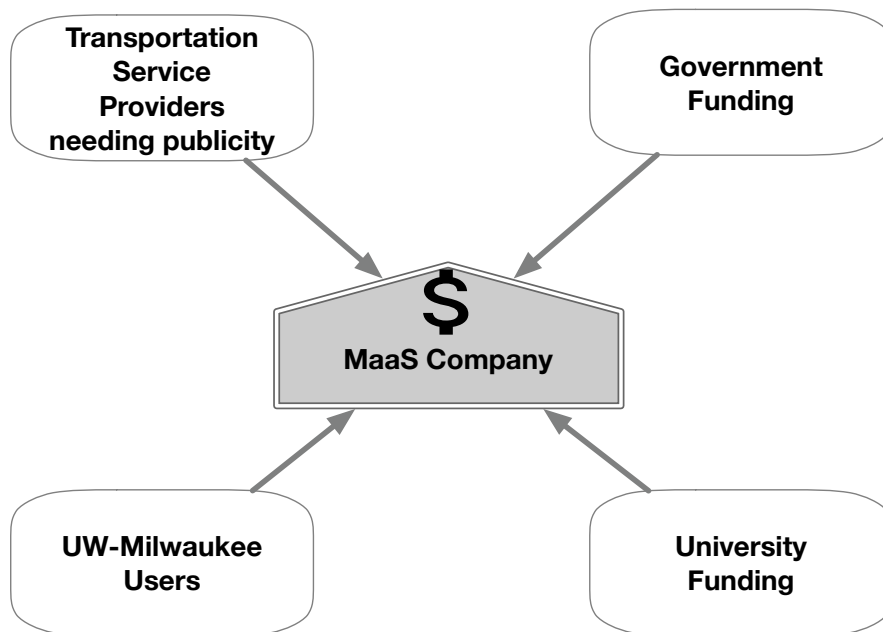


Figure 13:40 Initial Financial Revenue Sources.

7 RISK ASSESSMENT

Through SWOT analysis, risks of the product include uncertainties in partnership establishment, pricing and managing revenue distribution and irrational market response. However, the strengths and opportunities outweigh its threats and weaknesses tremendously.

Strengths	Weaknesses
<ul style="list-style-type: none"> • Low upfront cost • Integration of all the procedures required for traveling • Collaborative nature in relation to existing market players • Promote sustainable and healthy lifestyle • Improve campus efficiency and security 	<ul style="list-style-type: none"> • Vulnerability of computer power under high demand in the implementation phase
Opportunities	Threats
<ul style="list-style-type: none"> • Stable travel demand in campus • Students' curiosity in embracing MaaS • Extensive penetration of smartphone technology in campus • Mature software and hardware infrastructures • Unified payment structure (e.g. U-Pass) 	<ul style="list-style-type: none"> • Uncertainties in partnership establishment with service providers • Pricing and managing revenue distribution • Irrational market response

Figure 14: SWOT Analysis for Smart Campus MaaS.

8 CONCLUSION

The idea of Mobility as a Service is a recent concept; however, our proposal gives it a new direction and approach by putting light on its implementation and implication in a campus ecosystem. The Smart Campus MaaS concept identifies the users, advertisers, transportation service providers as the revenue streams, and estimates and the project's potential revenue influx for this new innovative serviceability-based business model. The projections made were supported by census data, statistics and research based on MaaS which creates a strong foundation of its real-world demand and applicability. The proposed product offers visualize service not only to be designed for users but also for the transportation service provider hence introducing the concept of Two-sided market. The market analysis identifies the benefits to its stakeholders as well as defines all possible risks associated with it. A target-based Growth strategy with potential revenue projected from each Target has been established. Finally, the projections from the Growth strategy not only forecasts the feasibility of the real-life applicability and revenue generation potential for University of Wisconsin Milwaukee, but also projects beyond Milwaukee and ultimately targets nationwide campus market. Nevertheless, the

business model itself can sustain more possibilities which is not limited by campus settings. Therefore, the market of MaaS company can be as big as the entire transportation market, but the share occupied by Smart Campus MaaS company not only depends on the available expertise but also your investment!

REFERENCES:

- [1] A. Sherman, “Apple services announcement lacking critical details,” 25-Mar-2019. [Online]. Available: <https://www.cnbc.com/2019/03/25/apple-services-announcement-lacking-critical-details.html>. [Accessed: 05-Apr-2019].
- [2] “Campuses,” *University of Wisconsin System*, 14-Mar-2017. .
- [3] E. National Academies of Sciences, *College Student Transit Pass Programs*. 2018.
- [4] UCL, “Feasibility Study for Mobility as a Service Concept for London,” *UCL Energy Institute*, 01-Jun-2015. [Online]. Available: <https://www.ucl.ac.uk/bartlett/energy/publications/2015/jun/feasibility-study-mobility-service-concept-london>. [Accessed: 05-Apr-2019].
- [5] “fs-maas-compress-final.pdf.”
- [6] “Future of mobility overview | Deloitte Insights.” [Online]. Available: https://www2.deloitte.com/insights/us/en/focus/future-of-mobility/overview.html?id=us:2ps:3gl:confidence:eng:cons:102218:nonem:na:E5061ZhK:1124733069:339149875907:b:RLSA_Future_of_Mobility:Future_of_Mobility_BMM:nb. [Accessed: 05-Apr-2019].
- [7] “Internet of Things (IoT) Market Report- Global Forecast 2022 | IoT Market.” [Online]. Available: <https://www.marketresearchfuture.com/reports/internet-of-things-market-1176>. [Accessed: 05-Apr-2019].
- [8] “Mobility as a Service Market - Global Forecast 2023 | MRFR.” [Online]. Available: <https://www.marketresearchfuture.com/reports/mobility-as-a-service-market-3109>. [Accessed: 04-Apr-2019].
- [9] P. Jittrapirom, V. Caiati, A. M. Feneri, S. Ebrahimi, M. Alonso Gonzalez, and J. Narayan, “Mobility as a Service: A Critical Review of Definitions, Assessments of Schemes, and Key Challenges,” *Urban Planning*, vol. 2, 2017.
- [10] L. Hu and R. J. Schneider, “Shifts between Automobile, Bus, and Bicycle Commuting in an Urban Setting,” *Journal of Urban Planning and Development*, vol. 141, no. 2, p. 04014025, Jun. 2015.
- [11] “Hu and Schneider - 2015 - Shifts between Automobile, Bus, and Bicycle Commut.pdf.” .
- [12] “Small Business Ideas and Resources for Entrepreneurs.” [Online]. Available: <https://www.inc.com/dave-kerpen/why-as-a-service-companies-are-the-way-of-the-futu.html%3E>. [Accessed: 05-Apr-2019].
- [13] Esmat Mirzamany and Joe Barrett, “Smart Campus: a route using 4G and 5G to serve the Smart City,” *Joint Information Systems Committee*, Mar. 2018.
- [14] Florence D. Hudson, “SMART CAMPUSES AND THE INTERNET OF THINGS.” Stony Brook Smart Campus & IoT v2.
- [15] M. Kamargianni and M. Matyas, “The Business Ecosystem of Mobility-as-a-Service,” *96th Transportation Research Board (TRB) Annual Meeting, Washington DC, 8-12 January 2017*, p. 14.
- [16] “The Everything as a Service (XaaS) Model,” *Linux Magazine*. .
- [17] “The Everything as a Service (XaaS) Model | Linux Magazine.” [Online]. Available:

- <http://www.linux-mag.com/id/7197/>. [Accessed: 05-Apr-2019].
- [18] DARNELL CHADWICK GRISBY *et al.*, “The Transformation of the American Commuter,” American Public Transportation Association.
- [19] “The Transformation of the American Commuter.” [Online]. Available: <https://www.apta.com/resources/reportsandpublications/Pages/Transformation-American-Commuter.aspx>. [Accessed: 03-Apr-2019].
- [20] J. Daggett and R. Gutkowski, “University Transportation Survey: Transportation in University Communities,” *Transportation Research Record*, vol. 1835, no. 1, pp. 42–49, Jan. 2003.
- [21] “University Transportation Survey: Transportation in University Communities - John Daggett, Richard Gutkowski, 2003.” [Online]. Available: <https://journals.sagepub.com/doi/10.3141/1835-06>. [Accessed: 05-Apr-2019].