Mobility-as-a-Service

The value proposition for the public and our urban systems

March 2018

MaRS

ARUP

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Research team

Arup

Arup is drawn to projects involving complex, atypical problems requiring non-standard solutions. We are uniquely positioned to serve a mix of public, private and industry clients with large stakes in the evolving mobility paradigm.

Arup conducts internally funded research and produces thought-pieces regarding the future of transit, highways, rail and airports. This research — along with targeted studies of impacts of driverless cars on urban streets and policy implications of driverless cars and the mobility-as-a-service ecosystem — demonstrates our commitment to exploring the outcomes of new and emerging mobility tools and services.

Ryan Falconer holds a PhD in sustainability and technology policy and has published 30 peer-reviewed book chapters and entries, journal articles and conference papers. Ryan is Arup's Cities Leader for Western Australia, having spent 2015 to 2017 in Toronto leading integrated planning for Arup in Canada. He has spoken to international audiences in New Zealand, Australia, Sweden, Hong Kong, China and North America on topics including mobility-as-a-service, automated vehicles and transit-oriented development.

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MaRS Discovery District

MaRS Discovery District (MaRS) is a not-for-profit innovation hub dedicated to driving economic and social prosperity. Based out of Toronto, Ontario, MaRS is a neutral third party that works with entrepreneurs, investors and companies to enable wider economic and societal impact, and with governments and industry to facilitate innovation across complex markets and systems.

Over the last few years, MaRS has been actively engaged in the shared and connected mobility area. This includes development of the sharing economy strategy for the City of Toronto, which is globally recognized for leading regulation in this area, detailed modelling on how shared and connected mobility solutions may impact the environmental and transportation challenges facing dense urban areas, and creation of the inaugural Urban Mobility Design Camp to further explore opportunities around shared and connected mobility. MaRS is currently exploring shared mobility pilot deployment with regional stakeholders (with the support of the Atmospheric Foundation) and is in the process of founding a shared mobility knowledge hub for the Greater Toronto and Hamilton Area.

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Declaration

This report represents the sole opinion of the authors and is not to be construed as directly representing the views held by the organizations listed. No interviewees or the organizations they work for exercised editorial control over the report.

Other credits

The authors would like to thank **Sasha Sud, Joe Greenwood** and **Wanda Wang** of MaRS Data Catalyst and **Tim MacLeod** of Bridgeable for sharing his firm's mobility-as-a-service research. Bridgeable is an award-winning strategic design firm focused on helping clients bridge the gap between what is known about a complex problem and how it can be solved. The company works to research, translate and design experiences across sectors ranging from mobility to healthcare to financial services.

We are thankful to **Bruce Schaller** of Schaller Consulting for his independent peer review and helpful comments on our draft paper. We encourage you to read Bruce's own work on the subject, available through his website. Additionally, we thank **Tim Gammons**, Director of Smarter Mobility & ITS at Arup, for his review and comments. Thanks to **Jesse Vernon** and **Karen Scarborough** for their thoughtful editorial reviews and graphical support.

Lastly, we thank all of our interviewees, including representatives of the Conference Board of Canada, Shared Use Mobility Center, City of Toronto, Metrolinx, Town of Innisfil, Kansas City Area Transportation Authority, and six mobility service and platform vendors.


MORTON'S
THE STEAKHOUSE
DIVVY

Executive summary

In this white paper, we explore the evolution of mobility-as-a-service, or MaaS: how it is redefining our conceptions of vehicular mobility and how we navigate around our cities and fulfil our life's work.

MaaS is a manifestation of new thinking around how transportation services are currently provided and used. MaaS is intended to improve the efficacy of and access to urban mobility through new services and online platforms. Many cities around the world have been exploring how to best deploy MaaS networks to optimize benefits for providers and users.

We consider MaaS to be both a physical service provision and a medium for accessing this service. We refer to the physical aspect of MaaS (the consumable travel) as the *mobility service component* and the media used to select travel as the *mobility platform*. In particular, we discuss how mobility services are contributing to reconceptualization of public transit and the role of transit in supporting urban growth and operations.[1] We also take stock of the documented impacts of these services on cities — both the positive and the negative.

In this paper we set a virtuous target for mobility ecosystems: the preservation and enhancement of public-mobility services, available to meet the needs of all segments of society at modest prices. The private sector can add mobility choices to the market — sometimes in partnership with the public — to help this target be attained; however, a net result that includes increased inequities or deprivation should not be accepted as a product of progress.

We believe the research makes an important contribution to the discussion around MaaS and should be of interest to governments, transit operators, private service vendors and the travelling public.

Approach

Much is taken for granted regarding the role and impacts of MaaS in our urban areas; accordingly, we aim to dispel myths relating to and improve appraisals of MaaS. We identify and clarify the roles of different stakeholders (agents in the mobility ecosystem), to help make sure the net result of MaaS is beneficial for society. This includes a critique of the role of the public sector and identification of important policy directions.

Our research method involved a deep dive into the emerging body of literature relating to MaaS, including peer-reviewed academic papers, thought leadership pieces and independent publications, as well as scans of available news sources and related web content. In addition, we engaged 14 senior industry specialists via a semi-structured interview format to elicit views relating to our research.

The findings from the primary and secondary research were considered within the context of our study area of interest: the Greater Toronto and Hamilton Area (GTHA). This allowed us to form conclusions regarding current depth of knowledge around MaaS and the identification and measurement of its operational impacts. We then developed recommendations regarding how to address both suboptimal impacts and knowledge gaps.

While our geographic focus is the GTHA, our findings and recommendations are relevant in many other North American contexts.

1 While MaaS can also support rural transportation services in areas where private transportation becomes a barrier to development, this is not the main focus of this study.

Findings

MaaS deployment and outcomes vary by region and are influenced by socioeconomics and sociodemographics, as well as factors like urban geography, overall trip patterns and quality/coverage of existing public transit systems. MaaS is also significantly affected by the availability and quality of regional communications infrastructure, such as through the availability of real-time data to support transit planning and services.

Our expert interviews indicated that the perception of the value proposition of MaaS varies from one agent group (consumers, vendors, transit agencies and other governmental stakeholders) to another and sometimes involves trade-offs between the interests of different agents. The primary trade-offs occur between consumers, vendors and transit agencies across trip market segments that the public sector has struggled to serve using conventional transit services. These segments simultaneously present some of the greatest opportunities and the greatest risks.

Based on our research and interviews, we have identified the following factors that affect value creation and the nature of trade-offs between different agents within the MaaS ecosystem:

- Urban socioeconomics and sociodemographics, including relative population heterogeneity, employment and the costs of travel in proportion to household/personal income
- The regulatory environment or constraints under which service vendors are required to operate
- Maturity of public transit systems, especially the extent to which they are road- or rail-based and their expanse across a particular geography
- Quality of transit journeys, including the legibility of the system, travel speed and time, price point and comfort
- The size and density of cities, as well as the distribution/concentration of land-use intensity
- The characteristics of alternative mobility services offered and the sustainability of these business models; MaaS can add incremental value to existing networks but sometimes requires subsidy.

Our research demonstrates that there is no existing means to prevent negative trade-offs — to limit value creation for one group of agents when it becomes a liability for another group. This is a fundamental issue that needs to be addressed when it comes to guiding and regulating MaaS.

The motivations for participating in the MaaS market differ from group to group and from city to city, and a model or best-practice operating framework has not yet emerged for this immature market. This sector faces a baseline of uncertainty, a lack of definition and expected results. It is therefore important for agents to recognize their knowledge gaps and limitations, and to work in partnership with other interests in pursuit of joint value creation.

MaaS concepts, services and outcomes vary significantly across markets, and the sector is changing rapidly. Different services appeal to different parts of the travel market. There are also opportunities to develop MaaS to solve sector-specific challenges, including delivery of health care services and solving immediate issues with transit access in new development areas, as well as many other sectors currently underserved by public transit or other conventional forms of mobility.

Recommendations

In many regions, the public sector is well behind par with respect to defining and implementing model regulatory frameworks, and the GTHA is no exception. Without clear regulations, some of the negative impacts of mobility service provision, such as competition with transit, variable service standards and congestion, are being dealt with in piecemeal and suboptimal ways. Established frameworks could facilitate the potential benefits of public-private mobility partnerships.

The following recommended actions address some of the data gaps identified through this research and clarify areas of responsibility regarding MaaS deployment.

1. Prioritize well-calibrated public-private-partnership-based mobility pilot tests, and develop and test model policies. Critical elements include compiling and evaluating evidence of similar models that have worked well in this specific sector, with a particular emphasis on data gathering, monitoring and evaluation
2. Consider government-owned enterprise in the sector, which can help backstop mobility services in marginal areas and set operating baselines for the industry. Such ventures would need to operate in accordance with private-sector principles to avoid additional burden on public expenditure
3. Further develop and consistently deploy information- and data-sharing protocols so that the type, quantity, granularity, accuracy and latency of the data needed to fulfil mobility choice selection become better understood
4. Redefine traditional travel-sector policy/regulatory approaches to be more flexible and adaptive — for example, by facilitating the incorporation of pilot feedback and rapid prototyping over time. This will help account for the speed of change in the sector and allow decision-makers some flexibility when it comes to establishing guiding frameworks
5. Investigate transitional or alternate contract models that allow MaaS to flourish across a range of vendor contracts
6. Reevaluate the role of government leadership in contexts where the public sector may be more impactful and efficient acting in a guiding capacity rather than as a transportation services provider. Government would still have a critical regulatory responsibility, including setting key performance indicators for vendors and monitoring compliance. Indicators must also be set (and met) for residual, publicly provided mobility services and the mobility system as a whole.

In fall 2017, the Association québécoise des transports published a special issue of *AQTr Magazine* that explored MaaS. Our research team published a thought-piece in the feature, as a precursor to this white paper, titled “The Value Proposition of Mobility Services: Opportunities and Challenges for Sustainable Operations.”

1 Introduction

The ways in which mobility is conceptualized, accessed and consumed as a service is rapidly changing. In this white paper we explore the evolution of mobility-as-a-service, or MaaS: how it is redefining our conceptions of vehicular mobility and how we navigate around our cities and fulfil our life's work.

1.1 Basis of research

Many industry bodies and governmental administrations are currently studying MaaS, including the Transportation Research Board, the International Association of Public Transport, Polis, the American Transportation Association, the Canadian Urban Transit Association, Federal Transportation Association (US) and Federal Highway Administration (US).

MaaS has become a popular way to describe the following, sometimes jointly, interchangeably or discretely:

- Travel options that are available at the discretion of the user and avoid locking them into ownership of a mode (e.g., a private vehicle) with its ensuing — and significant — sunk costs and ongoing maintenance, insurance and fuelling expenses
- Interfaces and platforms that provide users with access to specific or a selection of travel options, sometimes with a variety of supplementary data and functionality included (e.g., access to timetables, locational data, congestion information, payment options, travel-time estimates and comparative costings).

In this paper, we refer to the physical aspect of MaaS (the consumable travel) as the *mobility service component* and the media used to select travel as the *mobility platform*. In particular, we discuss how mobility services are contributing to reconceptualization of public transit and the role of transit in supporting urban growth and operations. We also take stock of the documented impacts of these services on cities — both the positive and the negative.

Mobility services are not entirely new; they are evolving and diversifying. Demand-responsive transit has been used in many contexts globally, but there have been few systematic attempts to assess their effectiveness in a comprehensive way.

Part of the challenge has been how to define effectiveness: Passenger numbers? Farebox recovery? Social impact? Or some combination of all of these? [1]. The new wave of innovation in the mobility market creates pressure to set these evaluative thresholds, and in an era of fiscal limitations, these will be shaped in part by financial considerations.

Fundamentally, we set out to better understand the travel market, identify the variables that influence trips undertaken and theorize how MaaS will continue to change how travel demand is satisfied or managed. Using the Greater Toronto and Hamilton Area (GTHA) as a geography of focus, we developed a knowledge blueprint that shows the current state of information regarding the impacts of MaaS, as well as the limitations of this knowledge. Our work is intended to provide the public and private sectors with actionable ways to leverage the best of the MaaS offer while avoiding, remedying or mitigating its less desirable effects.

We are concerned that the evolution of MaaS has thus far been motivated almost exclusively by the digital and information technology sectors, and private sector mobility innovators. For various reasons, governments (especially city governments) and public transit agencies have been reactive, resulting in a MaaS ecosystem that does not necessarily satisfy a broad agenda for our urban environments [2]. More work needs to be done to ensure that the potential social, economic and environmental benefits of MaaS deployment are actually realized for our urban and rural regions.

1.2 Approach

Our research method included a deep dive into the emerging body of literature relating to MaaS, including peer-reviewed academic papers, thought leadership pieces and independent publications. In addition, we screened online media for opinion pieces and press releases regarding MaaS across a broad range of geographies but with particular focus on North America. Finally, we engaged the following 14 senior industry specialists using a semistructured interview format to elicit views relating our to research:

- Four service vendors representing ride-hailing/pooling and one-way and two-way car-share platforms
- Two service platform providers
- Four academics or independent thought leaders recognized across North America for their contribution to the topic: Bruce Schaller of Schaller Consulting, Dr Julia Markovich of the Conference Board of Canada, and Cassie Hall and Creighton Randall of the Shared Use Mobility Center
- Four representatives of transportation services for municipal government or transit agencies in North America, including three involved directly with MaaS pilots (two in the GTHA): the City of Toronto, Metrolinx, Town of Innisfil and Kansas City Area Transportation Authority.

This study is predicated on the researchers' shared belief that the introduction of — and access to — new mobility service types must also preserve and enhance publicly available services. This standard may only be satisfied if services are available to meet the needs of all segments of society at reasonable prices.

Our research sought to define criteria to measure success or failure against this ambition. The role and impacts of MaaS in our urban areas are still largely unknown, and we aim to make a small contribution to dispelling myths and improving appraisals of associated services.

The remainder of this white paper is structured as follows:

- **Section 2 – The MaaS ecosystem:** What are mobility services, and how do they relate to conventional public transit?
- **Section 3 – Dimensions of travel, decision-making and the trip market:** How do people fulfil their life's work and what influences when, where, why and how they travel? We also introduce the GTHA for those who are not familiar with its basic geography, including transit operators and utilization
- **Section 4 – MaaS value propositions:** What value do mobility services offer to different stakeholders in the mobility ecosystem (vendors, consumers, transit agencies and various tiers of government)? What circumstances affect the value proposition?
- **Section 5 – Conceptualizing the impacts of MaaS on trip markets:** What are the conditions under which MaaS is influencing travel behaviour, and how does this vary geographically? We analyse the existing evidence base and several case studies from the GTHA
- **Section 6 – Knowledge blueprint:** Where is our understanding of the impacts of MaaS limited and why? This data map outlines the limits of our current knowledge
- **Section 7 – Policy and planning levers for cities of the future:** How can we deepen regional knowledge, capability and sound execution in the MaaS space?

2 The MaaS ecosystem

There are various interpretations and working definitions of MaaS, including MaaS the following:

… A mobility distribution model that delivers users' transport needs through the single interface of a service provider or via an interface that can integrate various transport modes [3] (the role of subscription may be emphasized within the latter type of model)

… A new way to offer and completely integrate transportation services by leveraging smartphone technology and internet provision, thereby providing service that is flexible, personalized and on-demand

… A single app to access and pay for various transport modes within a city or beyond, enabled by smartphone and ubiquitous internet connectivity [4]

Whatever the definition, MaaS is commonly understood as user-centric, as it is intended to improve the consumer experience in accessing and using mobility services. Digital connectivity between physical objects (the travelling public and the services they use) and virtual data enables this operation [5]. MaaS is also designed to be consumed on-demand and in a manner befitting the particular needs of a user, unlocking them from the convention of mobility ownership (e.g., assets like bicycles, cars and even parking spaces).

We consider MaaS to be both a physical service provision and a medium for accessing this service. Each component of the MaaS duo — the physical service and the digital platform through which service is accessed — has a variety of agents and attributes. The agents include vendors (providers of both service and platform), transit agencies, other government stakeholders and consumers. The attributes include types of services (or functionality) available and the technologies that enable these to be consumed. Altogether, these variables form the **MaaS ecosystem**.

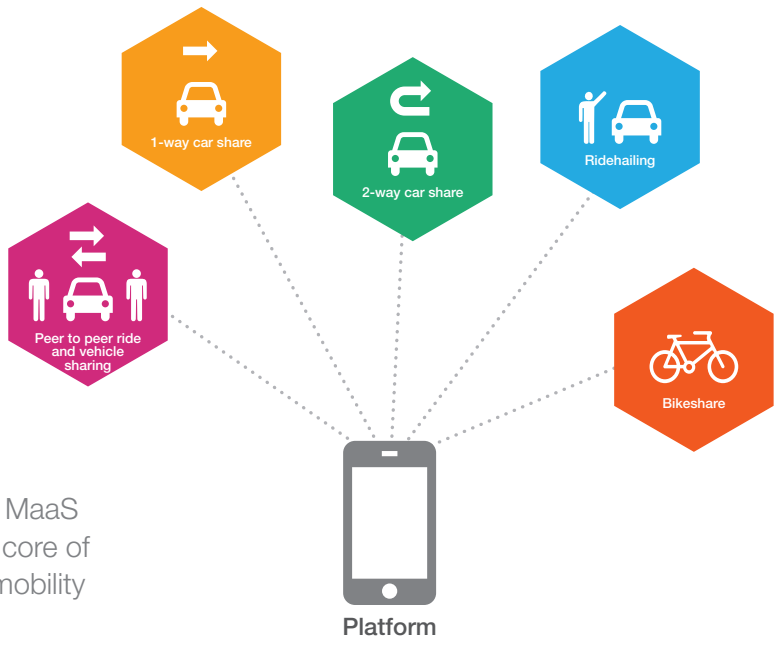
The MaaS ecosystem is dynamic and evolves constantly **(Figure 2.1)**, although some more conventional aspects of this ecosystem have had a long history. Conventional public transit, for example, is a form of mobility service that was available to consumers long before digital platforms such as Whim or Google Coord enabled dynamic trip planning, payment and other features. Taxi cabs have also long provided a higher-priced and door-to-door service for customers, thus satisfying some demands in the trip market.

The MaaS market as we know it currently has ballooned following rapid development of digital telecommunications technology. Digital innovation has spawned more ubiquitous and faster internet access, continually improving processing capacity, system integration and cashless payment services.

The rise of new forms of mobility service that depend on and leverage this technology has contributed to increased political attention. This attention has focused on the impacts these ventures are having on transport systems and infrastructure, their use of data, revenue models and goodness-of-fit within the existing regulatory environment.

Car-sharing schemes have been around for some time (e.g., Zipcar was founded in 2000), but real growth in and diversity of mobility service — the rise of ride-hailing — commenced in 2009 (Uber) and gained momentum in the US and other international markets after 2012, when Lyft entered the market. Many other service vendors have emerged since and vary across geographies.

Figure 2.1
MaaS ecosystem: evolving constantly

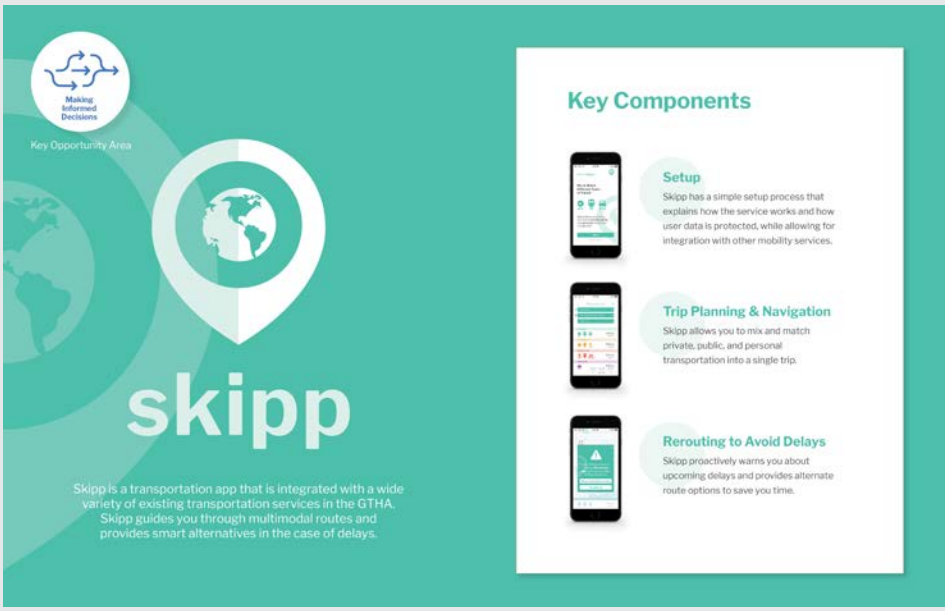


> According to the European MaaS Alliance [6], MaaS puts "users, both travellers and goods, at the core of transport services, offering them tailor-made mobility solutions based on their individual needs."

Enabling dynamic choice in the travel market: Skipp Prototype for the City of Vaughan

In 2017 the service design firm Bridgeable, together with the City of Vaughan and MaRS Discovery District, created a multimodal trip-planning application prototype for York Region in the Province of Ontario. The application was based on intensive field research to identify user needs and feedback on the daily commute experience. Commuting is a key quality-of-life issue for many residents of the GTHA, which experiences some of the most significant vehicular congestion in North America.

The resulting prototype was designed as a trip-planning application for the region. The application was built on a theoretical ecosystem of mobility options and designed to provide users with the tools, framework and information to plan transit around their life, instead of the converse.



The prototype videos can be accessed at www.marsdd.com/systems-change/data-catalyst/news/urban-mobility-ontario-challenges-solutions/.

Service innovation has led to many different choices for consumers, from ride-hailing to one- or two-way car-sharing, microtransit, bicycle sharing, carpooling and variants. Other researchers have conducted comprehensive studies of the ecosystem and its constituency [7–9].

Still, the economic implications of the rise of MaaS and how it has reshaped activity in conventional and overall trip markets are still poorly understood. We anticipate that mobility services and the platforms that enable them have disrupted the consumption of travel and altered people's decisions about how they move around their urban environments and under what circumstances. These are themes we explore throughout this paper. We ask and begin to answer the following pertinent questions:

- Are "last-mile" connectivity options **adding to vehicle use** and/or reducing active travel (e.g., walking), therefore creating additional challenges?
- Are some private-sector-provided services **replacing** trips that would otherwise have been made by conventional public transit?
- Are public transit agencies themselves utilizing digital platforms to **evolve** their service offerings?
- Are the public and private sectors working together to deliver effectively deliver **value** to consumers?

Bearing these points in mind, in this white paper we are concerned primarily with the following:

1. The promise of digital platforms and the extent to which they facilitate improved travel choices for customers
2. The measurable and hypothetical impacts of physical services on urban environments and the mobility market.

Such an assessment must reflect an understanding of how travel decisions are made. Additionally, we need to define more clearly the basis of the trip market that is being affected by the evolution of MaaS. We cover these points in **Sections 3 and 4.**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BIG Market Place: More than 200 arts, crafts, and information tables!
Card-Yard: Recycled materials animated by architecture, art and poetry!
Celebrate Here: Main Stage performance!
Joy/JOUEZ: Programs of play and pleasure! For all.
PlayFair: Games for children and adults!
Savour Bloor: In the stores, restaurants, patios, and the Bloordale Food Court!
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3 Dimensions of travel, decision-making and the trip market

3.1 Overview of trip making and travel choice

Travel behaviour and related decision-making are well covered in the literature and are complex fields of study. There remains considerable debate regarding the degree and directionality of influence of many variables on personal travel, from built environment characteristics to socioeconomics and sociodemographics [10–11].

Individual-level travel behaviour aggregates to other geographic scales, leading to the temporal, spatial and mode-based flows seen around our urban environments. The evolution of MaaS adds additional complexity to these equations.

Our study is most interested in how and under what circumstances MaaS influences travel choices. It is therefore important to identify how MaaS affects the **convenience, cost** and **time** required to conduct trips and, in turn, how this leads to **new** or **reassigned** trips (alternative trip routes, times and/or mode choices) compared to business as usual.

We recognize comfort to be an issue too but are concerned with the three primary variables as specified in our work. We focus on general trends including how the influences of MaaS (and its associated value propositions) vary between different trip purposes, locations in the urban environment and different sociodemographic and socioeconomic groups. In turn, we are concerned with the impacts of MaaS on the overall trip market, which comprises all the trips undertaken in any given area of study across a temporal unit of interest.

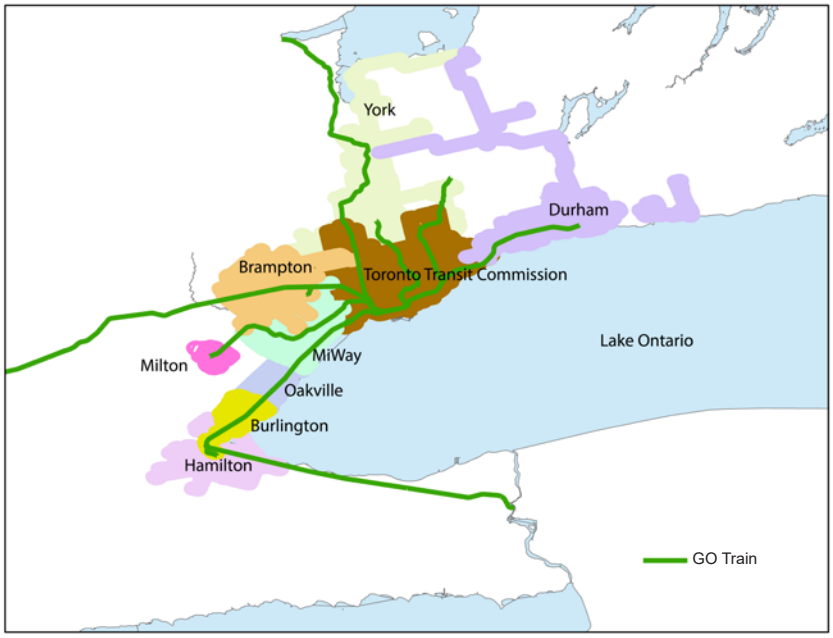
3.2 Our study area and its characteristics

Our unit of interest is the GTHA for an average weekday. The GTHA comprises of 30 separate municipalities, with the city of Toronto being the most significant (but not only) economic anchor of the region with a population of about 2.8 million.

Large urban regions like the GTHA have been very successful in providing increasingly attractive opportunities for people to live, work and grow, contributing to increasing gross densities of jobs and population. The region is forecast to grow in population from 7.2 million today to about 10 million residents by 2041. The GTHA includes all manner of land use, from activity-intense urban areas to rural/undeveloped regions. These density gradients are anticipated to remain in the long term, despite overall growth and densification.

There are 10 autonomous transit agencies in the region including one provincial agency, Metrolinx (**see Figure 3.1**). The area is served by a regional transit service (GO Transit, operated by Metrolinx).

Figure 3.1
Autonomously operating transit agencies in the GTHA



The value proposition of public transit needs to be marketed clearly to the consumer. This poster, attached to a bus shelter in an Australian city, appears to do the opposite.

In the city of Toronto, the Toronto Transit Commission (TTC) operates municipal transit services, including the existing three subway lines (four, if the eastern surface rapid-transit line is counted). About 12% of residents in the GTHA live within a five-minute walk of existing rapid transit lines. Approximately 23.3% of the city of Toronto population commutes via public transit, and in Hamilton, 9.3% [12].

The fragmentation of service provision presents challenges for integrating transit across the region; this is manifest in the lack of full fare integration and relatively recent introduction of a smartcard payment system (PRESTO). For the last four decades, there has been chronic underinvestment in public transit infrastructure, so the region's agencies are now playing catch-up.

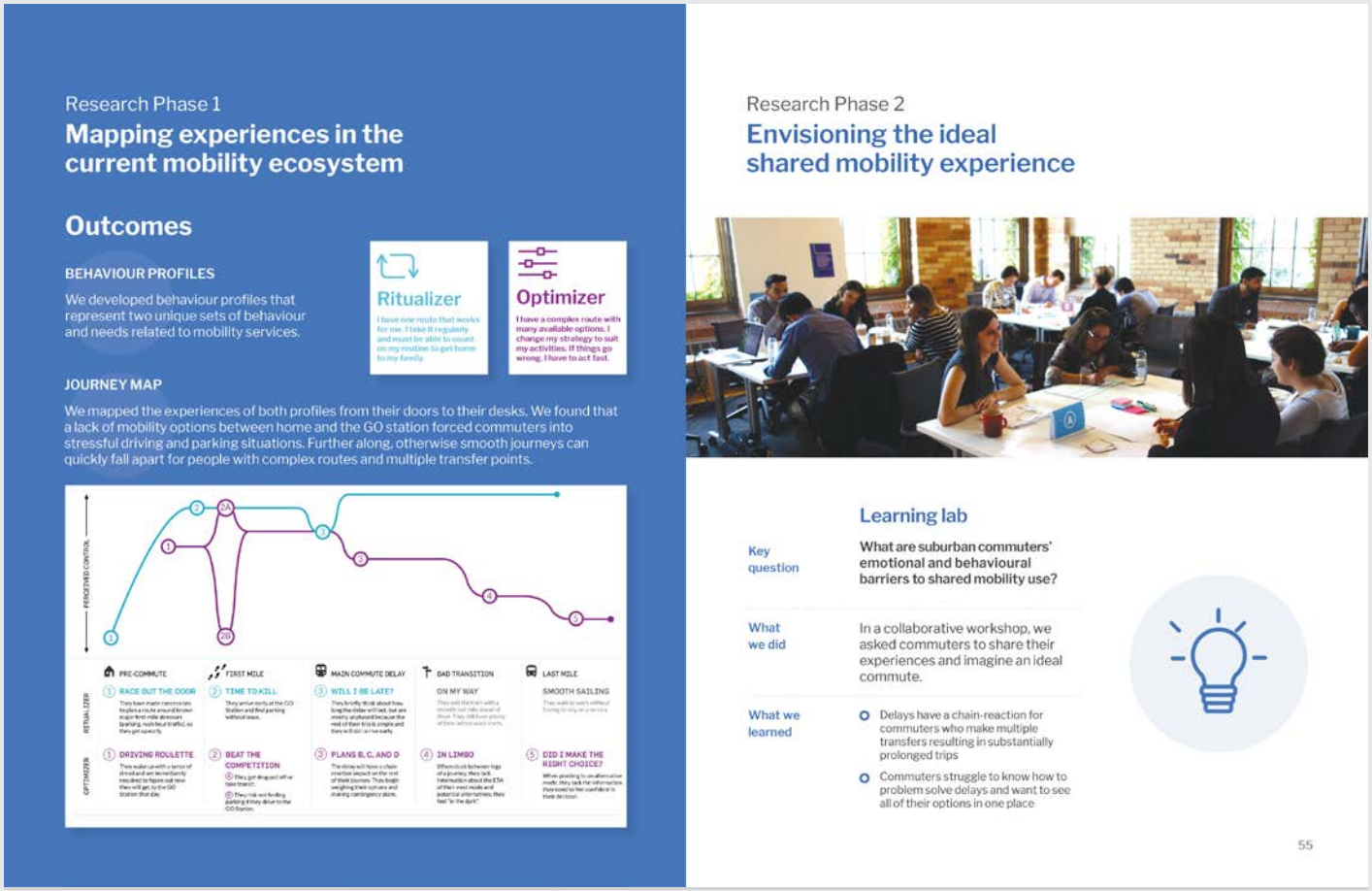
In particular, Metrolinx is partway through implementation of The Big Move, its regional plan, which was updated in 2017. A number of light-rail and bus-rapid-transit projects are in various stages of feasibility planning and design, and additional subway extension projects are being contemplated, include the Relief Line, Scarborough extension and Yonge North. Planning and design is underway for Regional Express Rail (RER), which will introduce 15-minute, two-way, all-day service on the GO rail network.

Given a combination of historical underinvestment in transit, urban growth pressures and governance model, the public sector faces challenges to address competing priorities:

- New transit capacity requirements (such as the Downtown Relief Line)
- New transit alignments, especially circumferential rapid transit (such as Eglinton Crosstown light-rail transit)
- Transit capacity to help structure and focus future urban growth (such as the Kitchener-Waterloo ION light-rail transit)
- Improved transit services in underserved and lower patronage areas to address social equity challenges (such as improved transit station access and suburban services).

Additionally, there have been several MaaS service and/or related enterprise initiatives in the GTHA over the last few years, including the widespread use of ride-hailing through Uber and the 2017 entry of Lyft, five years after Uber's initial entry into the market. Enterprise Carshare and Zipcar are long-standing providers of two-way car-sharing services while Car2Go provides one-way services.

Microtransit services include UberHOP (ride-sharing, running since late 2015), Line Six Transit (a privately run shuttle bus that ran from 2014 to late 2015 in Liberty Village), and RideCo (a 2015, one-year pilot that ran in Milton). Mobility service platforms include Citymapper and Transit App, and Finland's Whim is looking to enter the market.



Real-life laboratory

Bridgeable's study into consumer travel choice in the city of Vaughan

The large majority (from 80 to 90%) of personal transportation in the GTHA still occurs via single-occupancy vehicle. This mode use has significant implications for congestion, infrastructure, environment and overall quality of life for GHTA residents.

Transportation is now the largest and fastest-growing source of emissions in urban regions like the GTHA, and Ontarians are facing an average of 50% longer commutes due to congestion. North of Toronto, Highway 401 is the most congested freeway in Canada and challenges sections of highways in New York and Los Angeles for cause of delays [13].

Despite transportation investment and some growth of MaaS and MaaS-like opportunities, "mobility" in the GTHA is currently characterized by chronic congestion and acute pinch points, and these problems seem likely to get worse before they get better. This regional context is critical to consider in the deployment of any mobility solution.

In the next section we define the value propositions associated with MaaS from the perspectives of consumers, vendors, transit agencies and government. Some of these value propositions relate to amelioration of some of the ills associated with single-occupancy vehicle trips conducted using privately owned vehicles, which is a policy imperative for government in the GTHA.

We identify the types of trips and circumstances under which MaaS is contributing to new or reassigned trips — our focus shifts from theory to application. We support our analysis with evidence from the literature and the perspectives of our expert interviewees.


UGG
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CAR SHARE ONLY

4 MaaS value propositions

We are concerned with the value proposition of MaaS from the perspectives of consumers, vendors, transit agencies and government (our four key agents). Other researchers have argued that MaaS enables:

- A seamless and efficient flow of information, goods and people — both locally and over longer distances
- Globally scalable door-to-door mobility without the need for private car ownership
- A better level of service than private car
- An open ecosystem for information and services in intelligent transportation [14].

By theory and implication, MaaS may introduce more flexibility and inclusivity (convenience), affordability (cost) and connectivity (time) into our movement systems [2]. The shared use of MaaS may also pose significant environmental benefit if it displaces travel via single-occupancy vehicle.

However, these virtuous outcomes are not necessarily universal and the real-world impact of MaaS remains poorly understood [15]. Furthermore, research must distinguish the following:

- **Stated value and actual value:** As any agent in the ecosystem, am I receiving the benefits that I expect from MaaS?
- **Reassigned value:** Do I have to trade off benefits like convenience for cost and/or do benefits or me negatively impact others (e.g., through changed service coverage)?
- **Circumstantial value:** Under what conditions is value realized? Does it depend on the purpose of the trip I am undertaking, when I am taking it and to where? Would a similar trip taken elsewhere within the urban area generate less or more value? Do I need to make the trip at all?

We hypothesize value to be conceptualized differently by each agent in the marketplace (vendors being private-sector MaaS service providers) and for there to be some overlap in these interests (**Figure 4.1** gives some examples of value). We intended for our research to identify the contexts in which overlap does and does not occur.

We asked our 14 expert interviewees to define the general value propositions associated with MaaS for each agent group they represented. Summary responses are provided in **Box 4.1.** The interviews were conducted in mid-2017, and the full interview schedule is included in **Appendix A**, along with detailed results from the engagement. We included specific responses in the next section where we conceptualize the *impacts* of MaaS on the trip market.

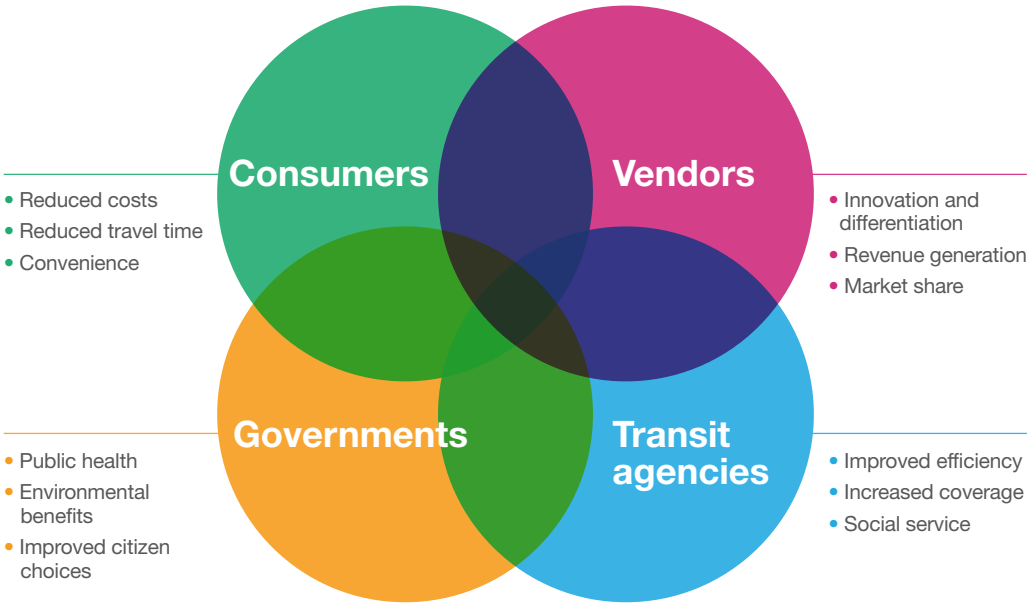


Figure 4.1
Conceptualizing the value of MaaS for each agent

Box 4.1
Potential value propositions of MaaS

Agent	Value proposition of MaaS
Vendors	• Provides means of entry into the transportation service market (economic opportunity) • Decentralizes responsibility for services and improves means to target particular customers/trip market segments • Offers greater opportunity for innovation in mobility provision
Consumers	• Offers more travel choice tailored to specific needs of the user • Provides cost savings and enables pay-for-use, as users no longer need to own a car or pay for parking or other incidental costs like fuel and insurance • Promotes convenience through ease of access to and payment for mobility • Offers flexibility, especially regarding route choice, time of travel and whether or not users want to share rides • Particularly attractive in dense urban areas with a multiplicity of mobility options; furthermore, users can worry less about congestion and parking
Transit agency	• Addresses gaps in the conventional transit network, especially first-last mile connections to suburban stations and suburban-to-suburban routes • Improves off-peak transport options when conventional transit is not viable • Replaces conventional routes with low patronage that operate at significant subsidy • Provides needed redundancy and added reliability into the system; this is particularly relevant in cases of extreme weather and other extraordinary events • Drives innovations in the travel market, which can have positive spin-offs for the agency (such as new partnership models; improved booking, payment and information tools; and beneficial data-sharing agreements)
Government	• Provides possible reductions in personal vehicle ownership among residents, with positive impacts on environment and congestion • Improves urban connectivity by providing solutions to first-last mile and suburban-to-suburban travel problems • Improves social equity as various sociodemographic groups may have better access to applicable travel choices and the city services they require • Reduces demand on scarce urban property for parking with positive outcomes for built form, amenity, etc.

Partnerships can take a number of forms, including bus replacement arrangements (Altamonta Springs, Arlington), shared-service access platforms (Citymapper) and hardware support (access to Twin Cities Metro Transit's smartcard), and inducements (Montreal STM discounts for bike- and car-sharing). Much of the industry analysis proposes that ride-hailing services are largely a complement to rather than substitute for transit.

Our research found the greatest *potential* for realized value associated with the trip types (or segments of the trip market) shown in **Box 4.2**. In particular, many of the mobility partnerships between transit agencies (or municipalities) and service vendors that have been trialled or operate today in North America were formed to improve mobility choices within low-density environments — especially for trips to and from rail stations.

The reason is *perceived joint value*: agencies are able to offer consumers better services than they could otherwise and at lower subsidy per rider. Vendors benefit from the subsidy provided, the marketing support and endorsement of the public sector, and all things being equal, a bigger slice of the trip market.

It is this promise of joint value — a theme raised repeatedly by expert interviewees — that transit agencies are looking to seize upon by signing service agreements with vendors like Uber and Lyft [16]. The transit–vendor partnership model has become a key aspect of Lyft branding [17]. Other vendors have marketed their role differently in the trip market, with some criticism of the focus on singular rather than joint value [18].

There are additional promises of value for the public sector. Broadly, alternatives to private car ownership such as ride-hailing and car-share schemes may reduce private car ownership and demand for parking spaces. In some cases, they may also address unmet travel demand, especially among lower income earners and disadvantaged groups residing in car-dependent locations who cannot afford to own and operate vehicles of their own.

Mobility partnerships may therefore work to address a range of social and urban policy objectives through provision of services such as bicycle sharing, one- and two-way car-sharing, fixed or dynamic microtransit and/or pooled or exclusive ride-hailing. In the GTHA, one or more applications of service may provide solutions to the use cases in **Box 4.2**; however, this requires further exploration through dedicated pilots and prototyping deployments.

▶

Box 4.2
Trip types/segments of the trip market with greatest potential for realized value

Trip Types		MaaS service solutions
First-last mile connections	Facilitating trips between residences and transit stations in suburban areas is a common concern for transit agencies in North America, and those operating in the GTHA are no exception. Low development densities around stations lead to relatively low levels of conventional feeder (usually bus-based) transit service and dependence on park-and-ride and kiss-and-ride for station access. Park-and-rides consume land and add capital and operational costs to the transit system. Traditionally, taxis have operated at a price point that exceeds most consumers' willingness or ability to pay.	Ride-sharing, ride-hailing and microtransit
Suburban-to-suburban trips	Trips between low-density locations or low-density origins and suburban centres are difficult for traditional transit to service effectively. Short operating hours, circuitous routes and long headways contribute to dependence on driving, with the result that those without cars are negatively affected by low levels of access and personal mobility. Again, taxis have tended to operate at a price point that exceeds most consumers' willingness or ability to pay. In the GTHA, providing alternatives to the suburban-to-suburban single-occupancy-vehicle commute offers one of the single largest opportunities to effect positive environmental impacts in this sector.	Ride-sharing, ride-hailing and microtransit
Airport trips	Airports are located typically well outside downtowns and therefore do not always have access to significant transit hubs. Many air passengers have to transfer multiple times to access the airport using traditional transit services. Taxis have often been the default and only realistic mode choice for many consumers to access the airport. Alternatively, consumers may drive to the airport and park their vehicles in car parks provided or arrange personal drop-offs. The vehicular congestion that can manifest itself is compounded by employee commute trips. In the GTHA, the Pearson Airport Employment Zone is one of the densest employment areas in the country and is significantly underserved by higher order transit.	Ride-sharing, ride-hailing and microtransit
Hospitality and events trips	If a consumer is socializing and wishes to drink alcohol, and/or is undertaking extraordinary travel for a special event like a concert or sports game, they may want or be compelled to avoid driving or riding a bicycle. They may also be less willing or able to use conventional transit. Until recently, traditional taxis may have been the only reasonable mode choice.	Ride-sharing, ride-hailing and microtransit
Off-peak trips/ shift workers	Trips outside peak periods — especially later in the evening, overnight, very early or on weekends — must be conducted when there is lower (if any) availability of conventional transit services, limiting mode choice in many cases to driving or traditional taxis. These trips are often centred on low-density industry or manufacturing zones, which further compounds the availability of options.	Ride-sharing, ride-hailing and microtransit
Downtown trips	There can be many conventional mode choices for trips originating in or conducted around a downtown environment. Nevertheless, the availability of MaaS service options can encourage residents of downtowns to avoid car ownership and even ownership of personal bicycles, and can act as a substitute for walking and conventional transit trips.	Ride-sharing, ride-hailing, microtransit, car-sharing (one- and two-way), bicycle-sharing
Health care/ health service delivery	Traditional delivery of health care services can be costly and does not always well serve the needs of the mobility impaired, particularly if multiple jurisdictions having different agency and mandates are involved in the delivery of the trip. Health care service providers are actively seeking opportunities to facilitate and optimize the delivery of mobility for their clients, in a manner that maintains (or enhances) the level of community connection and care already being provided.	Ride-sharing, ride-hailing and microtransit

In practice, we expect that value manifests differently depending on characteristics of the urban environment and the consumers undertaking travel, namely:

- **The nature of the urban space: Is travel occurring in small, medium or larger urban areas?** This can be determined or interpolated by the population and overall mobility catchment area of the geography in question
- **Where in urban areas trip does demand arise?** E.g., suburbs versus the downtown, inter-urban, other. The nature of this demand will also be influenced by the general density of various locales within a region, the type and volume of trips taken (i.e., mobility use case), as well as the infrastructure in place to enable travel
- **Who is conducting the trip?** What are their sociodemographic and socioeconomic circumstances and mobility needs? This will be determined in part by population and related economic and employment indicators, and influenced by the existing transit networks and mobility options in a particular region.

Value also manifests differently depending on the perspective of the agent (**Box 4.3**).

Section 5 discusses the impacts of MaaS, citing published evidence and expert opinion. In particular, we examine conditions affecting *the realization of value* for different agents, focusing on the trip types we have identified (**Box 4.2**). We also assess value trade-offs between agents depending on the nature of trip demands being fulfilled, which helps to focus policy and planning needs and recommendations.

▼

Box 4.3
Characteristics that affect the value proposition of MaaS

Agent	Characteristics that affect the value proposition of MaaS
Vendors	• Regional receptivity to innovation/service • Type of regulatory context in place • Customer willingness to pay or price point (expected profit margin will be a driver) • Current extent and quality of mobility services in place
Consumers	• Cost and speed of MaaS service offer (affordability of change in service compared to benefits offered) • Flexibility and convenience of offer • Regional and/or specialized coverage • Specialized or unique service
Transit agency	• Cost of MaaS service compared to business-as-usual alternative • User uptake and original mode displaced • Effect on existing assets and services • Result on transit ridership and/or vehicle kilometres travelled • User experience • Integration experience
Government	• Result on transit ridership and/or vehicle kilometres travelled • User experience • Impact on existing infrastructure • Broader impacts on the quality and operation of the urban environment • Citizen access to service, including ability to pay

5 Conceptualizing the impacts of MaaS on trip markets

5.1 Observed value of MaaS and basis for trade-offs

In **Sections 3** and **4** we proposed that the underlying value proposition of mobility services to consumers is reduced travel time, reduced cost, added convenience or some combination of the three. We also referred to particular segments of the trip market that may be relatively ripe for mobility-service uptake because consumers are more likely to realize value. These include, but are not limited to, first-last mile and off-peak trips. Consumer value, in turn, can create a value proposition for vendors and for governments, offering the opportunity to meet social mandates and fulfil public travel demands in more efficient ways.

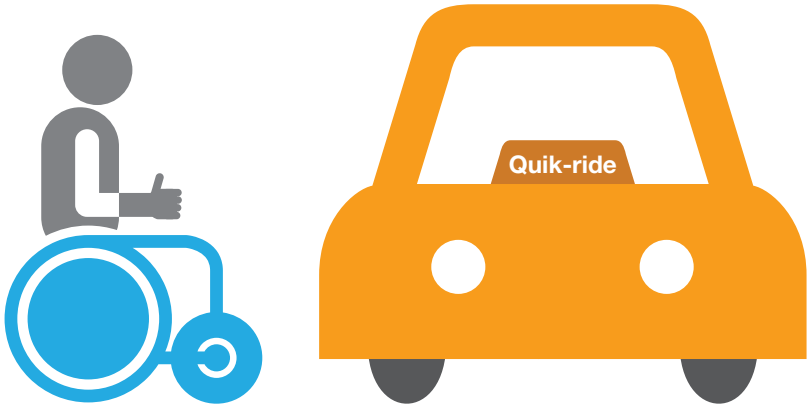
In the introduction to our paper, we set a virtuous target for our mobility ecosystems: the preservation and enhancement of publicly available services, and for these to be available to serve the needs of all segments of society at reasonable prices. The private sector can add mobility choices to the market — sometimes in partnership with the public — to help this target be attained; however, a net result that includes increased inequities or deprivation should not be accepted as a product of progress.

Our research reveals evidence of a series of observed impacts — some beneficial and others problematic — on different trip markets associated with deployment of mobility services. These impacts are associated largely with the hypothesized value propositions (**Section 4**); however, there are significant trade-offs and, in some cases, benefit for some agents to the detriment of others. These conflict with the virtuous target we have established.

As we have argued consistently, impacts depend significantly on contextual factors, including the nature of service offered and how mobility services are regulated. It is therefore of no surprise that the small evidence base that exists today regarding the impacts of MaaS must be interpreted with caution.

Any discussion of impacts starts with a consideration of who is consuming mobility services. Despite the presumed broad appeal of MaaS, most mobility service customers are urban, relatively young and generally affluent [19–20]. Our expert interviewees pointed to a growing socioeconomic and sociodemographic market for mobility services, but such services have to evolve to present new users with a stronger value proposition.

For example, uberASSIST is an evolved and diversified ride-hailing service to meet the needs of mobility-impaired customers. It features industry-trained drivers equipped with vehicles to accommodate scooters, walkers and folding wheelchairs.



> There was consensus among our interviewees that MaaS is for everyone; however, the greatest uptake so far has been among younger urban dwellers. Growth opportunities for MaaS include the former urban dweller, the senior segment and those wishing to change to a car-free lifestyle. More work and planning need to completed to understand whether MaaS deployment will also realize benefits for less-dense areas as well as other population segments, and if it does, what the value trade-offs will be.

Mobility service uptake has been found to lead to some of the broader and socially valuable outcomes sought by governments. For example, one study of car2go members found that access to the car-sharing programme allowed some customers to dispose of their private vehicles or suppressed their acquisition. Each car2go vehicle removed between 7 and 11 private vehicles from circulation and reduced household vehicle kilometres travelled (VKT) among subscribers [19].

"Slower, less reliable bus service leads to more dissatisfied passengers, who may also turn to ride sharing. Meanwhile, the gap between a bus line's expense and revenue would grow, making service less affordable" [24].

Another recent study of car-sharing services in the San Francisco Bay Area showed that urban dwellers using car-share programmes own fewer cars than those who do not; although this observation did not extend to similar suburban populations. Significantly, only about 2% of the population and 3% of households identify as car-share members, a small slice of the travel market [20].

Other research has found that substitution of MaaS for conventional public transit occurs and herein is the root of a headache for governments: can mobility services undermine transit, and under certain circumstances, do they actually add to aggregate VKT? If the answers are yes, then without careful planning, partnerships with vendors to improve mobility services in some contexts (e.g., first-last mile) may have unintended consequences for transit and transport policy.

Some North American research shows that most trips conducted by shared vehicles would probably have occurred by car anyway [19]. Other research shows that a significant percentage of ride-hailing trips would otherwise have been by active or public transport, or not occurred at all [21–23].

Research conducted in New York demonstrates that over the last two years, ride-hailing vendors have started attracting riders from transit, walking and cycling, increasing VKT and adding to congestion. In daily trips to and from Manhattan, the absolute number of hailed trips serving this demand and overall urban VKT have all increased, while transit trips have declined [24]. This research accords with findings for a broader sample of urban areas in the US [22].

The Southeastern Pennsylvania Transportation Authority (SEPTA) has reported steep reductions in transit patronage since ride-hailing became available. Although there is no evidence of direct causation, the price point and increasing convenience of services such as Uber has led to mode substitution [25]. Similar issues have been observed in Boston [23].

In the Pennsylvanian case, Uber has implemented policies — like financial incentives to drivers — to improve coverage outside of denser urban areas, which has reduced transit's relative appeal within SEPTA's area of administration. Uber argues that these policies provide improved service to consumers, but they also draw patronage from existing transit.

In busy urban places such as New York City, even small changes in VKT and vehicle density can have profound impacts on operations [24]. Deadheading (no passenger) kilometres associated with ride-hailing services may range between 20 and 50% [22]. The impact of ride-hailing-related VKT has contributed to legal cases in cities including San Francisco, which are questioning governments' and consumers' shares of the value proposition [26].

Research conducted in 2015 in the GTHA found varying impacts on transit usage as a product of Uber service availability (until 2017, Uber was the only ride-hailing company operating in this geography). The researchers concluded that Uber is more likely to substitute for transit in smaller cities and cities with bus-based transit systems, and a complement in larger cities and those with stronger rail-based networks [27].

However, the TTC's Ridership Growth Strategy, released in December 2017, features some concerning numbers and observations relating to transit agency ridership [28]. Although the TTC has measured a significant increase in ridership satisfaction due to significant investment in service improvements and enjoyed ridership growth overall, since 2014 adult ridership has declined by 4%, or 16 million rides a year.

According to the TTC, this finding is mirrored in other regions that are most comparable to the TTC (eight large-scale multimodal transit agencies in the US and Canada). These areas show patronage reduction (unweighted average) of 2%.

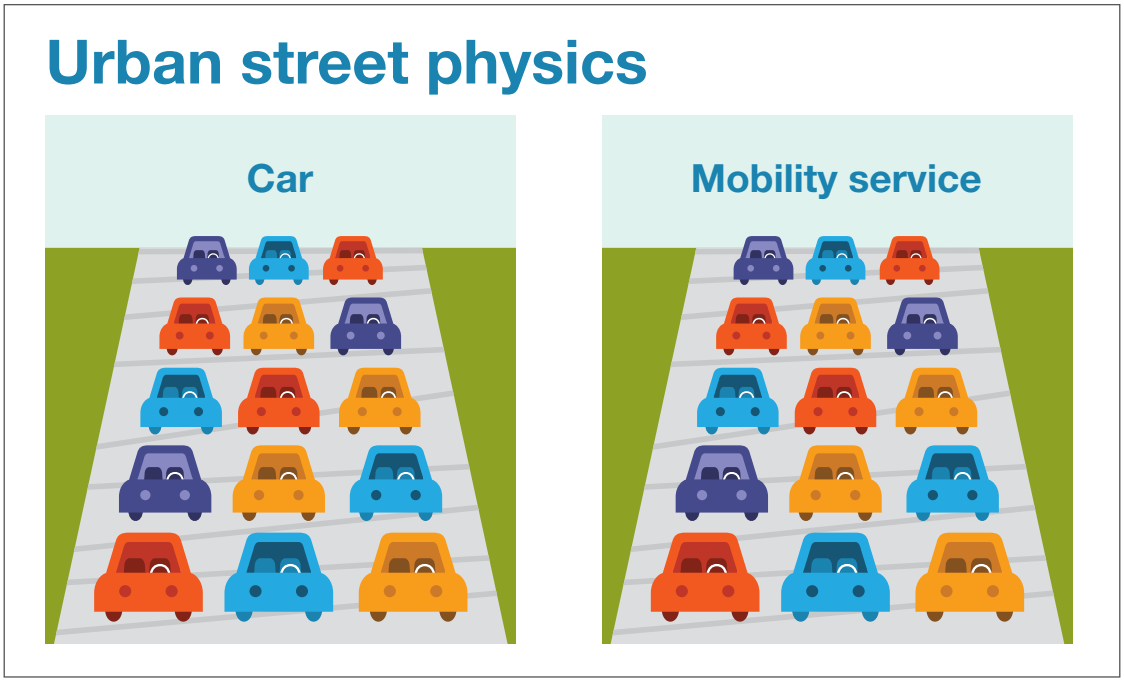
Although the Toronto Census Metropolitan Area also shows a slowing of employment growth rates, which seems to be mirrored in TTC ridership (at least when it comes to adult ridership decline), the TTC's study places emphasis on the impact of digital ride-hailing on ridership and states explicitly: "the rise of digital ride-hailing has a direct negative effect on intra-city transit" [28].

The transit ridership decline is being measured in some US cities but not others. Some research links the decline to the proliferation of mobility services, citing more recent (post-2015) data that correlate increased TNC rides with declining use of transit services [24]. Other research concludes that more evidence is needed and that geographic variables affect the relationship between TNC availability and transit usage [29].

Critically, our research demonstrates that there is no existing means to limit value creation for one group of agents when it becomes a liability for another group. In part, this is because the motivations for participating in the market differ from group to group. Furthermore, a model or best-practice operating framework has not yet emerged for this immature market.

We see the primary trade-offs occurring between consumers, vendors and transit agencies across trip market segments that the public sector has struggled to serve using conventional transit services. These segments simultaneously present some of the greatest opportunities and greatest risks.

"As on-demand mobility continues falling in price while increasing coverage, transit agencies risk being hollowed out by their would-be partners" [30].



Moreover, vendors do not necessarily limit their service offerings to market segments offering the best potential value for government and transit agencies. The evidence presented earlier shows that mobility services can compete with conventional public transit, which is not consistent with preferred public policy. The following are a few examples:

- UberHop, a Toronto-based service, offered professionals a semi-demand-responsive service at a premium to TTC-operated transit, but with a seat guaranteed [31]
- Lyft has introduced a shuttle service in San Francisco that serves select and peak-hour downtown routes. The service is claimed to outperform conventional Lyft and Lyft Line services at being "cleaner, faster and more pleasant than taking public transportation" [32]
- In early 2018, Lyft introduced a promotion during regularly planned closures of the Line 1 subway in Toronto, matching TTC fares ($3.25 for any trip up to $10 in value, with longer trips subject to a $6.75 discount), for up to 10 trips.

Overall, our research identified a series of significant impacts of MaaS, albeit using a relatively small number of trips fulfilled by mobility services in the context of all trips in the defined trip market. Some of these impacts can be positive or negative, and others are trade-offs, depending on context and the type of mobility service being evaluated (**Box 5.1**).

There are challenges to achieving virtuous outcomes, and in part, the solution lies in regulation (see **Section 7**). Mobility services and their impacts also require a great deal more study. Academic enquiry should seek to do the following:

- Improve our knowledge map of the ecosystem and provide support to third parties — including transportation planners and researchers — who want to access and analyse the data generated to improve our understanding of how, when and why MaaS is utilized (see **Figure 5.1** for an example application)
- More clearly establish differences in the nature and scale of impacts depending on urban context
- Refine policy and regulation in accordance with these contextual qualities.

Box 5.1
Evidence-based impacts of MaaS in North American trip markets

Discrete impacts observed	
Reduced car ownership	Stronger observed association with car-sharing compared to other mobility services
Reduced private vehicle use	Stronger observed association with car-sharing compared to other mobility services
Increased urban congestion	Stronger observed association with ride-hailing compared to other mobility services
Increased VKT	Stronger observed association with ride-hailing compared to other mobility services

Contrasting impacts observed		
Transit ridership impacts		
Complementary relationship with public transit		**Competitive relationship with public transit**
Stronger observed association with ride-hailing compared to other mobility services		Stronger observed association with ride-hailing compared to other mobility services
Consumer impacts		
Net consumer cost, time and/or convenience benefits (e.g., paying less overall while enjoying improved travel)	Consumer cost, time and/or convenience trade-offs (e.g., paying more for increased convenience or reduced travel time)	Net consumer cost, time and/or convenience costs (e.g., losing access to cheaper bus services following replacement with mobility services, which are more expensive [sometimes prohibitively so] to use regularly)

5.2 Demonstrating value in the Greater Toronto and Hamilton Area

Realized value associated with MaaS remains poorly understood, and this is true in the context of the GTHA. The public sector is acting to improve its understanding, in part through piloting mobility partnerships. The research sector is also contributing through deepening consumer engagement.

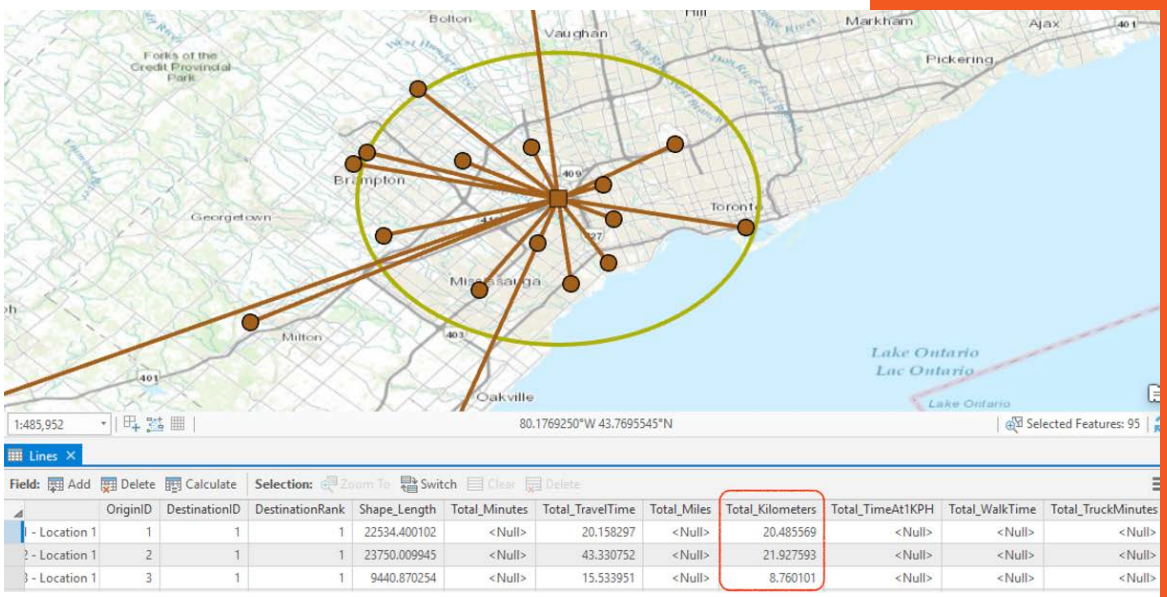
We researched three case studies of MaaS pilots in the GTHA, presented in **Box 5.2.** One is a now-complete mobility partnership operated in the town of Milton, which aimed to improve first-last mile connectivity. The second is an ongoing partnership between the town of Innisfil and Uber to supply pseudo-transit to members of the community, addressing a lack of conventional transit service owing to Innisfil's location and size. The third is a mobility service prototyping project run over summer 2017 in the city of Vaughan.

Collectively, the case studies reinforce the value proposition of mobility services — especially for consumers. In addition, the Innisfil pilot demonstrates the benefits of public-private partnerships to serve trip market segments that have been historically difficult for conventional transit services to address. Specifically, the Milton pilot represents a mix of missed opportunity and learning experience for all agents.

There is evident value to policymakers and regulators being involved directly with deployment of MaaS to test and evaluate impacts on the ground, and to allow for shaping of such projects to best inform future policy. Government must learn to be more nimble.

"[We] would like to see policy drafted that allows us to be comfortable with failure, but also fund things that may not succeed. It's a hard nut to crack. This experience has proven to us there are times that you have to leap… to be trailblazer, one has to be ready for failures and modifications that would be needed…"

Town of Innisfil, Ontario



	OriginID	DestinationID	DestinationRank	Shape_Length	Total_Minutes	Total_TravelTime	Total_Miles	Total_Kilometers	Total_TimeAt1KPH	Total_WalkTime	Total_TruckMinutes
- Location 1	1	1	1	22534.400102	<Null>	20.158297	<Null>	20.485569	<Null>	<Null>	<Null>
- Location 1	2	1	1	23750.009945	<Null>	43.330752	<Null>	21.927593	<Null>	<Null>	<Null>
- Location 1	3	1	1	9440.870254	<Null>	15.533951	<Null>	8.760101	<Null>	<Null>	<Null>

Figure 5.1
Example of MaRS Data Catalyst route analysis estimating total VKT by single-occupancy vehicle for a major employment zone. This tool identifies alternate MaaS options to enable mode shift.

GO Connect [33–35]

From May 2015 to March 2016, the GO Connect mobility pilot was run in the town of Milton as a weekday peak hour service facilitated by Metrolinx, the Town of Milton, a local taxi company and an app provider, RideCo. The project and app-based demand-responsive ride-sharing service were conceived as a pilot to test ways to improve consumer access to GO stations. Its specific objectives were as follows:

- Increasing (proxy) transit service routing efficiency and providing AM service to GO stations as an enhanced alternative to the existing (municipality-operated) shuttle bus service
- Improving the cost effectiveness of connecting riders with GO rail services, owing especially to challenges of irregular GO departure times
- Cost-neutrality to the Town of Milton and minimal administrative support requirements (Metrolinx agreed to pay any costs over and above the baseline shuttle bus service)
- Growing transit ridership
- Remedying or mitigating demand on park-and-ride
- Using real data to support future route design, planning and service delivery applications including expansion to outlying and industrial (low density) areas.

The former GO Connect service operated across three zones and via one of three routes selected manually by the driver based on passenger boardings. It served about 110 customers per weekday evening. The new service featured the following:

- 8-metre shuttle buses
- Consumer registration and booking via a web portal or app
- Door-to-station or local hub-to-station model of service depending on price paid by the consumer ($1.95 versus $1.40)
- App-based trip notifications and SMS support for consumers without smartphones
- Call centre support provided by the Town of Milton
- Customer service monitored via rating system built into software
- Pickup options based on 15-minute headways
- Allowance for accessibility requirements to be specified, with trip timing adjusted accordingly.

The potential trip market was gauged by surveying existing GO customers who drove to the station and user habits of the pre-existing GO Connect service. Marketing was handled by Metrolinx via intercept discussions at GO stations and print media.

The partnership set the following performance monitoring criteria:

- On-time performance
- Trips completed
- Average trip times
- Customer service
- Financial information, including monthly costs, vehicle hours, passenger trips and fares collected.

Target performance outcomes were as follows:

- 125 daily regular customers
- 250 daily total customers
- 31% net cost reduction per ride compared to the pre-existing GO Connect service.

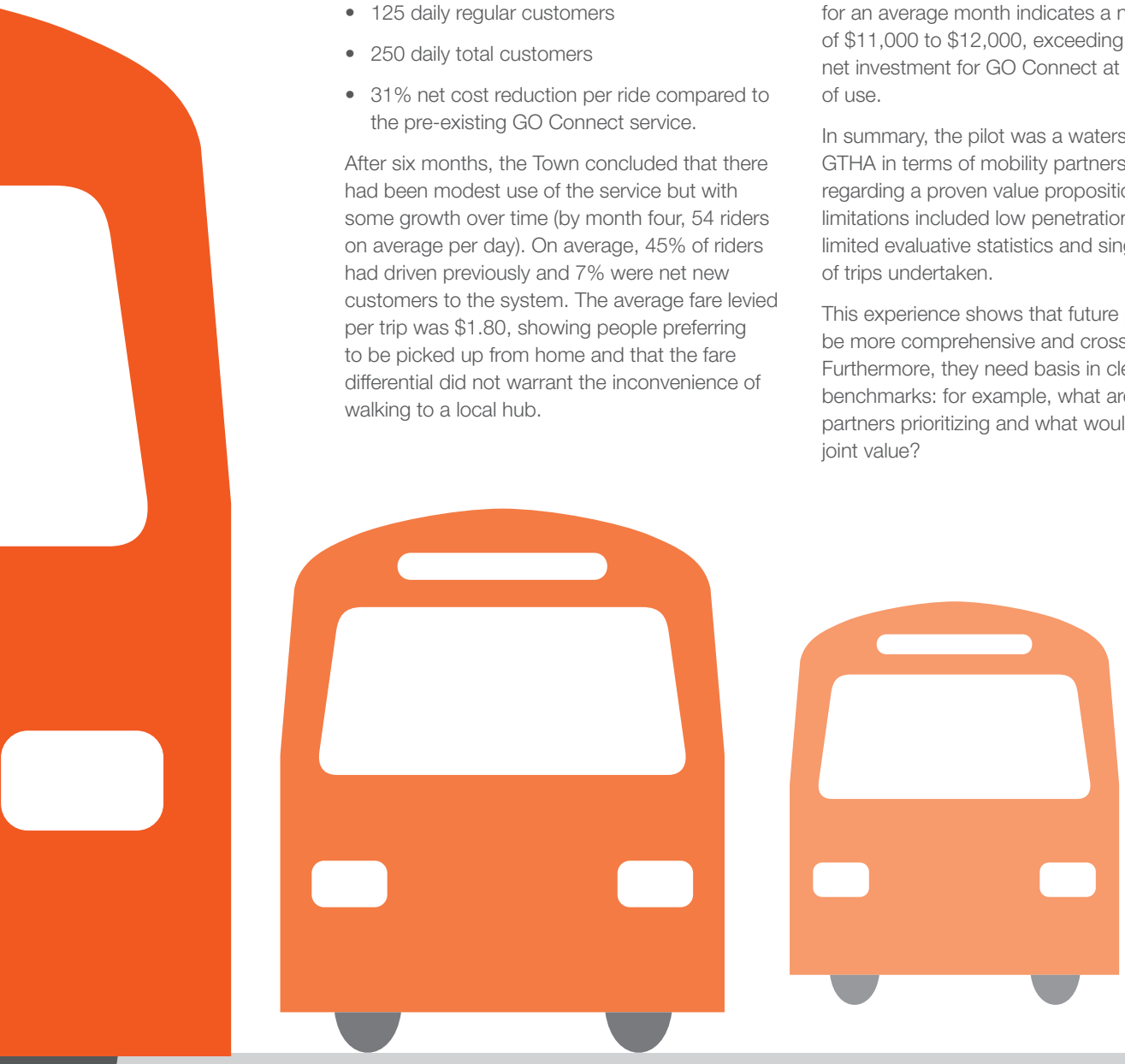
After six months, the Town concluded that there had been modest use of the service but with some growth over time (by month four, 54 riders on average per day). On average, 45% of riders had driven previously and 7% were net new customers to the system. The average fare levied per trip was $1.80, showing people preferring to be picked up from home and that the fare differential did not warrant the inconvenience of walking to a local hub.

The pilot was discontinued after 12 months, leaving system users to transition back to pre-existing GO Connect services. Ex post facto analysis showed rides topped out for the last three months at around 85 per day: about a third of the target and 75 to 80% of pre-existing services. A survey of riders had 27 responses and these were highly favourable, but not powerful.

Limited financial cost analysis was undertaken and released publicly. Data for November 2015 showed an investment of $7.50 per ride (operating costs minus fare paid). This investment level multiplied by average daily trips and aggregated for an average month indicates a net investment of $11,000 to $12,000, exceeding the $10,000 net investment for GO Connect at lower levels of use.

In summary, the pilot was a watershed for the GTHA in terms of mobility partnership but weak regarding a proven value proposition. Its particular limitations included low penetration and use, limited evaluative statistics and singular purpose of trips undertaken.

This experience shows that future pilots must be more comprehensive and cross-geographic. Furthermore, they need basis in clearer evaluative benchmarks: for example, what are the various partners prioritizing and what would demonstrate joint value?



Innisfil Ride-Sharing Transit System [36]

In May 2017, the Town of Innisfil commenced a 24-hour, seven-day-a-week transit scheme based on partnerships with Uber and Barrie Taxi (the latter providing accessible services). The scheme was the first to provide a form of transit service to the town, which had no pre-existing conventional bus-based service.

The partnership approach was selected because the Town considered a bus-based, Town-operated service to be cost-prohibitive relative to the level of service it would provide the community. As the only proponent able to offer the Town an application-based service that included a pool option, Uber was one of the selected partners.

The objectives of the scheme were as follows:

- Provide a form of transit service where none existed previously and at a manageable cost to the municipality
- Provide for local trips and connections to trunk transit such as GO rail services
- Gather data on demand for such services and use this data to make decisions regarding evolution of the service into the future.

The fare structure included $3 to $5 one-way rides for trips to and from four key destinations and a $5 discount on other fares. The Town budgeted $100,000 for a six- to nine-month pilot.

The Town facilitates trip bookings by supplementing the standard Uber app with a call-in booking service (Town-hosted), staffed 0830 to 1630 hours. Computers are also available at municipal centres to enable bookings for those without smart devices.

The first two months of operation yielded 4,868 trips (approximately 0.15 trips/resident over the period), including no accessible trips, and an operating subsidy (paid to Uber) of $26,462 ($5.43 per trip) based on the types of trips taken. The Town has concluded that this is a favourable investment relative to the level of service being provided and cost of operating a more conventional bus-based service.

The Town set up an online and hard-copy survey to elicit feedback on the service. Results of this surveying are pending.

In practice, the Town is subsidizing a travel service vendor, thereby reducing the price for travel charged to customers. This makes these services — which are not subject to public sector operating criteria regarding coverage, hours of operation or minimum service levels per se — more appealing to a wider market and, conceivably, for more trips and trip purposes.

Still, the price point is relatively high, especially for repeat/regular trips. There is also limited evidence of the Town setting performance benchmarks to be evaluated and establishing with the vendor data handover requirements to enable objective assessment of the efficacy of the scheme.

City of Vaughan mobility service prototyping

Over summer 2017, Bridgeable and MaRS Data Catalyst collaborated on a project defined to answer the research question “how might shared mobility be leveraged to drive transit adoption amongst suburban commuters?”

The project team used a service design approach to engage suburban commuters in order to understand how shared mobility might improve their commutes and increase transit adoption. Service design is an interdisciplinary approach to service planning and execution that uses mixed-methods research and rapid prototyping and testing to understand user needs and create impactful services.

The team used several methods to complete the project scope:

Ethnographic research: Ride-along interviews and design probes were conducted with a sample of 14 commuters, including a mix of drivers, TTC riders, and GO train riders. The ride-along interviews were video recorded and began at commuters’ homes, took place during the duration of their commute and ended at their workplace. Design probe kits consisted of a customized journal that asked commuters to self-document through photos and drawing, and to reflect on their experience in the moment. These methods allowed the team to ask open-ended questions of commuters and gave us insights into commuters’ behaviour, perceptions of different modes and common struggles during the course of daily commutes.

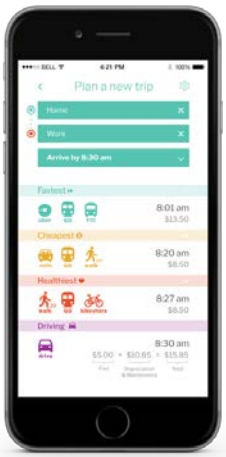
Learning Lab: Following ethnographic research, the team hosted a learning lab with nine GO train riders, in addition to MaRS staff and transit stakeholders from York Region. During the Learning Lab, participants were asked to think out loud, collaborate with other commuters and transit stakeholders and answer questions about their experiences commuting. Commuters were asked to reflect on how they make decisions about mode and route during their daily commute, identify persistent challenges they experience and review shared mobility services that exist in other cities, relating how these services might improve their current commute. The Learning Lab provided understanding of key behavioural and emotional barriers to transit use and unmet needs that solutions should seek to bolster.

Prototyping and validation experiments: Prototype solutions including a trip-planning app, a dynamic carpooling service and a microshuttle service were created based on the needs uncovered through earlier research phases. These solutions were then tested with project participants to establish value propositions via a mid-fidelity, clickable prototype of the planning app, prototype videos that showed how each of the service concepts would work from the perspective of a user and service cards that presented the value proposition and key features of the dynamic carpooling and microshuttle services. The app prototype and service cards were then field-tested at GO stations to get feedback from commuters in a naturalistic setting. Finally, six commuters were invited into a project office to provide in-depth feedback.

Key learnings

Seventy hours were spent in the field over the course of the project engaging with over 80 commuters from Vaughan. The project team discovered that suburban commuters are struggling with two problems that shared mobility might play a role in fixing:

1. Suburban commuters are driving to GO stations in high numbers because they are seeking control and reliability, and do not perceive they have other options. GO station parking lots are congested, and commuters need to arrive very early in the morning to secure free parking. They describe this experience as the worst part of their commute and, often, their day
2. Suburban commuters struggle to see all of their mode options in one place and have difficulty weighing the cost and time implications of different routes. Additionally, when faced with delays they struggle to know how to problem-solve and find an alternative route that will get them to work on time.



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Images © Bridgeable

The project yielded some guiding principles for implementation of shared mobility solutions for suburban commuters:

1. **Allow me to plan transit around my life** – Currently, commuters need to plan their day around transit and want to be able to plan transit around their day. This means that new solutions need to be responsive to demand, easy to book dynamically and have backups so that if one service fails, commuters have another option
2. **Give me the freedom and control my car gives me** – Commuters drive the first mile because they perceive that it gives them control and flexibility despite stress. Commuters need to feel a sense of control and be reminded about the stress of driving to consider alternatives. The alternatives themselves give clarity regarding service routes, cost and payment, and estimated arrival times. Messaging about new services should state clearly how solutions solve the struggles associated with driving
3. **Take the hassle out of decision-making** – Commuters struggle to make trade-offs relating to mobility decisions that work for them. Commuters need planning tools that go beyond information and allow them to make choices by displaying the time, cost and convenience of mode options in one place and measure these costs against the true cost of driving
4. **Build trust with transparency –** New services can feel risky to commuters if they do not know the brand or need to rely on non-professional drivers. Commuters will not share personal and payment information with services they do not perceive as trustworthy and therefore will not use these services
5. **Amplify reliability with integration** – Commuters will not use service they do not experience or perceive as reliable — backups are essential to creating reliability. New service should be organized around GO train times and account for delays. Additionally, new services should overlap one another to create backups
6. **Make visible the cost of driving** – Commuters perceive their car as a sunk cost and tend to think of driving as "free," whereas other options are pay-per-use. Despite not paying for parking at GO stations, the cost of monthly parking is an anchor point for commuters and costs of alternatives will be judged against this cost. New services need to make visible to commuters the cost and stress of driving and use the cost of monthly parking as a reference point. Incentives or free trials of new services are an evidence-based strategy to combat the sunk cost of cars
7. **Show commuters their options when they need them** – Transit delays are often hidden from view unless commuters actively seek them out, and when delays occur, commuters struggle to see their alternative options in one place and make an informed decision about next steps. Commuters need to be notified when something goes wrong, and they should be able to consider all their options quickly and make a choice that will save them time.

▶

Mapel GO Station

5.3 City prototypes – learning from limited evidence

While significantly more study of MaaS is needed, our research identified that value creation and the nature of trade-offs depend on the following:

- Urban socioeconomics and sociodemographics, including relative population heterogeneity and costs of travel versus household/personal income
- The regulatory environment or constraints under which service vendors are required to operate; in the GTHA, for example, Uber licensees are restricted to making pickups within particular municipalities
- Maturity of public transit systems, especially the extent to which they are road- or rail-based and the expanse of this service across a particular geography
- Quality of transit journeys including the legibility of the system, journey time, price point and comfort
- The size and density of cities as well as the distribution/concentration of land use intensity
- The characteristics of the mobility services offered
- Associated factors that compromise the journey or cost; these are often ignored and could be better explained or assessed (e.g., locations where paid parking applies will have a different impact if there is no parking charge; similarly, the degree of congestion will impact decisions that are made).

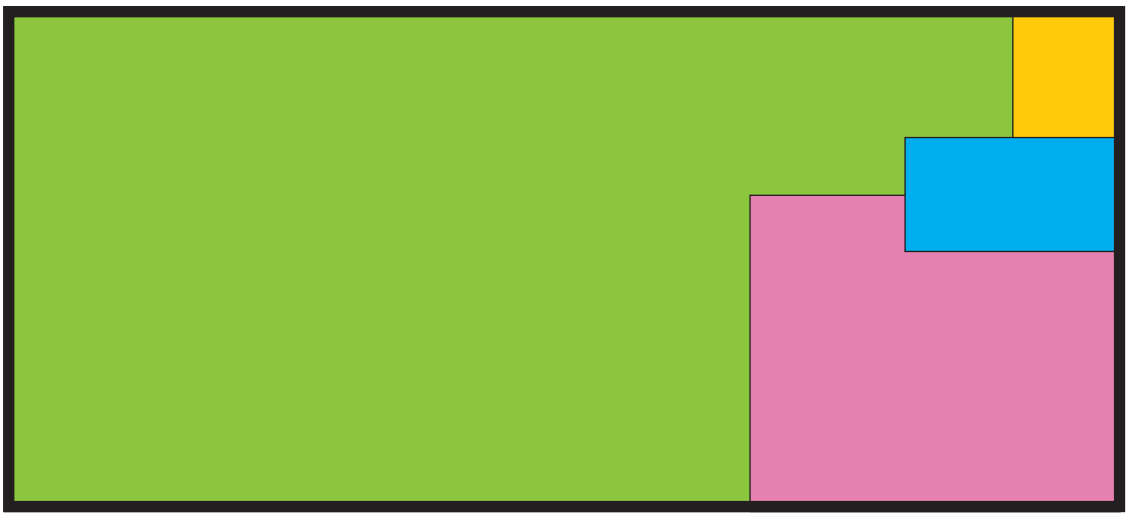
With these factors in mind, we have conceptualized a series of trip market models that illustrate the (potential) aggregate effects of mobility services on trip-making, depending on context. These models contemplate impacts based on the availability of new vendors and service offers in the market, and access to these offers via new purchasing platforms.

Our models relate specifically to how trips are taken. The intent is not to ignore other impacts of mobility services; rather, we want a strong link back to our original virtuous premise regarding the preservation and enhancement of publicly available mobility services. The purpose of our conceptual models is to provide a basis for understanding relative opportunities and respective threats for cities, and for tailoring public policy (something we discuss further in **Section 7**).

In time, we believe that experience and performance will allow these models to be refined. In particular, the growing evidence base will link increasingly contextual factors with outcomes on the trip market.

Figure 5.2 is the first and simplest of our models. It shows an indicative share of trips being provided by transit within a theoretical trip market. It also shows a number of trips, which might also be provided by a transit agency, being enabled by mobility platforms. In addition, a share of trips are shown to be satisfied by non-public service vendors.

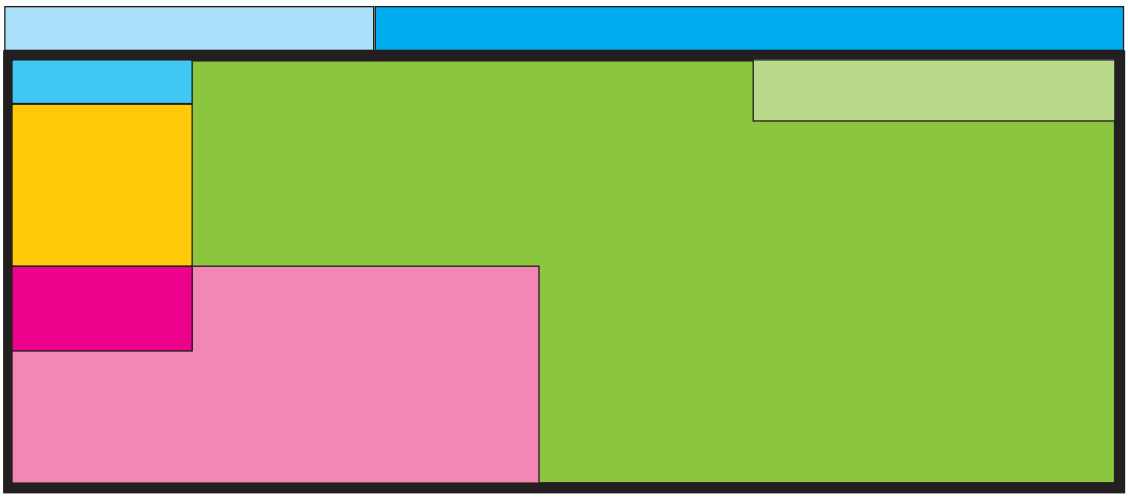
Figure 5.3 imagines mode choice within a more complex trip market, perhaps following entry of a number of new platforms and vendors. In this market, there are a number of possible implications for mode use and these depend on the purpose of trips taken amid many of the other rich, contextual factors experienced in cities.



Legend

- Auto trips
- Transit
- MaaS
- Active transportation
- Base trip market

Figure 5.2
Simple model of the trip market



Legend

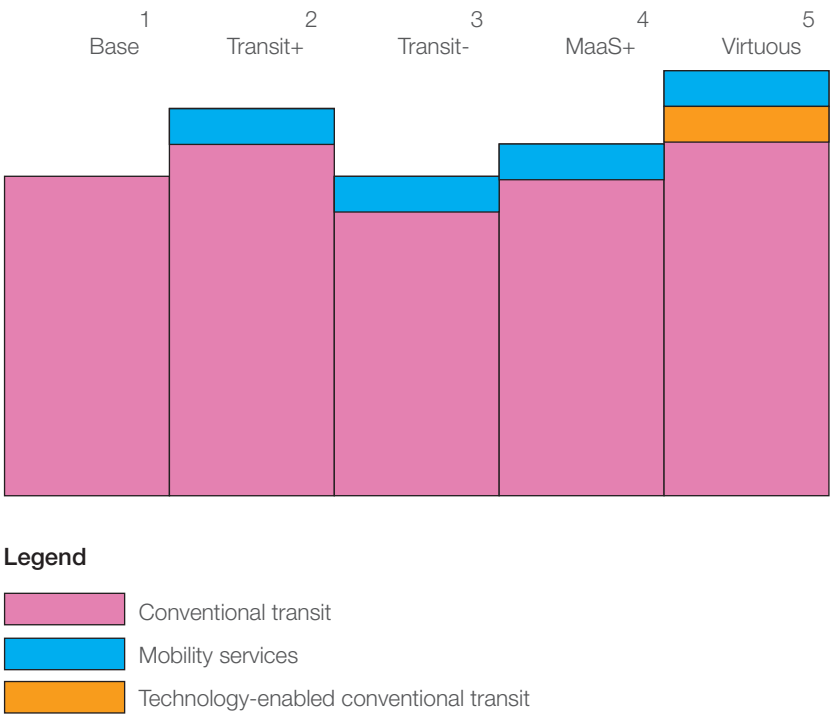
- Auto trips
- Auto trips replaced by mobility services
- Induced trips due to MaaS
- Active transportation trips replaced by MaaS
- Added conventional transit trips enabled through MaaS technology
- Active transportation
- Conventional transit trips replaced by new mobility services
- Conventional transit trips
- Base trip market

Figure 5.3
Complex impacts on trip market, conditional on the way in which MaaS is deployed

Figure 5.4 provides a series of five city models. These are based on what we have learned through our research.

1. Model One is our baseline
2. Model Two reflects a positive outcome whereby new mobility services replace trips otherwise taken by private vehicle and improve access to backbone public transit. This might occur in affluent cities with well-established rail-based public transit, which may also have well-defined mobility partnerships
3. Model Three shows new mobility services replacing some conventional transit trips. This may be the outcome in less affluent cities and/or those characterized by less comprehensive and/or bus-based public transit services. In some cases, government might facilitate the mode switch, which is the case in Arlington, Texas where this was perceived as a means to create the most aggregate value within the trip market
4. Model Four shows the more neutral outcome whereby MaaS replaces some public transit trips, enables others and otherwise replaces private vehicle trips. This outcome may occur as a consequence of variable effects across cities (i.e., internal variation)
5. Model Five is the target, which is a virtuous outcome for cities and the strongest joint value proposition. This virtuous outcome yields the net benefits of Model Two with added benefits arising from consumers, service vendors and the public sector leveraging the power of service platforms. It is therefore the basis for our pursuit of more knowledge regarding MaaS and its impacts (**Section 6**), and recommendations for the public sector arising from our work (**Section 7**).

Figure 5.4
Conceptual model of MaaS impacts on transit in cities



1. Baseline
2. MaaS supports increased use of conventional transit (e.g., provides access to services and encourages new patrons)
3. MaaS replaces conventional transit
4. MaaS adds to conventional transit trips
5. MaaS supports increased use of conventional transit, and MaaS platforms add further to use


MaRS
ARUP

6 Knowledge blueprint

There is a clear need to understand the variables that affect MaaS impacts on trip markets and its ultimate delivery on suggested value propositions. The discussion in Section 5 showed that our understanding of both these areas is growing but patchy.

Value is derived from impacts, and the impacts of MaaS on consumers, vendors and the public sector vary currently in scope, scale and even in direction. Impact is, in turn, derived from changes within the trip market, and the measurement of these changes needs attention and improvement. Short of more study, we are unable to answer confidently questions regarding whether value creation is

- Scalable
- Open to all or restricted to certain agents
- Negotiable/flexible (e.g., avoids locking agents into single options)
- Transferable (e.g., applicable universally or at least between locations sharing similar basic urban characteristics).

Focusing on measurement, we have reviewed available data sources in the GTHA and allocated these across two dimensions: agency (who collects/compiles data) and trip characteristics (the nature of travel) (**Figure 6.1**). These sources, in the aggregate, yield much of the current basis of knowledge regarding impacts of MaaS on the trip market. Consumers tend to generate rather than compile data but this can depend on their active opting in to data-aggregation schemes.

Figure 6.2 represents our appraisal of knowledge among specific agent groups regarding how MaaS is influencing trip characteristics. **Figure 6.3** shows how we believe this could improve, assuming better leverage of available data sources.

In the context of the GTHA, the knowledge gaps (delta between current and potential or needed knowledge) are linked to a series of fundamental operating and governance matters, which we discuss in **Section 7**. Even with improved knowledge, we caution that agent groups will not be able to answer all questions regarding MaaS and its effects — especially as MaaS continues to evolve. It is therefore important for agents to know and respect their knowledge gaps, and work in partnership with other interests in pursuit of joint value creation.

▼

Figure 6.1
State-of-play knowledge source map for different agent groups in the GTHA

Trip market characteristics	Stakeholder/source				
	Government	Transit agency	Vendor	Consumer	Other parties
Who is making the trip?	Transportation Tomorrow Survey (TTS) Wheeltrans usage Social services subscriptions Vehicle registration details	PRESTO data / Transit app data	Registrations/ subscriptions	Privacy restrictions / opt-in	Wi-Fi/Bluetooth cell-phone data
Why is the trip being made?	TTS	PRESTO data / Transit app data	Origin-destination data		Credit card data
When + where?	Toll data (407) Toronto Parking Authority (TPA) data	TTC gate counts PRESTO data Door counts (vehicles) Schedules Vehicle capacity Price data	Origin-destination data GPS data (routing)		Wi-Fi/Bluetooth Credit card data
How (mode)?	Traffic signal loop and actuation data CCTV Bike-share utilization		Service vended		Credit card data

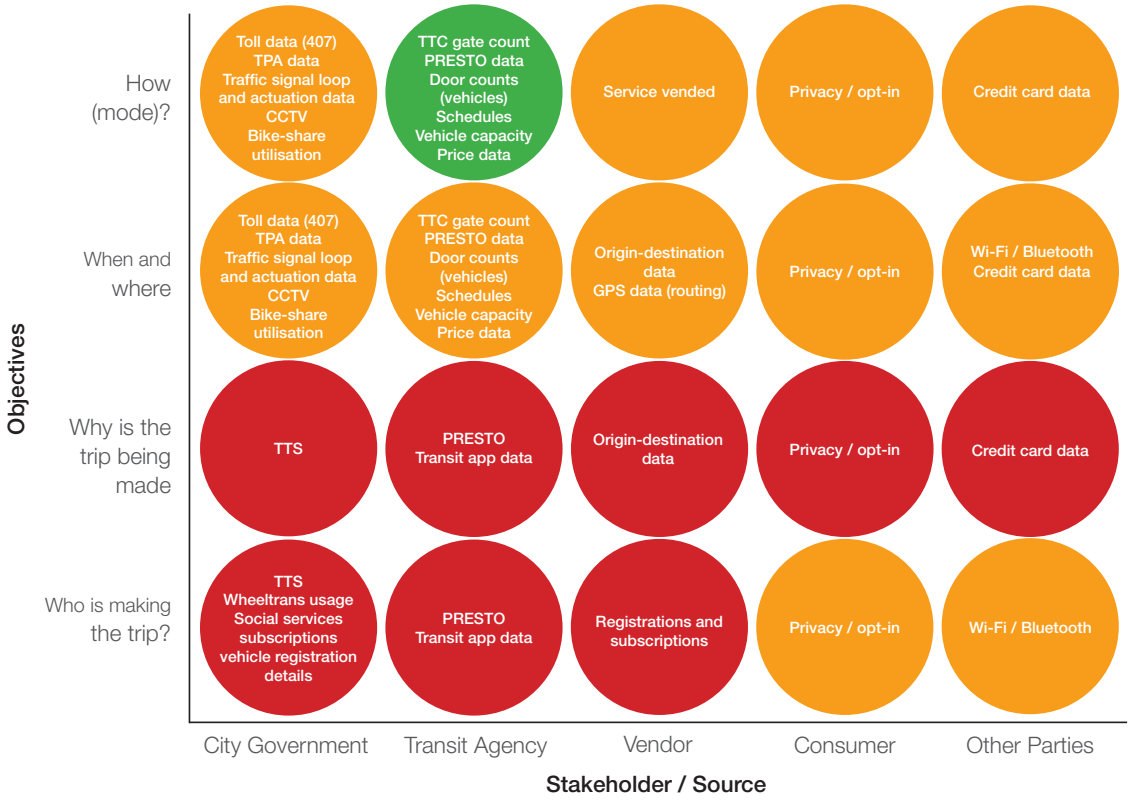


Figure 6.2
Agent group knowledge basis regarding MaaS influences

Legend

- Good leverage of data
- Mediocre leverage of data
- Poor leverage of data

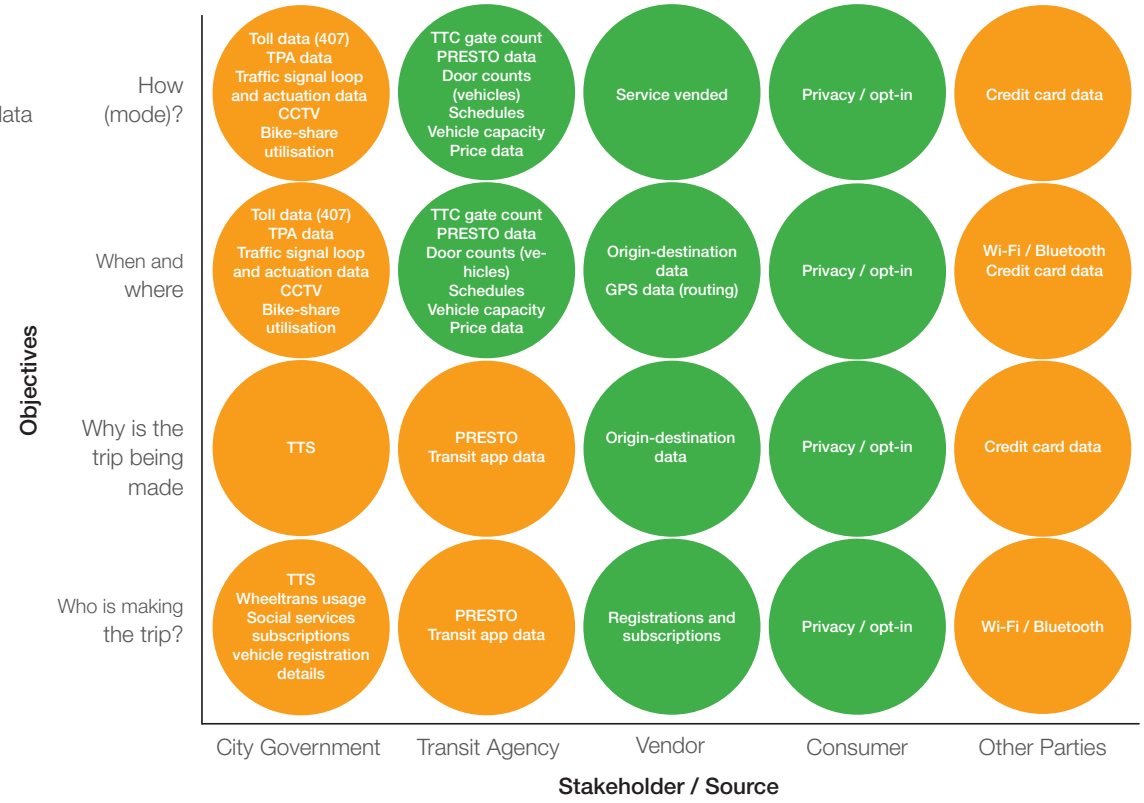


Figure 6.3
Potential agent group knowledge basis regarding MaaS influences. Improvements stem from more collaboration, consumer education, government prioritization and reduced private-sector secrecy.

7 Policy and planning levers for cities of the future

Based on current evidence, the convenience, time and/or price offer to consumers of a variety of forms of mobility service can be compelling. The private sector innovates to satisfy travel demand in ways that the public sector cannot, and this yields utility to consumers.

Yet, mobility services (as distinct from conventional public transit) do not suit all trips and cater presently to a relatively small share of the overall trip market. In the medium term, we anticipate this share remaining relatively small for a number of reasons.

Firstly, mobility service vendors have a commercial raison d'être, which is sometimes at odds with public policy. These differences in values were identified in Section 4 and are discussed in other research papers [18, 37–38]. This limits the extent to which the public sector can and should support deployment of MaaS (at this time).

Secondly, disaggregated (low-occupancy) travel causes the same issues whether a consumer is driving themselves or being driven. Mobility services in their current forms are unable to carry the same volumes of passengers as conventional mass transit, contributing to urban congestion and increasing per-traveller VKT if that traveller would otherwise use the subway, metro or other public service.

Thirdly, there are challenges communicating value to consumers and habit can sometimes trump people's willingness to change their behaviour. Furthermore, there are practical limits to people's abilities to trade one benefit for another, such as time for price.

Fourthly, more predictive, data-fuelled models of operations in low-density areas and dynamic service schemes do not automatically translate to viable businesses. This means that the levels of service required to cause significant shifts in the trip market may not be something that the mobility sector can currently satisfy.

Modest impacts on the trip market in the aggregate may still be significant in specific contexts and may influence the appetite of certain users to shift from one mode to another. This is beneficial if the shift happens from single-occupancy vehicle, less so if it cannibalizes public transit. Given such uncertainties, the public sector cannot afford to be inert [1–2, 29]. Even with willingness to partner and pilot test, government must be prepared to gather data, conduct thorough analysis, demonstrate flexibility and require that vendors and platform providers satisfy specific key performance indicators.

These are no small challenges given the difference in value propositions and conditions under which value is realized among different agent groups. Furthermore, uncertainty regarding how MaaS is influencing the trip market today and how next-generation services will influence it in the future, means the onus is on government to institute a policy framework that avoids stifling innovation. Simultaneously, this framework must ensure benefits for a wide spectrum of consumers as well as the urban system that hosts travel.

The characteristics of cities and the populations they accommodate (see Sections 3 and 4), and the nature of the service being vended add further complexity to this picture. For example, the literature shows that the influence of individual service types — ride-hailing compared to car-sharing, bike-sharing and so on — on travel behaviour and impacts that result, differ quite significantly.

> Interviewees from all agent groups were relatively comfortable with the idea of regulating MaaS; however, vendors argued that government needs to better understand best practices and have more faith in the market. In contrast, representatives from the public sector bemoaned a lack of knowledge regarding controls on operators to leverage balanced value equations.

Our expert interviewees proposed a need for basic data-sharing templates or arrangements transferable between projects and open for tailoring depending on project goals.

The planning and policy levers that governments could therefore consider include the following:

- Defining a pilot-testing framework with latitude to try, fail and learn. For example, under the banner of Innovate UK, the UK government is investing money in many projects with elevated risks compared to conventional ventures to establish lessons from failure and success
- Modelling or testing policy/service agreements for new mobility partnerships prior to full deployment or program backing. This will help to address concerns regarding replacement of conventional transit service. More permanent policies should be contemplated only when transit agencies and city governments have evidence of impacts of new service arrangements and there is low risk of any consumers being worse off owing to service changes
- Concurrently creating an operating framework and transparent evaluative basis for any mobility partnerships or independent schemes that accounts for regional priorities (e.g., reduced congestion and increased accessibility)
- Establishing clear provincial leadership on MaaS, such as dedicated support for efforts to evaluate MaaS, and developing model policy for mobility management based on such efforts
- Formulating and prototyping of new business models for transit service provision in some instances, which accounts for some conventional services being supplemented or replaced by mobility services where this makes most sense. Current evidence suggests that service provision in rural and low density suburban locations is a strong proposition
- Establishing a government-owned operator in the mobility market to help generate competition, set minimum service standards and provide a backstop should the private sector underperform
- Establishing uniform data collection, management and application protocols for mobility vendors as a condition of licensing. There is broad agreement that travel data is powerful but it is also patchy, cumbersome and noisy (e.g., useful information is mixed with vast amounts of marginal or superfluous data) [38]. In our view, there is a basis for an arm's-length data clearinghouse or a non-vendor lock-in broker service. The Shared Streets initiative in the US, a collaboration between NACTO, the World Resources Institute and the International Transport Forum, is a step in this direction [39].

"A consortium representing the mobility providers that participate in a MaaS ecosystem should have the responsibility and power to work alongside the MaaS provider to ensure that discounts, subsidies and pricing match the principles of the city/region. For example, if congestion is an issue, priority discounts should be given to services that offer greater number of customers per vehicle."

Kansas City Area Transportation Authority

Operating frameworks should be based on the following fundamental objectives:

- Generating net benefits for customers on average and for citizens/regions at-large
- Generating net benefits for at-risk, disadvantaged and/or special needs groups like the elderly or disabled
- Satisfying trip demand not easily or well-catered for by conventional public transit services
- Avoiding directing funding — even in the form of operating subsidies provided to the private sector — to marginal projects rather than investing in more valuable projects, unless fulfilling a social mandate for the transit agency [40]
- Avoiding creating unchecked business opportunity for vendors to compete with conventional transit across other segments of the trip market, ultimately hollowing out public services [25, 30]
- Supporting wider goals for sustainability and public good; this means managing the potential for increased congestion and VKT through appropriate pricing mechanisms.

There are several existing governance challenges in the GTHA that can reduce the effectiveness of the levers described:

- Diffusion across government (municipalities and the province) of responsibility and jurisdiction for owning and operating transit services
- No clear leadership when it comes to who should oversee, operate and/or integrate new mobility services into regional or urban planning
- Fragmented buy-in to the use of mobility platforms, which is generally related to the diffusion of responsibility for transit services previously mentioned.

There is onus on broader industry to yield the following:

- More independent study of impacts within a range of contexts and associated with different types of mobility platforms and services
- More pilot tests of joint mobility schemes including well-defined before, during and after data capture and analysis by the public sector and partners
- Key performance indicators and measurement of actual performance against these indicators over time.

Earlier, we hypothesized modest growth in the uptake of MaaS over the medium term. In the longer term, the introduction of automated vehicle fleets, which we anticipate occurring at scale sometime in the 2020s, represents the long game for a number of mobility service vendors. This will change the economic and value dynamics of MaaS and is worthy of discussion in a separate paper.

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Appendix A
Summary of expert interviews

Approach

Interviews followed a semi-formal structure design to elicit interviewee feedback on the following questions:

1. How would you define MaaS and the MaaS ecosystem?
2. What is the value proposition of mobility services to consumers and cities/regions?
3. Who is the target market? Why?
4. How would you summarize trends in uptake of mobility services? How big could the share of the trip market be?
5. What aspects of government policy towards mobility services are good and/or not good? What information does government need to support mobility services?
6. How can we manage the impacts of mobility services, such as added congestion and exclusionary pricing? Who has responsibility for this management?
7. How do the impacts of mobility services vary from city to city and across region? What are some of the key conditions for these differences? What about inter-city movement? What are the different barriers for different cities or regions?
8. Under what conditions should service vendors share data with cities/regions? What should this data-share arrangement include?
9. Is there anything else you would like to share?

High-level results for each interview topic are summarized in the following sections. Where relevant, nuances identified for each agent group are identified.

1. The Definition of MaaS

All interviewees responded that MaaS can be conceived as one platform integrating planning and payment for travel; however, vendors emphasized cost effectiveness and convenience, and government representatives, how important it is to understand the impact of MaaS and how it can be integrated within applicable policy frameworks.

Academia/research	Vendors	Platform providers	Government/transit authorities
Single platform, integrated across all access modes, based on demand.	Single platform, integrated planning and payment, convenient, individualized, cost-effective, carless travel.	Integrated planning and payment.	Need to study the impact; policy framework has to evolve more quickly.

2. The value of MaaS for consumers, cities and regions

All interviewees responded that the value proposition of MaaS is in the potential for cost reduction for consumers. Vendors stated that their services can reduce congestion in urban areas whereas researchers and government representatives emphasized the value of providing a multimodal environment and effecting better land-use planning when it comes to transport provision. In particular, public sector interviewees referred to the potential for virtuous partnerships between vendors and government agencies.

Academia/research	Vendors	Platform providers	Government/transit authorities
Consumer: cost savings and convenience	Consumer: cost savings and convenience	Consumer: cost savings; reduced car ownership	Consumers: less cost and more choice tailored to need
Cities: environmental benefits; creating multimodal lifestyles	City: reduce vehicle ownership; improve the environment and reduce congestion; encourage multimodal redesign.	City: Reduce congestion; reduced infrastructure demand; environmental savings.	Cities: improved connectivity and efficient use of existing transit.

3. What is the MaaS target market?

Many interviewees believed that MaaS should be for everyone. Nevertheless, interviewees noted the distinction between current users/early adopters and untapped population segments that may form the next 'big opportunity' for MaaS. For some, this may be the product of mobility partnerships albeit the value may manifest in different ways for different agents.

Academia/research	Vendors	Platform providers	Government/transit authorities
Everyone. Early adopters are young and without cars but this can gradually evolve to include users interested in reducing car ownership.	Everyone is the target. First urbanites, then ex-urbanites, and also the senior population.	Everyone, but urban areas are more profitable. Currently focused on younger demographic; however, may evolve to include second car owners.	Everyone who needs to commute (both residents and visitors); especially in dense urban areas. Services will evolve eventually to suit the needs of seniors and facilitate trips in less dense areas.

4. What kind of trends is MaaS displaying in the market?

Most interviewees voiced faith in the growth of MaaS and expressed that an increasing segment of the trip market — especially trips conducted in less dense areas — will be by mobility services as the sector evolves. Vendors and government interviewees proposed that MaaS may eventually replace the personal vehicle trip; however, others were less optimistic about longer term impacts on travel behaviour.

Academia/research	Vendors	Platform providers	Government/transit authorities
Early adopters are young urbanites; however, seniors are an emerging market and MaaS will replace conventional taxi services. The speed and depth of impact on the trip market will depend significantly on public policy and the willingness of government and public transit agencies to collaborate with the private sector.	The market is growing fast because different types of services are/can be provided for different population segments. Market share will expand as MaaS evolves to provide more services to specific groups.	MaaS is not for everyone. Still, it is an adaptable service that has a high customization component. Will become part of service infrastructure.	Influences depend on the form and size of cities, the demographics of their populace and types of MaaS services on offer.

5. Policy: The good and the less good

In general, interviewees representing academia/the research community, vendors and platform providers argued that when it comes to MaaS, enablement is good. In contrast, government representatives argued that the public sector needs to play a stronger role in leading and regulating the trip market, understanding the impacts of new mobility and overall, creating an environment for MaaS development and deployment that balances the values of all agents.

Academia/research	Vendors	Platform providers	Government/transit authorities
Needs to have regulation and be enabled; government needs data.	Needs to be enabled; however, government also needs to be educated on best practices and have faith in the market.	There needs to be a better environment to govern mobility. The market is immature and the public sector is not responding quickly to innovation in the sector. More P3 partnerships and open data. More consideration of pay-per-use (i.e., road tolls).	The private sector leading innovation is a positive; however, innovation cannot happen in a policy vacuum and short of overarching objectives that balance the value of innovation for all agents in the market. Policy has to balance incentivisation with disincentivisation in certain circumstances.

6. How do we manage the impacts of MaaS?

There was a consistent view that little is really known regarding the impacts of MaaS across a range of variables such as congestion, transit usage and value creation. There is an even poorer appreciation of how outcomes vary depending on context. Furthermore, there were aligned views regarding the need for more study before introducing comprehensive policy or legislation.

Academia/research	Vendors	Platform providers	Government/transit authorities
Government needs to lead with strong, clear vision and develop more of an understanding of impacts of MaaS.	There is a need to understand better impacts before managing them. Policy and legislation should not stifle innovation.	Knowledge is still lacking. The public sector needs to take the lead on assessing impacts. Need ability to measure and manage through fees and incentives.	Much more work is required to understand impacts and their antecedents. Responsive policy frameworks are required and government must be nimble to help balance value creation.

7. How do the impacts of MaaS vary across regions?

Broadly, interviewees argued that urban density is the key attribute affecting MaaS deployment both within and across regions. Vendors and researchers, argued that service availability should be similar across regions but tends to be curtailed by regulatory differences. Government representatives tended to emphasize cross-regional differences depending on availability of mass, rapid transit and implications of municipal land use policy.

Academia/research	Vendors	Platform providers	Government/transit authorities
Key conditions for operation include urban density and demographics: the young, affluent and urban are the most typical users. Regulatory patchworks inhibit spread and growth of service.	Services are similar cross-regionally but there is variability in use depending on the consumer base. City density and connectivity determines how successful services will be.	City density and connectivity determines how successful services will be. Local planning conditions are additional influences.	Enabling conditions are broad and include urban density, transit connectivity, land-use planning variables, congestion and cultural/education context.

8. What about data?

Interviewees were asked for circumstances under which vendors should enact data-sharing agreements with cities and regions. Most interviewees argued that most data should be shared and that privacy should be prioritized in any sharing agreement. Still, vendors were adamant that the objectives for use should be clarified prior to enacting any agreement and exhibited sensitivity around how data could be analyzed and interpreted. Government representatives voiced some frustration that vendors are not as forthcoming with data as they would like and data packets from specific trials are not sufficient to form a complete picture of the impacts of MaaS. This makes it difficult to develop flexible policy.

Academia/research	Vendors	Platform providers	Government/transit authorities
Key datasets that should be handed over by vendors to government include demographics, multidimensional trip data, data on quality of journey and other experiential feedback.	Cities should have a clear understanding of application when asking for data. Privacy should be respected.	MaaS operators should be required to submit aggregated data. There is a need to understand the big picture for the benefit of the ecosystem; yet in consideration of Personally Identifiable Information.	Aggregated data should be provided and privacy should be respected. There is a need to have policy guidelines on data-sharing and for sharing of information between multiple agencies form a comprehensive picture of the ecosystem.


voda AU
12:01
Location
University Law Faculty
Walk 13 min
1.1 km
Return Journey
13 mins
Destination
Bicycle Hub
Map
Time
CO2
Savings
Profile

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