FUTURE CITIES CANADA

SHARED MOBILITY IN CANADA: CONSIDERATIONS FOR OPEN SMART CITIES

COMMUNITY SOLUTIONS NETWORK
RESEARCH BRIEF

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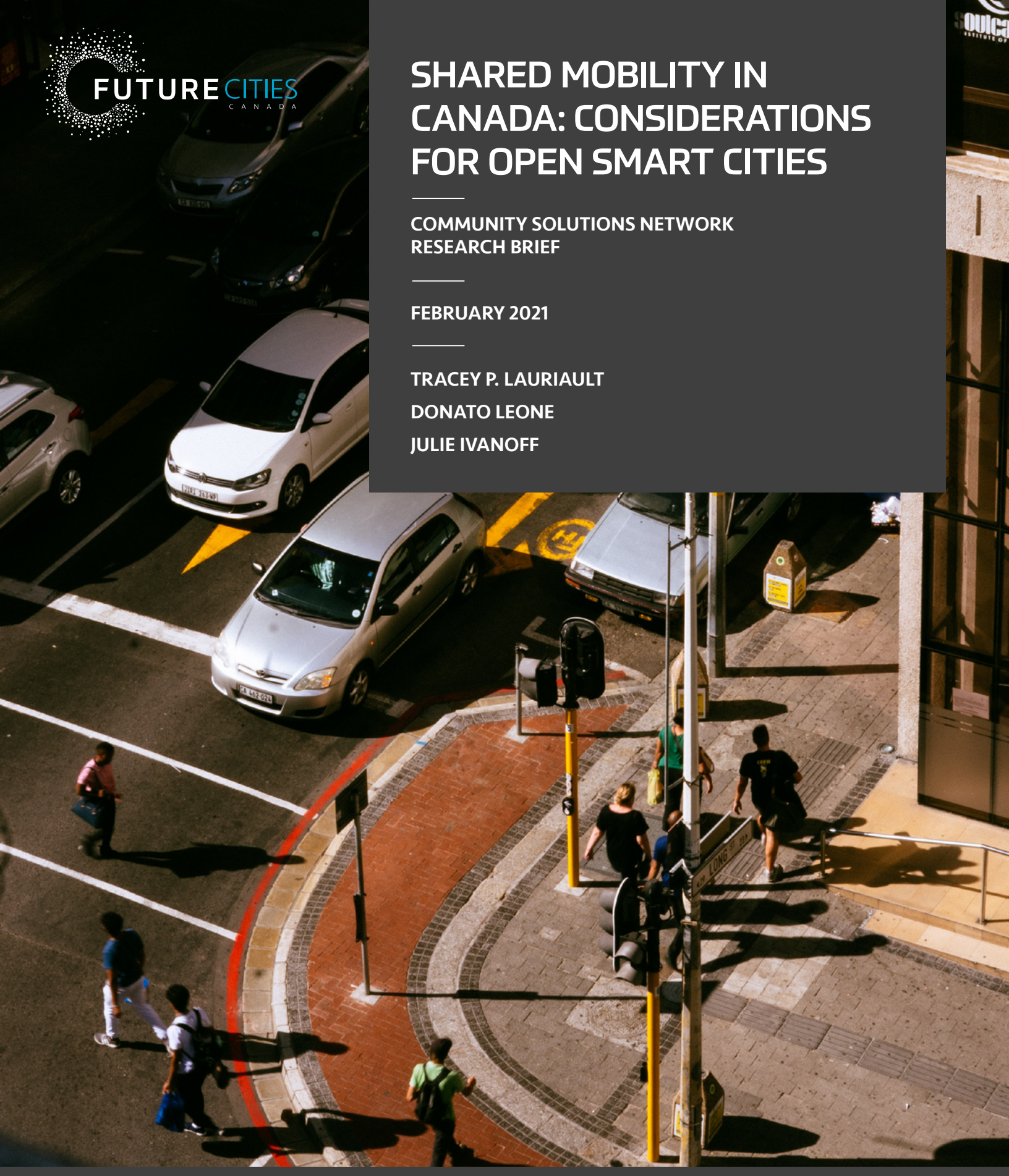

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Executive Summary

Digitally enabled 'shared mobility' services have become a prefered option for personal transportation in cities. Enabled by Internet-of-Things (IoT) devices and applications, shared mobility is multi-modal and includes: taxi-like *ridesourcing* (e.g. Uber); on-demand *carsharing* (e.g. Communauto); *micro-mobility* with bikeshare (e.g. BIXI) or scooter-share (e.g. Lime); *microtransit* via high-occupancy, on-demand vehicles like mini-buses or shuttles (e.g. TransDev); and hybrid variations of these models (e.g. UberPOOL).

Shared mobility services are dominated by private companies that rely on large fleets of IoT-enabled shared vehicles and algorithmic routing software. As transportation in Canada is managed by multiple levels of government, Indigenous communities, and local transportation agencies, interjurisdictional collaboration on shared mobility governance is required between these actors and with private service operators. Open Smart Cities can take a lead governance role in this sector by managing how shared mobility technologies and data are deployed and integrated into public urban centers in a way that is collaborative, ethical, transparent, and that benefits all, including the public good.

IoT-enabled vehicle fleets in shared mobility provide easily accessible rental and for-hire personal mobility options in cities. These mobility technologies such as vehicles and docking stations need to be physically integrated into urban centres, as 'curb space' has become competitive as more mobility options and services become available. Tools such as permit systems, service caps and limitations, and effective and sustainable procurement standards are required to effectively plan for shared mobility integration. These integration processes include establishing some form of data and technological sovereignty by city administrations where the terms of incorporation are set to protect public interests and to make services accountable.

Shared mobility technologies produce valuable and sensitive data about the movement of users and transportation networks. These data can benefit many processes such as transportation planning, urban planning, and traffic management. Accessing and analyzing these data will require effective and normalized data governance approaches which are currently in their infancy. There is also the need for data sharing agreements for inter-jurisdictional collaboration with private actors. Furthermore, data standards to promote data interoperability, and measures to protect user privacy and security for sensitive and identifiable data, need to be established.

As cities work to integrate shared mobility technology and data into public space, there will be unique challenges to account for:

- Shared mobility is dominated by the private sector, which presents issues regarding the control of public data.
- Shared mobility is investment-heavy and requires expensive IoT systems, vehicle fleets, vehicle stations, and data management systems.
- Shared mobility may negatively impact transportation networks by increasing vehicles on the road and these private services often do not take into consideration people with disabilities or people who do not have access to credit.
- Shared mobility services could replace public transit in some places which may leave some unserved.
- Shared mobility services collect sensitive data (including financial, personal, and movement data) which are vulnerable to attacks or mistakes.
- Ridesourcing services employ gig workers who live under precarious labour conditions and economic uncertainty.

Shared mobility also offers opportunities for current and future transportation developments such as:

- Partnering with public transit and offering first-mile and last-mile connecting rides to transit hubs.
- Improving regional movement by connecting rural areas to transit hubs, potentially increasing rural transit usage.
- Providing infrastructure that can be shared with autonomous and electric vehicles (i.e. charging stations, sensors, etc.).
- Integrating intelligent transportation systems (ITS) which utilize similar technologies (GPS, e-commerce, algorithmic routing, etc.).

An Open Smart City approach provides a framework to assess shared mobility as a smart system for Canadian communities, by identifying the opportunities these forms of transportation can offer, by addressing the challenges and by mitigating the risks.

Foreword

by Open North

First defined in 2018 by Lauriault, Bloom and Landry, an Open Smart City is one where all actors, including residents, collaborate in mobilizing data and technologies to develop their community through fair, ethical, and transparent governance that balances economic development, social progress, and environmental responsibility.

As Canadian communities across the country explore smart city initiatives, there is a pressing need to better understand the opportunities and risks presented by data and emerging technologies and put open smart city principles into practice.

Open North has commissioned a series of research briefs for policymakers and practitioners to provide insight into how data and technology intersect with challenges local communities are grappling with, such as food security and shared transportation. The research briefs identify complex policy issues from an open smart city lens, describe their importance and provide key considerations for policymakers.

This research brief identifies how an open smart city approach could be applied to shared mobility in communities across Canada. From Uber to bike shares, the emergence of shared mobility services in the past few years has begun to disrupt and reshape transportation in local markets. As new services emerge and become increasingly more complex and interconnected, it's critical that we consider an open smart cities lens in shaping their governance and use. Decision makers must consider how these new technologies and its associated data can be governed in a fair, ethical and transparent manner to meet the economic, social and environmental needs of communities.

Acknowledgements

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The research builds on the Open Smart Cities Guide, which provided the first ever definition of an Open Smart City. It was published in 2018 as a part of a year long collaborative research project led by Open North and funded by Natural Resources Canada's GeoConnections program in 2018. The authors are Dr. Tracey P. Lauriault (Carleton University), Rachel Bloom (Open North) and Jean-Noé Landry (Open North).

These research briefs are produced for the Community Solutions Network, a community-centric platform for communities to connect and build a national centre of excellence in open smart cities. As the project lead, Evergreen is working with lead technical partner Open North and other partners to provide valuable information, learning opportunities, advisory and capacity building services to Canadian communities in key areas of data and technology, helping to improve the lives of residents.

We offer—at no cost to communities—a comprehensive Advisory Service for Canadian communities interested in developing and implementing open smart cities projects. To learn more about the Advisory Service, please visit communitysolutionsnetwork.ca.

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What is Shared Mobility?

Urban centres have increasingly turned to shared mobility to reduce greenhouse gas (GHG) emissions, traffic congestion, the number of single-occupancy vehicles on the road, and to offer transportation alternatives. Shared mobility systems offer multi-modal transportation alternatives to personal-vehicle ownership and public transit.

Shared mobility assets or vehicles are shared by one or more users, operated by privately owned and co-operative business models, and are typically accessed through on-demand digital applications or peer-to-peer (P2P) services (Olateju et al., 2019). The idea of shared transportation is not new with the first forms being carpooling[1], ridesharing, and public transit (Olateju et al., 2019; Shaheen & Cohen, 2019b). In this brief emphasis is placed on emerging digital services as shared *mobility* rather than shared *transportation*—mobility referring not only to the movement of people and things but also accessibility to multiple, quality transportation options that are timely, affordable, and safe (Fortunati, 2018).

This research brief focuses on emerging and digitally enabled shared mobility developments which are distinguished by their use of information and communication technologies (ICT) that provide flexible and personalized mobility options. Shared mobility services and networks have proliferated as a result of smart devices employing the Internet-of-Things (IoT), specifically smartphones, applications and location-based services (LBS). LBS is a robust internet and cellular infrastructure for in-vehicle software which enable early IoT-based shared mobility systems such as Uber, Lyft, and BIXI Montréal. Other underlying social and technological enablers include global positioning systems (GPS) and Global Systems for Mobile (GSM) technologies that track the movement of vehicles, platforms that host services on smart devices, and increased data collection and analytics for mobile applications to efficiently auto-route trips on digital platforms. Shared mobility developments are also referred to as "Mobility-as-a-Service" (MaaS) which are personalized, user-centric transportation services that are offered through a digital platform (MaRS Discovery District & Arup, 2018).

There are several modes of shared mobility which fall into four main categories and one hybrid model. These are: ***ridesourcing*** (also known as ride-hailing), ***microtransit***, ***carsharing***, ***micromobility***, and a ***hybrid shared mobility*** model as described in Table 1 (p.6).

Shared mobility modes vary in terms of vehicle ownership, organizational form and business models. Some vehicle fleets are privately or cooperatively owned, some are publicly operated, others take the form of personal vehicle sharing (PVS) organizations. There are also mobility vending services that some cities, companies, or universities use in lieu of owning a fleet, such as carshare services Communauto (2020a) and Zipcar (2020) or bikeshare service DropBike (2020). Some services offer vehicle rentals (cars, bikes, scooters, etc.) while others operate for-hire vehicle services where passengers connect with shared vehicles and fares are algorithmically-determined (Shaheen, Cohen, & Zohdy, 2016). Additionally, hybrid models can include microtransit that either replaces or augments public transit, which was the case for the small town of Innisfil, Ontario (Pentikainen & Cane, 2019). Ridesourcing companies such as Uber and Lyft also operate ride-splitting services, UberPOOL and LyftLine, which act as ride-sourcing-carpooling services between strangers. Ridesourcing has also been integrated with a co-operative ownership model where users hold an ownership stake in the service, which is often seen with carsharing (CCA, 2009; Vézina, 2018). Shared mobility services therefore often adapt and adjust to meet local needs.

The focus of this brief is on personal transportation rather than on other shared mobility services such as those for mail delivery (e.g. Amazon) or food delivery (e.g. UberEats, SkiptheDishes, DoorDash, etc.). We also do not discuss other emerging and disruptive technologies in the transportation industry, such as individual or fleets of self driving vehicles.

Canada is home to many shared mobility services with at least 45 different services operating across the country (Fai, Hassan, Khan, Lauriault, & Ramirez, 2020). There are many private carshare, ridesourcing, and bikesharing services in major

1 Carpooling arrangements where the driver and passenger(s) incidentally share a common starting point and destination. These arrangements can be acquaintance-based (friends and family), between co-workers, or can be casual arrangements with strangers (Shaheen & Cohen, 2019b)

Table 1: Shared Mobility Types in Canada

Mode	Definition	Operational Models & Variants	Examples (CA)
Ridesourcing (also known as ride-hailing)	Taxi-like mobile apps that link drivers with passengers and that facilitate the transaction between these actors (Jin et al., 2018).	***For-hire vehicle service:*** Passengers are connected to a peer driver who provides mobility services with their personal vehicle (Shaheen, Cohen, & Zohdy, 2016).	Uber Lyft Tappcar
Microtransit	Alternative transit services that use demand-responsive, algorithmic processes to provide flexible routing and scheduling of high-occupancy mobility vehicles like minibuses and shuttles (Olateju et al., 2019).	***Fixed route and schedule:*** Vehicles take a pre-determined route and schedule but can respond to pickup and drop-off demand via crowdsourced requests. ***Flexible, on-demand routing and schedule:*** Dynamic service that determines routing and schedules based on user demand and traffic (Shaheen, Cohen, & Zohdy, 2016).	Transdev RideCo
Carsharing	Shared usage of a fleet of vehicles by members of a service, on a per-trip or subscription basis. Carsharing offers on-demand service, flexible usage, and smart IoT technology for managing trips and vehicle access (Olateju et al., 2019).	***Station-based:*** Fleets are available at designated lots or stations, where they must be returned. ***Free-floating:*** Fleets are available in public parking spaces within designated zones (Ferrero et al., 2018). ***Personal Vehicle Sharing (PVS):*** Users offer access to their personal vehicles for a fee (Shaheen, Chan, Bansal, & Cohen, 2015).	Enterprise Carshare Zipcar Communauto FLEX Evo ShiftRide Turo
Micromobility	Services that offer short-term rides on low-power vehicles on an as-need basis. Vehicles are IoT-enabled and connect to platforms to manage trips (Shaheen & Cohen, 2019a).	***Bikesharing:*** On-demand access to bicycles that start and end at stations or within a defined area (dockless). ***Scooter-sharing:*** An organization maintains a fleet of dockless electric (sometimes gasoline) scooters in a city or in multiple locations (Shaheen & Cohen, 2019a).	BIXI Montréal Mobi by Shaw Go Lime Bird Loop
Hybrid Models	Shared mobility services that integrate multiple operational and business models from multiple different modes of shared mobility into a hybrid service.	***Ridesplitting:*** Carpool apps which use the ridesourcing model to set up carpool rides between strangers (Shaheen & Cohen, 2019b). ***Ridesourcing-microtransit:*** Ridesourcing applications replace public transit (Pentikainen & Cane, 2019). ***Co-operatives:*** An ownership model where service users buy a stake in the service and/or vehicle fleets. Used in carsharing and ridesourcing (CCA, 2009; Vézina, 2018).	UberPOOL LyftLine Uber/Innisfil Modo Kootenay Co-op Eva

urban centres. There are also various microtransit companies contracted by cities and businesses to provide alternate transit services. Some examples are RideCo (n.d.) and Transdev Canada (2020) who have worked with Canadian cities to provide first-mile and last-mile connections, paratransit, and autonomous shuttle solutions. In addition, shared mobility options are often regulated by local municipal codes and by-laws specific to local contexts. For example, ridesourcing might be classified as a transportation network service (TNS) (License By-Law, City of Vancouver By-Law No. 4450, 2020), as a personal transportation company (PTC) (Licensing of Vehicles-For-Hire, Toronto Municipal Code Chapter 546, 2019), or as an auxiliary taxi-cab service (Taxi By-law, By-law 16-044 of The Regional Municipality of Waterloo, 2016), regardless they are generally managed and regulated as vehicles-for-hire or taxi-cabs in by-laws and legislation.

While there are many differences, high-level policy goals in Canada are similar and often offer shared mobility to help reduce GHG emissions, traffic congestion, support for first-mile and last-mile connection to public transit, and public transit synergy (Fai et al., 2020).

Uber and Communauto in Canada

In this research brief we take a look at two shared mobility services, Uber and Communauto, since these illustrate the different methods of implementation and the regulatory challenges that municipalities must overcome.

Uber is a ridesourcing company with a platform that mediates a ride transaction between drivers and users in need of a ride. Rides are booked via a mobile application or online where passengers and drivers create accounts to use the application and either ride as a passenger and/or to drive with Uber as a gig worker[2]. Trips, routes, and costs are prearranged, and the app tracks the ride using GPS and GSM technology (Uber, 2020a). Uber and similar services are regulated by taxi-cab legislation at municipal and provincial levels. However, responses to the disruption caused by Uber in the taxi-cab industry have differed—and both Quebec and Vancouver have recently allowed Uber and other ridesourcing companies to operate in their jurisdiction, following years of taxi-cab driver protests and pilot projects to assess impacts (Chan, 2019; Lapierre 2019). There are also other issues with this type of platform economy, the most notable being concerns regarding the payment of federal and municipal taxes in Canada (Black, 2020; Phillips, 2016). Furthermore, labour disputes between Uber and its drivers have resulted in gig economy organizations such as Fairwork[3] to protect this new class of gig workers by developing Fair Work Principles[4] (Oxford Internet Institute, 2020). Despite the many benefits of shared mobility, it is not without controversy.

2 'Gig workers' are defined by Statistics Canada as workers who enter into contract arrangements with firms to complete a task for a negotiated cost and time. This includes independent contractors, freelancers, and on-demand workers whose employment is mediated through an online platform (Jeon et al., 2019). Fairwork's definition of gig workers is focused on digital employment and refers to anyone who works through a platform that "digitally mediates transactions of labour" (Oxford Internet Institute, 2020).

3 See the Fairwork FAQ https://fair.work/en/fw/about/faqs/

4 See the Fairwork Gig Work Principles https://fair.work/en/fw/principles/fairwork-principles-gig-work/

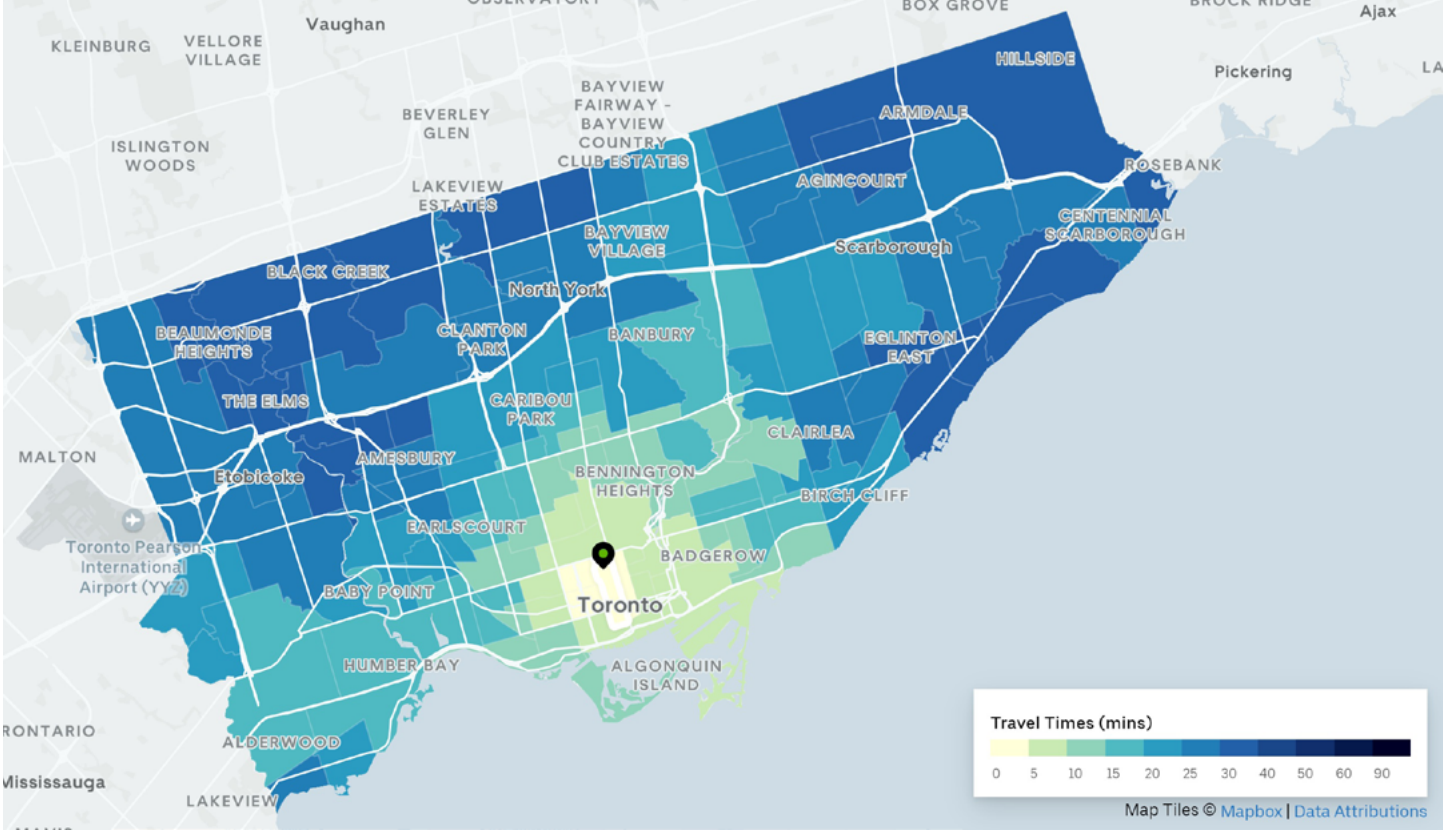

Figure 1: Uber Movement "Travel Times (mins)" map for Toronto, ON
(Uber, 2020b). Retrieved from https://movement.uber.com/?lang=en-CA (26 Nov 2020)

Uber is known for the extensive data they collect through their platform, which are also valuable to municipal transportation authorities. *Uber Movement*, a website launched in 2017, offers insight of what intelligence Uber data can provide through interactive, colour-coded city maps that depict near real-time the movement of traffic at any time of day or night (see Figure 1 below). Uber has however been hesitant to share data with municipalities, citing concerns for privacy and business advantage (Dobush, 2019).

Communauto is a membership based carsharing company which offers both a station-based service which is a pick-up and drop-off at a designated 'station' type of arrangement with a fleet of their vehicles, and a free-floating service where cars are picked-up and parked freely in public spaces. Communauto operates in various Canadian cities including Toronto, Montréal, Hamilton, and Ottawa, and is slightly different in each of these locations as a result of local by-laws and membership. To become a Communauto member, users must scan or mail documents to the company and this includes a photocopy of their driver's license, a recent driving record, and an insurance claim history (Communauto, 2020b). Once a member, users can rent cars via a mobile app, website, or by telephone, and they access Communauto cars via an RFID card mailed to members and if in Quebec it is integrated as part of the City's OPUS transit card, and in other cases members can also access vehicles through their smartphone application (Communauto, 2020c). Each Communauto service is adapted to local demand and context.

To provide on-demand services for their cars, Communauto and other carsharing services require space such as designated parking stations and/or parking spaces for pick-up and return, and in the case of free-floating models, vehicle assets may occupy valuable public parking spaces. Municipalities thereby regulate carsharing through parking by-laws and licensing systems, to limit the number of carsharing vehicles that are parking in public spaces and charge a nominal fee to reimburse communities for the dedicated use of these spaces. Cities often cap the number of carsharing cars allowed to operate and require designated parking zones and lots (By-law Concerning the Parking of Self-Service Vehicles, City of Montréal By-Law 16-054, 2018; Street and Traffic By-Law, City of Vancouver By-law No. 2849, 2019; Traffic and Parking Code, City of Toronto By-Law 1409-2011, 2011; etc.). These restrictions have resulted in some companies abandoning services in some cities, for example Car2Go left Toronto as a response to steep parking permit pricing (Rieti, 2018). In many cases parking is negotiated with condominium corporations, housing co-ops, universities, shopping malls and with some companies who use carsharing for their employees instead of buying their own fleet of company cars (Fai et al., 2020).

Why Shared Mobility Matters

Policy Considerations

Governing Shared Mobility Technologies

The combination of ICT innovations with transportation has resulted in an explosive growth of shared mobility services and user adoption. Shared mobility services offer flexible and varying modes of personal transportation options beyond individual car ownership that are easy to use and readily accessible on personal digital devices and on-demand access. As shared mobility services become widely adopted in urban regions, they become an important element of municipal transportation networks. Shared mobility technologies are smart transportation technologies and in an Open Smart City[5] that fosters values of meaningful collaboration and participation between public and private actors, the governance of shared mobility technologies would be "ethical, accountable, and transparent", and these would be governed to balance economic development, social progress and environmental responsibility (Lauriault, Bloom, & Landry, 2018, p. 7). Due to the reliance on IoT technology and applications in shared mobility services, issues with urban integration, smart technologies and data need to be considered in shared mobility planning.

Opportunities and challenges. The popularity of shared mobility presents both opportunities and challenges to municipal transportation services. Shared mobility providers focus on user experience which has the potential to increase the usage of their services. Sometimes this leads to an increase in transit use especially if integrated to serve the first and the last mile problem with transit, as was the case in Calgary where RideCo closed the gap between its urban centre and newer communities with microtransit and saw steady increases in ridership (Fast, 2019). This is especially the case when the service is easy to use, has automated payment systems and provides on-demand, safe and reliable service anywhere and anytime with one card for all (Metrolinx, 2018). In other cases, developments in shared mobility are technology—and capital investment—heavy resulting in these services being provided by large private transportation and application software companies. Since the most popular services and technologies in this industry are privately owned and operated, cities need to employ robust governance strategies that consider how shared mobility technologies are to be integrated into their public and urban transportation networks and systems.

Governance questions. Shared mobility technologies raise numerous public space, transportation, planning and governance questions, as follows:

- Can a transit pass be used seamlessly with a shared mobility system?
- Are there tax incentives for users and service providers to offset the gains on environment and traffic reductions?
- Do emerging shared mobility services require increased access to reserved parking?
- Can builders reduce the number of parking spaces and allow for carsharing?
- Can carsharing be a viable alternative for rural and remote communities who cannot afford a transit service?
- What of accessibility when the usual transit service is unreliable?
- Could microtransit be a solution between towns in rural areas, to get people to essential services or as a commuting strategy from rural and suburban areas and large cities?
- Could these be viable solutions for First Nation reserves and rural and remote Indigenous communities?
- Is there seed funding to start up these services and ongoing support to keep them viable and sustainable?

Financial support. There are any number of strategies to seek financial support for shared mobility services. For example:

- The City of Montréal Supply Department (2019) sought proposals from providers to plan and implement an automated shuttle pilot project on Montréal public highways;
- There have been multiple funding opportunities supported by the Federation of Canadian Municipalities (FCM) for studies and pilot projects concerning shared

5 Open Smart City Guide v1.0: https://docs.google.com/document/d/13Oz7fdN1fcX29FikKoMn28DUkH738_296bqZmnYKYAs/edit

mobility and other sustainable transportation solutions (FCM, 2020a; FCM, 2020b); and
- Research and development (R&D) project funding was provided by the Canada Urban Transit Research & Innovation Consortium (CUTRIC) to examine topics such as big data and transit, smart vehicles, and intelligent transportation systems (ITS) (2019).
- Shared mobility requires innovative funding approaches, along with regulation and creative governance and decision making.

Multi-jurisdictional collaboration. Transportation in Canada is governed by three levels of government, federal, provincial and municipal, in addition to First Nation communities, each with specific jurisdictional responsibilities. Collaboration between multiple levels of government and communities, interjurisdictional collaboration between the same levels of government, and across sectors with the private sector, co-operatives and not for profit organizations is not easy but is required.

Governance. Governance issues include the integration of shared mobility models in the city and with existing transit systems and procurement that involves negotiating data ownership and sharing agreements, as well as a system of accountability. In other words, shared mobility solutions need to be governed in such a way where "data management is the norm and custody and control over data generated by smart technologies is held and exercised in the public interest. Data governance includes sovereignty, residency, open by default, security, individual and social privacy, and grants people authority over their personal data." (Lauriault, Bloom, & Landry, 2018, p. 6).

Urban Integration of Shared Mobility

Shared mobility services have been a challenge for city administrators due to their sudden, disruptive potential to transportation systems and networks. As popular services are predominantly owned and operated by 'start-up' software companies, shared mobility developments have quickly and suddenly emerged and are growing fast, leaving regulators in a reactive position to new transportation innovations that generally operate within legal grey zones (Harry, 2016). The rapid and sudden innovation in shared mobility is however well past its infancy. Cities are now in a position to proactively adopt measures to effectively integrate and procure shared mobility into existing transportation networks, including with transit and infrastructure, before services are launched and fleets of vehicles offering services are dropped into cities overnight.

IoT technologies and mobile devices have enabled on-demand rental and for-hire services where users can find and access shared vehicles or can hire a ride anywhere within an urban area. While efficient, these services require care, attention and deliberation and plan with providers and residents as to how best to physically integrate these vehicles and devices into urban spaces. As mentioned earlier, carsharing services for example can be station-based, which requires designated vehicle lots, or free-floating, which requires the use of public parking spaces, and cities have adopted permit systems to manage this land use (see examples of by-laws that apply to Communauto as identified earlier). Other forms of shared mobility present other issues related to urban space. Microtransit vehicles for example may increase flexibility through on-demand pick-ups and drop-offs, however this may cause issues on major arterial roads where these stops may be frequent, often disrupting transit service corridors and slowing the movement of regular individual vehicles (Toronto Transit Commission, 2016). Micromobility services, particularly dockless scooter-sharing, have also caused urban disruption as the vehicles can be left anywhere in a designated area after a trip, leading to scooters being discarded on public walkways, intersections, and private property (Bowles & Streitfeld, 2018; Charbonneau, 2020).

Curb Management. City curbs have become spaces of competition for shared vehicles to park or pick-up and drop-off passengers (Shaheen & Cohen, 2019a). Like carsharing, other forms of shared mobility will need to be integrated into effective curb space management policies. Shaheen and Cohen (2019a) outline various elements of curb space policy regimes for micromobility, and some of these tools may also apply to other forms of shared mobility. These policies could include formal and codified application processes to service a particular area, vehicle and device caps, service area limitations

with permissible and prohibited zoning, designated parking areas, operation and application fees, and equipment and operation requirements such as maximum operational speeds or insurance requirements (Shaheen & Cohen, 2019a). Ultimately, increasing mobility options in cities can benefit urban movement and transit options, however the physical space these shared vehicles and services occupy and use requires careful and mindful planning in a way that does not impede other transportation initiatives and the day to day travel of regular city vehicle mobility.

Procurement. As shared mobility services continue to appear and evolve, effective procurement strategies will be important for realizing the benefits and opportunities that shared mobility services offer in terms of public transportation planning. Partnerships and agreements will need to be made with the companies who possess the technological capacity and equipment to deploy a shared mobility service, and cities can set the terms of these arrangements in a way that benefits all parties involved, including the public good. Establishing procurement standards through guidelines/toolkits would be beneficial to the governance of shared mobility in cities.These might include:

- Trying to procure local, smaller enterprises to avoid market domination by large multinational companies, an example being local carshare co-operatives which utilize shared ownership, assets and costs between local members (e.g. Modo, Kootenay Carshare, Peg City Car Co-op);
- Promoting sustainability by mitigating e-waste and poor labour practices; and
- Transparent procurement such as public disclosure of contracting to ensure sovereignty and accountability over data and space (Lauriault, Bloom, & Landry, 2018).

There are several resources that city officials can adapt to promote sustainable and ethical procurement in shared mobility, and these include the *Open Contracting Data Standard* (OCDS) (Open Contracting Partnership, 2017) or *The Forum for the Future's Sustainable Procurement Tool* (Lauriault, Bloom, & Landry, 2018).

Accessibility. Partnering with shared mobility services and integrating these technologies into public transit offerings will also require consideration for potential barriers to access. Transit agencies provide a primary source of mobility for vulnerable populations including low-income and paratransit riders. The reliance and need for smartphones, credit/online debit cards, and a data plan to utilize shared mobility services can prevent unbanked/underbanked and disconnected populations from accessing and enjoying the benefits of technology-enabled transportation options. Regulators will have to consider that the affordances of IoT technologies may not be applicable to everyone (Westervelt et al., 2017). Additionally, in the case of for-hire services like ridesourcing, gig workers are usually not properly trained or are not properly equipped to assist individuals with disabilities (Ditta et al., 2016). As for-hire services are procured to perform public work, cities may need to work with private operators to establish training and education protocols that account for vulnerable populations who rely on public transportation. An Open Smart City strives to make ICT accessible to all, including unbanked people, people with disabilities, and the elderly. *The Global Initiative for Inclusive ICT* or *G3ict* is one initiative that offers the *Smart Cities for All*[6] toolkit to support inclusive and accessible smart city strategies, and this may be applied to shared mobility planning.

The integration and growth of private shared mobility services in the realm of public and personal transportation will require close attention as cities work to take a lead governance position in municipal transportation. City curbs will require effective management to incorporate digital on-demand mobility options and procurement strategies should consider sustainable and accessible options for shared mobility users. Services such as SAFETRIP[7] that provides rides to healthcare providers and pays fees via the healthcare system or services such as SCOOT[8], which stands for Stronger Communities through Open and Organized Transportation, are welcomed additions to shared mobility, but in Canada, more is required

6 Smart Cities for All initiative: https://smartcities4all.org/
7 SAFETRIP for healthcare: https://www.safetrip.co/
8 On the SCOOT service: https://www.disabilityscoop.com/2018/12/07/ride-sharing-disabilities/25793/

on this front. In the context of an Open Smart City, integrating private mobility industry into public spaces will also require consideration for technological disability, accessibility, and financial access and support for users as well as new innovative start-up funds to support this type of shared mobility solution.

Data and Technological Sovereignty & Accountability

Large software application companies such as Uber and Lyft have come to dominate shared personal transportation in urban centres, which complicates the municipal and regional governance of these activities. Cities which aim to adopt accountable and transparent governance processes in public transportation are faced with a budding industry of private technological innovations that include privately-owned software and IoT-enabled vehicle technologies. In an Open Smart City which plans to govern in an ethical, accountable, and transparent way, the dominance of private companies in shared mobility may challenge notions of data and technological sovereignty, as well as accountability and transparency.

Sovereignty. Data and technological sovereignty refers to the "ability of citizens to set the terms of use and intended purpose of technology", which can include the technical platform and it's associated data, algorithms, infrastructures, and knowledge (Lauriault, Bloom, & Landry, 2018, pp. 6-8). Establishing this form of social and technical agency and sovereignty over systems recognizes the importance of technology in the management of a city's vital systems, including mobility, and asserts that this management should meet the needs of the community and collective life in an open, transparent and democratic form (Lynch, 2019). This idea clashes with the 'closed' nature of most shared mobility services in operation, who utilize extensive terms-of-service and privacy policy agreements to allow the use of their technologies and software. Such agreements state that the organization will collect and use user information for lawful purposes (i.e., to collect debt, or to catch fraud), for administrative purposes such as for account creation and communication, and for promotional purposes such targeted marketing through tracking systems like cookies or Google Analytics (Fai et al., 2020). In many cases, the privacy policies and terms-of-service are vague and allow for the monetization of user information, and consent to these terms is considered mandatory for use of the service (Petersen, 2019).

Collaboration with private industry will often be necessary to integrate shared mobility into public and personal transportation networks due to the heavy costs of technology and innovation in this field that is well established in the private sector. Mitigating the risks to technological sovereignty and exercising control over data that are produced by smart shared mobility devices should be approached in a way that promotes meaningful participation and shared responsibilities between public and private actors, rather than stifling innovation through strict restrictions. While mobility services may set the terms of use over technology and data collection on their platforms, cities can and should take steps to ensure that these technologies operate with transparency and that any non-personal data collected can be utilized as a public resource by the city for planning purposes (Lauriault, Bloom, & Landry, 2018). As will be discussed later, effective data sharing agreements are critical to governance in this area.

Accountability. Public transit provided by private industry raises additional concerns for accountability. For example, integrating digital platforms that are driven by for-profit organizations in a public system may over-emphasize benefits of efficiency and operability, which may sideline ethical governance principles of accountability and transparency and also the equitable delivery of the service to all residents in a city regardless of ability, income or where they live (Lauriault, Bloom, & Landry, 2018). Data privacy and security are key to the safe management of sensitive data, and privacy by design[9] needs to be part of these systems, to build trust between users and providers and to mitigate data breaches as was the case with Uber (Fai et al., 2020; Shaheen, Cohen, & Zohdy, 2016).

9 *Privacy by design* asserts that the privacy and security of personal data in ICT systems cannot be "assured solely by compliance with regulatory frameworks", but should be "an organization's default mode of operation" through proactive, transparent, and secure measures that are embedded into the design of ICT systems (Cavoukian, 2011, p.1-2).

Shared mobility technologies in cities require effort from public and private administrators to ensure that these services are deployed in an ethical, sustainable, and secure fashion, this involves shared responsibilities and the building of a "culture of trust" (Lauriault, Bloom, & Landry, 2018, p. 11). Shared mobility systems offer many benefits and some unresolved issues concerning urban integration, planning, access, procurement, data and technological sovereignty and accountability. Shared mobility systems also produce big data, which can be very useful for cities for planning and system integration, and governing challenges in terms of data sharing, privacy and security.

Governing Shared Mobility Data

Shared mobility platforms, applications and technologies collect vast amounts of administrative and near-real-time data that are useful for transportation and traffic planning. These data assets include several data types, including:

- ***Administrative data:*** insurance, vehicle fleets, accounting, finance, etc.
- ***Client data:*** registration, usage patterns, social insurance numbers, credit information, driver's licenses, etc.
- ***Real-time data:*** location data, mileage, vehicle diagnostics, routing, etc.
- ***Financial transaction data:*** e-commerce services, online credits/wallets, account information, etc.
- ***Data visualization:*** routing maps, in-car navigation, real-time usage data, indicators, KPIs, etc. (Fai et al., 2020).

Shared mobility data are of high value to city administrators, policymakers and service providers. By mobilizing the data collected and managed by shared mobility operators, city administrators can work to serve the interests of the public in numerous ways. These include planning purposes to better understand the movement patterns and demand for travel in a region, policy research on the use of shared mobility services, better management practices concerning traffic network events, and for monitoring purposes to ensure that regulation is enforced and complied with. The data can serve interests at multiple governmental scales, with more long-term applications and planning at the provincial/regional level and more "granular" data needs at the municipal level including "route and path data" (Matute, Cohen-D'Agostino, & Brown, 2020, p. 2). These data include geospatial traffic movement data (speed, mode and time) and other data from public transit and shared mobility operators that can inform broader urban and transportation policy goals (MaRS Discovery District & Arup, 2018).

With the types of data that are collected, shared mobility services can offer insight into numerous policy areas, including transportation networking, real-time traffic management, public transit, addressing market gaps in mobility, faster emergency services, increased safety, better urban design and planning, insurance, land use and parking, and in the case of for-hire services, it may be possible to address labour issues related to gig workers. In addition, the data collected by shared mobility services can also be integrated with the urban form and design of city transportation networks—the use of GPS and GSM technology can document city movement in real-time by location—creating valuable insight for transportation master planning, urban design, connecting rural and interregional locations, and the placement of shared mobility stations and vehicles.

Accessing shared mobility data can be challenging for cities since most services are privately owned and operated. Some shared mobility services are more open, for example micromobility services typically offer both open data and open and public application programming interfaces (APIs). Other services such as ridesourcing companies like Uber and Lyft restrict access to APIs, and carsharing companies often do not use any APIs (Transit App, 2018). Collaboration between city administrators, shared mobility operators, and the public when it comes to data sharing agreements is essential, so that terms balance public good and private sector bottom lines in a mutually beneficial fashion.

Data governance. Data governance includes processes which allow cities to manage technologies and protect citizen interests and privacy, while keeping private corporations accountable for their activities and actions and maintaining their competitive advantage. Data governance can take many

forms, including data strategies which define and determine how data are used; data policies that address sharing, privacy, and third-party involvement; standards and protocols for security, data management and sharing; oversight and compliance plans/audits; legal contracts; data modelling and associated methodological literature; and information about the technologies used, including about algorithms, AI, and API's (Fai et al., 2020).

Many universal approaches to data governance have already been formulated and may be useful for future shared mobility planning. The Data Management Association (DAMA) for example offers a standard model of governing the 'lifecycle' of data assets that is adaptable to local contexts, legislation, and institutional arrangements and is an example of an approach that could be adopted in shared mobility governance regimes to enforce accountability and standardized data (2017). Currently, shared mobility as an industry lacks a foundation for effective data governance, namely universal data sharing agreements and data standards; not all cities have the capacity to do this.

Since shared mobility data governance regimes are relatively new, the foundations for effective and beneficial collaboration with private shared mobility operators need to be set. Primary issues for policymakers include: the need for data sharing agreements, developing shared mobility data standards, and issues concerning privacy and surveillance.

The Need for Data Sharing Agreements

To leverage the benefits offered by shared mobility data, some form of data sharing regime between cities and private industry providers needs to be developed. Shared mobility service providers typically do not share data with cities by default, thus some form of data sharing agreement is needed to arrange sharing practices in a way that benefits all of the parties involved, as well as the public interest. Currently in Canada, there are no universal federal, provincial, or municipal approaches to shared mobility data sharing. Existing models of data sharing vary by jurisdiction and are subject to local transportation contexts. Local examples of data sharing arrangements include:

- In 2016 the City of Montréal partnered with traffic app 'Waze', a now Google-owned app where users can find shortcuts by collaboratively sharing traffic data. In exchange for data provided by 103,000 Montréal Waze users, the Urban Mobility Management Centre in Montréal shared real-time traffic data that was captured via cameras, sensors, and radars. This decision follows Montréal's goal to be a leader in smart city initiatives and benefits the city, application, and Waze users (CBC News, 2016).
- Fitness IoT company Strava signed a contract with the City of Ottawa and Gatineau to share its GPS location data that are collected through fitness devices and smartphones for two years. Ottawa and Gatineau sought to use these data to make more informed infrastructural decisions that concern how people cycle throughout the city (Tremblay, 2016).
- The City of Toronto requires TNS companies (ride-sourcing services) who wish to operate in the region to agree to a "Vehicle-for-hire Data Sharing Agreement", which specifies the types of data that the service must collect, the manner of this collection, security and transfer methods for the data, and the types of data that must be disclosed to the city (License and Permit Issuing Office of the City of Toronto, n.d.).

Data sharing efforts can take various forms and require further investigation regarding scalable and replicable models that can adapt to local and regional contexts. The Institute of Transportation Studies at the University of California defines three possible alternative shared mobility data sharing approaches which could be used by regulatory agencies to gain access to "disaggregated data, analysis, and sharing of aggregated statistics and information", including:

- Arrangements where the mobility provider leads the analysis of data under municipal data requirements and methodologies;
- Where the regulatory agency leads analysis and requires the reporting of certain data as a condition of licensing/permitting; or
- Where a third-party brokers the data and leads analysis for public agency clients (Matute et al., 2020, p. 12).

While each model may have unique benefits and limitations, the Institute reports that each model must be built on some form of trust whereby: data are complete and accurate, and analyses by mobility operators or third parties are accurate and properly conducted (Matute et al., 2020).

Data sharing agreements show promise for opening data streams between private and public transportation operators, however a universal framework for sharing mobility data is needed. As most current data sharing agreements are subject to local jurisdictional context, there is little data interoperability across scales, provincially or federally nor between cities. Standardizing data sharing practices between transit agencies, and transportation planning groups with shared mobility companies can improve cross-government compatibility and can assist smaller and rural communities who may lack the scale, expertise, and capacity to develop effective data sharing agreements (McCoy et al., 2018). This offers the opportunity to plan transportation at a larger scale.

Lack of Shared Mobility Data Standards

Data standards are a strong governance tool in an Open Smart City and are necessary for establishing effective data sharing regimes, as a means of ensuring that data have value and utility and can be effectively mobilized by various levels of government, various departments, and for shared mobility operators. For governments at the federal, provincial, and municipal scale, established data standards can be an effective policy tool to support interdisciplinary and cross-jurisdiction shared mobility research and to allow for greater comparability and planning across different jurisdictions.

As is the case with mobility data sharing strategies, data standards in this industry are in their infancy and there is no universally adopted approach. Three of the primary shared mobility standards developments are detailed in Table 2 below.

Shared mobility and transportation experts also advocate for the integration of shared mobility with open data standards

Table 2: Shared Mobility Data Standards

Shared Mobility Data Standard	Description
General Transit Feed Specification (GTFS)	GTFS is an established shared mobility data standard that was developed by Google and TriMet in 2015. This standard assists route and schedule data sharing between public transit agencies and software developers, such as for integration with Google Maps (Google Developers, n.d.; GTFS, n.d.). GTFS operates under a Creative Commons BY 4.0 License (Creative Commons, n.d.).
General Bikeshare Feed Specification (GBFS)	GBFS was developed by the North American Bikeshare Association (NABSA) in 2015 and is used in seven Canadian cities, including Toronto, Montréal, and Vancouver. It was created to standardize bikeshare data in a publicly accessible and uniform format. GBFS operates under a Creative Commons License for Public Domain (NABSA, n.d.). The Institute for Transportation and Development Policy (2018) recommends GBFS as a best practice for bikesharing.
Mobility Data Specification (MDS)	MDS was developed in 2018 by the Los Angeles Department of Transportation and is now owned by the Open Mobility Foundation. MDS extends GBFS specifications to include dockless e-scooters, dockless bicycles, and potentially carsharing through added APIs. Unlike GBFS's public focus, MDS focuses on standardizing shared mobility data for cities and regulatory agencies in a comparable format for analysis (Open Mobility Foundation, n.d.).

including open and public APIs. Guiding principles for establishing these data standards includes:

- Data standards in shared mobility should be open, including support for data access, data quality and timeliness, and open data platforms and dashboards (Shaheen & Cohen, 2019a);
- To improve interoperability and sharing between different government levels and service operators, open standards should be established and should outline consistent forms of data sharing practices (Ditta et al., 2016);
- The integration of data sharing standards between government, transit authorities, and shared mobility providers can improve the planning and evaluation of environmental, economic, and social opportunities (Dunsky Energy Consulting, 2017);
- Cities can require public, open, and standardized APIs and common data formats (.xls, .csv, etc.), and historical data should be provided on a timely basis (Transportation for America, 2019).

Setting standards for the collection and sharing of shared mobility data allows cities to integrate data from multiple sources for planning and governance. As these sharing strategies in their current form are mostly jurisdictionally contingent, there is an opportunity to define a multi-jurisdictional approach to transit and shared mobility data standards in the same way that cities have developed common data licences in Canada.

Privacy and Surveillance in Shared Mobility

The large amount of data captured by IoT-driven shared mobility services also demands that cities consider the privacy and surveillance impacts of this collection. To administer services, companies collect a wide-range of sensitive data including personally identifiable, financial, and trip information, which makes privacy and security a primary concern for consumers (Shaheen, Cohen, & Zohdy, 2016). These data could include names, phone numbers, licenses, credit card information, and trip data such as trip durations and locations (Jin. et al., 2018).

Current legislative developments in Canada will have an impact on the future of privacy and surveillance in shared mobility data collection. The recently tabled Bill C-11[10] includes new data protections, changes in privacy regulation, fines for companies who do not follow the law, and greater consumer protection when it comes to data and algorithmic decision making. Under this Bill, private organizations who collect personal data will be required to provide general accounts on how their automated systems use personal data to make decisions, and this includes explaining decisions, predictions and recommendations to individuals as part of their right to access their personal data. Other innovative provisions include exceptions to consent requirements for the internal use of existing personal data stores, as well as the facilitation of socially-beneficial de-identified data sharing (Scassa, 2020). Although Bill C-11 addresses data privacy protection at the federal level and some gaps will need to be filled in provincial data plans, the sweeping reforms to the data environment of Canada's private sector will undoubtedly affect shared mobility service providers who collect personal, financial, and transportation data (Scassa, 2020).

Cities will need to assess the privacy and surveillance risks associated with shared mobility applications and platforms as these services become integrated into urban transportation networks. The highly sensitive and identifiable nature of transportation and financial data collected by shared mobility services creates the potential for external or internal threats to privacy and security. Bill C-11 is a step in the right direction for protecting the privacy interests of shared mobility users however regulating and standardizing data collection, management, and security procedures on shared mobility applications could further help establish uniform data collection regimes that are transparent, ethical, secure, and that benefit the public interest.

10 *BILL C-11: An Act to enact the Consumer Privacy Protection Act and the Personal Information and Data Protection Tribunal Act and to make consequential and related amendments to other Acts (2020)*, https://parl.ca/DocumentViewer/en/43-2/bill/C-11/first-reading

Potential Risks and Opportunities

Potential Risks Presented by Shared Mobility

With the complexity of operational and ownership models used by shared mobility services, there are various risks for public agencies and policymakers when working in this sector. Risks can also be exacerbated by the unprecedented COVID-19 pandemic which has put sanitation and social distance as high-priority health goals, leaving the future of shared vehicle assets and trips uncertain, let alone creating health risks for drivers. This threat should be considered along with the risks presented here. Below are some of the primary issues to overcome some of the concerns with shared mobility operations in an Open Smart City:

Lack of control of public data. Effective data ownership models may be difficult to achieve in public/private partnerships. For instance, on one hand governing agencies may have more control over the form and use of data when they own the service/operation, however they may lack the necessary capacities for managing, securing, and analysing the data in a meaningful way. Capacity is an issue for smaller jurisdictions. On the other hand, private company ownership of shared mobility services could better allow for the valuable analysis of services since there are technical data science skills, but this can lead to vendor lock-ins, issues with funding, and a lack of control over data (Transportation for America, 2019). Data sharing agreements need to consider data ownership when collaborating with private industries so that control over the data is transparent and meets the needs of all parties.

Negative impacts on current transportation networks. Certain operational forms and services have contributed to negative impacts on transportation policy goals. For example, ridesourcing services have been linked to various issues including: increased road congestion due to high numbers of vehicle fleets operating (Anderson, 2014), increases in overall vehicle kilometres travelled (VKT) due to driver "deadheading" or driving without passengers (Henao & Marshall, 2019), and accessibility issues where drivers usually are not trained or do not possess the equipment to assist people with disabilities (Ditta et al. 2016). As shared mobility becomes integrated with transit initiatives and municipal policy goals, administrators will need to consider how these services will interact and integrate with the current built transportation environment, public transit policy including universal access, and accessibility and the possible effects that may come as a result.

Competition with public transit services and modal shifts. Different modes of shared mobility have had mixed impacts and effects on public transit usage, which may be a risk to long-term municipal transportation plans, investments, and policy goals. Some forms of shared mobility have become a competitor or detriment to public transit options. For example, private ridesourcing has the potential to decrease public transit usage by acting as a popular, more personalized transport alternative (Jin et al., 2018), and the Toronto Transit Commission (TTC) reports that private microtransit services may compete with public transit while also causing congestion along conflicting routes with public transit vehicles (TTC, 2016).

Cities will want to consider their own transportation context and may want to integrate shared mobility services into existing regulatory structures and urban planning as a means to promote synergy with public transit operations. This could include aligning systems into urban form, such as designating pick-up/drop-off points and bikeshare/scooter-sharing stations near transit stations, or by pursuing private-public partnerships and developing multimodal transit passes to encourage both transit and shared mobility usage. Working these considerations into transportation planning could mitigate or offset risks to existing transportation infrastructure that arise when new shared mobility options become more prevalent than public options.

Privacy and surveillance risks. The large trove of sensitive data collected on shared mobility platforms is at a high risk of attack and requires strong data security procedures to protect from potential mistakes or hacks, which have already occurred. For example, a Citi Bike glitch in 2013 leaked credit information of over one thousand users, and Uber was breached in 2015 when over 50,000 driver names and license data were stolen (Shaheen, Cohen, & Zohdy, 2016). There is also the possibility of misuse by providers who monitor the movement of people's trips and detect individual patterns that if revealed may cause harm.

Additionally, the usage of internet-connected GPS technologies and vaguely worded terms of services/privacy policies in shared mobility poses some surveillance risks to consumers. For example, scooter-sharing services have been highlighted for their potential to develop identifying profiles on consumers through hyper accurate tracking of last-mile trips, which can reveal personal information such as "living arrangements, employment, social connections, and consumer behaviour" (Petersen, 2019, p. 194). This invasive collection of location-based data are personal data about consumers that have been sold to advertisers, data brokers and other third parties. Shared mobility platforms, such as scooter-sharing services Bird and Lime, often use vague wording in privacy policies that allow for the monetization and sharing of consumer data with third parties. The ability to opt-out of data collection in these arrangements is often illusory, as consent is necessary to use the service (Petersen, 2019). Possible approaches to these issues include standards for the anonymization of shared mobility data (McCoy et al., 2018), strict privacy practices with opt-in option to invasive practices, and standardized security and transfer methods (Transportation for America, 2019).

Poor labour conditions in the gig economy. Shared mobility companies can be driver for-hire services and Uber is a classic example of this in the ridesourcing industry with its gig workers. Companies such as Uber define drivers as "contractors" instead of "employees", despite taking on traditional employer roles such as worker surveillance and fare control (Steinberger, 2017). Research has shown that these arrangements are precarious and promote economic uncertainty in drivers, they lack protections and rights for workers in terms of wage, benefits, and dismissal protection, and they allow the ridesourcing company to ignore employer obligations including social security, tax liabilities, and pension plans. These arrangements also often result in a lack of regulatory compliance by unknowing drivers, who may fail to understand the consequences of improper income reporting and taxation processes for independent contractors (Black, 2020). As cities work to collaborate with and integrate these for-hire services into urban transportation, developing fair labour practices that promote security and safety for shared mobility drivers should be considered. Fairwork[11] is one example of a project which has developed principles and standards to protect gig workers which can be used to measure and evaluate gig worker conditions (Oxford Internet Institute, 2020).

Potential Opportunities of Taking Early Action on Shared Mobility

Integrating shared mobility into the planning of transportation and transit ecosystems offers various opportunities for city administrators and policymakers. Such opportunities include:

Improving multimodal movement through transit synergy. Shared mobility has the potential to be integrated with transit services to increase transit adoption by providing opportunities for quick and efficient multimodal trips (Pentikainen & Cane, 2019; Fast, 2019). For example, positive synergy can be achieved when free-floating carsharing and micromobility fleets are used as a first- and last- mile option for transit trips (Tyndall, 2019) or when rush hour congestion on transit routes is reduced due to bikeshare work commuting (Wang & Zhou, 2017). As these shared services also have the potential to compete with public transit, private-public collaboration is vital to ensure that users have access to a wide-range of options while also ensuring that transportation resources and networks are not wasted and eclipsed by private transportation options. Additionally, by setting data standards in a way that allows cross-jurisdictional analysis between shared mobility and transit data, transit providers can research and analyze multimodal movement, plan to effectively interconnect shared services with public transit hubs, and can promote shared mobility as a first- and last- mile option for transit trips.

Improved rural and regional transportation. Shared mobility services are promising solutions for interregional travel and transit in rural areas. Innisfil, Ontario for example partnered with Uber in 2018 to use on-demand ridesourcing services as an alternative to public transit. The results of the project were positive among residents and Transit staff, and

11 See Fairwork principles: https://fair.work/en/fw/principles/fairwork-principles-gig-work/

transit adoption levels rose dramatically. It should be noted that the high levels of transit adoption resulted in exorbitant costs, and Innisfil in 2018 was massively over budget. Innisfil reports however that despite the overspending, transit costs became significantly more efficient for moving significantly greater volumes of people and transit trips, and that a comparable cross-town coverage from a bus-route would have been significantly more expensive (Pentikainen & Cane, 2019). On-demand offerings for transportation through smart applications show promise for sustainability and usage in smaller communities that have lower rates of public transit usage and higher rates of single-car ownership, but expected increases in transit adoption and their subsequent costs will require consideration when preparing program budgets and estimating public transit system use in small and rural regions.

Establishing shared mobility data standards which include standardized sharing agreements can encourage safe partnerships between private industry and rural municipalities as well. Smaller regions may lack the capacity to develop governance strategies for shared mobility data and could benefit from a replicable and scalable governance approach that can benefit their needs and policy planning. Developing a standard shared mobility form that can be used across jurisdictions may also assist smaller jurisdictions in pursuing effective partnerships with private industry while ensuring dataset compatibility across different government levels (McCoy et al., 2018).

Getting ready for autonomous and electric vehicles. Transportation policy and industry literature designates autonomous and electric vehicles as high-impact and disruptive innovations on the future of shared mobility, and on the transportation industry more broadly (Mentor Works, 2019; Ontario Centres of Excellence, 2019; Reeder et al., 2019). As policymakers integrate shared mobility data into transportation governance and urban planning, there is also an opportunity for administrators to consider the future built environment required for these upcoming technologies and how they can be integrated with shared mobility developments (charging stations, autonomous car parking and sensors, etc.).

Using intelligent transportation systems (ITS). ITS refers to technologies which support and improve the operation, safety, and maintenance of transportation networks, such as smartcards and e-commerce, transit monitoring through real-time information and GPS, closed circuit and on-vehicle monitoring, and sensing and signal technologies (Canadian Urban Transit Association, 2017). Shared mobility services utilize similar technologies for operation (GPS tracking, e-commerce, algorithmic routing, etc.) and naturally fit into ITS. Defining data standards can assist with integrating shared mobility into current ITS arrangements as ITS demands multi-jurisdictional collaboration due to the seamless connection between roads in different jurisdictions. Isolation for ITS systems can result in poorer service, increased costs and congestion, and missed opportunities for jurisdiction-integrated transit services (Welsh, 2011). Future ITS initiatives can better plan to integrate shared mobility when transit and shared mobility data are standardized for sharing.

Conclusion

Shared mobility presents many risks and opportunities for policymakers and will need to be assessed as a smart system in different Canadian contexts. An Open Smart City approach offers a framework and principles for cities to work towards integrating shared mobility into public transportation networks in a way that is ethical, transparent, and that benefits municipalities, services and the public while mitigating risks. Collaboration on multiple government levels, between jurisdictions, and between private and public actors will be required to establish standards, strategies and frameworks that enable cities to take a lead role in the governance of emerging and digital shared mobility developments.

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