Mobility as a Service (MaaS) within Smart City Planning

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Abstract

The terms ‘smart city’ and ‘smart urbanism’ are oftentimes followed by statements about an environmentally friendly, sustainable, and data-driven urban future. Statements as such can be quite assumptive and controversial because the smart city is not homogenous and can vary from location to location. However, a smart city strives to be a technologically driven urban environment that uses a collection of sensors, monitors, and devices to collect specific data and information from humans. The information collected, extracted, and analyzed within the smart city is highly dependent on human interactions with such smart technology. Once the data from the city dwellers and visitors is extracted through the use of smart technology, big corporations, companies, transit agencies, and municipalities can better predict overall usage, patterns, and flows within the smart city.

Mobility-as-a-Service (MaaS) is an emerging form of public and private transportation that allows for MaaS users to book and pay for a trip via smartphone, website, or call centre all through a single platform. MaaS’ overarching goal is to shift away from personal modes of transportation and to reduce overall traffic congestion. MaaS covers a wide variety of public transportation options such as On-Demand Transit (ODT), Automated Vehicles (AV’s), Electric Scooters (e-scooters), etc. ODT and AV’s provide shuttle buses to connect urban dwellers to their destinations, whereas e-scooters are available for a single individual to complete their trip. Therefore, this paper intends to focus on the use of smart technology and IoT within our transportation system and the political divides transportation can create within our built environment. Additionally, this paper will explore how MaaS micromobility options are changing our urban public transportation system and how such change impacts the level of access city dwellers have to such services.

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Firstly, I would like to personally thank my supervisor and advisor Roger Keil for his tremendous guidance, support, and help throughout the entire duration of the MES program and writing process. Thank you for introducing me to urban theory and sparking my interest in urban planning in ENVS 2200. Roger helped keep me focused and motivated during the entire process and was always available whenever I had any questions and/or concerns. Thank you for your unwavering support, words of encouragement, and motivation. I would like to thank Zachary Spicer for always making me ask the hard questions and for reinforcing my interests in transportation planning. Thank you to the Transit Integration team at Metrolinx for introducing me to new mobility projects and thank you to Josh Tzventarny for connecting me with my interview participants.

I would to acknowledge the support and love from my family, my friends, and my significant other whose encouragement and kind words always helped me through such an extensive and tiresome journey. To my mother, thank you for always guiding me through life and for being an exceptional role model. I would like to specially thank my father, who was unfortunately not with me physically through this process, but nonetheless guided, supported, and loved me throughout the entire process. A sincere thank you to my significant other; without his patience, support, and kind words this process would have been more stressful at times. This paper would not have been possible without the help and support of these people who have truly made me believe in myself and helped me achieve my goals.

To my MES Cohort of 2022, we had an interesting COVID-19 virtual learning experience. Despite being virtual, we still supported one another throughout the duration of the MES program and made some great long-lasting friendships. Good luck to everyone on their

future endeavours. Finally, I would like to thank my Professors and the Faculty of Environmental Studies and Urban Change for providing me with a rewarding academic journey.

Foreword

This major paper has been submitted to the Faculty of Environmental and Urban Change in order to fulfill the requirements of the Master in Environmental Studies (MES) Planning program. This major paper is an extension of the theories and themes discussed in my Plan of Study. My Area of Concentration for my plan of study is Planning for the Smart City: Socio-Political and Spatial Implications. My interests in the use of public and private space in addition with the use of technology in our urban fabric influenced my research. In addition, my internship at Metrolinx during the summer of 2021 strongly influenced my decision to take a transportation planning perspective on smart city planning and smart technology. During my time at Metrolinx, I worked on developing an On-Demand Transportation Toolkit that outlined best practices and lessons learnt from case studies across Canada. Although my Plan of Study has evolved and transformed throughout my enrolment in the MES program, my interest in smart technology, smart urbanisms, and the socio-political and spatial implications remained. These interests, allowed me to grow my ideas beyond smart city rhetoric and helped me purpose a paper in this field.

The topics engaged in this paper are directly aligned to those outlined in my Plan of Study:

- Component 1: Smart Urbanism
- Component 2: Participatory Planning
- Component 3: Urban Political Economy

This paper has allowed me to combine and intertwine my personal experience, working experience, and academic interests into a single project. This research paper has allowed me to discuss the future of smart transportation, participatory planning in the smart city, and the socio-political and spatial implications of embedding smart technology in our urban fabric and

transportation system. The suggestions and conclusions made in this paper serve to fulfill the goals of my area of concentration and could be used for local municipalities and transportation planners when considering/creating a smart transportation system.

List of Abbreviations

AODA – Accessibility for Ontarians with Disabilities Act

AV – Autonomous Vehicle

COVID-19 – The disease caused by the SARS-C0V-2 virus that led to a pandemic in 2020

E-scooter – Electric Scooter

FMLM – First-Mile Last-Mile

GP – Growth Plan

GTHA – Greater Toronto and Hamilton Area

ICT – Information and Communications Technology

IoT – Internet of Things

LIDAR – Light Detection and Ranging

MaaS – Mobility as a Service

ODT – On Demand Transportation

PPS – Provincial Policy Statement

RTP – Regional Transportation Plan

SPLIT – Subsidized Passes for Low Income Transit

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Chapter 1: Introduction

Toronto is a growing metropolis that is seeing a rise of technological innovations and is home to an ever-increasing tech ecosystem (Metz, 2022). Starting in 2017, Google's sister company, Sidewalk Labs pursued the Quayside project in the city of Toronto, presenting a "sustainable and technologically advanced" plan that was supposed to be implemented in Toronto's eastern waterfront by 2040 (Sidewalk Toronto, 2020). However, the project was discontinued in May of 2020, ostensibly due to the economic impact of COVID-19 (Goodman, 2020). Sidewalk Labs brought an immense amount of attention to the city of Toronto and to the Quayside in particular. Scholars, urban planners, technology companies, etc. were all interested in the Quayside project and specifically in the impact the technology proposed for Quayside would have on the existing character of the city of Toronto and its urban fabric and atmosphere. Historically, it is important to note, that Toronto's waterfront has always been an important and influential parcel of land. The area has an extensive planning history that is critical to consider when understanding the implementation of smart city technology into the urban fabric. The first reformation project for Toronto's waterfront was planned in 1912 (Desfor, 1993). The Harbour Commissioners wanted to invest in the land and fill AshBridge Bay Marsh with concrete to reduce public health risks and increase overall industrial activity within the space (Desfor, 1993). However, in the 1950s, the industrial employment rates started dropping and the Harbour Commission began facing financial problems due to the lack of revenue (Desfor, 1993). Throughout time, the city of Toronto's Quayside has been home to technological advancements to serve the overall functioning and economy within the city. For example, canoes, steamships, boats, etc. were used in the city of Toronto's waterfront as a way to export and import shipments. The newest technological wave of innovation in the area was to include smart technology (i.e.,

sensors, cameras, monitors, etc.) introducing the phenomenon known as “the smart city”. Smart city technology creates an atmosphere of surveillance and invasion of privacy. Therefore, the implications of implementing smart city technology need to be considered and how smart city technology changes the overall character of the area and how city dwellers and passersby interact with the space.

In addition to the attention Sidewalk Labs brought to the city of Toronto, Amazon and Amazon have already built a skyscraper (i.e., 120 Bremner Blvd) in the downtown core that brings in a high presence of social media and investment into the city. Also, the University of Toronto has received a $100 million dollar donation from local business leaders to build a complex that is expected to use artificial intelligence technology and biotechnology (Metz, 2022). Projects such as this one gain a lot of social media attention and demonstrate the city of Toronto’s aim to create a distinguished digital presence and booming tech industry. However, the project failed and leads us to question if the city of Toronto’s aim to create a distinguished digital presence may not succeed? However, as of June 2022, the city of Toronto announced 800 new affordable housing units at the Quayside site going up with a two-acre forest and a rooftop farm (Jacobs, 2022). This new development plans to focus on indigenous culture and to be a zero-carbon community located on Toronto’s Quayside. Jacobs (2022) highlights that smart cities “…tend to overlook the importance of human beings in the quest for technological solutions” when referencing Sidewalk Labs. Therefore, the “Quayside 2.0” project aims to create a more green and livable space with an emphasis on green infrastructure, urban farming, and urban agriculture (Jacobs, 2022).

This paper aims to explore ideas, theories, and concepts focused on the implementation of smart technology and IoT into our urban fabric and how that implementation can influence

access and equity to the existing and incoming city dwellers. In particular, this paper intends to look more closely at public transportation and initiatives such as Mobility as a Service (MaaS) and On-Demand Transit (ODT). The main question guiding this research is how MaaS and micromobility transportation options (i.e., ODT) enhance our public transportation system and overall network connectivity? In addition to that, this paper has a particular focus on the implementation of smart technology into our transportation system and what local municipalities are doing to mitigate access and equity concerns. This paper argues that with the implementation of smart city technology into our public transportation system, the overall sense of place, access to public space and amenities change due to the constant surveillance and data extraction, collection, and analysis. Using the City of Belleville and Milton Transit as case studies, this paper will closely examine and analyze how and why on-demand transportation services have been implemented into the existing public transportation system. Through such an analysis, this paper will be able to better understand the on-demand transit services' user demographics, service area, operational considerations, and mitigation strategies in regards to access and equity.

For the purpose of this research, I ground myself in urban political economy in order to establish how the capitalist mode of production can create unequal access to the built environment (i.e., access to transportation options and public space). By taking such an approach, I plan to explore and pay specific attention to the political economies of smart urbanisms and the socio-political divides smart transportation can create within our built environment. My research relies heavily on leading science and technology academic, Rob Kitchin, who's work on how smart technology and software implementation, data collection, extraction, and analysis can reshape our city and the ways in which we access space within the built environment (Kitchin, 2011). Rob Kitchin's work was heavily relied upon due to his

background in smart city technology and his discourse related to the controversy surrounding the smart city. I plan to better understand and explore how MaaS and micromobility options are changing our urban public transportation system and how such change impacts the level of access city dwellers have to such services. MaaS and micromobility transportation options are an important topic of research because they provide a range of public transportation options that allows for users to customize and book their own trips via digital devices. My research for this paper aims to test how accessible and equitable MaaS is and how it can contribute towards enhancing micromobility options within dense urban areas and overall network connectivity.

Chapter 2: Research Methods and Framework

2.1 Qualitative Research Methods

A mixed-method research design was used to explore and understand concepts that relate to the smart city, urban governance, surveillance, Mobility as a Service (MaaS), and On-Demand Transit (ODT). Mixed methods research "…is both a methodology and a method, and it involves collecting, analyzing, and mixing qualitative and quantitative approaches in a single study or a series of studies" (Creswell, 2006, pp. 1). The central theme driving this research is MaaS, access, and equity concerning our existing transportation network. Through exploring different materials and literature, this paper aims to gain a better understanding of how MaaS applications across select areas of Ontario have influenced access and equity concerns. The central theme and major concepts are explored through existing contemporary literature, peer-reviewed academic articles, emerging studies, and published news media. Such contemporary literature, peer-reviewed academic articles, emerging studies, and news media analysis assists in creating a conversation that outlines how micromobility transportation options are situated within MaaS and the functioning of the platform. The analysis of peer-reviewed academic articles, contemporary literature, and news media entails a collection of information in regards to the operationalization of MaaS, main concerns regarding urban data governance and the extraction of personal information, accessibility, and participation within smart transportation. More specifically, this research asked how and why the location of the on-demand transit service is chosen, why the on-demand transit service was implemented, what demographic the transportation service intends to serve, payment structure, booking system, and mitigation strategies in regards to inequities and accessibility. This research paper examines how MaaS and micromobility transportation options enhance our public transportation system and overall

network connectivity. In addition to that, the paper questions how equitable and accessible such technologically driven transportation options are and what local municipalities are doing to make transit more accessible. By looking at ODT within select municipalities in Ontario, this paper explores how the implementation of smart technology into our transportation system can alter how urban citizens and visitors interact, access, and participate within urban space and how such participation within the smart city may cause socio-political divides.

2.2 Research Method: Policy Analysis

In addition to the exploration of contemporary literature, peer-reviewed academic articles, emerging studies, and published news media; this research has also looked at existing policy documents in relation to the Province of Ontario and the selected case studies. By engaging with such policy documents, this research can be situated within existing policy documents and objectives outlined by the City of Belleville and the Town of Milton. For this research, the Growth Plan (GP), Regional Transportation Plan (RTP), the Municipal Act, the Public Transportation and Highway Improvement Act, Transportation Master Plans, and Official Plans have been reviewed and analyzed in relation to the case studies listed above. Reviewing these policies allows for this research to be situated within existing policies, objectives, and goals related to micromobility and the objective to shift away from a car-centric transportation system.

2.3 Research Method: Semi-Structured Interviews

For this research, interviews were used as a key qualitative research method. A semi-structured interview method was chosen to encourage a two-way conversation between myself and the interviewee. Semi-structured interviews allow the researcher to prepare an interview guide outlined with questions, however, the researcher is permitted to ask the questions in various orders and allows for follow-up questions (Kirby et al., 2016). Therefore, the interview is

adjusted based on the responses provided which tend to be very useful when the researcher is familiar with the topic and questions are geared towards finding new information (Kirby et al., 2016). Semi-structured interviews provide the interviewee with more room to provide detailed and elaborate responses to the question posed by the researcher. It is important to note that due to COVID-19 all of the interviews were conducted through an online Zoom platform to ensure the health and safety of all participants.

The semi-structured interviews were 45-minutes in length and aimed at exploring how each service is operationalized, key objectives, key considerations, and any mitigation strategies the transit service providers intend to/have used to increase equitable and accessible transportation services. The City of Belleville and the Town of Milton were selected as case studies for this research. These two areas were selected for this research because of their existing on-demand transportation service. Both the City of Belleville and the Town of Milton are fast-growing municipalities that saw a need for demand-responsive transit. Pilot projects were conducted in both areas and the success of those projects led to the implementation of on-demand transportation services. All interviewee results were cross-checked with existing policy documents and peer-reviewed academic articles found in the mixed-method exploratory research part of the research process. Participants were asked to voluntarily participate in this research via email and consent forms were signed before the interview. Interviewees were given the option to have their interview recorded (audio and/or visual). After the interviews were completed, all the interviews were later transcribed and coded.

2.3.1 Semi-Structured Interview Questions

As previously mentioned, the main question guiding this research is how MaaS and micromobility transportation options (i.e., ODT) enhance our public transportation system and

overall network connectivity. In addition to that, this paper has a particular focus on the implementation of smart technology into our transportation and what local municipalities are doing to mitigate access and equity concerns. It is important to emphasize that the interviews were conducted in a semi-structured format and the interview questions were asked in a similar format. However, the order of the questions varied depending on the flow of the interview conversation and the information brought about. Questions asked during the interview process are as follows:

1. Please state where you are currently working and what your position is with this organization. Tell me a bit about yourself and your background and what brought you to this position.
2. Please describe the general location, demographics, service area, and geography of your On-Demand Transportation service.
3. Who/what company provides the operational software and how was the company/software selected for your service?
4. How and why did your municipality/region decide to provide an on-demand transportation service to your service area?
5. Briefly explain how your On-Demand Transportation operates?
6. What are the methods of booking a trip?
7. What is the payment structure of your service?
8. How many operational vehicles do you currently have?
9. Based on ridership rates/data, who is the main user of your transportation service?
10. What are the peak hours of your service?

11. How do you ensure that your service is accessible to those of all ages, races, abilities, gender, and socio-economic status?
12. Do you have any mitigation strategies to enhance access to the service you provide?

2.4 Research Method: Thematic Mapping

In addition to conducting semi-structured interviews, a thematic mapping technique was used to organize major themes, theories, and ideas discussed in the contemporary literature, peer-reviewed academic articles, emerging studies, and published news media. Having major themes and key ideas organized in chronological order and cross-referenced with one another allowed for an easier planning and writing process. The major themes, theories, and ideas reviewed were: the smart city and smart urbanisms, racialization and segregation, surveillance/security, data governance, participation, access and equity, and smart mobility. These seven major themes, theories, and ideas guided the overall research process.

Microsoft Excel was used to chronologically and thematically organize the literature reviewed to ensure that major themes, theories, and ideas were organized effectively and efficiently. Microsoft Excel was the selected software because of how seamlessly new literature could be added to the database and the software allows for advanced searching and filters. Thematically mapping out major themes, theories, and ideas ensured that during the writing process of this paper, an advanced theme-specific research method was used. Therefore, key themes were easily identifiable with the corresponding author/scholar and date of publication. This aspect of specific thematic searching ensures that specific authors are grouped based on major themes discussed and therefore cross-referenced with the date of publication. By doing so, allowing for the paper to be systematically and chronologically reviewed. The date of publication is particularly important when reviewing literature and preparing for the writing process because

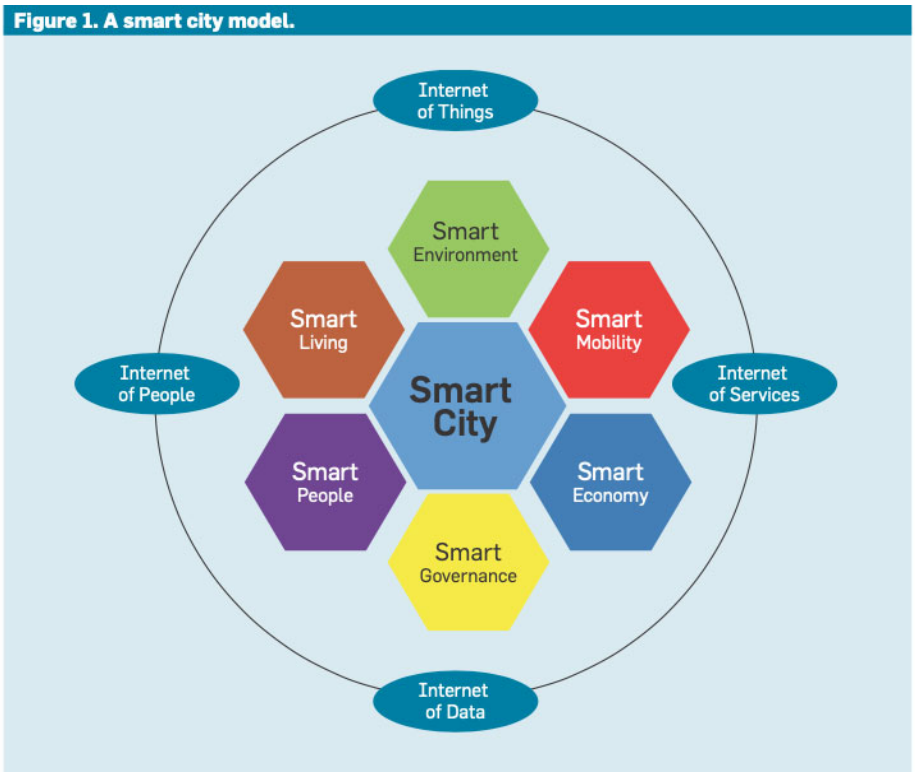
it ensures that the researcher is aware of the current historical, political, economic, and social environment in which the literature was written. Understanding when and what major themes, theories, and ideas were discussed in which period of time allows for the researcher to better understand the author and the basis of their beliefs. For example, as a researcher in the 2020s, the impacts of COVID-19 should be considered to better understand the overall environment the research was taking place in.

Chapter 3: Overview of the Smart City and Smart Urbanisms

3.1 Overview

There have been many different definitions provided for the term “smart city”. For example, Khatoun & Zeadally (2016, p. 47) define the smart cities as “places where information technology is combined with infrastructure, architecture, everyday objects, and our bodies to address social, economic, and environmental problems”. In Khatoun and Zeadally (2016) definition of the smart city, they heavily rely on the implementation of smart technology in our urban fabric and do not necessarily consider the implications of implementing smart technology into our urban fabric. **Error! Reference source not found.**, taken from Khatoun and Zeadally (2016), the diagram depicts a smart city model consisting of six major components: environment, mobility, economy, governance, people, and living. Surrounding those six major components are the Internet of Things, Internet of Services, Internet of Data, and Internet of People. Thus, implying that the internet and smart technology overlook all aspects of the functionality and day-to-day city life. The smart city is often referred to as a “systems of systems” (Khatoun and Zeadally, 2016). Systems of systems refers to the idea that there are many minor systems (smart technology) that operate within and throughout the larger system (the smart city).

Figure 1: A Smart City Model (Khatoun and Zeadally, 2016)

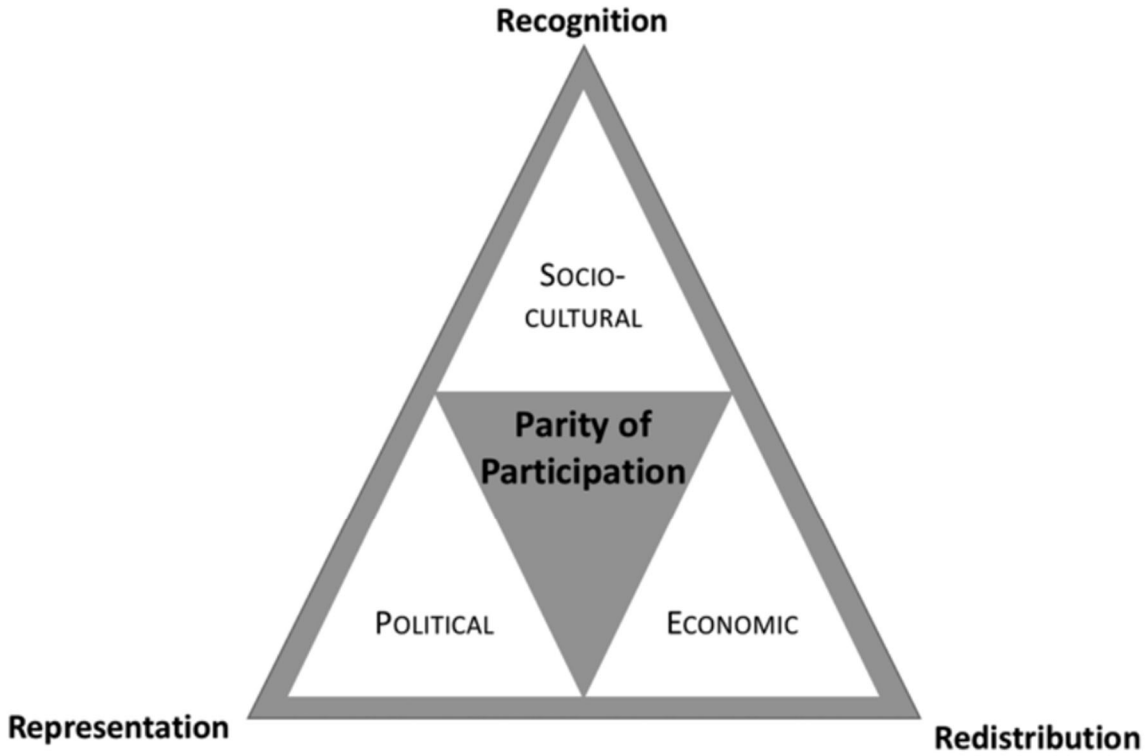


Meanwhile, Kitchin (2013, p. 1) defines the smart city as "…increasingly composed of and monitored by pervasive and ubiquitous computing and, on the other hand, whose economy and governance is being driven by innovation, creativity and entrepreneurship, enacted by smart people". Kitchin (2013) believes that embedding smart technology and information into our urban environments, does not automatically make our urban infrastructure smart. Rather, it is how smart technology and information is used "in conjunction with human and social capital and wider economic policy, is used to leverage growth and manage urban development that makes a city smart" (Kitchin, 2013, p. 2). This point that Kitchin (2013) brings forward is interestingly related to this research because it emphasizes the reliance on humans and how human interaction can influence the productivity of smart city technology within our urban fabric. Kitchin's (2013)

definition of the smart city heavily relies on the interactions of humans, social capital, and economic policy within the smart city.

Rosol and Blue (2022, p. 8) define the smart city "…as encompassing twinned patterns of urbanization and digitization which converge in mediated, networks, data-and algorithm-driven mode of urban planning on a global scale, albeit in geographically specific ways". Rosol & Blue (2022) base their definition of the smart city with a social justice framework. With this framework in mind, Rosol and Blue (2022) explain that critical urban scholars are increasingly finding injustices within the smart city and how such injustices within the smart city are remaking urban space and urban policy. Therefore, urban scholars need to pay particular attention to how the implementation of smart technology and smart city initiatives are changing the overall character and access to the urban environment. Rosol and Blue (2022) reference Nancy Fraser's model of justice and three dimensions of justice to ensure participation. The three dimensions of justice include redistribution, representation, and recognition. **Error! Reference source not found.** depicts a visual representation of the three dimensions of participation. At the centre, the parity of participation is encompassed by socio-cultural, political, and economic concerns. Thus, implying that to provide equal and just participation, the socio-cultural, political, and economic factors must be considered to understand how they contribute to participation within the smart city.

Figure 2: Three Dimensions of Participation (Rosol and Blue, 2022)



Redistribution mainly deals with who gets what within the smart city and the socio-economic dimensions of justice in terms of wealth, information, resources, labour, etc. (Rosol and Blue, 2022). For example, who is controlling the data and information about people, places, and processes within the smart city (Rosol and Blue, 2022)? Representation considers who is included and heard within the smart city. In a globalizing world, it is no longer unquestionable that a modern nation-state provides the appropriate and just way of thinking (Rosol and Blue, 2022). Therefore, as urban scholars and urban critics, we must consider how the implementation of new information technology and information is being used within the smart city and who is included/excluded within the urban fabric. Finally, recognition is the decision-making process of who gets what and where the decision-making process takes place (Rosol and Blue, 2022). Recognition directs specific attention towards "…institutional patterns, structures, and policies that produce and sustain inequities of social status" (Rosol and Blue, 2022, p. 4). It is important

to note that there is no established hierarchy among the three dimensions. Justice for and within the smart city must be fought on economic, cultural, and political terrains to ensure the participation of all people and interaction within the city.

For the purpose of this paper, Khatoun and Zeadally (2016), Kitchin (2013), and Rosol and Blue's (2022) definitions of the smart city are combined to create a definition specific to this paper; the smart city is driven by data and algorithms in which information technology is combined with infrastructure, people, places, and everyday objects to compose and monitor the computing of the city. Such monitoring and computing of the city is driven to govern the urban fabric, allow for creativity, and **can** be used as a way to address socio-political, economic, and environmental problems (Khatoun and Zeadally; 2016, Kitchin, 2013; Rosol and Blue, 2022). Below Table 1 clearly outlines the three main definitions discussed above. Data are extracted and analyzed through the use of physical devices, monitors, cameras, sensors, etc. This data is then computed into algorithms to manage and monitor urban flows and human interactions with the urban fabric. Typically, big corporations and municipal agencies extract data to gain more information and to gain an overall better understanding of the city dwellers and visitors to see how the city operates as a whole.

Table 1: Three Main Definitions of the Smart City

Author(s)	Date	Definition
Khatoun & Zeadally	2016	"…places where information technology is combined with infrastructure, architecture, everyday objects, and bodies to address social, economic, and environmental problems" (p. 47)

Kitchin	2013	"…increasingly composed of and monitored by pervasive and ubiquitous computing and, on the other hand, whose economy and governance is being driven by innovation, creativity and entrepreneurship, enacted by smart people" (p. 1)
Rosol & Blue	2022	"… as encompassing twinned patterns of urbanization and digitization which converge in mediated networks, data-and algorithmic-driven mode of urban planning on a global scale, albeit in geographically specific ways" (p. 8)

The term "smart city" is almost used as a catchphrase in social media and news articles to address technology in our urban fabric. Oftentimes, the term "smart city" is followed by environmentally friendly, data drive, sustainable, innovative, etc. Additionally, the term "smart city" or "smart urbanisms" are used as blanket terms to express the implementation of technology into our urban fabric. However, there is considerable controversy on the benefits and concerns around the smart city and the implementation of information technology into our urban fabric. Despite the controversy and assumptions, the use of the term "smart" has within a city; generally, a smart city strives to be a technologically driven urban environment. Leorke et al. (2018) explain how the smart city aims to produce and create technologically advanced cities that are innovative and disruptive. This questions the intent behind the smart city and information technology within our urban fabric. Therefore, this paper strives to answer how the smart city is disruptive and what mitigation strategies municipalities can implement specifically in regards to smart transportation to close the gaps that are prominent in our transportation

system. In a technologically driven urban environment, a collection of sensors, monitors, and devices collect specific data and information from humans that interact with the city and its urban space. Using terminology as such (i.e., smart city, innovative, technologically driven, etc.) poses great room for urban dwellers and visitors to question the intentions behind the smart city, raise concerns about the implementation of technology into our urban fabric, and base assumptions on the extraction and collection of urban data and the purpose in which the data is used for. The term smart city can be deceptive in the sense that it promotes technological solutions to urban problems. However, oftentimes the level of surveillance and monitoring is not mentioned within the definition of the smart city leading urban dwellers to believe that the smart city can solve our urban problems with the implementation of such technology.

3.2 Interacting with the Smart City

Within the smart city, city dwellers and visitors are constantly being monitored through the use of smart technology and what is commonly referred to as the Internet of Things. Through the Internet of Things (IoT), as Jittrapirom et al. (2017) explain, the use of sensors, monitors, and devices that can connect with one another to exchange and transfer data. Embedding sensors, monitors, and devices within cities allows for further accentuation and connectivity between the physical objects and spaces within our urban fabric with the virtual data being collected and extracted (Jittrapirom et al., 2017). It is important to note that in the smart city, urban environment, and humans are all strongly interconnected with one another. The smart city cannot exist without the interactions humans have with the technology embedded in our physical urban environment. Therefore, the data collected within the smart city is highly dependent on human interactions with the smart city. Once the data from the city dwellers and visitors is extracted through the use of smart technology, big corporations, companies, transit agencies, and

municipalities can better predict overall usage, patterns, and flows within the smart city. Therefore, the smart city promotes a constant sense of securitization and monitoring. It is very important to acknowledge that everyone within the smart city is being monitored, accounted for, and surveilled regardless of their desire to participate in the smart city.

The smart city is not homogenous and cannot be classified as environmentally friendly, innovative, or sustainable just because technology is involved in the operationalization and monitoring of the urban fabric. However, one type of smart city or smart urbanism can and will vary from one location to the next because of different geographical locations, topography, demographics, economy, and so forth. Graham (2013, p. 198) explains how "Cities are no longer just confined to their material presences: they have become both digital and digitised" and goes on to explain that there are many invisible and digital layers to the city that collect data and are structured by coding, data analysis, and software. Cities and urban spaces are now able to communicate and share data due to the digitization of public and private spaces and human interactions with information technology that is embedded in our urban fabric. Throughout the city and smart transportation, every interaction or passing within the urban environment and smart transportation is being monitored and data is being collected and analyzed from monitors, sensors, cameras, etc. Thus, tracking specific movements and flows within the city. These movements can be traced back to specific times, places, locations, people, etc. through the use of smart technology.

The tracking of movements within the smart city ultimately changes the way that the city operates and what the city means to urban dwellers and visitors. Participating in the smart city is no longer a willing act, instead, there are cameras, sensors, monitors, etc. that are tracking urban flows and movements at all times without individual consent. According to Graham (1999), with

the implementation of smart technologies and new networks within our urban fabric, a dualization is created. This dualization insinuates that powerful global-local connections are created that place value in our urban fabrics while ignoring large investments in telecommunication networks. By implementing networks and smart technologies into our urban fabric, cities are then created to be a place of control, financial surplus, and informational hubs. Major cities are no longer a place of just business, social interactions, and communication but increasingly becoming hubs of technological change that demonstrate patterns of investment and information in newer technologies (Graham, 1999). Moving towards the smart city, there is a reliance on the interaction of humans and social production to manage and maintain such centrality within a large city. These points that Graham (1999) and Graham (2013) make are extremely significant to consider because they emphasize how the implementation of smart technology and a shift towards the network society can alter how the city centres operate and how urban dwellers interact with the city. Castells (2002) states that the network society is a social formation that uses social and media networks as a prime mode of organization. Therefore, "The interaction between the revolution in information technology, the process of globalisation and the emergence of networking as the predominant social form of organisation constitutes a new social structure: the network society" (Castells, 2002, p. 148). The network society is not wholly based on modern societies per se, rather it also takes into consideration cultural, economic, and political factors (Castells, 2002). Thus, we must question how such tracking and emergence of networking within our urban fabric changes how the city operates and how city dwellers and visitors interact with the city.

3.3 Planning Towards the Smart City

Urban intelligence and smart technology are much more than just the extraction and collection of information. The urban environment and overall view of the city change through the passage of time and current political views/goals. After WWII, the city was seen as an industrial engine that will boost the economy and provide jobs. In the 1950s and 1960s, the major goal of that era was to renew our urban environment and create room for business and infrastructure projects (Stein, 2019). The intention behind this urban renewal process was mainly for the upper and middle classes to allow for the purchasing of property and the privatization of public space. By spatially fixing an area, its overall market value goes up (Stein, 2019).

By the 2000s, we saw a rise in portable devices (Kitchin, 2017b). Portable devices allowed for business and communication to be taken anywhere and pushed the limits we had previously known beyond office buildings and homes. The concept of the smart city began to take hold in the late 2000s (Kitchin, 2017b, p. 20) when it gained a lot of attention and traction across cities and big corporations. This push toward the smart city and urban renewal created an urban environment of possibility and envisioning a future where technology is used on a daily basis to enhance urban space.

3.4 Intentions behind the Smart City

The intentions of the smart city and data collection within our built environment need to be considered as it creates a politically complicated urban environment (Mattern, 2017). By implementing smart technology into our cities, the overall atmosphere of the urban space is altered. City dwellers and visitors will feel the constant sense of monitorization that changes the way people interact with the city and feel within the space. As far back as 1999, Graham (1999) explored the reconfiguration of space through telecommunications and the movement towards a

more technologically advanced urban environment. Referring back to the dualization discussed in Section 3.2; through the implementation of smart technologies and networks, Graham goes on to explain that the powerful local-global connections create a space that holds a certain value that is based on the networks of institutions when on the other hand investment plans are ignored for newer communication networks. This idea that Graham (1999, p. 162) puts forward is interesting to consider with the smart city framework in mind because by bringing networks together, cities are created as a control centre of not only information but also finance and media control. Cities are the hub of advanced and rapid technological change and patterns of investment. Therefore, big cities provide the perfect place for new technologies and ideas to be further explored and tested. However, a change in one part of the city can cause a chain reaction in various other parts of the city. For example, the idea of Sidewalk Labs being implemented into the city of Toronto's waterfront caused a ripple effect where other companies were looking to see how to add more smart technology to Toronto. Therefore, as planners, we must carefully analyze and consider how technological changes can influence our current and future urban environment. Planners also need to consider how current and future plans can alter existing social, economic, and political structures in place and what such changes may cause down the road. What are the implications and potential benefits of embedding such extensive technology into our urban environment?

Mattern (2017) explains that "At the highest levels of government, we see evidence and quantitative data manipulated or manufactured to justify reckless orders, disrupting not only "politics as usual," but also fundamental democratic principles". This poses questions in regards to governance principles and ethics related to our environment. By pushing quantitative data to project our urban futures, we are creating a space where technology and big data are controlling

our future. As urban dwellers, a major question we need to ask ourselves is who is in charge of this data? What do the data share agreements entail? Who is analyzing the data and what intentions do they have behind their analysis? Using a data governance, surveillance capitalism, accessibility, and equity framework this paper looks at how smart technology has been implemented into transportation systems in the City of Belleville and the Town of Milton through on-demand transit services that collect and extract large amounts of data from transportation users.

Chapter 4: The Role of Technology in the Smart City

4.1 Restating the Definition of the Smart City

To reiterate the definition of a smart city used throughout this paper; the smart city is a driven by data and algorithms in which information technology is combined with infrastructure, people, places, and everyday objects to compose and monitor the computing of the city. Such monitoring and computing of the city is driven to govern the urban fabric, allow for creativity, and **can** be used as a way to address socio-political, economic, and environmental problems (Khatoun & Zeadally, 2016; Kitchin, 2013; Rosol & Blue, 2022). This definition encompasses a wide range of overarching goals and objectives of the smart city while understanding the socio-political disadvantages and concerns regarding the implementation of smart technology into our urban fabric.

4.2 How is Technology Used within the Smart City?

The implementation of technology into our urban fabric is the key driving factor behind the smart city and in most cases is the selling point to municipalities and big corporations. This is because the use of smart technology in our city allows for urban flows and patterns to be tracked to predict the future needs and requirements of the city. By doing so, municipalities and big corporations can use the data extracted from the smart technology to conduct long-term forecasting and better predict usage and flows within the city. Kitchin (2011 and 2017a) explains that the use and implementation of smart technology can reshape our cities and can improve efficiencies, and effectiveness, increase economic productivity and competitiveness, innovative business, and environmental sustainability. He believes that urban practices are becoming coded, and the city is becoming a collection of computers where software and hardware are an essential part of our urban fabric (Kitchin, 2011). Kitchin (2016, p. 1) states that data-driven urban

environments allow for a computation understanding of a city's systems that allows for logical and calculative results and procedures. In general, data extraction and storage are increasingly becoming very prominent in our daily lives. The role of technology in our day-to-day lives is becoming more prominent than ever before. Cameras, sensors, mobile devices, etc. are everywhere throughout our urban fabric and are constantly collecting information. Kitchin (2011) believes that we are entering a new phase where smart technology and IoT are "everywhere". For example, the software can even enact characteristics of being alive, operating, and doing work in the world (i.e., process data, evaluate situations, decision-making software, etc.). In addition to that, the software that we use daily is embedded in our social systems and there is a power associated with software usage (Kitchin, 2011). Smartphones, security cameras, search engines, etc. are continuously extracting data from users to manage and analyze usage. For example, as an individual searches through Instagram or Google, etc. they are imputing data and tracking their click-rates to better understand that individual's likes, dislikes, interests, etc. Having access to such information enables big corporations and municipalities to the power of knowledge and information of the demographic in which they serve.

In the current day context, people are relying on portable digital devices and technology more than ever before. The use of technology and information systems is embedded into our day-to-day lives and is therefore tracking, collecting, and analyzing data throughout our entire day. Kitchin thinks of the smart city with a conceptual and theoretical framework. He believes that through the 'translation' and 'transduction' of data, a city can be programmed into code and used to create a more programmable city (Kitchin, 2011). This programmable city allows for municipalities, transit agencies, and businesses to better understand the flows within the urban fabric and better predict overall usage and consumption. He goes to on explain that "It is now

standard practice that urban information systems and spatial data infrastructures are used to organise, process, and present data concerning cities and their citizens in order to provide an evidence and analysis base for public policy development, implementation, and monitoring" (Kitchin, 2011, p. 949). He discusses how smart technology is a way in which to manage the city and how the 'tagging' of individual people within the smart city enables data collection and analysis, thus referring to how the use and practice of information systems provide evidence for big corporations and municipalities to base their development and policy analysis. However, it is important to question the intent behind data collection and who the developments and new policies are made to serve.

Khatoun and Zeadally (2016) explain how there are five major essential components within the operationalization of the smart city; broadband infrastructure, e-services, open government data, ubiquitous computing, and big data. Broadband infrastructure deals with the connectivity to citizens through the use of wired and wireless networks. Meanwhile, e-services entail electronic services that use information communication technology. Some examples of e-services include customer services, sales, operations, delivery, etc. Open governmental data is data that can be freely used and accessed by anyone. Open government data can be used to improve citizens' daily lives and allows for sustainable infrastructure, e-governance, etc. (Khatoun and Zeadally, 2016). Ubiquitous computing deals with heterogeneous devices that communicate with heterogeneous networks (i.e., MaaS and online transportation platforms). Finally, big data is a key component to the operationalization of the smart city and is the collection of huge amounts of information being extracted from IoT. Through these five essential components of the smart city, we can better understand how and why data extraction and collection are used within the smart city. Kitchin (2016) explains how urban big data is analyzed

at an aggregate level to provide a snapshot or brief idea of what is happening in the city within a particular moment. Through the collection of hundreds of thousands of particular moments, the data will show a wide range of events and activities within the city which depict the overall patterns and flows within our urban fabric. Hashem et al. (2016) state that the key enabler of the smart city is the use and possibility of IoT in everyday objects and devices. Therefore, by having IoT embedded in our everyday lives and devices, we are enabling a connection across a network of technologies. Through the process of network connections and cloud computing, large amounts of data can be transferred from one device to another in almost a seamless connection. Hashem et al. (2016, p. 750) state that "…cloud computing can provide the virtual infrastructure for utility computing that integrates monitoring devices, storage devices, analytic tools, visualization platforms, and client delivery". This paper speaks to the advantages and disadvantages of cloud computing and big data in our transportation system. In chapter 5, this paper will outline how cloud computing and smart transportation intersect.

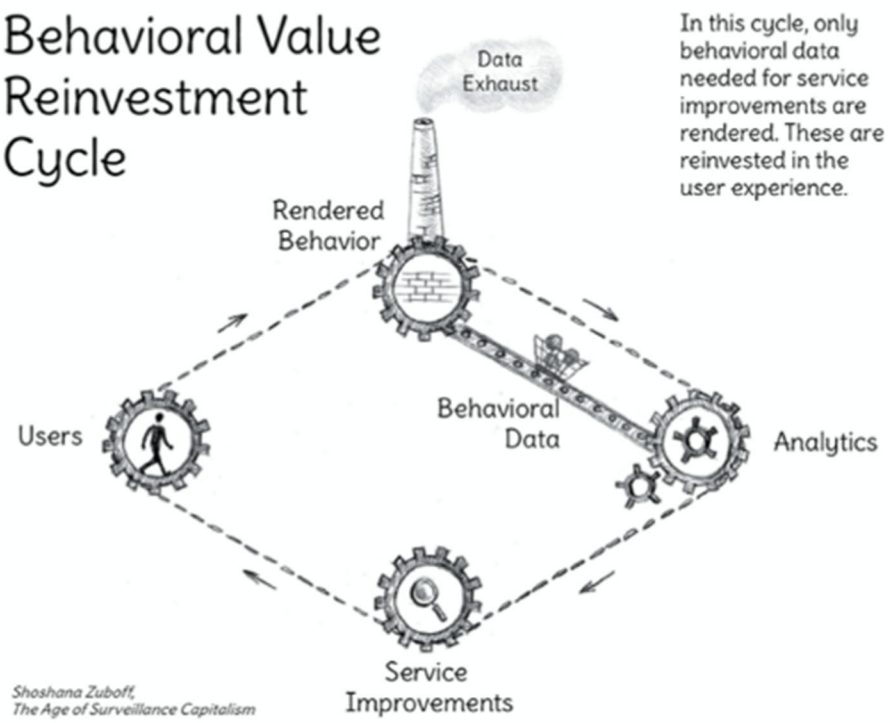
4.3 The Impact of Surveillance within the Smart City

This section of this paper pays specific attention to the impact of smart technology in our city and how constant surveillance promotes an unjust and uneasy urban fabric. Generally, when referring to a smart city, it is assumed that technology is used as a way to increase knowledge and improve our overall quality of life. In this case, pro-smart city urbanists celebrate a network that connects devices and uses cloud computing as a way to share and track big data. However, it is important to question how the implementation of smart technology in our urban fabric can enable a dangerous information society that creates anxiety and uncertainty for urban citizens and visitors. Zuboff (2019, p. 14) explains that "Surveillance capitalism unilaterally claims human experience as free raw material for translation into behavioral data". Therefore,

information collected and analyzed in regards to behaviour can feed into manufacturing processes which Zuboff (2019, p. 14) refers to as "machine intelligence". The information generated allows for predictions to be made about the user and consumer behavioural patterns. Overall, it is important to note that surveillance capitalism was not invented, rather it is the result of digitization and the use of digital technology in our day-to-day lives.

Through the implementation of smart technology in our urban fabric, surveillance capitalists have grown wealthy from the surplus of information and big data. Zuboff (2019, p. 16) explains that surveillance capitalists have discovered a way to "…nudge, coax, tune, and herd behavior toward profitable outcomes". For example, when surfing the internet or a social media feed, the click rates and most-watched genre will generate algorithms and put forward advertisements that are specifically tailored to the user. Popescu (2015) explains that smart cities are made gradually and in parts. Popescu (2015, p. 80) states "Data is both the thrust behind smart city proposals, and in addition the methods by which they are enforced, but the fundamental objectives of the schemes is furthering economic advancements". Thus, smart technology and data collection enable economic growth and prosperity. Popescu (2015) puts forward this idea of the smart city being unbiased. However, how can targeted media marketing and the production of algorithms specifically tailored to an individual be unbiased? Figure 3 depicts the Behavioural Value Reinvestment Cycle taken from Zuboff (2019).

Figure 3: Behavioural Value Reinvestment Cycle (Zuboff, 2019)



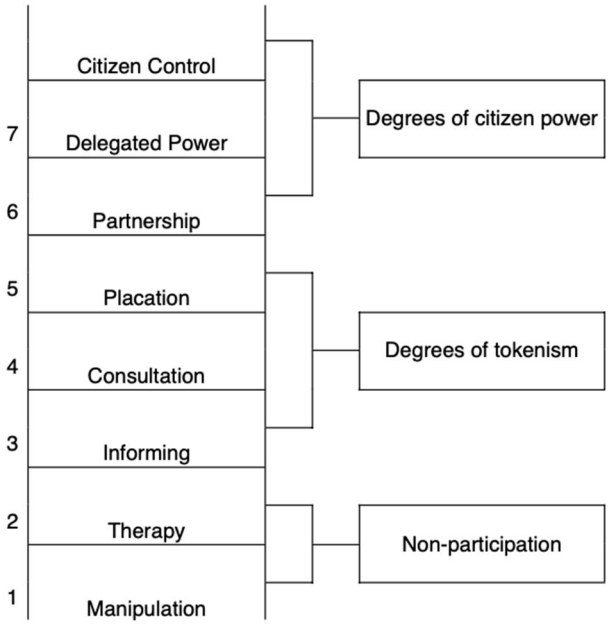
Zuboff (2019) explains that every search on a user platform creates is analyzed and fed back into the system. Zuboff (2019, p. 51) states that "User provided the raw material in the form of behavioral data, and those data were harvested to improve speed, accuracy, and relevance and to help build ancillary products such as translation". Therefore, through the use of smart technology, data collection, and analysis, the user is subject to advertisements and marketing schemes to benefit big corporations and companies. Thus, putting an idea in the user's head that they need X product. This process of data collection and marketing schemes enables big corporations to profit off the data being collected across software and devices. Surveillance capitalism is not the technology itself, rather it needs and thrives off a platform that it operates upon.

Kitchin (2016) refers to "geosurveillance" as a way to track locations and movements of people, goods, vehicles, etc. This form of tracking specifically relates to MaaS and the implementation of smart technology in our transportation system. Consequently, in this paper I discuss how the implementation of smart technology in our transportation system creates access and equity concerns. Tracking of movements and locations within our urban fabric can infringe on an individual's sense of place within the city and impact their overall experience within the city.

4.4 Participation within the Smart City

Using smart technology, our urban environment is constantly being monitored. As mentioned previously, smart technology relies on human interaction to collect and analyze data. Without human-technology interactions, the smart city cannot function and cannot generate big data. Through every movement, passing, and interaction humans have with smart technology, data and information is collected and stored across the IoT. Therefore, it is important to ask how participation impacts the smart city and how the use of smart technology changes how we perceive participation in the city. Lane (2005) refers to Arnstein's (1969) "Ladder of Participation". To conceptually understand participation within the smart city, a broad understanding of the Ladder of Participation is needed to grasp how the distribution of power influences public participation. Figure 4 depicts the eight rungs of the Ladder of Participation (Lane, 2005).

Figure 4: Arnstein's (1969) Ladder of Participation (Lane, 2005)



Each of the eight rungs is grouped into degrees of participation (i.e., non-participation, tokenism, and citizen power). Decision-making and policy creation do not happen at the same point in the process and cannot be assumed that they are done in unison (Lane, 2005). Lane (2005, p. 286) explains that "…genuine participation is only achieved by having power in decision-making ignores the range of benefits which may be associated with being consulted throughout other stages in policy-making areas". Therefore, it is assumed that having power within the smart city enables an individual to participate in the way they choose (i.e., citizen power). For example, big corporations have the power to place smart technology within the urban fabric and the buildings they own. Thus, providing the company with a wide range of big data to analyze.

Therefore, by broadly understanding the "Ladder of Participation" we can situate smart city participation within Arnstein's (1969) framework. Through the implementation of smart technology in our urban fabric, there is a tension created between citizen power, participation,

and inherent non-participation. For this paper, inherent non-participation refers to the human-technology interactions that urban citizens and visitors encounter when travelling throughout the city. Embedding smart technology in our urban fabric, makes participation within the city involuntary. In regards to transportation and movement throughout the city, public transportation riders must input user information into their software. Therefore, when riders provide personal information, the involuntary participation in the smart city and smart transportation is very prominent. Transit agencies and municipalities are then able to track when a ride has been taken, where it has been taken to, and the frequency of trips. By travelling throughout the urban fabric, urban dwellers and visitors are being monitored simply by being present within that space. Cardullo and Kitchin (2018) reference Arnstein's (1969) Ladder of Participation and how tokenism is a way to inform and consult the public as a way of participation. However, tokenism and this form of participation do not allow the urban citizens to change the way that things are done within the city, rather it just informs them of what is being done with the idea of participation in mind. Building off Arnstein's (1969) Ladder of Participation, the smart city lends itself to the processes of digital governance and surveillance capitalism. There is a certain tension that is created between the use of smart technology in our urban fabric that habituates uneasiness and the feeling of securitization.

Cardullo and Kitchin (2018, p. 1-2) explain that "…smart city initiatives enact forms of algorithmic governance that control and discipline citizens, as well as being tools to produce and reinforce neoliberal logics of urban management and entrepreneurial urban development". Therefore, citizenship within the smart city favours consumption and individual autonomy. Individual autonomy is the specific attention towards the self and individual actions rather than the collective whole. The smart city collects information on the individual and creates

assumptions about the city based on millions and millions of interactions. Therefore, in this sense, smart technology, and the individual autonomy the smart city idea puts forward is problematic because the urban fabric is a complex environment that provides a collection of services and resources to its inhabitants.

4.5 Impact on Public and Private Space

Smart city technology and the implementation of cameras, monitors, and sensors can alter the existing character and feel within an urban space. The impact on public and private spaces should be considered when understanding the impacts of smart technology within our city. Not only does the smart city and smart technology promote involuntary participation, but it also creates a space where urban citizens and visitors' sense of place changes due to the area being highly monitored and securitized. This chapter addresses concerns regarding the use of information, urban political economy, and participation within the smart city. Leorke et al. (2018) explore ideas focusing on a technology-driven urban vision. This vision includes investment in new technologies and spaces, developing new relationships, and creating tourist attractions and spaces/places of interest to the public (Leorke et al., 2018). This shift towards an urban vision that Leorke et al. (2018) talks about is particularly important to the smart city and MaaS discourse because it highlights the reliance on smart technology and the user. Smart cities are viewed as a "densely networked and ubiquitously connected urban centre" that connects to a variety of smart infrastructure and devices (Leorke et al., 2018, p. 32). This connection allows for a variety of new opportunities to arise and enables urban governance. Konig (2021) explains the challenges that arise from data-based value creation and how data-based value creation can highlight urban problems that can never be neutral. Therefore, the urban problems that are highlighted through data collection, extraction, and analysis can raise concerns in regards to

biases and discrimination within public and private spaces. The extraction of data can create value for many big corporations, municipalities, transit agencies, etc. However, what is important to consider is that citizen-centric data extraction demands participation within the smart city and smart infrastructure. Thus, forcing urban citizens to participate in the smart city does not mean that the citizens are active within data governance, rather it demands accountability. Therefore, we must ask the question if someone does not wish to participate or have their data collected, should they avoid certain parts and amenities offered within the smart city. The use of smart technology within the smart city, in this sense, can create an unjust and exclusive environment that only allows those who wish to participate in the smart city to join. Thus, changing how urban dwellers and citizens perceive and interact with public and private spaces.

Smith and Low (2006) explain that there are different meanings attached to public and public space. Public space can be a range of locations available which can include streets, parks, media, internet, shopping centres, etc. The major difference between public and private space is the level of access, use, and nature of entry (Smith and Low, 2006). Private space is typically marked, blocked off, and protected by the companies or people who own the space. Whereas, public space is supposed to be made available to anyone and everyone who chooses to use it. However, public space varies from location to location and is not homogenous. The public sphere and public space are socially constructed and produced (Smith and Low, 2006). Therefore there is a desirable behaviour that is expected within public spaces (Schuilenburg and Peeters, 2018) and the use of smart technology within these spaces inadvertently enforces such behaviour. The word “public” insinuates that this object or place is open to all and many. However, public space can be controlled and monitored which inadvertently impacts access to a

certain public sphere. For example, Harvey (2006, pp. 21) refers to a lower-income family trying to access a higher-end café. The café is a private commercial space that is supposed to be available to the public in a public location. However, the family is left feeling excluded and marginalized in a public setting due to higher-income prices that cater to higher-income individuals. This relationship between the public, public space, and the public sphere is so prevalent today because the rise of commodity-driven planning where spaces can produce more marginalization and exclusion in parts of the city that are supposed to welcome all.

Duarte and Firmino (2009) argue that ICTs (Information and Communication Technologies) can lead to the transformation of the spatial formations within cities. ICTs is a term used within smart technology discourse that is a unified information and communication system. The authors continue to explain that the "infiltrated city" allows for the monitoring and analysis of citizens without their awareness or even acknowledgment of such information extraction processes (Duarte and Firmino, 2009). Therefore, there is this sort of invisible presence ICTs have within our environments that can protrude into the daily lives of the urban citizen. To further this thought regarding the invisible presence of ICTs, Bloch (2021) refers to community policing as a "place-based manifestation of racialization and class antagonism" (p. 2). This racialization of particular areas can contribute to the criminalization of segregated communities and gentrification processes. Bloch (2021) discusses the use of an app called Nextdoor. Nextdoor is an app that allows for community networking and community policing. Such community policing enables aversive racism/muted racism and further enhances neoliberal rule. There is this overall shift in the urban reality with the implementation of such ICTs and I think it is important to acknowledge and better understand the implications of such technology.

How do ICTs change the way people feel about public spaces? Is it just to have a constant sense of invisible eyes on the street?

Chapter 5: Overview of Mobility as a Service (MaaS)

5.1 What Is Mobility as a Service (MaaS)?

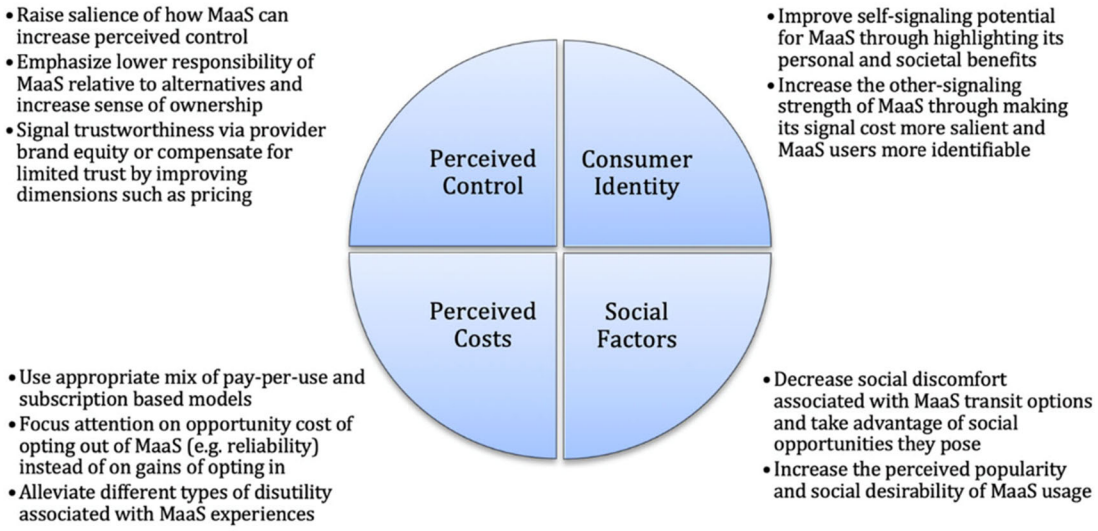
Mobility as a Service or more commonly known, as MaaS, is an emerging form of transportation and operating software that aims to serve and provide multimodal transportation services. Hensher, Mulley and Nelson (2021) explain MaaS as a framework to assist in delivering multimodal transportation services that position the user or transit rider at the centre of the operational software. MaaS aims to achieve a multimodal, complex, and sustainable operation software that provides transportation riders with customizable trip options. Jittrapirom et al. (2017, p. 13) explain that MaaS aims to "...offer a tailored mobility package, similar to a monthly mobile phone contract and includes other complementary services, such as trip planning, reservation, and payments, through a single interface". Through a tailored mobility package, transportation riders can plan, book, and pay for a trip using multiple mobility forms through a single platform. Using multiple transportation options is a key selling point to MaaS because it allows transportation riders to book trips using a combination of public and active transportation methods.

The shift towards MaaS platforms and transit services represents a "natural evolution of transportation planning around the world, as cities continue to look for ways to reduce congestion in manners that complement, but does not supplant, traditional public transportation providers such as buses and trains" (Zwick and Dundon, 2021, pp. 192). Jittrapirom et al. (2017) explain that MaaS is seen as a way to decrease carbon emissions and encourage a more sustainable transportation system. In addition to this, Jittrapirom et al. (2017) go on to explain that MaaS can help to enhance access and equity concerns through the shifting from an ownership-based transportation model to an access-based transportation model. By shifting away

from an ownership-based model (private cars) toward an access-based transportation model is extremely important for the progression of our transportation infrastructure and overall movement. An access-based transportation model prioritizes ride-sharing, reduces and alleviates congestion on the roads and subway system. However, MaaS software operates similarly to smart city technology. MaaS can be seen as an aspect of the smart city initiatives and MaaS software extracts transit riders' information and data to better predict traffic flows, transportation needs, travel patterns/times, fare structure, and user demographics. Therefore, how can MaaS increase access and equity if the software upon which it is operating is constantly monitoring transit rider information and data? Typically, transit agencies, municipalities, and software providers have access to the information collected. However, what is being done with this information and who is it being shared with? Tomaino et al. (2020) look at how social and psychological factors and the implications such factors have on our transportation system and MaaS. Social and psychological factors can influence a rider's perspective and choice to use public transportation which overall impacts MaaS usage. MaaS provides an automated travel experience for transit riders and provides access to different forms of transportation (i.e., bike-sharing, trains, buses, etc.). This form of transportation and trip planning provides transit riders with a comprehensive range of services and payment options. However, transit riders may feel like such a high level of automation takes away from their sense of control of their desired modes of transportation (Tomaino et al., 2020). Such automation in trip planning and various modes of transportation options being chosen for a single trip can make the transportation rider feel like they have lost their sense of power and responsibility in their movement across the city. Figure 5 shows a Venn diagram taken from Tomaino et al. (2020), outlining suggestions to assist with psychological acceptance and adoption of MaaS. By identifying barriers, raising awareness,

and addressing concerns regarding MaaS adoption and implementation, some social and psychological barriers could be reduced.

Figure 5: Psychological Acceptance of MaaS (Tomaino et al., 2020)



However, speaking from an accessibility perspective, having a wide range of transportation options available to get from one destination to another can prove to be confusing and challenging. Being unfamiliar with an area, not speaking the language, or having a lack of experience with public transportation can create barriers concerning MaaS usage. Therefore, when considering implementing such an advanced and user-tailored transportation system, it is important to consider the service from an equity and accessibility perspective. This paper addresses such barriers and what municipalities and transit agencies are doing to mitigate accessibility and equity barriers for their rider demographic.

5.2 Purpose of Mobility as a Service (MaaS)

Private vehicles currently dominate our transportation system. The production and usage of privately owned vehicles have enabled substantial economic growth and have aimed to

increase the quality of life for the average driver due to the flexibility and privacy that personal vehicles offer. However, such reliance on privately owned vehicles has led to mass car use, traffic and road congestion, car crashes, poorer air quality, social exclusion, and physical inactivity. Taking a private vehicle to and from one's destination limits that individual's time outside and keeps them isolated from others throughout their commute. The push towards "smart" technology in our transportation system creates a vision where personalized transportation service is available and on-demand. The shift towards MaaS as Docherty, Marsden, and Anable (2018, p. 118) explains is one "...where individuals' ownership of vehicles is increasingly replaced by "usership", that is the ability to purchase access rights to an interoperable package of mobility services (car, taxi, rail, bike share) owned by others, usually corporate, providers". As Docherty, Marsden, and Anable (2018) mention, the shift away from ownership to a usership transportation model allows for transit riders to have certain "access rights" to mobility services. These "access rights" allow for transit riders to purchase a trip and provide the transit rider with a variety of transportation services that are typically owned by corporations and/or local municipalities. Technical trip planning in this sense is supposed to be purposeful and calculated to plan a quick and efficient trip for the transit rider. However, the level of governance, data extraction, and collection should be considered to better understand the intent behind MaaS software.

As I will show below, my research was designed to cast light on the role the government and local municipalities play within MaaS and the implementation of smart technology in our transportation system. MaaS intends to serve as a connection to existing transportation hubs and aims to serve and solve the First-Mile Last-Mile (FMLM) problem. Zwick and Dundon (2021) explain that shared mobility services are important because they bridge transportation

connections and assist with solving FMLM problems. The FMLM problem refers to sets of individuals who live outside of walking distance of their nearest public transportation hub/option (Zwick and Dundon, 2021). More specifically, the FMLM problem is the challenge associated with moving people between transportation stations, transportation services and their home, workplace, etc. The overarching goal of solving the FMLM problem is to make improvements to transportation access for people to start/complete their trip to and from their destination. For example, if an transportation rider takes a train to a major transportation hub, and it is another 2km to get to their final destination, they can book an e-scooter, e-bike, or take a subway to their final destination, thus completing their "last mile". Therefore, these individuals must find alternate forms of transportation options to begin and/or end their trip.

5.3 How is Mobility as a Service (MaaS) Implemented and Operationalized?

MaaS and micromobility transportation options are currently emerging forms of transportation that allows for rider-specific trip routing and planning. MaaS is still a relatively new term that is being used within transportation planning and is a service that is expected to further network connectivity and transit integration across various forms of micromobility transportation options. However, the timelines and technological goals of MaaS are still to be determined and implemented across Canada. The implementation of MaaS is mainly concerned with three key factors; the performance of smart technology, policies, and the economy (Zwick and Dundon, 2021). Therefore, the implementation and operationalization of MaaS are still undergoing implementation considerations. MaaS and micromobility software will most likely be developed by local municipalities or big transportation corporations to utilize existing transportation systems within the urban fabric. The case studies discussed in latter sections of this paper explain on-demand transportation services that have been implemented in the City of

Belleville and Town of Milton. As previously stated, MaaS is still an emerging form of transportation that has yet to be implemented in Canada. However, on-demand transportation services contribute to the overarching goal of MaaS and is one of the micromobility transportation options offered within MaaS.

Theoretically, MaaS intends to provide transit riders with a single platform software that allows them to book and pay for a trip via smartphone, website, or call centre. MaaS's overarching goal is to shift away from personal modes of transportation and to reduce traffic congestion. MaaS covers a wide variety of public transportation options such as On-Demand Transit (ODT), Automated Vehicles (AVs), Electric Scooters (e-scooters), etc. ODT and AVs provide shuttle buses to connect urban dwellers to their destinations, whereas e-scooters are available for a single individual to complete their trip. For example, if an individual wanted to plan and purchase a trip to the downtown core of the city; they could book a ride via train and then take an e-scooter from the train station to their final destination, which would ultimately relieve their FMLM connection. This trip requires two different forms of transportation, yet the individual can plan, book, and pay for both forms of transit through a single platform instead of connecting to different software and services to complete their trip.

Chapter 6: Types of Transportation Services Offered within Mobility as a Service (MaaS)

6.1 Types of Transportation Services used within Mobility as a Service (MaaS)

As explained in Chapter 5, Mobility as a Service (MaaS) is an emerging form of transportation and operating software that aims to serve and provide multimodal transportation services across a single platform. MaaS aims to achieve a multimodal, complex, and sustainable operation software that provides transportation riders with customizable, rider-specific trips. Through a customized and tailored mobility package, transportation riders can plan, book, and pay for trips through a single interface. The key driving factor behind MaaS is the software's ability to plan a trip that uses a variety of transportation options to help the transit rider to get to and from their destination in the most efficient way possible.

This section aims to provide a broad overview of the various types of transportation services that could be offered within MaaS which provides city dwellers and transit riders with a variety of transportation options that assist with overall network connectivity and micromobility within our urban cores. Christoforou et al. (2021, p. 3) state that "…micromobility includes all transportation modes that allow their users to make a hybrid usage and behave either as a pedestrian or a vehicle at their convenience". Some examples of micromobility options include bicycle sharing, shared electric scooters (e-scooters), autonomous vehicles (AVs), subway, train, buses, on-demand transportation (ODT), etc. Trains, subways, buses, and bike-sharing are all rather traditional transportation services that are provided in most metropolitan areas. Shared e-scooters and AVs are relatively new forms of transportation that are still being piloted across the world. An overview of ODT will be provided in sections to come.

An AV is a self-driving vehicle that is capable of driving and sensing its surrounding environment to safely navigate our roads. AVs require little to no human interaction to operate and assess their environment using LIDAR (Light Detection and Ranging) to assist with driving functions (Laidlaw, Sweet, & Olsen, 2018). Duarte and Ratti (2018) suggest that autonomous vehicles should be used as a feeder mode to bring passengers into transit-oriented developments and communities. Therefore, allowing the passengers to access another form of transit to finish off the rest of their trip through various modes of public transit. Duarte and Ratti (2018) also suggest that while personal cars are parked 96% of the time, autonomous vehicles will be able to take people for trips around the city at any point in the day. Therefore, reducing the overall parked time. However, Faisal et al. (2019) suggest that the lack of knowledge on how the new technology associated with autonomous vehicles will disrupt current and future policy strategies and question how planners will address such disruptions. Zwick and Dundon (2021, p. 189) explain the six levels of automation in AVs as being a "…technological hierarchy that serves as an important guide for gauging the sophistication of an AV, as well as the market at large". The six levels of automation include (Zwick and Dundon, 2021):

- Level 0 → cars only operate by specific directions from the driver
- Level 1-2 → beginning of automation where a few tasks are being automated
- Level 3 → when the car can handle some driving tasks and functions automatically (limited to predictable environments and driving circumstances)
- Level 4 → almost all driving functions can be done automatically without human interaction
- Level 5 → autonomous vehicle is adaptable to all driving circumstances, environments, and interactions without any need for human interaction

These six levels of automation are helpful in understanding where our advancements in AV technology currently are and clearly outline a goal of where AVs are heading. However, AVs are still in the testing and piloting phase and there are many safety concerns related to the implementation of AVs. Zwick and Dundon (2021) state on page 190 that vehicle-to-everything is the "…ability for vehicles to connect to their surroundings using cellular technology to better guide vehicles and alert them to obstacles". Therefore, this shift from ownership to usership is becoming even more prominent with the rise of new technology and autonomous vehicles. In a vehicle-to-everything scenario, the driver will no longer be needed at all. Thus, what will the future of car ownership look like?

E-scooters more commonly known as electric scooters are motorized stand-up scooters powered by a small battery. Shared e-scooters are currently not available in the city of Toronto due to the safety and congestion concerns associated with them. E-scooters have a max speed of about 45 km per hour (Hardt and Bogenberger, 2019) and can therefore be a hazard to pedestrians if used on sidewalks. Additionally, if e-scooters were to be road in the cycle lane, they could impede existing cyclist traffic and municipalities would need to consider adding an e-scooter lane to the existing road network. Therefore, current policies and road infrastructure do not exist in the city of Toronto yet to provide safe shared e-scooter usage.

6.2 Overview of On-Demand Transportation (ODT)

On-demand transportation or ODT is demand-responsive transportation (DRT) service that provides transit riders with a flexible routing system. Sanaullah et al. (2021, pp. 285) define ODT as "…a service with flexible routing (origin and destination) and operation (pick-up timing) based on the user's demand". In addition to this, ODT can be seen as an "alternative form of providing transit, where vehicle routes and schedules are determined by passenger

demand typically facilitated through a technology application unlike fixed-route transit where transit service has a predetermined route and schedule" (Canadian Urban Transit Association and Metrolinx, 2022, p. 7). ODT is typically most beneficial in lower density and lower populated communities where it is too expensive to operate multiple fixed-route transportation services (Volinski, 2019). This form of DRT provides transit riders with real-time data, trip updates, and timing. Transit riders can book an ODT ride through a smartphone, website, or by calling a customer service representative. Providing transit riders with a variety of booking methods is an important step to making ODT more accessible for people of all abilities, ages, etc. (Tooley et al., 2019). Having a booking option via phone call is important to limit the digital divide for those who do not own or have access to the internet or their personal devices.

Zhang, Farber, and Young (2021) explain how ODT encourages participation and can be delivered at low costs and improve the overall customer experience. However, as mentioned in chapter 4, participation in the smart city and smart transportation is not always voluntary. For transit riders to use the ODT service, they must input their personal information into an app. The app then extracts data about the transit rider trip patterns, destinations, trip timing, etc. to better predict usage and transportation patterns. Typically, local municipalities and their software providers have access to this information, and it is important to question how the data is being used and whom it is being shared with.

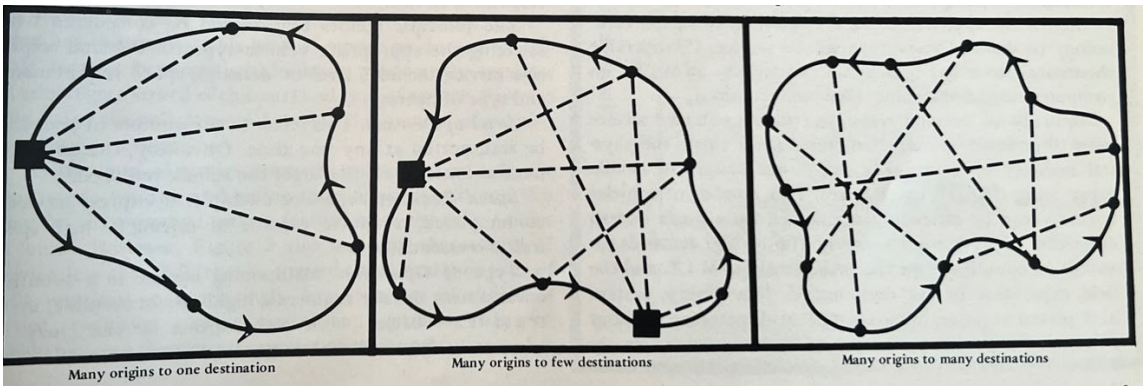
6.3 History of On-Demand Transportation (ODT)

Historically, ODT was known as dial-a-ride or DRT. In the 1940s post-WWII, urban development began to sprawl outwards past the city centres and urban cores (Lundberg and Lustig, 1972). This urban sprawl resulted in low-density areas with many detached homes with a large amount of land. During this time, conventional transportation services were not able to

meet the needs of the residents due to the changing land patterns and settlement areas. Lundberg and Lustig (1972, p. 1) explain DRT or ODT as a "customer-activated, door-to-door transportation service". The transportation rider would have to call a dispatcher or representative to book a ride and provide the dispatcher with their origin, destination, number of passengers, etc. (Lundberg and Lustig, 1972).

Lundberg and Lustig (1972) state that DRT can be operated or used in three different ways; route deviation, dynamically routed, and subscription. Route deviation is the diversion of a transportation trip to pick up another passenger along the way (Lundberg and Lustig, 1972). Whereas dynamically routed DRT has three modes (Figure 6) which entail many origins to one destination, many origins to few destinations, and many origins to many destinations (Lundberg and Lustig, 1972).

Figure 6: Modes of Dynamically Routed Demand-Responsive Transportation Service (Lundberg and Lusting, 1972)



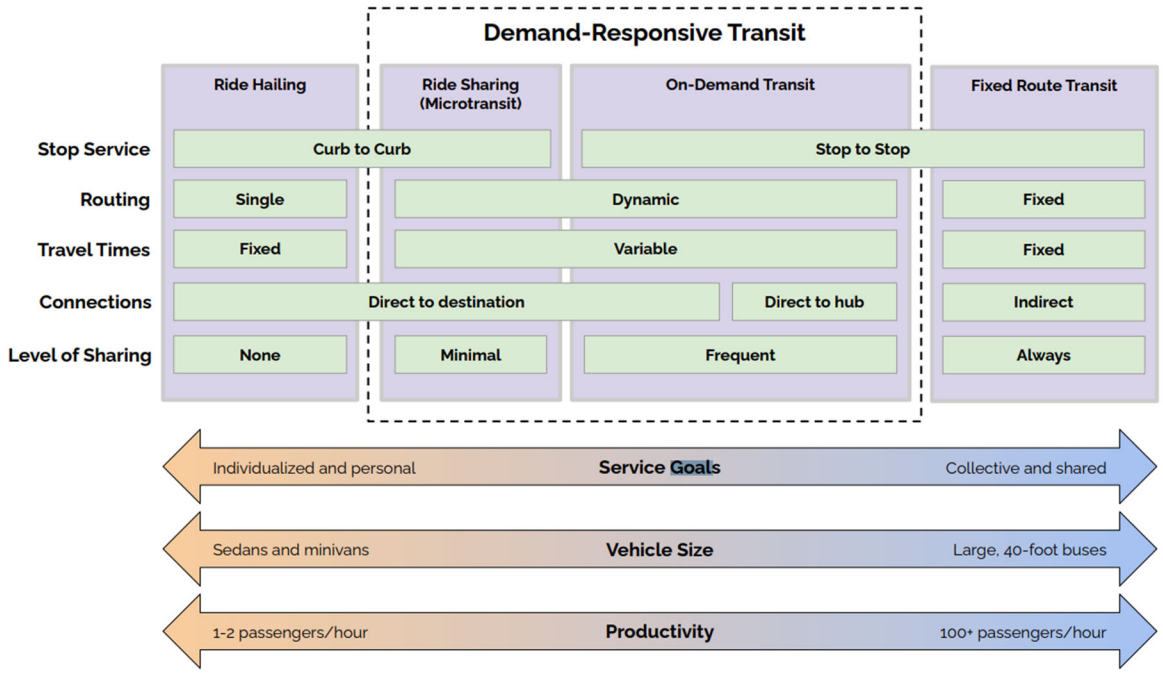
Many origins to one destination are when multiple transit riders need to go to one location, whereas many origins to few destinations are when multiple transit riders need to go to a couple of locations. Finally, many origins to many destinations are when many different transit riders need to go to many different locations. Lastly, subscription DRT is when regular transit riders need to book their regular trips on a weekly to monthly basis (Lundberg and Lustig, 1972). DRT

or ODT historically and in the current day context has been used as a ride-sharing transportation option.

6.4 On-Demand Transportation (ODT) in Current Day Context

Currently, ODT services are available through an online booking system or can be booked via phone call, as previously mentioned. It is important to note, that ODT varies from ride-hailing services in the sense that ride-hailing is when an individual requests a driver to take them to their destination (i.e., Uber, Lyft, taxis, etc.). Ride-hailing as Young and Farber (2021, p. 84) explain provides "…the same level of mobility as automobile ownership but without the associated costs (e.g., maintenance, insurance, license, parking, etc.)". ODT shifts more towards ride-sharing where a company and software system matches transportation riders with drivers to take them to a mutual destination. Figure 7, taken from Klumpenhouwer (2020, pp. 5) shows a conceptual diagram of ODT or DRT and ride-hailing services.

Figure 7: Overview of DRT/ODT (Klumpenhouwer, 2020)



In this diagram, it is shown that ODT or DRT provides curb-to-curb dynamic service that operates with variable times. ODT or DRT intends to connect transportation riders to the nearest transportation hub and provide frequent ride-sharing.

ODT services have been implemented across Canada and this paper plans to explore case studies that relate to the implementation and operationalization processes. ODT can be used as a feeder to fixed-route transportation and transportation hubs and can assist with solving the FMLM problem (Sanaullah et al., 2021). ODT's overarching goal is to build ridership, provide FMLM connections for transportation riders, serve aging populations who may not be able to drive, and increase transportation coverage at a lower cost for municipalities (Klumpenhouwer, 2020). These goals and objectives (Klumpenhouwer, 2020) emphasize is relative to local municipalities, transit agencies, and corporations who are implementing the ODT service. In the coming chapters, will look at the concerns and objectives of ODT service from the perspective of the transportation riders in order to address any inequities or accessibility issues in ODT implementation and make recommendations to mitigate any access or equity concerns.

Chapter 7: Case Study Analysis

7.1 Overview

For this research, the City of Belleville and Milton Transit's on-demand transportation (ODT) services were reviewed and analyzed. I conducted interviews to gain a better understanding of how each on-demand service was operationalized, the key considerations made when implementing the service, and any mitigation strategies the municipalities are planning on implementing/implemented to ensure equitable and accessible transportation.

The City of Belleville was chosen as one of the case studies, due to its award-winning and nationally recognized service. In 2019, the Canadian Urban Transit Association (CUTA) awarded the City of Belleville the Innovation in Transit Award (City of Belleville, 2019). The award was shared between the City of Belleville and Pantonium Inc. (service provider) to reward their nationally recognized ODT service (City of Belleville, 2019). In addition to national recognition, the City of Belleville was chosen because of its shift from late-night transit to on-demand late-night transit in September of 2018 (City of Belleville, 2019). Therefore, having run on-demand services for nearly four years, the City of Belleville is already well established and knowledgeable in regards to ODT. Milton's ODT service was selected because of its successful pilot project that led to full implementation once the pilot period ended. Milton Transit is relatively new to ODT and launched its pilot ODT service in May of 2021 and ran until September 2021 (Transit Alternative Service Delivery Strategy, 2021).

For this paper, representatives from the City of Belleville and Milton Transit were interviewed to gain an overall better understanding of their ODT service implementation, best practices, and lessons learnt. Background research was conducted to understand how smart city initiatives and MaaS relates to ODT service implementation. In addition, this research considers

existing policy documents and objectives outlined by the City of Belleville and the Town of Milton.

7.2 Policy Analysis

In 2018, Metrolinx released a Regional Transportation Plan (RTP) that is the successor to The Big Move and sets out transportation goals and objectives for 2041. The RTP outlines transportation development, objectives, and best practices throughout the Greater Toronto and Hamilton Area (GTHA). Additionally, these documents aim to address how government and transportation agencies will work together to support a prosperous economy, increase the quality of life, and consider environmental factors. The *Provincial Policy Statement* (PPS) outlines the objectives of transportation systems planned within and across the Province of Ontario. The PPS aims to provide transportation options that increase the use of active and public transportation. The PPS (2020) states that "Strong, liveable and healthy communities promote and enhance human health and social well-being, are economically and environmentally sound, and are resilient to climate change". In addition to this, the PPS (2020) aims to enhance multimodal transportation options that connect transportation modes and connections across jurisdictional boundaries. *A Place to Grow: Growth Plan for the Greater Golden Horseshoe* (2020) or more commonly known as "The Growth Plan" sets out policies and guidelines to help manage growth and development throughout the region. These policies, guidelines, and goals include designating specific cities and areas as Urban Growth Centres to identify growth and appropriate planning for development by recognizing barriers. In particular, section 3.2.2 (2b) states that the region needs to "offer a balance of transportation choices that reduce reliance upon the automobile and promotes transit and *active transportation*". Therefore, the Province of Ontario is recommending

that local municipalities have consideration for reducing reliance on automobiles and promote alternative forms of transportation (i.e., active and public transportation).

In reviewing these provincial policy documents, it is clear that they all set out policies and guidelines to manage growth, enhance transportation options, and promote alternative forms of transportation. However, these high-level provincial policies are rather vague and do not consider new and emerging forms of public transportation (i.e. MaaS, ODT, etc.). Therefore, without specific provincial policies that clearly outline how ODT or MaaS can be implemented leaves room for interpretation and disconnect when local municipalities try to implement new ODT services. By implementing specific policies and guidelines at the provincial level can contribute to enhancing our public transportation system and can promote accessible and equitable transportation services.

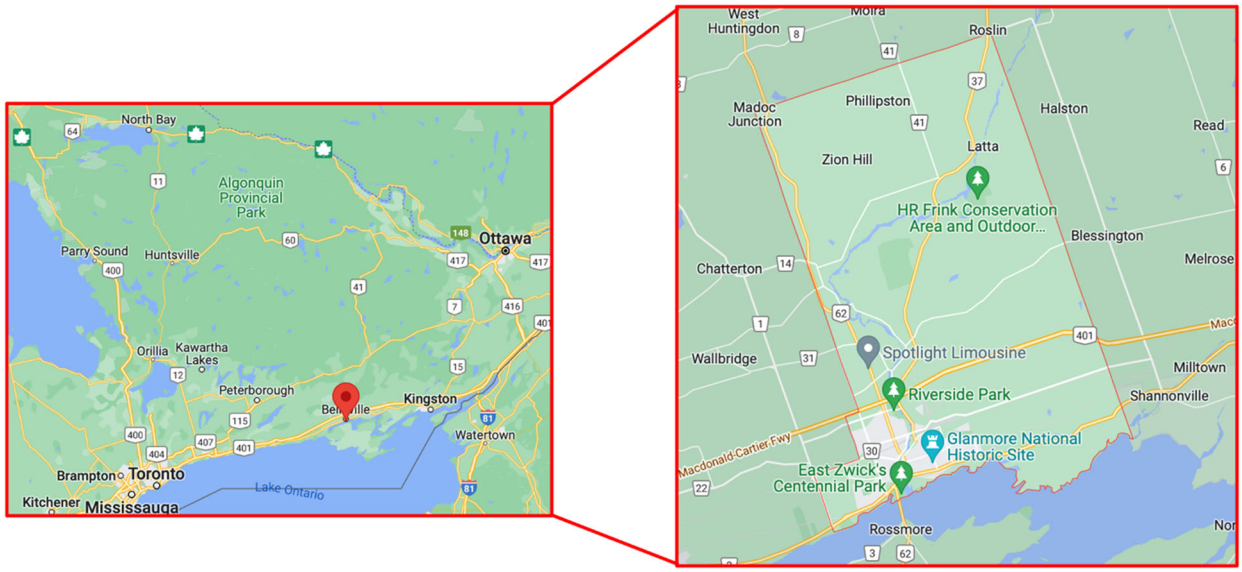
The *Municipal Act* (2022) states that a lower-tier and an upper-tier municipality may pass by-laws related to transportation services (excluding highways). The *Public Transportation and Highway Improvement Act* (2022) allows the Minister to enter into an agreement with a firm or corporation where they can "…design, develop, construct, test, and operate all or any part of a demonstration transit system related to public transportation. Therefore, through the *Municipal Act* (2022) and the *Public Transportation and Highway Improvement Act* (2022) municipalities are able to pass by-laws related to transportation services and procure and implement new mobility projects with the approval of the Minister. This point is particularly interesting to the discussion around MaaS and ODT because these policies allow for municipalities to try to implement innovative transportation services at the local level. However, as noted above, there is no descriptive policy or guideline outline at a provincial level to ensure some regularity of ODT or MaaS services across the province.

7.3 Case Study: City of Belleville

7.3.1 Overview: City of Belleville

The City of Belleville is a combination of rural and urban landscapes and sits along the north shore of the Bay of Quinte on Lake Ontario. The City of Belleville is roughly 190 kilometres northeast (Figure 8) of Toronto, Ontario (City of Belleville, n.d.).

Figure 8: Context Map of the City of Belleville (Google Maps)



Belleville has a population of roughly 49,000 people and roughly 200,000 people live within a 30-minute drive of the City (City of Belleville, n.d.). Belleville is a relatively low-density community with a small population across a large geographic area, therefore it is expensive for the City of Belleville to operate fixed-route transit all day long. The City of Belleville's Transportation Master Plan (2014) highlights the prioritization of the existing and future needs of their transportation infrastructure. The Plan intends to guide transportation infrastructure, promote active and public transportation, create transportation recommendations, and examines the deficiencies in the City of Belleville's transportation system over the next 20 years. Section

6.6 of Belleville's Official Plan (2020, p. 124) states that the City intends to improve its public transportation system and to create "…viable alternative to use of the private automobile, including for those with disabilities". Therefore, this policy outlined in the City of Belleville's Official Plan (2020) emphasizes the desire to shift away from personal vehicles toward public and active transportation methods.

Since the City of Belleville covers such a large geographic region and has such a small population, most citizens will utilize their personal vehicles to get around. However, those without a license, with disabilities, or who aren't comfortable driving are left with limited options to get around. In 2018, the City of Belleville switches its late-night fixed-route transit (Route 11) to an ODT service to provide transportation riders with real-time ride-sharing services (Sanaullah et al., 2021).

7.3.2 Interview Results

As previously mentioned, ODT services are optimal when there are low ridership rates and high operational costs (Sanaullah et al., 2021). The City of Belleville partnered with Pantonium Inc. in 2018 to launch a transportation service that aimed at providing transportation riders with on-demand late-night service. Prior to ODT service implementation, the City of Belleville's public transportation service ended at 9:30 pm on weeknights (Interview, Buck and Cooke, 2022). However, there was a high demand for public transportation services due to workers from the industrial park and Loyalist College. The City of Belleville originally were working to develop a fixed-route service to serve those passengers when they were approached by Pantonium Inc. to help launch an on-demand pilot project in their area (Interview, Buck and Cooke, 2022). Buck (Interview, 2022) explains that having a population of just over 50,000

people made the City of Belleville the ideal test market because its operation staff was small and there were a lot fewer people involved in the decision-making processes.

There are about 313 bus stops across the City of Belleville, and their ODT service runs to every bus stop available (Interview, Buck and Cooke, 2022). The City of Belleville currently has about 21 40-foot conventional buses. However, the City of Belleville is undergoing a Transportation Operational Review in the upcoming year, so there may be changes to their existing fleet. Only 2 fixed-route buses at night are now needed since the on-demand service has been implemented (Interview, Buck and Cooke, 2022). In addition to the 2 fixed-route buses, 3 on-demand buses run throughout the day that feeds to and from the on-demand service (Interview, Buck and Cooke, 2022). Before the COVID-19 pandemic, the City of Belleville averaged about 250 passengers per night, meanwhile at the peak of the pandemic, the City of Belleville was serving about 50 passengers a night. As of April 2022, Buck and Cooke (Interview, 2022) state that they serve about 75 to 100 passengers per night.

Pantonium Inc. deals with the operationalization of the trip booking system to assist with the transportation riders' trip optimization (Interview, Buck and Cooke, 2022). The Pantonium product can work on any type of vehicle or any size and any combination (Interview, Buck and Cooke, 2022). Trips can be booked online through the app, on the website, via phone call and/or email, or can be booked at the stop with the driver (Interview, Buck and Cooke, 2022). However, booking at the stop with the driver does not ensure that the transportation rider will be guaranteed a spot and so it is strongly encouraged to book ahead of time. Once the transportation rider books their trip, they are put into a queue which then gets populated into the driver's tablet to notify them that there has been a trip requested (Interview, Buck and Cooke, 2022). The fare structure for their ODT service is the same offered for their traditional public transportation

services with an adult fare being $3 or a monthly pass of $65 (Interview, Buck and Cooke, 2022). The City of Belleville's ODT service mainly serves people who work part-time in the evenings, seniors, and students who work after school or have extracurricular activities. The peak time for ODT services is around 11:00 pm because of all the people who need to book rides after they get off work at night from the Kellog Canada factory, Proctor and Gamble Inc., and Magna International Inc.

7.3.3 Accessibility and Equity Mitigation Strategies

In addition to the regular booking system, the City of Belleville is looking into software and smart technology system that scans a transportation rider's QR code upon entry (Interview, Buck and Cooke, 2022). Scanning the transportation rider QR code will notify the bus driver of the trip they booked and ensure that the passenger is getting on the right bus. This QR code scanning system can be beneficial for the transportation rider because it confirms the trip and ensures that transportation riders are booking their trips ahead of time. This can prove to be beneficial for those with accessibility needs or who do not speak the language to help provide the transportation rider with more comfort knowing they are boarding a bus going in their desired direction.

Buck and Cooke (Interview, 2022) explain that all buses are fully accessible and compliant with the AODA. The City of Belleville ensured that all ODT bookings can be taken in a variety of ways (i.e., phone calls, email, etc.) to alleviate socio-economic and accessibility concerns. The City of Belleville's telephone operator has the ability to translate for those who are hearing impaired, speaking impaired, or for those who do not speak the language (Interview, Buck and Cooke, 2022). Additionally, the City of Belleville's ODT service has the same fare

structure as their regular service and a reduced fare payment option is available for those who are eligible.

A "pole talk" button is planned to be implemented at all stops that connect back to the scheduling service. The "pole talk" function acts as a "pick me up" button that provides a visual and audible prompt to notify the rider of the next bus arrival time and notifies the driver that someone is waiting at a specific stop (Interview, Buck and Cooke, 2022). Buck and Cooke (Interview, 2022) explain that the City of Belleville does a lot of outreach to different organizations in the area such as the social service, Alzheimer's Society, etc. to look for input on the barriers that need to be addressed in regards to public transportation.

7.4 Case Study: Town of Milton

7.4.1 Overview: Town of Milton

The Town of Milton is located in Southern Ontario approximately 50 kilometres southwest of Toronto (Figure 9). The Town of Milton is a fast-growing area where there is an increasing demand for new office spaces, industrial development, mixed-use residential developments, and commercial communities (Town of Milton, n.d.). According to Statistics Canada (2021) census data, about 132,979 people living in the Town of Milton with a median age of 36 years old. Halton Region's Official Plan (2021) states that mobility and public transportation should be affordable, provide convenient access, safe, and efficient. Providing convenient access to public transportation is a key aspect of ODT services and being able to plan, book, and pay for a ride via a single platform. Additionally, having a demand-responsive transportation service enhances efficiency, connection, and overall convenience. However, it is important to note that new mobility projects or on-demand services are not mentioned in the regional official plan. Milton Transit Service Review and Master Plan Update (2019) provides

short-term goals and objectives to make improvements to existing and future transportation needs from 2019 to 2031. Milton's Transit Service Review and Master Plan Update (2019) emphasizes the need for public transportation in order to create and build complete communities. As shown in Figure 9, the Town of Milton is a relatively rural community with some urban centres, making it a great community to consider ODT service implementation. As previously mentioned, ODT service is most beneficial in areas with low density, low ridership rates, and high operational costs

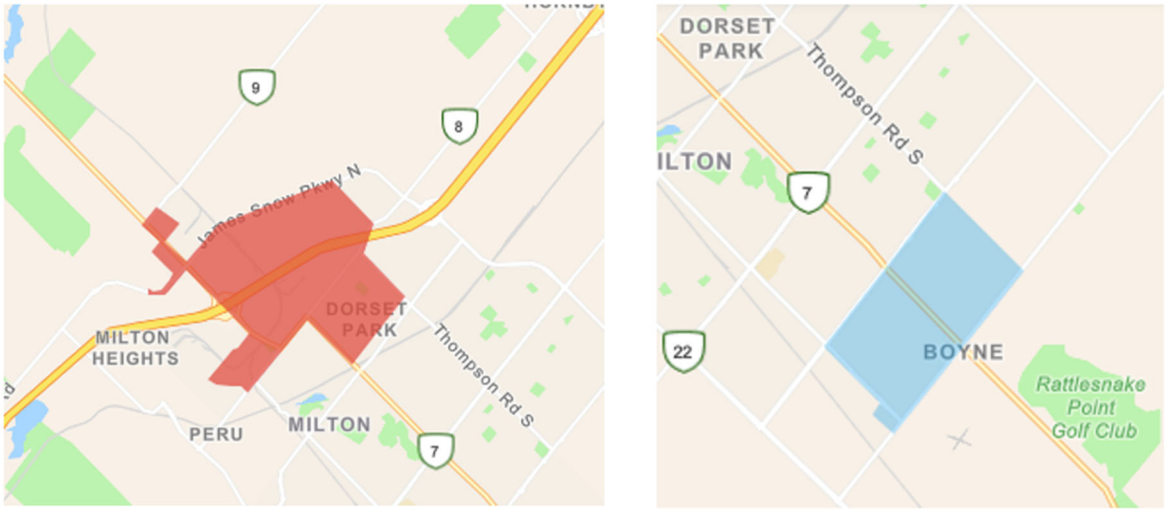
Figure 9: Context Map of the Town of Milton (Google Maps)

7.4.2 Interview Results

The Town of Milton is on the western edge of the GTHA and has a fast-growing population and transportation system. The Town of Milton's transportation aims to provide alternative service delivery such as microtransit and ODT services (Interview, D'Alessandro, 2022). The Town of Milton is a rather young community with plenty of young families with young kids. D'Alessandro (Interview, 2022) states "…we have an opportunity here to capture that youth market and get them using transit early and often". Therefore, as that youth market

begins to age and become adults, there is a stronger chance that they might continue using public transportation regularly and pass that on to their children. The Town of Milton launched its ODT service in September of 2021, which aimed to comingle and integrate its ODT service with its specialized door-to-door transportation service (Interview, D'Alessandro, 2022). By doing so, the Town of Milton can utilize its existing fleet to service the specific service areas. Figure 10 shows the key areas that were chosen for ODT service in Milton due to their low performance on fixed-route service within those areas.

Figure 10: Town of Milton ODT Service Areas (Town of Milton, n.d.)



The red polygon on the left represents the 401 Industrial Zone service area that mainly serves the employees within the area. The blue polygon on the right represents the Boyne Zone 1 service area that provides on-demand services to the growing residential area. In general, the main user of the ODT service is the employee who lives and works in the Town of Milton (Interview, D'Alessandro, 2022). This point is important because it emphasizes the local residents usage of the ODT service but also poses room for opportunity and growth to expand the service to those who live outside of Milton. In both these areas, the performance and ridership rates currently do

not meet the standards for a fixed-route service (Interview, D'Alessandro, 2022). The ODT service runs from 5:15 am to 10:11 pm on weekdays and from 7:10 am to 7:40 pm on weekends (Town of Milton, n.d.). The peak time for ODT services tends to be between the hours of 6:00 am to about 8:30 am which is typically when people are heading to work or appointments. The Town of Milton currently has 10 vehicles in their existing fleet that serve the entire service area including their specialized services (Interview, D'Alessandro, 2022).

Milton uses Spare Labs as its operational software to help deliver its ODT service. The Town wanted to stray away from contracting vehicles out of a third party (Interview, D'Alessandro, 2022). Therefore, they began buying vehicles in 2020. Spare Labs was chosen and awarded a two-year contract because of the flexibility offered (Interview, D'Alessandro, 2022). In addition to the flexibility Spare Labs offers, the relationship between third-part planning apps provides a level of integration between their fixed-route system and their on-demand system. D'Alessandro (Interview, 2022) explains that making that FMLM connection when the trip planner is only able to connect to only ODT or only fixed-route services is very difficult to communicate and coordinate trip times. This feature offered by Spare Labs allows for a more seamless connection from one service to another. To book an on-demand trip, the transportation rider must go on the app to register themselves. Once registered, trips can be booked right away through the app, on a website, or via phone call. Also, the Town of Milton is connected with Token Transit which is an electronic fare system. All fares for their ODT service are the same as their conventional service with a single ride adult fare costing $4 and a monthly adult pass being $85.

7.4.3 Accessibility and Equity Mitigation Strategies

The Town of Milton tries to ensure that its ODT service is available to everyone and anyone who is eligible or needs to use their service. The town tries to ensure that people of all backgrounds, gender, race, socio-economic status, abilities, etc. can access their ODT service. In addition to this, Milton ensures that all trips that require accessibility services get picked up in fully accessible vehicles. The access+ program is a fully accessible transportation service that is available to all individuals with disabilities. Therefore, Milton's ODT service ensures that it is available to people of all abilities and can provide additional support to the access+ program. The Town of Milton releases an Annual Accessibility Plan to identify any barriers related to transportation and access. The town recently went through a bus stop signage refresh program to ensure that accessible language and figures are used at their bus stops, in their vehicles, online, etc. (Interview, D'Alessandro, 2022).

The upper level municipality, Region of Halton, has worked with the Town of Milton to deliver an affordability program in regards to fare and payment structure (Halton Region, n.d.). This program is called the Subsidized Passes for Low Income Transit, also known as SPLIT. The SPLIT subsidizes 50% of the fares for local travel for those who are within the low-income threshold that they have identified (Halton Region, n.d.).

Chapter 8: Critiques and Implications of Mobility as a Service and Interview Results

8.1 Overview

The City of Belleville and the Town of Milton both launched ODT services in their area in order to increase multimodal and public transportation access. As shown in both case studies, the City of Belleville and the Town of Milton aim to increase network connectivity and provide transportation riders with FMLM connections to their nearest transportation hub/destination. Both ODT services provide stop-to-stop demand-responsive service that promote ride-sharing. As demonstrated, on-demand transportation services cannot be a one-size fits all or cookie cutter approach. Local municipalities must examine their existing transportation network, fleet, service area, demographics, etc. in order to create objectives and goals for ODT implementation and operationalization. This chapter critiques the chosen case studies and addresses the implications such a service has on the community, and list three general recommendations for ODT implementation.

8.2 Critiques and Implications of the City of Belleville's and Town of Milton's On-Demand Transportation (ODT) Service

Overall, the City of Belleville and the Town of Milton implemented an ODT service that works best for their geographic area, demographics, ridership, etc. However, what is important to note is how accessible and equitable the ODT service is for people of all ages, races, abilities, gender, and socio-economic status. Both case studies offer fully accessible vehicles for persons of all abilities to use as well as the same fare structure as their conventional transportation service. Public transportation services must comply with the Accessibility for Ontarians with

Disabilities Act (AODA) and must provide accessible service for all individuals. In addition to providing fully accessible vehicles, all transportation riders pay the same fare structure as any other traditional transportation services. Therefore, those who are utilizing on-demand services do not have to pay more or less than the standard fare structure outlined by the municipality and transit agency. D'Alessandro (2022) explained that the Town of Milton partnered with Halton Region to provide an affordability program for fare payment structure. As previously mentioned, the SPLIT program is extremely helpful to those who are of lower income and need to get to and from their destination.

Additionally, both case studies demonstrate the ability to plan, book, and purchase an ODT ride via phone call, mobile app, or online. Providing transportation riders with the option to book via phone call can alleviate the digital divide or socioeconomic barriers. For example, those who do not have the funds to purchase and maintain a cellular device, are still able to book a ride using a company phone, pay phone, etc. This feature also allows for people who do not know how to use a mobile device or the internet to plan and book a ride with the assistance of an operator. This feature is extremely important for the operationalization of ODT services, because it reduces socioeconomic barriers and allows for transportation riders to ask the operator questions in real time. Being able to ask questions in real time and get an immediate response is very important because it can eliminate confusion, uncertainty or uneasiness when riding ODT services for the first time.

Another key feature that the City of Belleville offers is the pole talk function that allows for transportation riders to notify the driver that they are waiting at a particular stop/location. This feature improves access and communication with the driver and allows for transportation

riders to request a last minute trip. However, by requesting a last minute trip through the pole talk feature, the transportation rider still has to wait in the queue for the next available vehicle.

Despite these mitigation strategies to improve access and equity concerns in regards to ODT service, it is important to understand how the use of technology and data collection can influence the transportation service. As this paper explains, the implementation of smart technology into our urban fabric and transportation system enables an influx of data collection, analysis, and monitoring. Therefore, we must question how exactly the data is being used, who has access to the data, and what is being done with the data? Sanaullah et al. (2021) explains that every trip contains the transportation rider's information about the trip creation, requested time, arrival time, location, number of riders, etc. Transportation rider information is collected, stored, and analyzed by the local municipalities and transit agencies to inform future ridership rates and desired locations. However, with such extensive data collection and analysis, the rider's comfort levels with the data being collected should be considered. Such extensive data collection changes the atmosphere around public transportation and enables constant monitoring and securitization of public space and public transportation. Therefore, we must question if such data collection infringes on an individual's comfort levels and right to public amenities and public spaces. Additionally, since ODT services are better suited for small rural communities where traditional conventional transportation is too expensive and ridership rates are low, the population size in these areas is typically smaller as well. Having an ODT service in a lower populated and rural area can create some concerns regarding anonymity. Typically in smaller communities, people know one another and such securitization and data collection can create concerns for transportation riders. For example, an ODT rider would like to book a trip from a stop near their rural home where only a few homes are within the area. The data collected, such as trip origin

and destination, from the ODT service can make it very easy to guess who is using the service and where they are going. This form of data collection and securitization is important to consider because it could infringe on an individual's comfort levels with the service and the data being collected regarding their rides.

Bissell (2022) interviewed 30 drivers from Melbourne who facilitated rideshare and food delivery trips. Additionally, Bissell (2022) spoke with 30 customers of the service, 10 gig workers, and 20 industry stakeholders to understand why so many people (customers and drivers) are feeling the impulse to leave the gig economy. According to Bissell (2022), drivers say that they are underpaid, have to deal with racist comments, and are not given enough breaks during their working hours. These equity and accessibility concerns related to using and working for the gig economy are important to note because they emphasize the need for equity and accessibility mitigation strategies. Bissell (2022) outline key policy recommendations to ensure that workers are adequately compensated, more investment in public transportation, penalties for abusive behaviour towards the workers, etc. Despite what is going on in the gig economy, the case studies discussed in this paper use drivers hired by local municipalities to provide the ODT service. Even though the drivers in the case studies are hired on by municipal governments, does not mean that they do not face racism, rudeness, and abuse from customers. Therefore, in addition to transportation rider's access and equity concerns, the drivers need to be considered and included in the conversation as well. The drivers are the fundamental backbone of ODT operationalization and without the help of the drivers, the ODT service would not be function-able.

8.3 Recommendations

Based on the mitigation strategies previously discussed in relation to the case studies, this paper concludes by outlining three key recommendations of ODT implementation and operationalization.

Recommendation 1: The creation of a provincial level policies that outlines ODT service implementation and operationalization. These policies will ensure that there is some regularity between municipalities who have existing ODT services and those who are planning on implementing an ODT service. High-level provincial policies will ensure that ODT services have similar features, accessibility, fare structure, etc. Thus ensuring that the ODT services across the Province of Ontario are up to standard with pre-existing policies. Additionally, provincial rules and/or guidelines should be created to assist smaller communities or municipalities who do not have the resources to deal with ODT services and software providers.

Recommendation 2: Ensure that all transit agencies and municipalities have a subsidized funding program to make certain that individuals of all socioeconomic backgrounds have access to affordable public transportation.

Recommendation 3: Create public transportation educational programs that outline wayfinding tools, fare payment, booking methods, etc. to ensure that those of all abilities know how to use all public transportation services. This will ensure that even if an individual is uncertain on how to use a particular service, they are provided with step-by-step instructions to allow them to confidently use public transportation services.

The three recommendations listed ensure that those of all abilities, socioeconomic status, race, etc. are able to access various public transportation services. D'Alessandro (2022) explains that oftentimes, public transportation services do not do enough to ensure that people of all abilities and socioeconomic backgrounds can access such a basic public amenity. Following these recommendations ensures that a broad policy and structure of ODT services is provided at a provincial level. In addition to this, these recommendations ensure that public transportation funding and education is available to those who may need or want it.

Chapter 9: Conclusion

This paper explores ideas, theories, and concepts related to the implementation of smart technology and IoT into our urban fabric and how that implementation can influence access and equity concerns to the existing and incoming city dwellers. This paper has a particular focus on how smart city technology has and is going to be implemented into our public transportation system and initiatives such as Mobility as a Service (MaaS) and On-Demand Transit (ODT). My investigation paid particular attention to how MaaS and micromobility transportation options, such as ODT, can enhance our public transportation system and overall network connectivity. However, through extensive review of scholarly articles, this paper addresses concerns regarding data governance, surveillance, and data collection demonstrate that MaaS and ODT services can infringe on a transportation riders' overall sense of place, access to public space and amenities. Extensive data extraction can leave urban dwellers, visitors, and transportation riders questioning the importance of smart technology in our urban fabric and what the intent/purpose is behind such data extraction. The tracking of movements and locations within our urban fabric can infringe on an individual's sense of place within the city and impact their overall experience within the city.

As previously mentioned, this research is grounded in urban political economy in order to establish how the capitalist mode of production can create unequal access to the urban built environment which, in this period of urbanization, depends heavily on how smart technology and software implementation, data collection, extraction, and analysis reshapes our city and the ways in which we access space through these technologies (Kitchin, 2011). Kitchin (2013) believes that embedding smart technology and information into our urban environments, does not automatically make our urban infrastructure smart. Rather, it is how smart technology and

information is used "in conjunction with human and social capital and wider economic policy, is used to leverage growth and manage urban development that makes a city smart" (Kitchin, 2013, p. 2). Therefore, the smart city, urban environment, and humans are all strongly interconnected with one another. The smart city cannot exist without human interactions with the technology that is embedded in our urban environment. The data collected within the smart city is analyzed to better predict overall usage, patterns, and flows within the smart city. However, everyone within the smart city is being monitored, accounted for, and surveilled regardless of their desire to participate in the smart city. This involuntary position causes huge concerns regarding access to space, surveillance, and data collection. Through the implementation of smart city technology into our urban fabric, urban citizens and visitors may feel as if their right to public space, access, and personal movements and information is being infringed upon. Therefore, this paper heavily referred to access, control, participation, and surveillance discourse in the smart city and smart transportation and how such extensive data collection can cause uncertainty and uneasiness of the city dwellers, visitors, and transportation riders.

This paper looked at how smart technology has been implemented into transportation systems in the City of Belleville and the Town of Milton. In particular, this paper used the City of Belleville's and the Town of Milton's on-demand transportation services as case studies. Through the collection and extraction of large amounts of data from users of the ODT services it was possible to better predict ridership rates, usage, travel patterns, etc. This paper paid particular attention to who has access to the data being extracted, what is being done with the data, and the city dwellers, visitors, and transportation riders level of comfort with such extensive data extraction. Through focused research, interviews, and policy analysis, this paper was able to situate ODT services within existing policy frameworks. The interview process,

provided information about how the ODT services are operationalized, as well as any mitigation strategies the City of Belleville and the Town of Milton used to combat access and equity concerns. Based on the information collected through the research and interview process, three recommendations for ODT implementation and operationalization were made:

Recommendation 1: The creation of provincial policies that outlines ODT service implementation and operationalization.

Recommendation 2: Ensure that all transit agencies and municipalities have a subsidized funding program to make certain that individuals of all socioeconomic backgrounds have access to affordable public transportation.

Recommendation 3: Create public transportation educational programs that outline wayfinding tools, fare payment, booking methods, etc. to ensure that those of all abilities know how to use all public transportation services.

These recommendations are based within a smart city, data governance, surveillance, access, and equity framework. Extensive data collection and analysis from smart technology can pose great room for urban dwellers, visitors, and transportation riders to question the intentions behind the smart city and smart transportation options (i.e. MaaS and ODT). As Mattern (2017) explains, the intentions of the smart city and data collection within our built environment need to be considered as it creates a politically complicated urban environment. Implementing smart technology into our cities can change the overall atmosphere of the urban space. City dwellers and visitors will feel the constant sense of monitorization that changes the way people interact with the city and feel within the space. Generally, the implementation of smart technology in our transportation system changes the overall sense of place, access to public space/amenities due to the constant surveillance and data extraction, collection, and analysis. The three

recommendations listed address the desire that those of all abilities, socioeconomic status, race, etc. will be able to access various public transportation services.

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Appendices

Brief Professional Biography of Interview Participants

Paul Buck

Paul Buck is the Manager of Transportation Services for the City of Belleville. He has worked at the City of Bellville for nearly five years and has worked in public transportation for about 25 years. Prior to working for the City of Belleville, Paul Buck worked for Peterborough Transit, Brampton Transit, and Durham Region Transit. During his time at Durham Region Transit, Paul ran a contract service out of the Town of Whitby through Coach Canada. In addition to the contract service with Durham Region Transit, Paul also worked on a number of services including experiential training, scheduling, etc. Paul explains that throughout his career, working in operations at the City of Belleville has been his favourite position and that he plans on continuing this position until retirement.

Trish Cooke

Trish Cooke is a Supervisor for the City of Belleville. She has been working in transit for roughly eight years now. In addition to her work at the City of Belleville, Trish has a background in dispatching. Trish worked for PW Transit Canada as a school bus dispatcher and that is what started off her career in the transportation industry.

Tony D'Alessandro

Tony D'Alessandro is currently working as the Director for Transportation Services for the Town of Milton. Tony has worked at the Town of Milton for about 15 years and has been involved in putting together Milton's transportation system from the bottom-up. Prior to working at the Town of Milton, Tony worked at Oakville Transit as a Service Planner. One of his main

responsibilities at Oakville Transit was to contract transit services out of Oakville's transportation system to assist Milton with their public transportation services. Additionally, Tony assisted with building the Town of Milton's fixed route transportation system and so the shift to working for the Town of Milton assisted with the continuing with the work he had started at Oakville Transit.