Curbing Enthusiasm: Examining Canadian Cities' Proactive Responses to Evolving Curbside Pressures

by

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AUTHOR'S DECLARATION

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Abstract

Transportation planning is increasingly concerned with the role the curb plays in urban environments. As the primary boundary separating mobility, accessibility, and amenity activities along a street, it is a highly contested interface between all three. In recent years the number and diversity of curb uses has exploded, placing even greater pressure on this facility. Traditional activities such as on-street parking are being squeezed by new mobility services, e-commerce deliveries, infrastructure supporting shifting transportation modes, and outdoor dining and amenity spaces, to name a few. New innovations such as autonomous transportation will likely further disrupt this mix of uses. As municipal policymakers struggle to keep pace with rapid changes at the curb, some are turning to a new, proactive approach: curbside management. By streamlining curb governance, establishing curb user priorities, incorporating flexibility of uses, and monitoring curb performance using new technologies, curbside management promises to improve outcomes for a greater number of street users.

Research of curbside management often focuses on specific policy aspects or technologies, but very few studies to date have helped municipalities assess their current practices or understand where a holistic approach could enhance their existing curb-related governance activities. These are important aspects to understand because many competing private curb interests do not necessarily align with the public interest for this equally public resource.

This thesis examines academic literature and practitioner guides related to curbside management to develop a best practice-based evaluation framework. This framework enables cities to examine their curb-related dimensions of governance, policy, organizational structure, and performance monitoring. Its primary intent is to help cities better understand how they presently manage their curb and determine where their greatest potential for improvements lie. The framework is applied to five case study cities in Canada—a context examined very little in curbside management research to date. Findings from these case studies reveal that organizational and policy integration, cost-effective curb utilization data collection, and streamlined by-law environments are areas with the greatest potential to improve management of the curb in Canada's urban areas.

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Throughout this journey my wife, Jennifer, has been a continuous source of encouragement for me, understanding my challenges and never taking them lightly. I can't imagine anyone I would rather have moved across the country with to pursue this degree and to share in this adventure. To my family and friends who have been cheering me on, both near and far, thank you.

Dedication

I would like to dedicate this thesis to my Dad, who passed away suddenly and unexpectedly earlier this year. He spent the final years of his life building a garden shed in his backyard, and on a warm August morning he sent me this text message:

> "…[Mom and I are] pretty pleased that you continue to make steady progress on your thesis. Hopefully you don't get discouraged by our constant questions. Remember, it took me 2 years+ to get my shed to the current "finished" look, and it is rewarding to see it. Some days I didn't feel like much was accomplished, but I couldn't have moved forward without those days also getting achieved. Right now you are in those days where everyone (probably yourself included) wishes you could jump to the last page. You still need to complete those details to get there, so don't get discouraged, but stick to your plan. Even when I had 90% of the siding installed, it still looked "ratty" until the final pieces were put into place, and they took more time than the second last pieces. So I want to wish you clear thinking and lots of motivation. Have a great day!"

This thesis is my garden shed. May it serve its purpose well. I miss you, Dad.

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List of Abbreviations

ACPD – Advisory Committee for Persons with Disabilities

ADAAG – Americans with Disabilities Act Accessibility Guidelines

AMDM – Agencé de Mobilité Durable Montréal

ARTM – Autorité Régionale de Transport Métropolitain

AT – Autonomous Transportation

AV – Autonomous Vehicle

CMA – Census Metropolitan Area

CRD – Capital Regional District (of Greater Victoria, B.C.)

CVLZ – Commercial Vehicle Loading Zone

DDOT – District Department of Transportation (Washington, D.C.)

FMQ – Fabrique des Mobilités Québec

HRM – Halifax Regional Municipality

ITE – Institute of Transportation Engineers

ITF – International Transport Forum

ITS – Intelligent Transportation Systems

LPR – License Plate Recognition

LZAM – Loading Zone Allocation Model

MaaS – Mobility as a Service

MMC – Montréal Metropolitan Community

MoD – Mobility on Demand

MOE – Measure of Effectiveness

NACTO – National Association of City Transportation Officials

OECD – Organization for Economic Co-operation and Development

PROWAG – Public Rights-of-Way Accessibility Guidelines

PUDO – Pick-up/drop-off

REM – Réseau Express Métropolitain

SFMTA – San Francisco Municipal Transportation Agency

STG – Special Traffic Generators

TNC – Transportation Network Company

Chapter 1 - Introduction

1.1 The Problem

The curbside of the street is an important but increasingly contested piece of infrastructure in modern cities. Historically it served as a containment barrier for street waste and excess stormwater, helping alleviate negative impacts on adjacent land uses (Wedul & Marritz, 2013). Today the curb has become an established delineator between pedestrian and vehicular traffic. It facilitates people, goods and services interfacing between transportation corridors and their surrounding urban environment.

Over the last two decades municipalities have begun re-evaluating urban street design, shifting their priority away from automobile-oriented mobility on one side of the curb, and towards enhancement of place-making and accessibility potential for users on the other side of the curb—the sidewalk. This design shift is known in transportation planning practice as 'Complete Streets.' Amidst this transition, several emerging and occasionally unanticipated street users have added new demand pressures on the curb, including:

- Transportation Network Companies (TNCs),
- E-commerce delivery vehicles,
- Bicycle or e-scooter (micromobility) services,
- Food trucks, and
- Sidewalk patios.

These 'new' users have disrupted curbside access previously enjoyed by the following 'traditional' users:

- Private vehicle operators (particularly those who park on the street),
- Public transit and taxi operations, and
- Urban freight.

There is a growing urgency with which cities assess how they manage the curb, because failing to keep pace with emergent curb uses is contributing directly to negative mobility and accessibility outcomes for all street users; indirectly to larger economic and environmental sustainability issues (Butrina et al., 2020). For example, an improperly allocated curb lane might compel a delivery driver to temporarily block a travel lane rather than search for a parking spot further away. This decision could delay a city bus while reducing visibility of a pedestrian crossing further up the street—creating both an efficiency and a safety issue. A holistic approach is desirable because one disruption along a street can rapidly deteriorate the on-street experience for many other users (Jaller et al., 2021).

Traditionally cities have managed the curb in a piecemeal fashion. Mechanisms used to manage the curb include:

- Proximal, temporal and pricing controls on private vehicle storage,
- Designated loading zones for passenger and commercial delivery vehicles, and
- Permit systems to accommodate alternate uses such as street patios, food truck operations and temporary construction.

While each of these can be an effective means to manage specific pressures in specific contexts, they can also fail to fully consider impacts on—or resulting from—competing curb uses. With the pressures from emergent and potentially unregulated curb uses, this compounds problems inherent to a non-comprehensive approach.

Curbside management addresses this challenge by engaging all stakeholders with an interest in curb access. This strategy collaboratively evaluates competing curb user needs and then develops both a prioritization scheme sensitive to a street's primary land use, along with the hard and soft infrastructure required to manage the curb efficiently and equitably. Critical to this approach is enforcement, which sets the standard for curb user compliance, focusing on achieving desired outcomes rather than simply generating income. Curbside management has gained traction with many cities owing to its potential to facilitate diverse curb uses through comprehensive stakeholder engagement (Mitman et al., 2018).

A successful curbside management strategy claims to produce several desirable outcomes for cities, notably:

- Reduced traffic conflicts and congestion resulting from cruising for parking or from illegally parked passenger/delivery vehicles (Ranjbari et al., 2021),
- Improved access to the curb by applying unique time-of-day permissions and dynamic pricing for different users (Alemi et al., 2018), and
- More available curb space for active uses by moving static uses (such as private vehicle storage) off street (Willson, 2018).
- Improved clarity and efficiency of enforcement activities (Diehl et al., 2021)

At the same time, the tools used to dynamically monitor, price, designate and enforce use of the curb are disproportionately the products of private tech innovators (Butrina et al., 2020). While this private-sector enthusiasm may improve outcomes for several curb users, it must also fit within a broader community ideal that views the curb as a public good for a wide range of formal and informal activities occurring on both sides of its boundary (Jaller et al., 2021). These activities need to be reinforced by sensible rules which set user priorities and are effectively enforced.

1.2 Topic Justification

The number and type of unique curbside users is evolving rapidly. In fact, research examining the state of curbside management practice less than ten years ago were not even considering mobility services which are commonplace today (Butrina et al., 2020). Furthermore, the demand for specific curb uses (such as e-commerce deliveries and outdoor amenity spaces) have accelerated significantly in the wake of the COVID-19 pandemic (Hanzlik et al., 2021).

Continued advancement of curbside management research is critical for cities to keep pace with emerging and evolving curb use trends because unabated growth of these activities is adding significant pressures to the operational efficiency of both streets and their respective curbs. Understanding what strategies ensure continued efficient and equitable access between the street and the curb is a legitimate public interest.

1.3 Research Question

Curbside management proactively assesses unique curb user needs, establishes user priority and is therefore a departure from reactive 'management of the curb.' The tools used by transportation planners for curbside management are not entirely novel—cities might already use many of the tools found within a comprehensive curbside management strategy but might do so along specific streets on an ad-hoc basis. Effective evaluation of cities' responses to changing curbside demands is of growing research relevance, as evidenced by case study examples in American (Butrina et al., 2020), British and Australian contexts (Marsden et al., 2020). In each of these studies, street uses are a critical component to understanding intent behind a city's curbside management strategy. If curbside pressures are unique for each city, their strategies ought to respond to and accomplish specific outcomes as well. City 'A' might have a problem with a TNC instructing drivers to drop passengers off in an unsafe location relative to other street users, while City 'B' might instead address delivery vehicles blocking a travel lane.

The primary purpose of this research is to establish and examine the linkages between:

- Pressures experienced by unique street users at or around the curb,
- Tools or policies curbside management offers to alleviate these pressures, and
- Literature-backed evaluation of these curbside management tools

This study examines these linkages in Canadian urban settings, a context which has been explored very little to date.

The central research question to this study is: **What are best practices in curbside management and how are they evident in Canada's major cities?** This question will be answered by conducting a

literature review comprised of published academic, media, private- and public-sector resources to establish a comprehensive framework for evaluating curbside management practices. This framework will be applied to five Canadian case-study cities, for whom a detailed review of publicly available city documents, reports, meeting minutes, and any additional municipal resources will help enumerate their curbside management activities currently underway. Their curbside management policies and practices will be evaluated using the framework developed with a focus on organizational structure; plans and implementation strategies; policies, agreements and regulations; and performance monitoring and evaluation. Finally, recommendations drawn from the evaluation will be presented in conjunction with a discussion of current and future curbside management challenges facing each jurisdiction, providing a unique snapshot of each city's current opportunities for policy and/or strategy development.

This study will examine the following five Canadian cities: Montréal, Edmonton, Hamilton, Halifax, and Victoria. These cities have been selected to provide a diverse range of geographies and urban populations (350,000 > 4,500,000). This will be further detailed in the 'Methods' section of this study.

Chapter 2 - Literature Review

2.1 The Curb as We Know It

Exploring the literature on curbside management begins by establishing what role the curb plays within the context of the street. While the curb has become the de facto separator of different modes of mobility and many users' access needs, these functions are understood differently by unique street users (Mitman et al., 2018).

If, for example, a street is viewed primarily from an individual mobility perspective, the curb becomes the interface by which users of higher-speed modes (private automobile, transit, bicycle, etc.) access the immediate surrounding amenities and slower mobility (walking) offered by the sidewalk environment. Thus, the curb can be a delineator of mobility prioritization from other economic and social functions. This interpretation of the curb has been a recent (20th century) phenomenon, owing to the popularity of private, high-speed modes of transportation, such as the automobile (Institute of Transportation Engineers [ITE], 2010).

Likewise, a street acting as a mover of goods and services views the curb as a highly commodified point of access by which these deliveries arrive. Thus, the curb must prioritize serving as many different delivery demands as possible, maximizing turnover of unique users and optimizing policies to best meet these objectives through pricing, use restrictions and effective enforcement (Malik et al., 2017).

In contrast, a street viewed as an amenity or place-making tool views the curb as a point for activating complimentary amenities for the surrounding street environment (Jaller et al., 2021). These might include parklets, street vendors, and additional greenery intended to enhance the social and aesthetic components of the street while reinforcing human-scale mobility along its sidewalk (Litman, 2015). This interpretation of the street and the curb has gained popularity in the last ten years as part of a larger movement known as 'Complete Streets'. A complete street shifts emphasis away from streets' vehicular mobility throughput and towards improved comfort, safety, and balanced priority for all users (Hui et al., 2018).

Realistically, streets are viewed through a combination of these lenses, and surrounding context is extremely important when determining the most appropriate balance from each perspective. However, this still results in a curb that is a competitive focal point for different street user priorities. Moreover, the dominant 20th century legacy of the curb has been as a place for parking and storing private vehicles (ITE, 2010). From a research perspective, this is a natural starting point to explore the

present understanding of curbside management, because even as the number and variety for curb-interfacing activities grows, curbside management is closely related to the body of research examining parking demand management. Despite on-street parking's decreasing value within a multimodal street, persistent parking demand in variably priced curb lanes presumably validates its existence along at least a portion of the curb.

Interest in parking management research has grown in the past thirty years because the curb has increasingly been viewed as a finite commodity. 'Parking economics' dictates supply be managed by designating curb space for specific, prioritized users (typically controlled with signage or painted curbs), or through additional off-street facilities. Similarly, parking demand is managed through pricing controls and temporal/time-of-day restrictions (again, typically controlled through signage). Under both sets of controls, effective enforcement contributes to the variable success of each policy, but also offers hints of policy deficiencies—instances where specific supply or demand controls fail to meet the needs of specific users.

Several studies have observed this phenomenon within specific elements of parking policies. For example, mismatched pricing between on- and off-street parking has produced several undesirable externalities for both streets and surrounding land uses. Seminal parking researcher Donald Shoup (2006) observed that cheaper on-street parking (relative to off-street pricing) correlates to more drivers circling city blocks in search of a vacant on-street parking space—known as 'cruising for parking'—significantly contributing to traffic congestion and pollution.

Arnott & Rowse (2013) expanded upon this research by investigating the dynamic value of specific vehicle trips as a predictor of curb usage at a higher price threshold, but also added the dimension of time restrictions (with effective enforcement) to eliminate cruising for parking. Their economic model concluded that given the heterogeneity of vehicle trips, these two tactics, along with banning curbside parking altogether can eventually eliminate cruising for parking, albeit with uneven impacts for different curb user categories.

While these studies focus specifically on managing parking supply and demand, they are applicable to curbside management insofar as they valuate the curb using the levers of spatial, temporal, and monetary controls to ensure predictable on-street supply, impacting how trips requiring vehicle storage are valued by the individual making them. This is important because the curb accommodates more than just on-street parking. As noted by Shoup (2006), focusing exclusively on parking has notable and outsized impacts on the functionality of the multimodal street. Research, therefore, built upon this foundation of curbside economics with an increased scope of street uses and users.

2.2 The Changing Dynamics of the Curb

The curb became a focal point for several established street user interests, but today there are a growing number of new street users compounding existing pressures at the curb.

TNCs and ride hailing services (such as Uber and Lyft) are a significant source of new pressure at the curb. Alejandro Henao and Wesley Marshall (2017) compiled research on aspects of TNC disruption to the transportation network and highlighted that they induce new travel demand, draw users away from more than one alternate mode of travel, and utilize the curb differently from the modes their trips replace. In particular, by upending the individual's costing of mode choices for a given trip, the task of measuring all these net impacts under a 'new' transportation paradigm—and how this translates to demand-level at the curb—has become very difficult to quantify (see also Karim, 2017). For example, while it may appear that pick-up/drop-off (PUDO) of a TNC passenger represents a gain in curb efficiency (compared with a driver parking their car in the curb lane), a TNC driver's behaviour before and after transporting their passenger represents an incremental traffic increase—a cost borne either by the road network (while searching for their next passenger), or at the curb (while waiting for their next passenger).

Likewise, mobile or 'pop-up' street vendors impact the curb through more than their own curbside occupancy. These relatively new business models alert customers to their operating location (via social media platforms, etc.) and induce different daily customer travel patterns (Pérez et al., 2021). Depending on customers' chosen mode of travel, this may compound existing curbside demand in the vicinity of the street vendor(s).

Micromobility services (including e-bikes and e-scooters) also interface with the curb and much like TNCs, their net impact is, in effect, a shifting paradigm of benefits and potential drawbacks. While they assist in improving usage of active transport infrastructure (such as bike lanes), they also impose new inactive curb uses in the form of docked parking facilities (Marsden et al., 2020; Nadkarni, 2020) and, in the case of dockless services, can block other users from accessing the curb if not carefully regulated (Brown et al., 2020).

The curb has also become a focal point for a growing volume of eCommerce deliveries. In addition to the rise in shipments handled by traditional freight companies and postal service, goods movement has been transformed by the practice of crowd-shipping—utilizing social networking to connect consumers and merchants with crowd-sourced delivery providers (Le et al., 2019). Today, parcels are delivered alongside consumables such as groceries and take-out restaurant food, and the driver delivering these goods increasingly operates out of their private vehicle. In an under-regulated

environment, a street's designated commercial loading zone has been assumed the legitimate shared domain of crowd-sourced delivery vehicles, which complicates enforcement when private, unmarked non-commercial vehicles occupy commercial loading spaces (Pérez et al., 2021).

In the future, the curb may also become both commodified and codified in order to facilitate autonomous vehicles (AVs) and their access needs. While the future role of AVs within the larger transportation system is presently unclear, its trajectory depends on whether their emergence shifts individual preferences away from consuming vehicles and towards consuming rides (Grush, 2018). AVs ability to remove labour costs from TNC services could factor into the competitiveness of TNCs and could subsequently reduce demand for on-street parking (Clark, 2019). Additionally, the way in which AVs operate within the sphere of 'mobility on demand' (MoD) or 'mobility as a service' (MaaS) have huge implications on curbside demand. If, for example, AVs are priced and/or regulated to feed the public transit system, curbside demand for PUDO activities in high-traffic areas could decrease. If, however, they are priced competitively enough to bypass the public transit system (i.e., end-to-end travel), the same curbside pressure could dramatically increase (Grush, 2018). Cities are left with the unenviable task of preparing for several possible scenarios for which their curbs may be used, the associated revenue impact from those uses, and the automation and shift in supply management and enforcement that their curbs will potentially require (Clark, 2019). This will be discussed in more detail later in this chapter.

Existing curb users have been impacted by the aforementioned 'new' curb pressures, and research suggests they have a varying degree of agency to adapt to this shifting landscape. Historically, the curb has been dominated by private vehicle storage (Marsden et al., 2020). As new curb uses squeeze the supply of curb space allocated for general parking, this impacts individual trip behaviour and, in some instances, encourages more organized groups of curb users to lobby for prioritized access.

Decreased parking supply in the absence of dynamically responsive pricing or time restrictions increases congestion caused by 'cruising for parking' (Arnott & Rowse, 2013; Shoup, Donald C., 2006), but it also can disincentivize end-to-end private vehicle travel if the generalized cost of access is deemed excessive to an individual. A 2014-16 travel and residential survey (Clewlow & Mishra, 2017) of seven major US cities found that 29% of urban respondents have adopted ride-hailing through TNCs (compared with 7% of suburban respondents) with parking cited as the most popular reason for the change (37%). This survey notes, however, that ride-hailing has had a minimal (<10%) impact on reducing vehicle ownership. In contrast, car-sharing programs have not only not mitigated existing curb pressures, but they are also well-organized under the umbrella of industry to negotiate designated curb space for their

fleet in some jurisdictions (Dowling & Kent, 2015). This phenomenon, known as 'renting the curb', happening on such a large scale represents a major shift from access designations given to public interests (emergency vehicles, service access), instead allocating finite curb supply to private interests for their exclusive profit (Dowling & Kent, 2015; Marsden et al., 2020).

The same limitation of curbside supply also has profound impacts on the movement of goods and services, but this manifests itself differently from general automobile traffic. Urban freight behaviour is characterized by shorter duration stops in closer proximity to their destinations in order to facilitate their deliveries (Amer & Chow, 2017). In the absence of curbside access, some delivery vehicles might cruise for parking (Dalla Chiara & Goodchild, 2020) but many more are likely to double park, especially when penalties for doing so are not effective deterrents (Figliozzi & Tipagornwong, 2017). This behaviour significantly compromises a street's efficiency, accessibility, and safety (Amer & Chow, 2017; Wenneman et al., 2015). While many streets in urban cores have designated on- or off-street commercial vehicle loading zones (CVLZs), some cities have already begun to experience freight demand outstripping all available commercial vehicle parking supply (Escand et al., 2018; Jaller et al., 2013). Additionally, a parallel stream of private, often crowd-sourced, unregulated and unidentifiable delivery vehicles can (often incorrectly) assume legal access to CVLZs and cause legally permitted commercial vehicles to block a travel lane (Ezquerro et al., 2020; Pérez et al., 2021).

Within the realm of commercial vehicle traffic, it is important to demarcate types of commercial vehicles because their curb access needs vary significantly. Highlighting this point was a 2019 Seattle-based study (Girón-Valderrama et al.), which categorized commercial vehicle types and observed their parking behaviour in central Seattle along blocks containing CVLZs. The study found that while the majority of delivery vehicles and over 75% of illegally parked passenger vehicles (potentially crowd-sourced delivery vehicles) dwelled in these zones for less than fifteen minutes, there were also many commercial vehicles dwelling in these zones for more than 30 minutes. The greatest proportion of these long dwell times were for service and maintenance vehicles. When including all curbside access outside of CVLZs along a city block, that proportion grew to nearly a third of all vehicle types. This disparity, the authors argue, "showed that servicing trips could skew the dwell time distribution of commercial vehicles and tend to take over most commercial vehicle parking operations of 30 minutes or longer" (p. 779). Municipalities, therefore, need to better understand how their commercial parking/loading areas are being used, and whether specific types of commercial vehicles are inadequately served by existing curbside supply without viable alternatives.

Among the most critical yet unpredictable curbside access requirements are that of the emergency vehicle. Their calls to an area may be infrequent, but their ease-of-access can be a matter of life and death and must be free of barriers to access (Kodransky & Hermann, 2011). Municipalities recognize that designating and regulating curb access for emergency vehicles is an essential public good, so this translates to a top-down policy action. However, these same policy mechanisms have also been leveraged by the private sector to acquire public curb space in order to serve private, for-profit interests (Dowling & Kent, 2015). In high demand areas of the curb, passenger loading activities have been piloted within emergency access points (such as near fire hydrants), provided the vehicle operator is present and can quickly move their vehicle in the event of an actual emergency (ITE Case Study, 2018).

All of the aforementioned curb interests focus on access from the street side. However, an in-demand curb also impacts existing adjacent land uses on the sidewalk side. Moreover, the long-term implications of rapid curbside changes on surrounding land uses are not yet fully understood (International Transport Forum & Organisation for Economic Co-operation and Development [ITF & OECD], 2018). The access demands of emergent curb users hamper an historic and assumed function of the curb lane in residential neighbourhoods—especially private vehicle storage—but this observation only tells half the story. It also influences an implicit decision made by residents: the availability of parking supply as a determinant for private vehicle ownership. To that end, research suggests that this relationship is stronger than many other household determinants for car ownership, and by extension, travel patterns (Guo, 2013). When reinforced through policy (i.e., parking maximums), its impact on residential property demand/development depends on location and associated housing type, but appears to support denser, multifamily housing in well-connected urban neighbourhoods while discouraging this same built form in suburban neighbourhoods (Li & Guo, 2018). Therefore, when an urban transportation network shifts towards greater multi-modal connectivity, it allows for denser land uses and the curb shifts towards accommodating a higher turnover of users, becoming a more productive interface (ITF & OECD, 2018).

Commercial properties depend on the curb for different purposes depending on time of day, but also contend with variable curbside pressures. Local businesses can hold powerful influence over their building frontage's curb for their own needs (Zalewski et al., 2011), but may also undermine the broader economic vitality of their street if they misperceive how others, including potential customers, utilize the street and/or curb (Arancibia et al., 2019). The commercial street ecosystem is dynamic and ideally accommodates different usage depending on the time of day. For example, morning rush hour brings curb pressures from freight deliveries (stocking retail shelves) and higher frequency transit accessing

stops. Conversely, midday traffic represents a shift in users and pressure: private parking, ride-share PUDOs of retail customers, lunch-hour food trucks, and reduced frequency transit dominate this time of day (ITF & OECD, 2018). A high demand curb with rigid designation of legal uses operates less efficiently, but a curb with flexible designations can adapt to changing user needs throughout the day (Roe & Toocheck, 2017). Moreover, in commercial districts where the curb is overwhelmed by demand from transit and freight, evidence suggests businesses are receptive to shifting freight deliveries outside of peak hours—possibly to overnight hours—to help alleviate daytime curb pressures (Chen et al., 2017).

Municipalities increasingly must grapple with how best to manage an in-demand curb. They are tasked with not only balancing the demands imposed by new and emergent curb users, but also anticipating and preparing for future and unforeseen curb pressures. A study by Zalewski et al. (2011) illustrates this point. Researchers surveyed staff from eight major US municipalities and found that all respondents reported addressing curbside pressures incrementally, meaning their impetus for curbside policy change was complaint-driven and often contended with political inertia. The study acknowledged some emergent curb uses at the time (mobile vendors, curb parklets and cycling infrastructure) but framed curb pressures as largely attributable to more 'traditional' curb users. Nevertheless, there were two underutilized management strategies emerging to respond to these pressures more efficiently: one, through a systematic restructuring of curbside governance and performance feedback (known as the 'Framework Model'), and two, through dynamic pricing of codified curb space(s) to reach a supply/demand equilibrium (known as the 'Performance Pricing Model'). With this context, survey results indicated municipalities were already struggling to keep pace with evolving curb demand pressures ten years ago, and the diversity of curb demands has only grown since then. For example, the study made no mention of e-commerce deliveries, and these have become a major source of curbside pressure today (Pérez et al., 2021). To that end, Butrina et al. (2020) provided an updated survey to determine how ten US municipalities are pivoting to the current experience with curbside pressures. Notable trends from this more recent study indicate municipalities have or are in the process of restructuring their organization of parking and curbside management operations (evidence of 'Framework Model' adoption), have a more focused knowledge of when/where the curb fails to meet user demands, and express a widespread desire for improved, more consistent data collection to better monitor and respond to curb pressures in the future. In particular, municipalities have experienced varying degrees of data sharing cooperation with TNCs operating in their jurisdiction. A survey study by Diehl et al. (2021) confirmed these findings, emphasizing both public and private sector interests share

"a desire for citywide policy goals around curb management, more consistent curb regulations across jurisdictions, and a common data standard for encoding curb information." (p. 1)

This final point brings attention to the efforts of technology innovators to offer new solutions to growing curb challenges. Technology innovators are at the intersection between public policymakers and a growing number of private curb users who desire a curb that efficiently meets their needs. These technology companies are creating solutions ranging from sensors and cameras (for monitoring curb occupancy) to electronic parking payment infrastructure and digital curb inventory databases (for the ability to share utilization data). This nexus of public/private interests have not always translated to a unified set of curbside access/management goals, particularly with the uncertain impacts of autonomous transportation (AT) on the horizon (Marsden et al., 2020; National Association of City Transportation Officials [NACTO], 2020). There are several challenges to overcome ahead of widespread adoption of technology solutions for curb management. Initially, public and private stakeholders must determine how the curb—a public resource—is equitably designated and priced for private activities. Eventually, a unified data standard for curb inventories would give municipalities the curb utilization data they require from private stakeholders while respecting companies' desires to protect proprietary operational information (D'Agostino et al., 2019; Mitman et al., 2018). Sensors and monitoring equipment need to provide accurate occupancy signals regardless of environmental conditions, and must represent a reduction in operations, maintenance and enforcement costs borne by municipalities (Diehl et al., 2021). Data collection and surveillance must also satisfy the public's interest for personal privacy in public spaces (Marsden et al., 2020). These challenges continue to influence the ongoing research for an equitable system for all potential users of an in-demand curb.

2.3 Curbside Management: Best Practices

With mounting pressure from a wider variety of curb users and new technologies promising to improve the mobility and accessibility of people, goods and services, the importance of a functional curbside management strategy cannot be overstated. A growing body of research complemented by several unique municipal experiences provides a roadmap for implementing curbside management tools to effectively balance diverse user demands. Where does a municipality begin? Zalewski et al. (2011) suggested that moving away from the default practice of responding to curb pressures incrementally meant embarking on one of two broad categories of curbside management response: the Performance Pricing Model or the Framework Model.

The former existed as a theoretical solution inspired by Singapore's congestion pricing strategy of 1975, as well as through performance-based traffic management programs in the United States through the 1990s. Its suitability for managing high parking demand was investigated through modeling done by Shoup (2006) and Arnott & Rowse (2009), with both studies showing promising results by metrics of parking turnover, targeted occupancy (%), and reduced cruising for parking. However, real world application of performance-priced curb space did not occur until the early 2010s, most notably with San Francisco's *SFPark* pilot program. While *SFPark* demonstrated reductions in driver search time and parking distance from destination (Pérez, 2015), this masked over some of the challenges created by a pricing scheme implemented in the absence of easily understood curb use policy (Diehl et al., 2021). Eventually, the San Francisco Municipal Transportation Agency (SFMTA) enveloped that program within a comprehensive *Curb Management Strategy* (2020). This would suggest that Performance Pricing is a useful tool to manage demand but not a comprehensive or standalone curbside management solution.

In contrast to Performance Pricing, the latter Framework Model begins with policy objectives and a vision for optimal street use before investigating on-street conditions (Zalewski et al., 2011). Because this process involves foundational changes, many municipalities begin by evaluating their pre-existing organizational structure as it pertains to parking management, enforcement, inter-agency communication, and response to emergent street and curb uses. Consequently, this process is accompanied by high upfront costs, with early adopters typically having the financial support of local business improvement districts/associations (Zalewski et al., 2011). Two early examples of Framework Model implementation include New York City's *Street Management Framework for Lower Manhattan* (Lethco et al., 2009), and Washington D.C.'s *Curbside Management Study* (2014). In Washington's experience, many of their existing practices and early technology adoptions became advantageous in moving forward with more nuanced policy. Undergirding all of this, however, was a governance structure that was nimble for two reasons: one, parking and curbside policies were integrated across a transportation department whose priorities were to enhance all modes of travel, and two, parking and curbside management's primary role within the system was not to generate revenue, but rather to achieve specific and defensible policy objectives (District Department of Transportation [DDOT], 2014). Their strategy's authors write, "This integration has been a significant factor leading to creative curbside uses such as car and bike sharing, streetscape improvements, bus bulbs and streetcar stations, and intercity bus regulations." (p. 4-1). It also reduces significant barriers to addressing communication between government departments, agencies, and the general public, and presents a unified front for establishing data-sharing agreements with the private sector. To further illustrate this point, Diehl et al.

(2021) contrasted the organizational structures of Seattle and Minneapolis, namely the centralization of Seattle's curbside management operations in contrast with Minneapolis' decentralized approach. The authors add that, "In Minneapolis, an advisor for the public works department said that systems from 50 to 100 years ago still define the agency's organizational culture, and that various departments lack connectivity." (p. 5) This suggests that a department/branch with a singular focus on curbside management operations will better approach true organizational integration, as they actively communicate with any agencies/departments whose responsibilities involve the curb. In many instances, this has also required organizations to make additional staff hires (Butrina et al., 2020) with broadened knowledge in data management and technology integration (Diehl et al., 2021).

Good organizational structure is a precursor to establishing curbside policy objectives, however, allocation of jurisdictional responsibility may either help or impede this objective. For example, Washington D.C.'s DDOT (2014) retains central control of policy formation, issuance (permits, licensing, etc.) and enforcement, whereas the City of Boise, ID cedes operational and maintenance control of roadways to overlapping Ada County, thus complicating the implementation of specific curbside management tools, treatments, and technologies (Diehl et al., 2021). Likewise, the City of Chicago has contracted its parking operations to a private company, although it successfully negotiated control of some pricing structures (Stout, 2021). Short of transitioning to a more consolidated governance structure, jurisdictional challenges are often overcome through collaborative or committee arrangements which respect division of roles and responsibilities but work towards ensuring that any and all curbside management policies and/or treatments are not delayed by jurisdictional bureaucracy.

Early adopters of curbside management strategies desired to respond to existing and emerging curbside uses proactively rather than reactively, provide an equitable and context-sensitive prioritization of curbside access to its many users, and establish a data-sharing standard between public and private stakeholders (Diehl et al., 2021). In order to attain a proactive management approach, cities would begin to assess existing street and curbside functions and then set the desired objectives for different street typologies (ITF & OECD, 2018). These typologies are functions of both surrounding land uses and time of day (i.e., spatial and temporal). An oft-cited example of this hierarchical framework is the City of Seattle's flex-lane curb use priority system (ITF & OECD, 2018; Mitman et al., 2018; Roe & Toocheck, 2017). Seattle categorically identified unique functions of their curb 'flex zones' (Mobility, Access for People, Access for Commerce, Activation, Greening, and Storage), and then prioritized these curb functions differently depending on surrounding land uses. For example, Greening (i.e., the planting of street trees, planter boxes, and stormwater swales) ranks as a higher priority for a residential street than on an industrial

street, but Access for Commerce ranks more important on an industrial street than a residential street. Setting this standard is important for helping different jurisdictions, departments and private stakeholders collectively understand the function, potential design treatments, and enforcement standard for these curb spaces (ITF & OECD, 2018). Likewise, Washington D.C.'s DDOT approached policy decisions using two categorical perspectives of curb usage: the customer's and the agency's (Dey, Dock et al., 2019). In doing so, DDOT was able to design pilot projects to achieve policy objectives in tangible ways for these categories. In practice, these objectives included reducing parking search time (a purely customer-oriented objective), addressing network congestion, pollution, safety and access concerns (supported by both perspectives), and deploying asset-lite solutions to reduce operating costs (a purely agency-oriented perspective; (Dey, Dock et al., 2019; DDOT, 2014). This would subsequently allow DDOT to look at more focused tools and solutions through an evaluative lens of their previous iteration(s), benefits and drawbacks, experienced by other jurisdictions.

There are a wide variety of specific tools and treatments to help organize the curb for different uses, but most feature some form of flexibility in terms of loading/unloading passengers, goods and services. Curbs with this attribute are often labeled a 'flex zone', which converts on-street parking spaces to instead handle PUDO activities, limit occupancy time, and encourage higher vehicle turnover, improving curb productivity. There are several observed outcomes to this type of curb treatment. A pilot study (Pérez et al., 2021) of seventeen PUDO 'hot spot' locations across two US cities (Washington, D.C. and Columbus, OH) found that dynamic curbside designations can effectively facilitate different users depending on time of day, can help municipalities better understand dwell time behaviour for different types of curb users (in this study, median dwell time for PUDO of people was 1.5 - 2.5 minutes; goods and services was 7 - 11 minutes), can reduce unsafe driving behaviour (such as blocking a travel lane), and can illuminate the seasonal/temporal variability of curb demand in cities. Previous research specific to Washington, D.C. (Pérez et al., 2019) confirms that PUDO zones create predictability for various users, especially when private TNC providers operate with geo-fenced curb access (see also Ranjbari et al., 2021). This helps ensure that a vacant, predetermined curb for drivers and passengers is available without excessive searching. While these results are encouraging, they are limited by external factors related to existing street context. A study conducted in Seattle (Ranjbari et al., 2021) observed no measurable difference from its own set of safety criteria (including vehicle speeds and incidence of jaywalking) but noted that its study area was a multi-modal street with prevalent jaywalking and slower vehicle speeds. Additionally, the study cautioned that space allocation for PUDO activities ought to be

optimally sized to ensure higher curb productivity while balancing TNC customer objectives with agency objectives. The authors write:

> The increased PLZ allocation and geofencing reduced dwell times, reduced the number of in-lane pick-ups/drop-offs, increased curb use compliance, and increased TNC passenger satisfaction. However, these outcomes will likely encourage commuters to use ridesourcing. Results of the study's passenger survey clearly show that ridesourcing service is attracting passengers who would have otherwise walked or used transit. If the end goal is to reduce traffic congestion, then measures to reduce—rather than encourage—ridesourcing and passenger car use as the predominant modes of commuting will yield benefits (p. 13).

Given that flex zone curb demand fluctuates temporally (Pérez et al., 2021; Ranjbari et al., 2021), these allocations could still complement areas with reduced-frequency transit service at specific times of day, but need to be limited when network capacity limits demand a shift to modes with higher throughput (ITF & OECD, 2018).

High-frequency or high-priority transit corridors deserve special attention, with several curbside management solutions helping prevent transit vehicles from being obstructed by other curb users, all while encouraging a more productive curb.

Transit priority lanes are a common feature of these solutions, but still require careful policy and design considerations both to maximize their efficiency and to permit curbside access for other users. In particular, policy considerations must address coordination between curbside management and transit agencies, enforcement tactics and their implications, and monitoring/evaluations structures to ensure long-term effectiveness (Cesme et al., 2018). From a design perspective, transit priority infrastructure integrates best with a well-managed curb when a bus lane's curb-adjacency can be limited only to bus bulbs—areas where the sidewalk extends the width of the outermost lane to abut the next travel lane. The remaining curb lane (or bay) may then be designated for flexible short-term uses (i.e., a flex-zone), restricting by time limits, dynamic pricing, specified use designation, or any combination thereof to ensure that a target curb occupancy (below capacity) is attained while minimizing traffic spillover into the transit lane (Roe & Toocheck, 2017).

Even when transit operates in mixed traffic, bus bulbs and restricted flex zone 'bays' significantly reduce the number of delays and conflicts caused by bus lane changes, double-parking, and/or increased traffic resulting from cruising for parking because the curb's designation is not randomly assigned (Roe &

Toocheck, 2017). Additionally, this type of design minimizes delay to transit vehicles by reducing their dwell times as well as the number of bus/vehicle conflict points (Mitman et al., 2018).

There are other transit-curbside design treatments whose benefits are tied closely to an agency's variable ability to actively enforce rules. A study by Cesme et al. (2016) evaluated several of these designs based on capital and enforcement costs versus the benefits to different street and curb users. The study revealed that while typical concurrent-flowing transit lanes provide significant benefits at a moderate cost, the majority of this cost is tethered to ongoing active enforcement. Alternatively, the study found that contraflow transit lanes (transit lanes operating in the opposite direction of one-way traffic)—while a higher capital cost and limited in broad applicability—can significantly reduce ongoing enforcement costs because they are a self-enforcing design. Another example of design assisting enforcement costs is the use of red paint to identify transit-only lanes. In both San Francisco and Chicago, this treatment resulted in significant reductions in hourly vehicle violation rates within marked bus lanes and provide an even greater cost-benefit ratio for jurisdictions with limited enforcement capabilities (Cesme et al., 2018; Roe & Toocheck, 2017). Finally, turn pockets and transit queue-jump lanes help other curb users access adjacent blocks for PUDO and loading activities while simultaneously improving transit service reliability (Roe & Toocheck, 2017).

When choosing street designs and establishing curbside access rules, associated enforcement costs require careful consideration because they can potentially drain agency resources. Depending on the governance environment, dedicated transit infrastructure can ease the rollout of automated enforcement utilizing bus-mounted cameras (Cesme et al., 2018). In this instance, street design helps because it virtually eliminates any legal reason for a vehicle to be blocking a bus.

While short-term curbside loading activities can coexist alongside dedicated transit infrastructure, longer-term curbside access availability increases the likelihood of lane obstruction for other modes, including transit (Mitman et al., 2018). Thus, moving longer-term curb uses and vehicle storage onto adjacent block or off-street facilities serves to minimize this possibility, but means that some curb users (in particular, service vehicles) sacrifice proximity to destination for additional time at a curb where they are not obstructing other street users (Mitman et al., 2018; Roe & Toocheck, 2017; see also Escand et al., 2018).

Curbside management strategies must also account for urban freight and delivery vehicle access needs. In particular, the policy mechanisms used to meet commercial vehicle access demands have to be understood within the context of securing adequate curb supply while discouraging undesirable behaviour, and this is not limited to commercial vehicle behaviour. For example, despite the relatively

inelastic relationship between demand for urban goods delivery and curb pricing (Amer & Chow, 2017), some curbside management strategies still include curbside pricing for freight loading zones yet continue to see reductions in double-parking and cruising for parking in those areas. How can this be? Despite delivery demand inelasticity, curb pricing can further disincentivize unauthorized curbside use by non-commercial vehicles by pricing these zones at the same rate as surrounding parking (Dey, Pérez et al., 2019). This example illustrates that, much like public transit, effective enforcement tactics are a critical component to help achieve urban freight curbside management access needs. However, enforcement can be significantly aided by smart policy as well. A Toronto-based study by Rosenfield et al. (2016) examined the relationship between haphazard parking enforcement, municipal parking revenues, and the prevailing risk-taking by commercial vehicles to park illegally, complete deliveries, and possibly avoid a citation. The study determined that a combination of designated delivery zones located strategically, combined with an annual permit to access these zones could achieve compliance, reduce enforcement costs (see also Dey, Pérez et al., 2019), reduce congestion from lane-blocking and cruising behaviour and still maintain the same revenue stream currently collected through citations. The study notes several North American and Australian urban cores and university campuses which utilize courier parking permits with positive outcomes. The City of Toronto is presently exploring the implementation of a permanent commercial vehicle permit as part of their Curbside Management Strategy (City of Toronto, 2017; ITE Case Study, 2018).

Some agencies have found success in modeling anticipated delivery patterns associated with surrounding land uses in order to designate adequate curb space for deliveries. Washington D.C. utilized a Loading Zone Allocation Model (LZAM) incorporating several variables (business data, alley access, freight trip generation data, etc.) to predict the freight needs for an area. This provided necessary data to require new development to add loading bays and/or off-street parking where the curb was overwhelmed and alternatives were not feasible (Dablanc et al., 2013; Dey, Pérez et al., 2019). This is a significant advantage to areas experiencing infill development because the addition of on-street priority access for deliveries/freight has a known inverse relationship on private/passenger vehicle search time and destination proximity (Nourinejad et al., 2014). Providing adequate off-street parking options or improved public transit capacity can theoretically reduce the incidence of commercial vehicle parking citations (Wenneman et al., 2015). Finally, municipalities developing urban freight management strategies have an opportunity to reduce the pressure of goods deliveries at the curb by focusing on specific strategies to enhance last mile logistics. While success of each tool is context dependent, public-sector initiatives tying desirable behaviour to certification schemes (including the potential for

preferential access and/or treatment) can help achieve a municipality's curbside access objectives (Dablanc et al., 2013). Freight management strategies can also manage goods delivery demand in dense urban areas through logistics consolidation facilities, alternative delivery vehicles/modes, non-peak-hour deliveries and intelligent transportation systems (ITS), whose tools/technologies can concurrently manage curbside access for other users (Dablanc et al., 2013; Mitman et al., 2018).

When shifting from reactive management of the curb to a proactive approach, municipalities benefit from accurate, granular curb utilization data to understand their existing curb conditions. Doing so enables municipalities to implement more targeted solutions to curb demands from different users and improves inter-agency or jurisdictional communication of driver behaviour (Abel et al., 2021). Data collection exists on a spectrum ranging from manual traffic counting to automated detection using cameras, mobile apps, GPS-tracking equipment, or in-ground sensors (Jaller et al., 2021). Traditionally curb or parking data collection was performed manually, however this method has several disadvantages: it is expensive, labour intensive, and fails to provide real-time data about curb utilization, thus eliminating opportunities for dynamic curb pricing or allocation schemes (Dey et al., 2017; Dey, Dock et al., 2019). Alternately, more automated approaches to curb data collection have their own limitations: their implementation costs are high, ongoing maintenance costs are variable (technology dependent), there will be increased personal privacy concerns, reliability issues can impose additional maintenance costs, and their suitability can be limited by the surrounding urban form (Abel et al., 2021; Dey et al., 2017). Short of obtaining real time occupancy data, semi-automated data collection methods (such as time-lapse cameras reviewed after the fact) can be useful for modeling or simulating exercises to anticipate curb demand and provide an estimate for adequate curb supply (Jaller et al., 2021). That said, curb utilization data provided in real time might be worth the expense for the curb management options it provides (such as reserved loading space in high-demand locations). Municipalities such as Washington D.C. (DDOT) have navigated this data collection environment by deploying small pilots to evaluate technology potential through the following criteria: accuracy, latency, reliability, versatility, scalability, ease of installation, and capital and operating life-cycle costs. (Dey et al., 2017).

Washington D.C.'s DDOT catalogs their experiences with various tools as a precursor to expanding curbside management solutions (such as performance pricing) or enacting design/policy changes (such as demarcated parking to improve in-ground occupancy sensor data accuracy) to ensure their preferred curb technologies complement their variable street contexts (Dey, Dock et al., 2019). The data obtained from these toolsets is valuable to more than just public agencies. TNCs, freight and emerging mobility providers can augment their mobility data with modeled or real-time curb occupancy

data to improve their operating efficiency. The general public can also benefit from real time curb data, with location availability, pricing/payment and time restrictions all possible through web-based mobile applications (Mitman et al., 2018). Local governments are also uniquely positioned to complement private actors who 'digitalize' curb inventories, but "only [focus] on the supply side, and do not monitor the demand side of curb access" (Jaller et al., 2021 p. 19). Public and private stakeholders are thus incentivized to establish standards for data sharing and overcome barriers related to anonymizing data which private companies deem proprietary, or which the general public deems an invasion of privacy (ITF & OECD, 2018).

Several third-party initiatives are working towards a data sharing standard including the Open Mobility Foundation's Curb Data Specification (Abel et al., 2021) and Shared Streets' CurbLR specification (Diehl et al., 2021). These tools help public and private stakeholders build accurate curb inventories without exposing industry secrets. Evidence suggests that third-party actors improve the private sector's willingness to share such data (Butrina et al., 2020; Diehl et al., 2021).

In summary, the best performing municipal curbside management strategies systematically explore new data collection technologies through pilot programs, have robust evaluation systems for these pilots including public consultation and cost-benefit analyses for the required infrastructure, and develop data sharing standards to encourage private sector participation in regulating, implementing and actively monitoring curbside access needs.

2.4 Literature Gaps

This thesis will address some notable gaps in the growing body of curbside management research. In recent years, curbside management's established practices have been reviewed through surveying and structured/semi-structured interviews involving both municipal staff (Butrina et al., 2020), and private stakeholders (Diehl et al., 2021). While these studies are helpful in identifying the current challenges facing both sectors, relating these experiences (along with their undergirding physical/policy infrastructure) to a detailed analysis of components found in a robust strategy are key to helping municipalities chart a path towards an improved, proactive and more adaptable curbside management framework. The authors Diehl et al. (2021) write:

> "Although this paper has outlined metrics for evaluating curb performance as a starting point, future research is needed to detail the benefits and drawbacks, data collection and technology requirements, and effectiveness of each metric. Finally, it

> would be beneficial to compare and contrast curb management practices in the U.S.A. with those in other countries" (p. 13).

This thesis connects the current body of curbside management research with a framework allowing municipalities to evaluate their existing practices in curb governance in light of best practices. Additionally, this framework is applied using five Canadian case study cities.

Evaluating existing conditions for cities is an ongoing concern for municipalities keeping pace with new and emerging curbside pressures. The authors Butrina et al. (2020) note:

> "[I]t remains an important challenge to determine universally relevant and context-specific metrics, strategic data collection approaches, management strategies, and evaluation methods for how to design, manage and continuously adapt curbside systems" (p. 6).

Furthermore, researchers outside of North America note the rapid mobilization of private interests to secure their piece of public infrastructure for their needs, reinforcing the need for the provider of this infrastructure to regulate how and for whom it is allocated (Marsden et al., 2020). Thus, this research will help mobilize public sector agencies to understand what policy, design, enforcement and technological solutions exist, and where their existing operations hold the greatest opportunity for improvement.

Chapter 3 - Research Methods

3.1 Overview

This study examines the state of curbside management practice in the Canadian urban context. It accomplishes this objective through five stages. First, a literature review (outlined in chapter two) establishes the existing academic- and practitioner-supported best practices for curbside management. Second, these components are categorized to develop an evaluative framework (a rubric) with a comprehensive set of criteria to assess a city's curbside management potential. These criteria are accompanied by appropriate scoring scales to assess their presence or degree of development within a city's physical, policy, or administrative environment. Third, a combination of geographic, demographic, and political characteristics are used to identify five Canadian case study cities whose attributes are sufficiently diverse from one another. Fourth, a structured scan of municipal documents is conducted for each city to uncover relevant information relating to each of the criteria found in the framework. Finally, each city's approach—outlined by available documentation—is assessed against the criteria outlined in the evaluative framework. Cities are scored and results summarized, quickly revealing areas of strength and areas which show room for improvement.

Previous studies have evaluated elements of curbside management through interviews (Butrina et al., 2020; Diehl et al., 2021; Zalewski et al., 2011), econometric modeling (Amer & Chow, 2017; Arnott & Rowse, 2013; Shoup, Donald C., 2006), and through pilot studies and field observation (Arancibia et al., 2019; Dey, Dock et al., 2019; Marsden et al., 2020; Pérez et al., 2019). In contrast, this study compiles the elements of a comprehensive strategy and develops a rubric whose criteria, although subjective, are justifiable by what previous research has identified to be best practices. This allows municipalities to evaluate their progress towards a 'best practice' ideal.

3.2 Evaluative Framework Development

Curbside management represents a shift away from reactive 'management of the curb' and toward a proactive approach. To ensure a scan of municipal documents uncovers evidence of this trend, the evaluative framework is structured to both categorize preexisting 'soft' municipal infrastructure while also linking each category to a set of evaluation criteria reflecting the literature-supported best practices in curbside management. Table 1 (below) displays the four broad categories and fourteen subcategories representing the dimensions of municipal governance of the curb as it presently exists.

Specific evaluation criteria, including their scoring systems, will be contained within each of these subcategories and will be covered later in this chapter.

Table 1 – Curbside Management Evaluation Framework – Main Sections

Organizational Structure
1. Intra-Jurisdictional Structure (Municipal Departments/Agencies)
2. Inter-Jurisdictional Structure (Tiered Municipalities; Provincial Ministries/Agencies)
Planning Documents
3. Curbside Management Strategy
4. City Transportation/Mobility Plans (Master, Active, Transit and/or Urban Freight)
Policies, Agreements, and Regulations Relating to the Curb
5. Core By-Laws
6. Private Sector Agreements
7. Curb Interface Design Standards
8. Permitting Systems
9. Amenity Policies/Agreements
Performance Monitoring & Evaluation
10. Data Collection
11. Data Sharing
12. Stakeholder and Public Engagement
13. Performance Monitoring
14. Pilot Programs

The fourteen subcategories within this rubric link between categorical municipal structures and evidence of a proactive approach to curbside management contained in the evaluation criteria.

The rationale for examining a municipality's intra- and inter-jurisdictional organizational structure is to understand the policy environment within which the curb is governed—in particular, it's complexity. Academic literature and practitioner guides call for organizational integration across municipal departments/agencies to help address increasing curb complexity efficiently rather than in a piecemeal fashion (Butrina et al., 2020; Zalewski et al., 2011). While municipalities (in theory) have great control over how they structure and harmonize their internal operations, this picture becomes cloudier at the inter-jurisdictional level. Higher orders of government prescribe municipal governance powers through legislation, meaning by virtue of which jurisdiction a municipality exists within, their ability to control aspects of curb governance may be significantly impaired, requiring increased coordination between each level of government (Pérez et al., 2021). Thus, a measure of inter-jurisdictional complexity is included in this framework to acknowledge an added governance challenge which may need to be

overcome by some municipalities, while not by others. Finally, evidence of curbside management staff integration is a precursor to curb utilization data collection and dissemination to all parties with jurisdiction over any part of the curb (Diehl et al., 2021; Marsden et al., 2020).

Municipal planning documents are another important dimension for this scan and subsequent evaluation. Even in the absence of a formalized curbside management strategy (which, if one exists, should be referenced in a given city's official and/or transportation master plans), evidence of curbside management as a future policy objective, or evidence of plan(s) for access management, parking, and other curb priorities are integral to a city's evolving planning policy framework. Inclusion of these documents in the evaluative framework and municipal scan are warranted because they provide the most focused policy for how a curb will be utilized, and for whom (Diehl et al., 2021; Zalewski et al., 2011). Moreover, where the curb is not framed within a standalone strategy, the planning environment governing items ranging from streetscape to active transportation to goods movement will all be significantly impacted by the orderly designation of curb space for prioritized uses (ITF & OECD, 2018; Mitman et al., 2018).

When examining a municipality's existing governance of the curb, some of its most granular details are found within policy documents, staff reports, by-laws, regulations and private sector operating agreements. These documents also provide an opportunity to evaluate the extent curb governance has either evolved incrementally or been completely restructured. Curbside management is a 'successor' to parking management (ITE 2010), so applicable evidence of its influence would be expected within parking policy and by-laws. Likewise, permitting programs are both a legacy of parking management and a component of a comprehensive curbside management strategy because they target the ease of frequent and/or special-needs users (residents, persons with disabilities, visitors, contractors, delivery vehicles) at a proximity and/or duration that creates predictable curb productivity for other users (Chang et al., 2022; Rosenfield et al., 2016; Shoup, 2018). Curb design guidelines are another important component capable of improving on-street loading activities (Pérez et al., 2021; Ranjbari et al., 2021), street user safety (Mitman et al., 2018), traffic lane efficiency (Roe & Toocheck, 2017), transit reliability (Cesme et al., 2018; Mitman et al., 2018; Roe & Toocheck, 2017), and even cost effectiveness of enforcement activities (Cesme et al., 2016). The degree to which municipalities engage in curb-use agreements with private-sector mobility services can, as previously mentioned, significantly impact the latitude for a data-sharing framework between these entities (D'Agostino et al., 2019; Mitman et al., 2018). This is potentially for a win-win for private sector services and public sector monitoring because one receives predictable designated curb space, while the other receives a real-time source for curb

utilization data. By the same logic, amenity policies and/or agreements with private businesses are an important curb-related dimension to evaluate because they signal acknowledgement of curb utility not just as an interface for mobile services, but as an enhancer of the sidewalk and adjacent land spaces of a street (Hui et al., 2018; Litman, 2015).

The final section of this evaluation tool is included because it encompasses the most direct evidence of a shift from reactive, incremental governance towards proactive solutions to changing curbside pressures. Strong curb performance monitoring and evaluation systems contain real-time curb utilization data collection, which is essential to enacting policies which quickly adapt to improve curb productivity (Abel et al., 2021; Diehl et al., 2021). Consequently, data sharing protocols are evaluated because of their potential to assist the creation of predictable curb access for different categories of users, which is in both public and private interests (Marsden et al., 2020). Feedback mechanisms include a qualitative layer for street/curb users and stakeholders to report on the functionality and prioritization of the street to specific interests (Jaller et al., 2021; Mitman et al., 2018). Amidst feedback and data-collection tools, a municipality must also demonstrate the ability to relate these to policies and plans and evaluate whether its stated objectives are being met (Jaller et al., 2021). The final component is to evaluate the propensity for municipalities to explore new curbside treatments using pilot programs. This is because they frame policy objectives through the categorical perspectives of both the agency and the curb user. By trialing practical solutions, this improves the cost-effectiveness of solutions implemented at a city scale (Dey, Dock et al., 2019).

3.3 Evaluative Framework Criteria and Scoring System

Contained within the subcategories of this framework are criteria which are scored on one of two scales: binary (0-1) or gradient (1-2-3). Binary scales indicate the presence (1) or absence (0) of a given element often found in exemplary curbside management strategies. Similarly, the gradient scales, depending on the criteria in question, assess whether an element can be characterized as basic (1), intermediate/moderate (2), or advanced/complex/comprehensive (3).

Selecting between each gradient scale is criteria dependent. The Basic-Intermediate-Advanced scale corresponds to criteria analyzing a municipality's competency and/or capacity for extensive policy development. The Basic-Moderate-Comprehensive scale uses slightly modified language to evaluate qualitative approaches to consultation processes. Put another way, it is a measure of 'thoroughness' in which a municipality carries out the criteria item. The Basic-Moderate-Complex scale is used for criteria whose subject (policy, organization, etc.) is evaluated for its level of granularity and targeted approach

for specific street users. A higher score is more desirable, with one caveat—criteria 2a and 2b which address inter-jurisdictional complexity each serve as counterweights to the other. A lower score for inter-jurisdictional complexity is likely more desirable, however, municipalities in provinces with more complex governance structures are potentially rewarded for overcoming this obstacle if they are well coordinated, as indicated by criterion 2b.

The finalized rubric with sections, subsections, relevant criteria, and evaluation scales prepares the evaluator to conduct a municipal scan. However, the subjectivity of each scale warrants further discussion in order to clarify the characteristics of each numerical value. Table 2 (below) contains two criteria which utilize the basic-intermediate-advanced gradient. Looking at criterion 1a, an evaluator identifies a procedural example of a curb-related decision impacting multiple internal departments/ agencies (note: municipal scan searching protocols will be covered in greater detail in section 3.5). If they find limited or no evidence of coordination in relevant documentation, this criterion would be scored with a "1". If organizational coordination is explicitly stated but unstructured—meaning impacted agencies are mentioned, but no procedural element to guarantee their involvement in impact decision-making is evident—this criterion would be scored with a "2". Finally, if curb decisions are integrated into all applicable municipal bodies with well-structured coordination and evidence of a compulsory review process, this criterion would be scored with a "3".

Table 2 – Curbside Management Evaluation Framework Criteria – Section One

Organizational Structure	
1. Intra-Jurisdictional Structure (Municipal Departments/Agencies)	
a. Coordination and/or Integration of Curb-Related Decision(s)	1 – Basic 2 – Intermediate 3 – Advanced
2. Inter-Jurisdictional Structure (Tiered Municipalities; Provincial Ministries/Agencies)	
a. Level of Complexity	1 – Basic 2 – Moderate 3 – Complex
b. Coordination and/or Integration of Curb-Related Decision(s)	1 – Basic 2 – Intermediate 3 – Advanced

In contrast to the gradient scale, binary scoring scales are assigned based on a scan of specific municipal documents. Table 3 (below) provides two examples of criteria with a focused scope of content. Looking at criterion 3a, an evaluator reviews a municipality's official plan, transportation master plan, and conducts a search of their government website for evidence of a formal curbside management strategy document. If this strategy document exists or is under review by council, this criterion would be scored with a "1". If no formalized curbside management strategy exists, this criterion would be scored with a "0". Within a formal strategy document, an evaluator now searches for evidence of a requirement

for full-time staffing for curbside management tasks, as per criterion 3b. If coordinating staff are included in the strategy, this criterion would be scored with a "1". In the absence of staff or a score of "0" in criterion 3a, this criterion would also be scored with a "0". This example highlights the compounding effect of higher or lower criteria scores on the overall score for each city and by extension, the evidence that a city is or is not adapting to curb pressures.

Table 3 – Curbside Management Evaluation Framework Criteria – Section Two

Planning Documents	
3. Curbside Management Strategy	
a. Does one exist?	0 – No 1 – Yes
b. If so, does it include an internal Curbside Management Team/Division/Committee?	0 – No 1 – Yes
4. City Transportation/Mobility Plans (Master, Active, Transit and/or Urban Freight)	
a. Degree of Acknowledgement of Curbside Complexities	1 – Basic 2 – Intermediate 3 – Advanced

Policy and by-law dimensions of curb governance are granular because they are designed to target and prioritize specific curb user activities. Consequently, a gradient scale is most suitable for evaluating these elements' degree of granularity. Because the evaluator is measuring complexity of curb-related policies and by-laws, this gradient scale is ranked using labels "Basic", "Moderate" and "Complex". Table 4 (below) provides several examples of 'complexity' criteria across several subcategories. Item 8f provides a helpful example for defining complexities. In this instance, an evaluator would review a municipality's residential/business services website and street by-laws for information on their parking permit program(s). The purpose of this scan is to identify who permits are issued for, what allowances a permit provides, where/when the permitholder may use specified curb space, and importantly, why the permit would provide added incentive (versus risking violations and forgoing an annual permit fee). If the municipality operates a permit system with limited variability in controls for unique curb users along designated block-faces during specified times and utilizes a 'blanket' fee structure for all permits, this criterion would be scored with a "1". If there is evidence that the permit structure targets some elements of unique users through a specialized system of permits and establishes a city-wide plan for curb access allowances for specific users (such as delivery vehicles in an urban core), this criterion would be scored with a "2". If this permit system is integrated into electronic parking and enforcement systems, including an automated verification system to link permit(s) to a vehicle's license plate or digital tracker, and if this permitting program utilizes Flex-zones which reallocate curb space dependent on time-of-day, this criterion would be scored with a "3". Likewise, the enforcement system

would score lower if reliant on higher cost human labour, and higher if enforcement is heavily automated and permit data access is easy for a municipality to verify.

Table 4 – Curbside Management Evaluation Framework Criteria – Section Three

Policies, Agreements, and Regulations Relating to the Curb			
5. Core By-Laws			
a. On-Street Parking Pricing/Temporal Scheme	1 – Basic	2 – Moderate	3 – Complex
b. Passenger/Freight Loading Zones	1 – Basic	2 – Moderate	3 – Complex
6. Private Sector Agreements			
a. Car-Share	0 – No	1 – Yes	
b. For-Hire Passenger (Taxi, TNC)	1 – Basic	2 – Moderate	3 – Complex
c. Micromobility	1 – Basic	2 – Moderate	3 – Complex
7. Curb Interface Design			
a. Accessibility standards for all active transport users	1 – Basic	2 – Intermediate	3 – Advanced
b. Integration of competing street uses	1 – Basic	2 – Intermediate	3 – Advanced
c. Active transportation vehicle storage	0 – No	1 – Yes	
8. Permitting System			
a. Local Residents	0 – No	1 – Yes	
b. Delivery Vehicles	0 – No	1 – Yes	
c. Construction/Service/Maintenance Vehicles	0 – No	1 – Yes	
d. Street Vendors (either side of curb)	0 – No	1 – Yes	
e. Motor Coaches	0 – No	1 – Yes	
f. Location(s)/Allowances of permit schemes	1 – Basic	2 – Moderate	3 – Complex
g. Enforcement System	1 – Basic	2 – Moderate	3 – Complex
9. Amenity Policies/Agreements			
a. Street Patio/Parklet Policy	1 – Basic	2 – Moderate	3 – Complex

While itemized policies or organizational integration are examples of criteria which can be evaluated using scales which categorize a level of attention to detail, these gradient scales also represent moving targets as the curb and its emerging user needs are becoming more complex. This is the reason for a fourth gradient scale using modified language to evaluate stakeholder and public feedback of curb-related governance. In this instance, a municipality's ability to adapt to the changing curb, new curb users and any foreseeable changes to the way the curb is managed, can all be measured by a consultative process that is robust and can meet unforeseen challenges facing the curb in the future. As a result, this gradient scale uses the labels "Basic", "Moderate" and "Comprehensive" to reflect that distinction. Table 5 (below) provides an overview of these feedback elements, including the aforementioned criteria in the subcategory "Stakeholder & Public Engagement".

Table 5 – Curbside Management Evaluation Framework Criteria – Section Four

Performance Monitoring & Evaluation			
10. Data Collection			
a. Technologies used for occupancy detection	1 – Basic	2 – Moderate	3 – Complex
b. Granularity of curb data	1 – Basic	2 – Moderate	3 – Complex
11. Data Sharing			
a. Agreement(s) with private stakeholder(s)	0 – No	1 – Yes	
b. Standardized data (i.e., data-sharing standard)	0 – No	1 – Yes	
12. Stakeholder and Public Engagement			
a. Curb-user and stakeholder feedback collection system	1 – Basic	2 – Moderate	3 – Comprehensive
b. Curb prioritization hierarchy reflective of adjacent land use(s)	1 – Basic	2 – Moderate	3 – Comprehensive
13. Performance Monitoring			
a. Evidence of curb performance objectives and/or targets	1 – Basic	2 – Intermediate	3 – Advanced
b. Evidence of a curb performance monitoring systems beyond recorded incident/violation rates	1 – Basic	2 – Intermediate	3 – Advanced
c. Evidence of proactive responses to poor performing curb elements	1 – Basic	2 – Intermediate	3 – Advanced
14. Pilot Programs			
a. Assessment capacity for new/emergent curb technologies	1 – Basic	2 – Intermediate	3 – Advanced
b. Functional demonstrations of new technologies/treatments	0 – No	1 – Yes	

Criterion 12a provides an applicable example of the “comprehensive” gradient scale. An evaluator would review a curbside management strategy paper (if one exists), policy documents related to transportation planning process (transportation master plan, urban goods movement strategy, etc.), and specific urban streetscape improvement summary reports. If these documents reveal a consultative process that is purpose-built for policy formation, but with limited feedback or limited mandatory policy reviews beyond the policy formation itself, the criterion would be scored with a “1”. If the municipality shows evidence of a consultative process that acknowledges curb pressures but does not link to the broader policy context which directs specific prioritization(s) for different curb users, the criterion would be scored with a “2”. If the avenues for consultation and feedback are transparent, integrated into all projects, and ensure that changes to a street or curb cannot proceed without a review of the existing process, and if the process finds categorical positions for new and emerging curb uses to be introduced to the existing policy environment, the criterion would be scored with a “3”.

All four binary and gradient scales form the basis for applying each of the evaluation criteria and fulfill the purpose of linking established practices to manage curb demand with literature-supported best practices in curbside management found in the global, and particularly the North American context.

3.4 Case Study City Selection

Several factors influence the final selection of case study cities for this research. Five cities will be selected for evaluation in order to reduce subjectivity and improve consistency in scoring, with additional considerations outlined below.

Regardless of whether cities manage their curb proactively or incrementally, evidence of high curbside demand can easily be identified by the presence of parking meters, time restrictions, and demarcation for loading and deliveries, to name a few. In the Canadian context, an urban core centering a sufficiently large enough urban area will feature some or all of these indicators. At the same time, curbside management practitioner guides discuss appropriateness of policy and implementation strategies dependent on the intensity and diversity of curbside pressures. Additionally, literature on the Framework Model of curbside management notes the resource intensity of organizational restructuring which may favor larger cities (Zalewski et al., 2011).

In order to capture these dynamics, this research will select from cities centering census metropolitan areas (CMAs) with a population >350,000 and will examine the full range of populations above this threshold found in Canada. Likewise, by selecting cities with diverse mode shares, the rubric can capture mode-specific curbside management responses such as cycling infrastructure in a city with a high percentage of active transportation trips. Finally, successfully implemented curbside management policies require strong organizational integration extending to (and potentially hampered by) provincial jurisdiction over portions of the curb and street. This dynamic varies from province to province; thus, this research will ensure each selected city represents a different province in order to capture the diversity of inter-jurisdictional relationships found in Canada. Table 6 (below) highlight eligible Canadian cities based on these criteria (Statistics Canada, 2017; 2022; Note: at the time of writing, commuter surveys have not been released for Census 2021, so 2016 commuter data has been used instead).

Many existing research papers and practitioner guides have examined aspects of curbside management in one Canadian city: Toronto (Amer & Chow, 2017; ITE Case Study, 2018; Nourinejad et al., 2014; Rosenfield et al., 2016; Wenneman et al., 2015). This research is interested in highlighting new cities with less exposure to the existing body of research, and thus will not be examining Toronto. As a result, Montréal has been selected to represent a major Canadian city with significant curbside

Table 6 – Canadian Census Metropolitan Areas (CMA) Profiles; Population >350,000

CMA Name	Province(s)	Urban Core Municipality	Population (2021)	Commute by Mode Choice (2016)
Toronto	Ontario	City of Toronto	6,202,225	Car: 68.04% Transit: 24.29% Active: 6.68% Other: 0.99%
Montréal	Quebec	Ville de Montréal	4,291,732	Car: 69.68% Transit: 22.28% Active: 7.23% Other: 0.82%
Vancouver	British Columbia	City of Vancouver	2,642,825	Car: 69.34% Transit: 20.36% Active: 9.06% Other: 1.23%
Ottawa - Gatineau	Ontario / Quebec	City of Ottawa	1,488,307	Car: 72.06% Transit: 18.33% Active: 8.66% Other: 0.96%
Calgary	Alberta	City of Calgary	1,481,806	Car: 77.92% Transit: 14.40% Active: 6.18% Other: 1.50%
Edmonton	Alberta	City of Edmonton	1,418,118	Car: 82.58% Transit: 11.27% Active: 4.68% Other: 1.47%
Québec	Quebec	Ville de Québec	839,311	Car: 80.41% Transit: 11.08% Active: 7.61% Other: 0.90%
Winnipeg	Manitoba	City of Winnipeg	834,678	Car: 79.12% Transit: 13.60% Active: 6.25% Other: 1.03%
Hamilton	Ontario	City of Hamilton	785,184	Car: 84.14% Transit: 9.84% Active: 5.14% Other: 0.88%
Kitchener - Cambridge - Waterloo	Ontario	City of Kitchener	575,847	Car: 87.69% Transit: 6.03% Active: 5.49% Other: 0.78%

Table 6 (cont'd) – Canadian Census Metropolitan Areas (CMA) Profiles; Population >350,000

CMA Name	Province(s)	Urban Core Municipality	Population (2021)	Commute by Mode Choice (2016)
London	Ontario	City of London	543,551	Car: 85.15% Transit: 7.24% Active: 6.67% Other: 0.94%
Halifax	Nova Scotia	City of Halifax	465,703	Car: 77.72% Transit: 11.79% Active: 9.19% Other: 1.30%
St. Catharines - Niagara	Ontario	City of St. Catharines	433,604	Car: 90.80% Transit: 2.71% Active: 5.38% Other: 1.11%
Windsor	Ontario	City of Windsor	422,630	Car: 91.50% Transit: 3.36% Active: 4.30% Other: 0.85%
Oshawa	Ontario	City of Oshawa	415,311	Car: 86.09% Transit: 9.55% Active: 3.42% Other: 0.94%
Victoria	British Columbia	City of Victoria	397,237	Car: 69.78% Transit: 10.89% Active: 16.91% Other: 2.41%

pressures. In the interest of selecting another large city (CMA population >1,000,000) in a province other than Québec and with a significantly different mode share, Edmonton has also been chosen. For a mid-sized city (CMA population 500,000 < 1,000,000) Hamilton is a suitable representative for the province of Ontario with the added factor of close proximity to Toronto. Looking at the smaller eligible cities (CMA population 350,000 < 500,000), Halifax and Victoria provide unique contexts due to their relatively high mode shares in transit and active transportation relative to their respective sizes. Together, these five cities represent five unique provinces and have disparate populations whose transportation mode choices are equally diverse.

3.5 Municipal Scan Searching Protocol

The objective of the municipal scan is to uncover relevant documentation related to all fourteen subsections of the evaluation rubric and then apply all criteria. One important facet of this protocol is

the varied (but hopefully consistent) terminology used by each city to describe a similar dimension or policy environment for each category of curb user. For example, the language surrounding (and in addition to) ride-share agreements could use any of the following to describe the same item: “ride-hailing”, “vehicle-for-hire”, “pick-up/drop-off (PUDO)”, “mobility as a service (MaaS)”, “new mobility”, etc. It may also—if operating through an exclusive agreement—refer directly to a company name rather than the service being provided (e.g., Uber, Lyft, etc.). Since the first subsections of the rubric focus on the policy and jurisdictional environment, the scan must yield overarching municipal documents, policies and plans which identify the preferred terminology and will become the focus of subsequent steps. Therefore, each categorical scan must flag these terms and place them in applicable subsequent steps for future scans.

Another component of this search protocol is to use initial scans to identify key documents, reports, meeting agendas and committee documentation and utilize their titles as secondary keyword searches to uncover as much relevant documentation as possible. This mimics the “ladder” methodology found in qualitative surveys but is instead used to understand the organizational and policy environment a city has developed around its curbs.

Step One: Initial Scan

To understand the governance environment, the first general online search phrase is “[City Name] Curbside Management”. Search results are catalogued under the following categories: ‘Government’, ‘Academic/Institutional’, ‘Media’, and ‘Other’. ‘Government’ search results are any contained within public-sector internet domains (municipal, provincial and/or federal). ‘Academic/Institutional’ search results are any contained within academic journals, university, or public policy think-tank organization internet domains. ‘Media’ search results are any contained within national media organizations, including editorials, but not letters to an editor. Finally, ‘Other’ search results are any that do not fit in the aforementioned categories including (but not limited to) private-sector companies, community advocacy organizations, online forums, blogs, etc.

Search results are scanned for keywords linked to street/curb user categories, paying attention to terms or definitions used by the public sector and any contrasting terms found in other categories of search results noted for subsequent scans. Ultimately, public sector webpages are the primary search results and the focus of this step, while the other three categories of webpages are secondary search results used for supplementary interpretation and evaluation of the governance environment. At minimum, this scan should uncover the subject municipality’s official plan (potentially multiple plans if

the municipality is tiered or operates within a regional/metropolitan governance structure) and any supplementary plans linked to transportation.

Step Two: Understand Jurisdictional Complexity and Decision-Making

Within the transportation planning document(s), keyword searches (using CTRL+F) of the terms "governance", "metropolitan", "region", "jurisdiction", "province" and/or "provincial" are used to uncover any content explaining the decision-making process for transportation decisions beyond municipal control. Additionally, a general search using the phrase "[City Name] Regional Plan" is used to uncover any documents or policy framework(s) for metropolitan governance with search terms "curb", "access", and "parking". The subsequent ladder searching of referenced documents rounds out the list of relevant material for jurisdictional complexity and should include any plans/strategies related to public transit, active transportation, and goods movement. Using these documents, criteria under subsections one and two of the rubric may now be evaluated.

Step Three: Review Relevant Transportation Plans

The first two steps have uncovered municipal, regional and/or provincial transportation policy and planning documents, which must now be scanned for content related to the criteria found in subsections three and four. For subsection three, if the scan has revealed a standalone curbside management strategy document, this becomes the primary source for content scanning in this step. If not, criteria on curbside complexity acknowledgement are evaluated via a scan of all other transportation planning documents. Evaluation must focus on the degree of interconnectedness between each respective mode's corresponding planning document(s) and the rest of the policy environment.

Step Four: Core By-Laws (Transportation & Zoning)

The next step of the searching protocol pivots to by-law scans. Attention must be given to the dimensions of curb governance which may exist in more than one municipal by-law document. The terms "by-law", "curb", "parking", "loading", "deliveries", "passenger", and "freight" are used to identify by-law documents found on municipal websites. Following this initial scan, depending on the language used by the municipality in the relevant documents, modified language is employed in a document search (again, using CTRL+F) to populate a list of by-law sections and articles which can be evaluated for degree-of-complexity and acknowledgement of existing and emerging curb users, as per subsection five.

Since parking is related to adjacent land uses, a scan of parking requirements potentially found within a zoning by-law should form part of this search.

Step Five: Private Sector Agreements

Identifying all private sector agreements related to the curb is a challenging search component due to the potentially varied language of the agreement(s) and public access to documentation. Regardless, a search begins within a municipality's web domain, followed by a general web search. If both searches yield limited results, then TNC websites may be scanned for evidence of relevant municipal agreements. Keywords should cover the terminology related to ride-hailing, car-sharing, off-street parking and micromobility services. Ladder searching of the initial round of documents should uncover more details related to curb usage permitted by each private partner.

Step Six: Curb Interface Design

This step requires a scan of a municipality's street design guide(s) for evidence of design standards which address user accessibility, simplify interfacing of people, goods, services, and amenity uses, and address vehicle storage for users of all modes. If the municipality has a curbside management strategy, these documents must be scanned for evidence of cohesiveness as opposed to a "siloed" approach. Attention must be given to corridor designs for multiple simultaneous modes, such as freight loading zones next to cycling tracks, or transit stop locations in relation to a block length. A municipality's comprehensiveness depends on the degree these documents reference others in the municipality's policy, governance and by-law environment, but must also reference design choices which are established best practices for simplifying curb activities.

Step Seven: Permitting System(s)

Vehicle permit systems are identified through a search of the municipality's website. Results should include any by-laws relating to parking, as well as online permit application information typically found on a 'parking' page of a municipality's website. Equally important is how on-street parking enforcement is managed. The purpose of scanning these systems is to evaluate the degree to which they accommodate different classes of curb users—both through unique permit allowances and by being applicable to different parking or loading zones. Consequently, the document and application form keyword searches should focus on terms which identify these users. "Residential", "Commercial", "Visitor", "Construction", and "Accessible" are examples of terms to be used in a keyword search. If

details on permit-only parking inventory are publicly available, it should also form part of the basis for sub-category eight's criteria evaluation.

Step Eight: Amenity Policies / Agreements

Much like permitting systems, amenity policies and programs are identified by searching a municipality's website. Keyword searches may include "Amenity", "Patio", or "Parklet". Media searches are helpful in this step to identify business application rates and uptake of a given program. Evaluation of criterion 9a should be mindful of a municipality's ability to adjust the program seasonally and take advantage of amenity space year-round. A keyword search could include "winter patio" to determine if the curb is used for amenity space outside of warmer months.

Step Nine: Data Management

This step requires identification of an Open Data portal if one exists for a municipality. If such a system exists, a search becomes two-fold: First, the portal is scanned for datasets relevant to the curb (using keywords previously identified in this section), which are evaluated against previously reviewed policy and strategy documents for interconnectedness. Second, the Open Data program is evaluated for having an overarching strategy to determine how data is used and applied to municipal governance decisions (which are evaluated further in sub-category thirteen). In the absence of an Open Data program, the search must instead utilize curb-related policies, programs and activities for evidence of data-driven approach assisting a municipality in its current and future operations. Particular attention must be given to data sharing which might exist in agreements with private stakeholders, such as TNCs.

Step Ten: Stakeholder Engagement

To understand the role of stakeholder feedback in a municipality, a scan of specific streetscape improvement projects, parking or business improvement district strategies is used to provide a real-world example of a consultation process the municipality undertakes. This is also complimented by a search of a municipality's website using the term "engagement" to determine what consultation looks like on city-run projects. This search should also determine if there are different feedback systems or forms for the general public, business owners, or other stakeholders with a vested interest in curb-related policy. Municipalities with a curbside management strategy document should provide detail as to how stakeholders of a given street help determine the mix and priority of curb uses the municipality protects through its projects and programs.

Step Eleven: Curb-Related Decision-Making

Related to data management and engagement, particularly for municipalities lacking an Open Data portal, is evidence of an established process for making curb-related decisions. This lies at the heart of whether a city is reactive or proactive when managing its curbs. This search is accomplished by first verifying through a municipality's Zoning By-Law whether parking provisions are static values or dynamically linked to more complex factors. Next, a scan of the municipality's 'parking' page on their website looks for evidence that factors other than individual reporting or applications impact provisions of the curb for different street users. Finally, a review of a municipality's curbside management strategy (if applicable) should highlight how a municipality monitors their curb performance or tests new policies, technologies or street treatments systematically.

Step Twelve: Pending Report Review (if applicable)

During the municipal scan, some documents may be uncovered which are not enacted as policy or implemented as a strategy. Examples include a technical study or policy review. These reports might make some recommendations for future actions for which little or no evidence exists of having been followed through on, or have actionable outcomes whose dates have already passed. These reports are the final supplementary piece to be factored into criteria evaluation as a potential snapshot of the conditions a particular element of curb governance exists in, however they should not be relied on as a central document in the municipal scan unless they have been ratified by a municipal council.

3.6 Case Study Data Interpretation

Documents and resources uncovered in the municipal scan procedure form the basis of scoring in the evaluation rubric, however, the results borne out by the rubric are not intended as a gradient scale of 'best performing' to 'worst performing' curbside management policies. Rather, the scoring system is meant to show what level of complexity a municipality's curbside management operations have, and where (if any) their policy/governance environment highlights strengths or weaknesses disproportionate to the remainder of their operations.

Exemplary curbside management frameworks in cities like Washington D.C., San Francisco and Seattle owe some of their advanced practices to their large urban populations, the quantity and diversity of curb demands in their respective urban cores, and importantly, their governments' willingness to experiment with managing the access needs of a diverse set of curb users (Chang et al., 2022). A city with a smaller population, or an urban core with reduced demands for specific transportation modes (such as less emphasis on freight deliveries or a lower demand for TNC services) might not have need for

advanced systems to organize their curb for these specific activities. This would be reflected by a lower evaluation score but is not necessarily indicative of a problem. This is why the evaluative framework categorizes criteria: related criteria with wide-ranging scores are designed to help highlight policy or operational elements which could be lagging behind the rest of their operations. They could also highlight a deliberate policy decision. If, for example, a municipality is not permitting TNCs to operate within their jurisdiction, they would see a lower score in subsection six, but this would only demonstrate a less complicated public-private operating environment.

Finally, some criteria scoring is subjective and/or dependent on reliable policy and planning documents. The framework is seeking evidence of proactive management in its existing governance environment, and a municipality very well might be managing their curb demand through a holistic lens. However, if a municipality is lacking supportive documentation for these activities, their efforts might not be captured by this data-gathering process. Regarding subjectivity of criteria scores, this study includes evaluation of five case study municipalities in part to mitigate this risk, because it provides multiple comparable examples for each policy decision, governance structure or implemented feature. This plurality should help differentiate basic activities from advanced, complex or comprehensive ones.

Chapter 4 - Results and Discussion

In this chapter, results from five municipal scans are reviewed. For each city, curbside management policies/practices are highlighted along with a table summarizing their scores. Next, three unique evaluation criteria have been selected to illustrate where each city performs well, performs average, and performs poorly. For each criterion, relevant literature and globally recognized best practices are compared with the Canadian city's specific policies in order to justify their score. This chapter concludes with a discussion about the lessons that can be drawn from the Canadian experience with curbside management.

4.1 Montréal

Montréal is the second largest metropolitan area in Canada, and the largest urban area examined in this research. It is an important center for francophone culture in Canada and has hosted major international events including the 1967 World's Fair and the 1976 Summer Olympics. Montréal is an important economic hub for manufacturing, aerospace, and transportation—home to eastern Canada's busiest port and the headquarters for Canadian National Railway. In recent years Montréal has experienced an economic revival, supported by a growing technology sector and a desire to become a 'living laboratory' for urban environment innovations, which includes new mobility services and curbside management (L'Agencé de Mobilité Durable Montréal [AMDM], 2021). This aspiration has been supported through partnerships between the municipal government, academic institutions and research collaboratives, such as the Fabrique des Mobilités Québec (FMQ).

Despite these recent developments, Montréal is extremely challenged to navigate organizational and jurisdictional complexity with its curb-related activities. The City of Montréal is comprised of nineteen boroughs, each with its own mayor and council. Moreover, Montréal is one of eighty-two municipalities which participate in the Montréal Metropolitan Community (MMC)—a governing body attempting to coordinate land-use and transportation planning at a metropolitan scale. Much like other provinces in Canada, Québec legislates governance of land use and mobility planning processes for its municipalities. However, Québec's government also exerts direct control over specific transportation-related operations in Montréal, such as taxi regulations, and indirect control of regional transportation operations through the Autorité Régionale de Transport Métropolitain (ARTM) which, in partnership with the province's crown corporation pension fund, operates the Réseau Express Métropolitain (REM) regional rail system (ARTM, 2023; City of Montréal, 2023a).

Montréal is taking specific steps to manage elements of organizational and jurisdictional complexity within its control. Recently a new parking and curbside authority, L'Agence de Mobilité Durable Montréal (AMDM), formed from the merger of two separate municipal agencies—each comprising parts of Montréal's parking operations. In 2021, AMDM added a third non-profit organization (called 'Jalon') to further support mobility data analysis. AMDM also released a ten-year *Organizational Strategic Plan*, which maps out procedures for future stakeholder consultation and strategy development—including curbside management policies. This restructuring intends "to take a citywide cross-cutting approach to mobility" (AMDM, 2021, pg. 3). However, to fulfill this objective, AMDM might require modifications to existing governing documents, including the *Charter of Ville de Montréal*.

It remains to be seen how these streamlining efforts at the municipal level will impact the coordination of transportation governance at the provincial level. In particular, the recent provincial legislation regulating taxis and TNC entrants (such as Uber) hampers direct municipal oversight, although Montréal appears to maintain control over taxi stand placement (City of Montréal, 2001). Provincial control of TNC operating agreements will likely complicate the City of Montréal's efforts to reach its own useful data-sharing agreement with these companies. To combat this, Montréal is proceeding on its own pilots to develop real-time curb occupancy data and a curb data-sharing standard across the island. This is a precursor to full curbside codification, which will likely help Montréal leverage how and where TNC loading/unloading activities take place within its jurisdiction. FMQ began with a pilot in the business district of Plaza St-Hubert, utilizing the CurbLR data sharing standard. There is hope that this pilot will provide useful lessons ahead of city-wide application.

Table 7 (below) provides an overview of Montréal's curbside management scores. Three criteria will be examined in greater detail below.

Criterion 8f examines the location(s)/allowances of the city's permit schemes. Academic literature and practitioner guides provide two dimensions of this measure representing best practice: First, permits must consider the diversity of curb users accessing a space—presumably within a permit-parking zone—while prioritizing and protecting specific users (i.e., allowances). Second, permit schemes must consider the utilization of zones, the competing curb uses generated by adjacent areas with a different mix of activities, and be able to adjust accordingly (i.e., location).

Washington D.C. provides a good example of both aspects of this criterion, because its permit scheme provides two tiers of residential permit parking restrictions, creates zones for nine special curb uses, and provides permits for five categories of visitors to these zones, covering nearly any conceivable short-term need while protecting these neighborhoods from undesirable spillover effects due to

Table 7 – Montréal Results

Categories	Sub-Categories	Criteria	Scoring System	Score
Organizational Structure 6/9	1. Intra-Jurisdictional Structure	a. Coordination and/or Integration of Curb-Related Decision(s)	1-2-3	2
	2. Inter-Jurisdictional Structure	a. Level of Complexity	1-2-3	3
		b. Coordination and/or Integration of Curb-Related Decision(s)	1-2-3	1
Planning Documents 1/5	3. Curbside Management Strategy	a. Does one exist?	0-1	0
		b. If so, does it include a CM Team/ Division / Committee	0-1	0
	4. City Transportation/ Mobility Plans	a. Degree of acknowledgement of curbside complexities	1-2-3	1
Policies, Agreements, & Regulations Relating to the Curb 20/34	5. Core By-Laws	a. On-street parking pricing/ temporal scheme	1-2-3	3
		b. Passenger/ freight loading zones	1-2-3	1
	6. Private Sector Agreements	a. Car-Share	0-1	1
		b. For-hire passenger (Taxi, TNC, etc.)	1-2-3	1
		c. Micromobility	1-2-3	1
	7. Curb Interface Design	a. Accessibility standards for all active transport users	1-2-3	1
		b. Integration of competing street uses	1-2-3	2
		c. Active transportation vehicle storage	0-1	1
	8. Permitting System	a. Local residents	0-1	1
		b. Delivery vehicles	0-1	0
		c. Construction/ service/ maintenance vehicles	0-1	1
		d. Street vendors	0-1	0
		e. Motor coaches	0-1	0
		f. Location(s)/ allowances of permit schemes	1-2-3	3
		g. Enforcement system	1-2-3	2
	9. Amenity Policies	a. Street patio/ parklet policy	1-2-3	2
Performance Monitoring & Evaluation 16/27	10. Data Collection	a. Technologies used for occupancy detection	1-2-3	1
		b. Granularity of curb data	1-2-3	2
	11. Data Sharing	a. Agreement(s) with private stakeholder(s)	0-1	0
		b. Standardized data	0-1	1
	12. Stakeholder and Public Engagement	a. Curb-user and stakeholder feedback collection system	1-2-3	1
		b. Curb prioritization hierarchy reflective of adjacent land use(s)	1-2-3	1
	13. Performance Monitoring	a. Evidence of curb performance objectives and/ or targets	1-2-3	3
		b. Evidence of a curb performance monitoring system beyond recorded incident/ violation rates	1-2-3	2
		c. Evidence of proactive responses to poor performing curb elements	1-2-3	1
	14. Pilot Programs	a. Assessment capacity for new/ emergent curb technologies	1-2-3	3
		b. Functional demonstrations of new technologies/ treatments	0-1	1
			TOTAL	**43**

commuter and commercial district parking (District Department of Transportation, 2014). Additionally, Washington compares the uptake of permits in their zones relative to the needs of nearby traffic-generating activity centers—called special traffic generators (STGs)—and uses this 'permit density' calculation to inform changes to the permit parking zone boundaries along with the potential for performance pricing measures in the vicinity of STGs.

Montréal's system for permits uses three broad categories to define its curb users: residential permit, non-residential, and self-service (car-share) vehicles (City of Montréal, 2023b; City of Montréal, 2023c). AMDM is launching a web portal for curb users to access and pay for daily, monthly or annual permits under their user categories. More importantly, this portal is integrated with a permit management system, which allows boroughs to manage permit issuance conditions and gather detailed data on permit usage by street, allowing them to adjust their rules easily (AMDM, 2021; 2022). Because of these innovative approaches, Montréal receives a score of "3" for this criterion.

Criterion 10b examines the granularity of curb-related data obtained through occupancy technologies (the measure for criterion 10a). Once again, best practices for curb data granularity are twofold: First, data is able to provide an aggregate overview of system-wide curb demands to inform an agency's response(s) (i.e., performance pricing) and second, data can—where appropriate—provide agencies and curb users about curb activity on specific streets in real time, improving access time and regulatory decision-making.

San Francisco and Washington D.C. provide excellent examples for each of these aspects. San Francisco's *SFPark* program uses in-ground sensors to provide their agency with the data required to implement performance pricing measures, but it has also been deployed in an app to provide users with up-to-the-minute parking rates, time restrictions and curb availability (Jaller et al., 2021; Nadkarni, 2020). More recently, Washington D.C. has combined occupancy data-technologies and data analytics to create an 'asset-lite' understanding of its curb activity (Dey et al., 2018). While this sacrifices some 'space-by-space' level of granularity, it still provides adequate street- and neighbourhood-level detail to set pricing and estimate parking availability.

Looking at Montréal, their advancement of this criterion can be best described as 'in-progress'. AMDM installed 85 occupancy sensors along two streets in the Plaza St-Hubert business district to test out data-collection systems which will inform both occupancy rates and inform their parking/wayfinding app, which remains in development (AMDM, 2022). Because Montréal is beginning to test and manage these data systems but has not implemented these tools at a full city-wide scale, they receive a score of "2" for this criterion.

Criterion 12b examines the use of a curb prioritization hierarchy to determine which street users require priority on a given street (as a relative measure). Prioritization hierarchies are closely related to Complete Streets design guidelines and permitted adjacent land uses as found in a city's zoning by-law(s) (Mitman et al., 2018).

Seattle was a pioneer in developing curb prioritization hierarchies, which delineate curb users into six categories, and then rearrange their priorities depending on a street's surrounding land-use (Jaller et al., 2021; Roe & Toocheck, 2017). This practice is becoming more common in newer curbside management strategies and can be adapted both in terms of categories of curb users and categories of land uses, as was done more recently in San Francisco's strategy (SFMTA, 2020).

Montréal appears to take a less systematic or structured approach to its assessment of curb uses framed within a street's land use context. The mention of a curb prioritization hierarchy is absent from AMDM's Organizational Strategic Plan. Rather, the authors write:

> Ultimately, deciding how to use the spaces should be based on a thorough understanding of the ins and outs of each option to avoid indirectly and unknowingly subsidizing a use. The Agency's in-depth knowledge will help make optimal recommendations for using street spaces. (pg. 27)

This stated approach is found within a set of policy objectives which focus on improving understanding of curb utilization and prioritizing curb user convenience, but it risks reinforcing and even amplifying status-quo curb utilization along with more reactive responses regarding whom the curb ought to prioritize. Because of these factors, Montréal receives a score of "1" for this criterion.

The major takeaways from Montréal's scores are that the city demonstrates an advanced capacity to implement and evaluate pilot programs, prioritize data collection and dissemination, and has made a concerted effort to improve its organizational structure and coordination efforts within and across jurisdictions. These elements are reflected in Montréal's relatively high scores in both 'Organizational Structure' and 'Performance Monitoring & Evaluation' categories. At the same time, Montréal has a complex regulatory environment which is the product of incremental policy approaches, which will need to be streamlined to support their ambitious policies. These efforts will be greatly supported by new or updated planning documents related to curbside management initiatives, and these are likely to come soon now that AMDM is a more established organization. In coming years, Montréal's scores in 'Planning Documents' are likely to improve, and eventually those scores will spill into the final 'Policies, Agreements, & Regulations Relating to the Curb' category.

4.2 Edmonton

Edmonton is the second largest urban area examined in this research and the northernmost major metropolitan area (> 1 million people) in North America. Edmonton's economy initially developed around agriculture but was bolstered by its selection as Alberta's provincial capital, its (now annexed) neighboring city's selection for the University of Alberta, and the arrival of two major railroads in the early 20th century. More recently, Edmonton has become a major staging area for oil and gas exploration to the north, as well as a hub for petroleum refinement and transport. Edmonton's retail and tourism economy generates unique traffic patterns due to the West Edmonton Mall—North America's largest indoor shopping center. All of these factors give Edmonton a diverse and decentralized employment base and make it an interesting city to examine from a transportation and curbside management perspective. Edmonton's municipal government is known for its leadership on several planning policy issues. These include the city-wide elimination of both parking minimums and exclusionary residential zoning by-laws. This trend continues with Edmonton becoming one of the first Canadian municipalities to approve a formal *Curbside Management Strategy* (City of Edmonton, 2022).

While Edmonton has a relatively simple inter-jurisdictional operating environment, its internal organizational structure is unconventional and thus challenging to evaluate. Its *Curbside Management Strategy* references to a 'Curbside Use and Public Parking Advisory Group'; however, this would exist within a city administration who recently dissolved their transportation department into several other departments handling infrastructure and land use planning (Faid et al., 2022). Additionally, some parking enforcement activities appear to have been contracted out. These are normally problematic signs as organizational integration is an important foundation for quick response to curbside pressures, although Edmonton apparently contends that shifting its transportation operations across its organizational structure would help to reduce siloing.

Time will tell if this arrangement leads to desirable outcomes, but Edmonton deserves credit for doing heavy lifting early with strategy development. This could well-position Edmonton to advance more detailed policies, technologies, and improved street design treatments in the future.

Table 8 (below) provides an overview of Edmonton's curbside management scores. Three criteria will be examined in greater detail below.

Criteria 3a and 3b examine the presence of a formalized curbside management strategy as well as a team, division, and/or committee to provide linkage to city street changes and curbside management policies. Formalized strategies supported by full-time staff are foundational to proactive policy development (Diehl et al., 2021). By doing both, municipal governments can develop actionable

Table 8 – Edmonton Results

Categories	Sub-Categories	Criteria	Scoring System	Score
Organizational Structure 5/9	1. Intra-Jurisdictional Structure	a. Coordination and/or Integration of Curb-Related Decision(s)	1-2-3	2
	2. Inter-Jurisdictional Structure	a. Level of Complexity	1-2-3	2
		b. Coordination and/or Integration of Curb-Related Decision(s)	1-2-3	1
Planning Documents 3/5	3. Curbside Management Strategy	a. Does one exist?	0-1	1
		b. If so, does it include a CM Team/ Division / Committee	0-1	1
	4. City Transportation/ Mobility Plans	a. Degree of acknowledgement of curbside complexities	1-2-3	1
Policies, Agreements, & Regulations Relating to the Curb 19/34	5. Core By-Laws	a. On-street parking pricing/ temporal scheme	1-2-3	2
		b. Passenger/ freight loading zones	1-2-3	1
	6. Private Sector Agreements	a. Car-Share	0-1	1
		b. For-hire passenger (Taxi, TNC, etc.)	1-2-3	1
		c. Micromobility	1-2-3	1
	7. Curb Interface Design	a. Accessibility standards for all active transport users	1-2-3	2
		b. Integration of competing street uses	1-2-3	2
		c. Active transportation vehicle storage	0-1	1
	8. Permitting System	a. Local residents	0-1	1
		b. Delivery vehicles	0-1	0
		c. Construction/ service/ maintenance vehicles	0-1	1
		d. Street vendors	0-1	1
		e. Motor coaches	0-1	0
		f. Location(s)/ allowances of permit schemes	1-2-3	1
		g. Enforcement system	1-2-3	2
	9. Amenity Policies	a. Street patio/ parklet policy	1-2-3	2
Performance Monitoring & Evaluation 9/27	10. Data Collection	a. Technologies used for occupancy detection	1-2-3	1
		b. Granularity of curb data	1-2-3	1
	11. Data Sharing	a. Agreement(s) with private stakeholder(s)	0-1	1
		b. Standardized data	0-1	0
	12. Stakeholder and Public Engagement	a. Curb-user and stakeholder feedback collection system	1-2-3	1
		b. Curb prioritization hierarchy reflective of adjacent land use(s)	1-2-3	1
	13. Performance Monitoring	a. Evidence of curb performance objectives and/ or targets	1-2-3	1
		b. Evidence of a curb performance monitoring system beyond recorded incident/ violation rates	1-2-3	1
		c. Evidence of proactive responses to poor performing curb elements	1-2-3	1
	14. Pilot Programs	a. Assessment capacity for new/ emergent curb technologies	1-2-3	1
		b. Functional demonstrations of new technologies/ treatments	0-1	0
			TOTAL	**36**

plans, develop curb prioritization hierarchies related to surrounding land use(s), and reduce siloing between municipal departments whose responsibilities might impact the curb.

As discussed in chapter two, Washington D.C.'s DDOT was a pioneer in prioritizing organizational integration to curbside management policies and practices. DDOT evaluates curbside pressures from both customer and agency perspectives before conducting pilot projects—evidence that staff apply cross-cutting methods to curb decision-making (Dey, Dock et al., 2019). Additionally, their 2014 strategy was ahead of its time for assessing their agency's relative strengths and weaknesses before establishing policy priorities, some of which remain relevant in more recent data-collection pilots (Dey et al., 2018; DDOT, 2014).

Looking at Edmonton, their city council approved its *Curbside Management Strategy* in August 2022 (Karstens-Smith, 2022) and is beginning to implement short-term actionable items. Their strategy was developed by and continues to rely upon a "Curbside Use and Public Parking Advisory Group" as its actionable items are implemented (City of Edmonton, 2022). Because of these developments, Edmonton receives binary scores of "1" for both criteria 3a and 3b.

Criterion 7b examines the relationship between curb interface design and considerations for competing street and curb-adjacent users. A practical example would be a curb cut or break in a curb barrier to accommodate commercial loading zone activities adjacent to a bicycle lane. Cities developing curbside management strategies must harmonize their modal priorities with street design guidelines to prevent deterioration of a street's safety and efficiency due to poor design choices. The ITE's *Curbside Management Practitioner's Guide* covers the treatment selection process in addition to pilot and 'living preview' approaches to assess curb performance prior to a permanent installation (Mitman et al., 2018). These approaches are expanded upon in ITE's *Curbside Inventory Report* to include an array of 'measures of effectiveness' (MOEs) which link data collection to curb performance and inform possible street design changes (Abel et al., 2021).

San Francisco employed this approach in a recent (2020) street design and curbside management project in the Inner Sunset neighbourhood. Since initial objectives included a reduction of lanes blocked by loading activities, design choices were made to improve visibility of commercial and transit loading zones to other street users (Abel et al., 2021; SFMTA, 2020).

The City of Edmonton recently updated their *Complete Streets Design and Construction Standards* (City of Edmonton, 2021) which applies to all street improvement projects initiated after mid-2018. Their *Curbside Management Strategy* is still in an early implementation stage, but the latter document identifies further updates and linkages to the former as its first actionable item (City of

Edmonton, 2022). Because these updates are not yet reflected in the Design and Construction Standards, Edmonton receives a score of "2" for this criterion.

Criterion 13b looks for evidence of a curb performance monitoring system providing utilization data beyond a basic measure of incident and/or violation rates. This is intended to provide a city's administration with ample information to adjust current policies or curb allotments (for different users). Performance monitoring begins by establishing curb performance metrics and developing systems to measure them through data collection. Metrics are also bound by policy objectives (performance-based), and can be adjusted through pricing, temporal, or design treatments.

Several US cities have adopted specific metrics to measure curb productivity, economic growth, and mode share distribution and are able to adjust policies and expand their scope to a city-wide scale. (Diehl et al., 2021). In Columbus, for example, a flex-zone pilot utilized a mobile app to help participating delivery companies access the zone through registration/verification of vehicle license plates. Columbus primarily collected zone utilization data to differentiate the needs of passenger and freight deliveries, but the app also leveraged surveys and violation reporting to help inform road safety, enforcement requirements, and potential for future flex-zone locations in other parts of the city (Pérez et al., 2021). Edmonton's *Curbside Management Strategy* briefly discusses the role data and technology play in understanding curb utilization under its fourth actionable item. The authors note:

> Collection and analysis of data should be a top priority in order to support improved decision-making around the strategic management of public parking spaces. This action should consider how technological advances can simultaneously support data collection. (pg. 18)

While this is an encouraging aspirational statement to guide development of a curb performance monitoring system, the remainder of the actionable item is lacking in detail and appears more interested in the potential of technology to improve curb user experience than as a data-collection tool. It also focuses exceedingly on parking as opposed to other curb uses. Because of this ambiguity and the lack of mention of data or performance monitoring in the remainder of the document, Edmonton receives a score of "1" for this criterion.

In summary, Edmonton's recent efforts towards proactive curbside management are ambitious at the policy level, but the details to guide their administration towards meeting its objectives are vague and leave much to be desired. It is possible these scores will improve as actionable items in its strategy document are implemented. For example, an update to the *Complete Streets Design and Construction*

Standards will consider curbside management objectives, relate its mode prioritization hierarchy to curb pricing mechanisms, and identify appropriate tools for data collection and enforcement. And yet, Edmonton's scores show clearly that data collection, performance monitoring, and evaluation capacity require much more attention going forward. Edmonton deserves credit for concentrating its early efforts towards organizational structure and strategy development, but now must translate its curbside objectives into concrete actions. Moreover, Edmonton will be challenged to manage emerging pressures placed at its curb as other recent policy actions—eliminating parking minimums and approving residential up-zoning city-wide—will begin to impact its off-street parking supply and by extension, automobile-dependent transportation habits (City of Edmonton, 2019).

4.3 Hamilton

Hamilton is the third largest urban area examined in this research and is a core municipality in Ontario's Greater Golden Horseshoe region. Hamilton developed a manufacturing and transport economy in the 19th century after its natural harbor was connected by a canal to Lake Ontario. Hamilton soon became the largest manufacturer of steel products in Canada and is home to the busiest Canadian port on the Great Lakes. Today, steel manufacturing plays a smaller role in Hamilton's overall economy, but the city remains a major manufacturer of consumer goods and also processes many agricultural commodities. Hamilton is also a major center for health research owing to McMaster University, located near its downtown core. These economic drivers mean that Hamilton, much like Edmonton, has a decentralized economy with many distinct nodes of employment. Additionally, many of Hamilton's commuter movements are impacted by its close proximity to the City of Toronto, fifty kilometers to the north-east. Hamilton's unique mix of industrial land use and mobility patterns make it an interesting city to examine from a curbside management perspective.

In 2001, the City of Hamilton was amalgamated with five neighboring jurisdictions into a single-tiered municipality. As a result, there are rural and urbanized areas of various sizes within Hamilton's current municipal boundaries. This has colored Hamilton's planning approach, placing increased focus on community level plans. To this point, the scan of municipal documents revealed several neighbourhood hubs and former town centers undergoing new community development plans, with new design and policy measures emphasizing safe mobility and accessibility for a greater variety of transportation modes.

This approach has been further supported by Hamilton's new *Complete Streets Design Guidelines* (City of Hamilton, 2022) which is where curbside management measures is also discussed.

Curbside management's position in this document is unique among the cities examined in this research and raises some interesting questions about the suitability of this approach. On one hand, it demonstrates a thorough integration of policy and design at the local level and produces some of the strongest acknowledgements of curbside complexities when compared with any other cities in this research. On the other hand, Hamilton is challenged to integrate this with broader policy, governance, enforcement, monitoring, and evaluation dimensions typically found in a comprehensive curbside management strategy. Under Hamilton's current approach, each 'Complete Streets' redesign utilizes a self-contained performance monitoring and evaluation approach, which is appended to an auditing tool but not applied to any city-wide performance measures. This means that Hamilton's curbside management implementation risks 'reinventing the wheel' with every new project as there isn't an overarching policy applied differently to streets prioritizing different modal share. There is a significant disconnect between these guideline standards and the linkages to relevant by-laws, permitting systems, and transportation network plans.

The success of Hamilton's approach will depend on how complete streets projects monitor their performance and provide applicable lessons for future complete streets projects. It is encouraging that Hamilton has made curbside management a mandatory consideration in street renewal projects, but the city needs to do more to make curbside management an integrated and essential component of its entire transportation network.

Table 9 (below) provides an overview of Hamilton's curbside management scores. Three criteria will be examined in greater detail below.

Criterion 4a examines municipal policy and planning documents for evidence of awareness and/or the need for a response to growing and changing curbside pressures and demands. Scores for this criterion rate the degree to which a municipality's reports, website resources, and other documents demonstrate understanding of the complexity of curbside challenges. Changing dynamics experienced at the curb are well-documented in academic literature (Chang et al., 2022; Jaller et al., 2021; Marsden et al., 2020). Specifically, research by Marsden et al. identified sixteen distinct curb user groups and underscored the fluidity of their anticipated changes in the form of demand, formality of its users, and behavior (i.e., time spent) at the curb.

Practitioner guides (ITF & OECD, 2018; Mitman et al., 2018; Roe & Toocheck, 2017) and some recent municipal curbside management strategies provide excellent examples of understanding these complexities and as a precursor to proactive policy and street design solutions. For example, the North Central Texas Council of Governments, representing the counties and municipalities for the Dallas-Fort

Table 9 – Hamilton Results

Categories	Sub-Categories	Criteria	Scoring System	Score
Organizational Structure 6/9	1. Intra-Jurisdictional Structure	a. Coordination and/or Integration of Curb-Related Decision(s)	1-2-3	2
	2. Inter-Jurisdictional Structure	a. Level of Complexity	1-2-3	1
		b. Coordination and/or Integration of Curb-Related Decision(s)	1-2-3	3
Planning Documents 3/5	3. Curbside Management Strategy	a. Does one exist?	0-1	0
		b. If so, does it include a CM Team/ Division / Committee	0-1	0
	4. City Transportation/ Mobility Plans	a. Degree of acknowledgement of curbside complexities	1-2-3	3
Policies, Agreements, & Regulations Relating to the Curb 22/34	5. Core By-Laws	a. On-street parking pricing/ temporal scheme	1-2-3	2
		b. Passenger/ freight loading zones	1-2-3	1
	6. Private Sector Agreements	a. Car-Share	0-1	1
		b. For-hire passenger (Taxi, TNC, etc.)	1-2-3	2
		c. Micromobility	1-2-3	2
	7. Curb Interface Design	a. Accessibility standards for all active transport users	1-2-3	2
		b. Integration of competing street uses	1-2-3	3
		c. Active transportation vehicle storage	0-1	1
	8. Permitting System	a. Local residents	0-1	1
		b. Delivery vehicles	0-1	0
		c. Construction/ service/ maintenance vehicles	0-1	1
		d. Street vendors	0-1	1
		e. Motor coaches	0-1	0
		f. Location(s)/ allowances of permit schemes	1-2-3	2
		g. Enforcement system	1-2-3	1
	9. Amenity Policies	a. Street patio/ parklet policy	1-2-3	2
Performance Monitoring & Evaluation 13/27	10. Data Collection	a. Technologies used for occupancy detection	1-2-3	1
		b. Granularity of curb data	1-2-3	1
	11. Data Sharing	a. Agreement(s) with private stakeholder(s)	0-1	0
		b. Standardized data	0-1	0
	12. Stakeholder and Public Engagement	a. Curb-user and stakeholder feedback collection system	1-2-3	2
		b. Curb prioritization hierarchy reflective of adjacent land use(s)	1-2-3	3
	13. Performance Monitoring	a. Evidence of curb performance objectives and/ or targets	1-2-3	2
		b. Evidence of a curb performance monitoring system beyond recorded incident/ violation rates	1-2-3	2
		c. Evidence of proactive responses to poor performing curb elements	1-2-3	1
	14. Pilot Programs	c. Assessment capacity for new/ emergent curb technologies	1-2-3	1
		d. Functional demonstrations of new technologies/ treatments	0-1	0
			TOTAL	**44**

Worth metroplex, released a *Curb Management Regional Planning Guide* (North Central Texas Council of Governments, 2020) which led with an overview of the growing and evolving number and type of curb users, but more importantly, linked their activities to the established and desired functions of a street's right-of-way (ROW). In doing so, the guide can frame specific curbside management tools, design treatments, and policies within an understanding of which curb users, transportation modes, and ROWs they are best suited to accommodate.

Hamilton provides a similar acknowledgement of curbside complexities. In their 2019 *Parking Master Plan* (City of Hamilton, 2021), the authors write:

> Curbside parking is steadily being displaced by short term uses like [Personal Transportation Providers] pick-up and drop-offs, commercial vehicles, new mobility devices, and eventually by [Connected and Autonomous Vehicles]. Unlike on-street parking, these new uses typically do not pay for access to space and represent a significant risk to future revenues if systems and processes are not put in place to facilitate payment by these users. The limited understanding of existing regulations will inhibit municipalities in planning for these new uses, resulting in an inefficiently operating curbside and potential lost revenue. By planning ahead for these new uses, [Hamilton Municipal Parking System] can identify ways to monetize short-term curbside use such that that all users of limited curbside space pay their fair share, and effectively maintain a functional and efficient curbside. (pg. 36)

Additionally, Hamilton's *Complete Streets Design Guidelines* (2022) cover existing and anticipated curb users while framing design treatments through 'principles' of flexibility and balancing priorities of unique users. The guidelines also anticipate the need for more extensive EV charging infrastructure and amenity improvements. Because of these thorough acknowledgements of curbside complexities, Hamilton receives a score of "3" for this criterion.

Criterion 7a examines accessibility standards for street user categories, particularly vulnerable street users and in flexible-use or amenity-oriented curb spaces. This is closely related to criterion 7b (examined in Edmonton's context earlier in this chapter) with one notable difference. With criterion 7b, mobility/accessibility considerations for different curb users are framed as trade-offs related to street and curb user prioritization. In contrast, this criterion looks for a minimum threshold for street and curb access design so as not to impede vulnerable street and/or curb users, such as persons with disabilities.

There are two broad categories in which this criterion is evaluated: permanent curb design and adaptive curb design. The former category is typically reinforced by accessibility guidelines. For example, American-based agencies/organizations with practitioner guides related to street design and curbside management typically reference the *Americans with Disabilities Act Accessibility Guidelines* (ADAAG) and *Public Rights-of-Way Accessibility Guidelines* (PROWAG), also reinforced by accessibility objectives and performance indicators highlighted in Complete Streets policy frameworks (Abel et al., 2021; ITE, 2010; Roe & Toocheck, 2017). The latter category is more difficult to evaluate because while 'living previews' or pandemic-related street repurposing projects are a part of curbside inventory assessment, their success is subject to increased consultation and feedback from local advisory/advocacy groups, especially since adaptive curb designs are less likely to be standardized.

For permanent design standards, Washington D.C. is cited for generous sidewalk widths (ranging from six feet in residential to ten feet in dense commercial) which can buffer different street activities and reduce access pressures (Mitman et al., 2018). Looking at adaptive curb design, San Francisco's Shared Spaces program is considered a huge success. Initially launched during the COVID-19 pandemic to provide a wider variety of street and curb uses while respecting physical distancing requirements, this program slowly evolved to address municipal agency coordination managing different curb uses with respect to other street user impacts (Hanzlik et al., 2021).

The City of Hamilton's approach shows progress in both of these dimensions but also indicates room for improvement. The design specifications and considerations outlined in its *Complete Streets Design Guidelines* are thoroughly detailed and accompanied by performance monitoring and community feedback elements. In contrast, Hamilton has been challenged implementing adaptive curb use designs, which have been criticized by its Advisory Committee for Persons with Disabilities (ACPD) on the grounds of being implemented too hastily and with inadequate consideration for street and sidewalk context (Peesker, 2022). Because a relevant municipal committee is not well-integrated into this decision-making process, Hamilton receives a score of "2" for this criterion.

Criterion 5b examines the complexity of passenger and freight loading zone regulations found in municipal by-laws. The municipal scanning process of this research intentionally looks beyond plans and policies to find evidence of curbside management initiatives translated into the subject municipality's legal and operational documents. If, for example, a municipality discusses new mobility and delivery services operating alongside traditional passenger and freight services in their planning/policy documents, but none of these mobility service categories are identified in relevant by-laws, it suggests a reactive management style to emerging curb challenges. Loading zone spaces are optimally regulated to

provide flexibility of user types (PUDO of passengers or goods; formal or gig-economy) while limiting time in these zones to under fifteen minutes.

Optimally, a wide variety of mobility services should be able interface with these 'flex-zones' with clear rules around wait times or other permitted uses, reservations or charges (if any) and enforcement, regardless of the category of permitted vehicle (Jaller et al., 2021). For each city, this will look slightly different, but it should be reflected in their by-laws. Flex-zone pilots in Washington D.C. have addressed commercial deliveries and PUDO services through separated time-of-day restrictions and a commercial delivery reservation system, but more importantly incorporated user registration for these zones, thus clarifying when and for whom these spaces may be utilized (Pérez et al., 2019; Pérez et al., 2021).

The City of Hamilton identifies "Commercial Vehicle Loading Zones" in its Parking By-law (City of Hamilton, 2023), applicable to a definition of 'commercial vehicle' which includes taxi cabs, but there are no specifics about prioritizing specific uses at different times of day. Its Streets By-Law and Traffic By-Law add very little information to the utilization of these zones, only that motorists obey relevant signage. Additionally, Hamilton has not updated its Parking By-Law to outline rules surrounding new mobility or delivery services, such as TNCs. Because the city's by-laws are lagging its policy and planning documents, in addition to revealing a very basic loading zone system, Hamilton receives a score of "1" for this criterion.

Presently, Hamilton discusses curbside management objectives largely at the community planning level—more so than the two larger cities examined earlier in this research. While there is brief mention of overarching curbside management objectives in its *Parking Master Plan* document, Hamilton's approach feels much more incremental and less focused on high-level policy or organizational integration. Compared with other cities in this research, Hamilton's scores are relatively high across all four evaluation categories, but this is mostly attributed to criteria where a high score is either easier to attain or where Hamilton's circumstances cities (such as interjurisdictional operating environment) are more favorable than other case study. Despite this caveat, Hamilton has provided a means to consider diverse and intensifying curbside pressures during street redesign projects. This could eventually lead to many streets with layouts complimentary to the tools and technologies eventually deployed if or when Hamilton adopts a formal city-wide curbside management strategy.

4.4 Halifax

Halifax is the fourth largest urban area examined in this research and the largest metropolitan area in Canada's Atlantic provinces. Halifax is located along one of the world's largest and deepest ice-free harbors and was settled as a strategic naval base for early British colonies despite being surrounded by marginal farmland and fisheries. Eventually, Halifax harbor would provide new economic opportunities via international trade—its port links extensive inland railway networks to the shortest transatlantic route to markets in Europe and beyond. Today, Halifax's economy reflects elements of this history—a strong navy and military presence, but also manufacturing and shipbuilding industries. Halifax serves as a regional hub for commerce, finance, government and academic research, and is among the fastest growing municipalities in Canada (Shumanty et al., 2022). For these reasons, its transportation challenges and curb-related pressures are more pronounced than might be expected for a city of its size.

Similar to Hamilton, the Halifax Regional Municipality (HRM) is a recent (1996) amalgamation of four municipalities. As a consequence, Halifax retains some legacy by-laws from former municipalities which govern streets and traffic in their respective urban cores, including Dartmouth and Bedford. Halifax's built form is a mixture of old and new infrastructure, including narrow streets which can pose challenges to automobile traffic and curbside access needs (King & Cooke, 2023). While Halifax doesn't discuss 'curbside management' explicitly, its new *Integrated Mobility Plan* (HRM, 2017) contains a detailed parking management plan, covering many aspects of the curb but notably omitting amenity considerations for the curb lane.

Despite this, Halifax's administrative infrastructure captures similar utilization data found in more comprehensive curbside management strategies, providing an exemplary 'asset-lite' approach for smaller cities to emulate. In the absence of resource-intensive curb lane technologies like occupancy sensors, the city has developed a parking permit web portal to provide visitors with access to temporary permits (HRM, 2023b). This system links the permit to a vehicle license plate and specified city block (with limited permits available per day, per block), helping to simplify the parking authority's enforcement operations. It also provides the city with valuable data on city-wide parking demands for specific locations, allowing the permit administration process to be better streamlined (O'Toole, 2023).

In addition to their parking permit system, Halifax is the only city in this study to have updated their by-law regulating taxis and other vehicles-for-hire to account for TNCs (HRM, 2022). Importantly, contained within this by-law are mandatory data-sharing requirements between operators and the municipality. Despite not having a formal curbside management strategy, Halifax appears to be strengthening links between parking and curb data management to policies found in its *Integrated*

Mobility Plan, such as a curb prioritization hierarchy. If Halifax can do the same between these parking policies and amenity considerations, they are well equipped with their existing infrastructure to provide a truly proactive curbside management approach.

Table 10 (below) provides an overview of Halifax's curbside management scores. Three criteria will be examined in greater detail below.

Criterion 6b examines for-hire passenger services as covered by municipal by-laws, including taxis, limousines and TNCs. In recent years, TNCs have contributed to increased curbside PUDO activity, but they do not fit adequately under the regulatory environment governing traditional personal mobility providers (Ranjbari et al., 2021). This is because TNCs utilize their own technology platform for wayfinding, ride-hailing and fare transactions, which are fundamentally different from taxis-related infrastructure regulated within preexisting municipal by-laws. As a result, municipalities have had to expand their by-laws to establish rules around the operation and licensing of TNCs, their drivers and their vehicles (Pérez et al., 2019).

Much like loading zones discussed in the previous section, specific details of for-hire passenger service by-laws will look slightly different in cities with varying levels of curb demands and pressures. Best practices seek to eliminate curb failure brought on by TNC drivers overwhelming access points in high-traffic locations. Cities such as Washington D.C. and San Francisco have expanded flex-zones in nightlife districts, replacing on-street parking to improve both curb productivity and multimodal street user safety. To understand the mobility patterns of patrons to these districts, both cities have entered data-sharing agreements to help optimize PUDO locations near origins/destinations in these high-traffic areas (Pérez et al., 2019).

Halifax has recently updated its By-Law T-1000 to include regulation of TNCs, including detailed operating requirements and mandatory data-sharing agreements between a TNC and the city using "a format accessible by the Licensing Authority" (pg. 25) and covering a variety of location, driver and user data. Halifax has decided to reserve taxi stands for the exclusive use of taxis and will rely on TNC PUDO data to determine changes to loading zones in specific parts of its city. Because of the clear and detailed vehicle-for-hire operating requirements covered in By-Law T-1000, including the only regulations concerning TNCs of any cities examined in this research as well as curb data sharing requirements, Halifax receives a score of "3" for this criterion.

Criterion 8g examines the enforcement system(s) accompanying curb-related regulations. In order to be effective, curb enforcement systems must accomplish two tasks: First, they communicate curb access rules clearly—especially in zones with flexible uses throughout a given day. Second, they

Table 10 – Halifax Results

Categories	Sub-Categories	Criteria	Scoring System	Score
Organizational Structure 6/9	1. Intra-Jurisdictional Structure	a. Coordination and/or Integration of Curb-Related Decision(s)	1-2-3	2
	2. Inter-Jurisdictional Structure	a. Level of Complexity	1-2-3	2
		b. Coordination and/or Integration of Curb-Related Decision(s)	1-2-3	2
Planning Documents 3/5	3. Curbside Management Strategy	a. Does one exist?	0-1	0
		b. If so, does it include a CM Team/ Division / Committee	0-1	0
	4. City Transportation/ Mobility Plans	a. Degree of acknowledgement of curbside complexities	1-2-3	3
Policies, Agreements, & Regulations Relating to the Curb 25/34	5. Core By-Laws	a. On-street parking pricing/ temporal scheme	1-2-3	2
		b. Passenger/ freight loading zones	1-2-3	1
	6. Private Sector Agreements	a. Car-Share	0-1	1
		b. For-hire passenger (Taxi, TNC, etc.)	1-2-3	3
		c. Micromobility	1-2-3	1
	7. Curb Interface Design	a. Accessibility standards for all active transport users	1-2-3	3
		b. Integration of competing street uses	1-2-3	3
		c. Active transportation vehicle storage	0-1	1
	8. Permitting System	a. Local residents	0-1	1
		b. Delivery vehicles	0-1	0
		c. Construction/ service/ maintenance vehicles	0-1	1
		d. Street vendors	0-1	1
		e. Motor coaches	0-1	0
		f. Location(s)/ allowances of permit schemes	1-2-3	3
		g. Enforcement system	1-2-3	2
	9. Amenity Policies	a. Street patio/ parklet policy	1-2-3	2
Performance Monitoring & Evaluation 16/27	10. Data Collection	a. Technologies used for occupancy detection	1-2-3	2
		b. Granularity of curb data	1-2-3	2
	11. Data Sharing	a. Agreement(s) with private stakeholder(s)	0-1	1
		b. Standardized data	0-1	1
	12. Stakeholder and Public Engagement	a. Curb-user and stakeholder feedback collection system	1-2-3	1
		b. Curb prioritization hierarchy reflective of adjacent land use(s)	1-2-3	2
	13. Performance Monitoring	a. Evidence of curb performance objectives and/ or targets	1-2-3	2
		b. Evidence of a curb performance monitoring system beyond recorded incident/ violation rates	1-2-3	2
		c. Evidence of proactive responses to poor performing curb elements	1-2-3	1
	14. Pilot Programs	a. Assessment capacity for new/ emergent curb technologies	1-2-3	1
		b. Functional demonstrations of new technologies/ treatments	0-1	1
			TOTAL	**50**

utilize limited municipal resources efficiently in order to establish the enforcement standard and improve compliance by all curb users.

While there are many methods to meet these objectives, common themes among top performing curbside enforcement systems include increased automation of surveillance activities and/or the use of a 'curb ambassador' program as an on-street presence. Automated enforcement technologies can improve productivity of curb surveillance (Nadkarni, 2020), but their implementation may be impeded by privacy concerns and require careful coordination between the public and local officials, at times involving higher levels of government (Chang et al., 2022). If such technologies are not permitted in one's jurisdiction, curb ambassador programs can be a useful alternative. These staffed programs combine the tasks of by-law enforcement officers with manual feedback and data collection of curb use. Ambassadors help to clarify rules to curb users, report feedback from specific curb user categories to the parking/curbside management authority and reduce the punitive nature of encounters typically associated with enforcement officers. Minneapolis offers a great example of this dynamic. The Minnesota Supreme Court banned the city from using camera enforcement and License Plate Recognition (LPR) technologies (Chang et al., 2022; Diehl et al., 2021), so they responded with a 'Mobility Hubs' pilot program, utilizing ambassadors to understand and ultimately address street, curbside and multimodal challenges (Hanzlik et al., 2021).

Halifax's permit portal improves their understanding of the travel patterns of specific categories of curb users, and even helps provide more targeted enforcement due to a voluntary license-plate registry with their permits. At the same time, their *Integrated Mobility Plan* is light on details regarding the adoption of new technologies or an ambassador program to improve the efficiency of their enforcement operations. Because of these factors, Halifax receives a score of "2" for this criterion.

Criterion 6c examines micromobility services as covered under municipal by-laws and includes bike-share and e-scooter services. These services can utilize docked or dockless vehicle storage systems (the latter often featuring geo-fenced zones), and these facilities often utilize curb space next to public active transportation infrastructure (Jacobson et al., 2021). It is important to regulate these services so that their curb space utilization improves curb productivity (Chang et al., 2022) while addressing street user safety and equity concerns (Shaheen & Cohen, 2019). At the same time, there are several complicating factors to consider when drafting effective regulations. For example, shared micromobility services may or may not share the same storage spaces with privately owned bicycles or e-scooters, potentially consuming more curb space and causing more street accessibility conflicts (Brown et al.,

2020). Additionally, storage system choice and location selection might present new mobility challenges for vulnerable street users, such as persons with disabilities (Shaheen & Cohen, 2019).

Cities with successful micromobility regulations typically utilize data-sharing agreements to help identify optimal storage sites based on historic frequency of trip termination prior to designating space, as was done in the city of Arlington, Virginia (Diehl et al., 2021). Seattle also developed storage guidelines for both shared micromobility and private bicycles/e-scooters around the maintenance of a six-foot wide 'pedestrian clear zone', allowing a combination of landscape-edge and curb lane options for vehicle storage which would not impede pedestrians or vulnerable street users (Shaheen & Cohen, 2019).

Recently, the province of Nova Scotia amended its *Motor Vehicle Act* to account for e-scooters, and Halifax has very recently passed a by-law to regulate the operation of privately owned e-scooters (HRM, 2023a), but has yet to implement a pilot to regulate shared micromobility service providers (although one is forthcoming). Because this regulatory environment is still in its infancy, Halifax receives a score of "1" for this criterion.

Halifax is an excellent example of a smaller municipality whose administrative environment has been kept simple, leveraging opportunities to acquire street- and curb-related data to inform wide ranging aspects of curbside management ranging from permit applications to TNC regulations. Halifax's by-law environment is also well organized and allows emerging curb users to be easily incorporated into existing by-laws (as with TNCs) or regulated under new ones (as with e-bikes and e-scooters). Halifax's *Integrated Mobility Plan* discusses integrating curbside demands with other mobility considerations without calling for sweeping organizational reforms, likely because the city has maintained an organized administrative environment requiring tweaking rather than restructuring. This is reminiscent of Washington D.C.'s initial conclusion that a clear organizational structure presents fewer operational headwinds, particularly when new and emerging curb users are introduced (Diehl et al., 2021; District Department of Transportation, 2014). These factors help explain Halifax's high scores across all evaluation categories, with performance monitoring and feedback collection systems representing the greatest potential for further improvement. If Halifax can examine potential new data-collection tools and provide more detail on how it will incorporate new curb occupation technologies in preparation for AT, this city will exemplify 'evidence of curbside management' in the absence of a formal strategy.

4.5 Victoria

Victoria is the smallest urban area examined in this research and the provincial capital of British Columbia. It is located on the southern tip of Vancouver Island in a region that has been settled for thousands of years by the Coast Salish peoples prior to the island becoming a British colony (with 'Fort' Victoria named its capital). Despite its deep and ice-free natural harbor, Victoria's potential as a transportation hub is mitigated by its inability to connect directly to transcontinental rail networks. Despite this, Victoria has developed an economy around government, regional services, and in particular tourism—owing to its mild (by Canadian standards) year-round climate and its unique collection of colonial-era architecture. These sectors also make Victoria's urban core a major focal point for its economy, resulting in outsized traffic pressures relative to the metropolitan area's modest size. Victoria's mild climate also contributes to an impressive mode share for active transportation—a higher percentage of Victorians commute by walking or cycling than in any other major city in Canada (Statistics Canada, 2017). The presence of tourism mobility services and expansive active transportation infrastructure make Victoria's curb-related policies an important case study comparison, even relative to much larger Canadian cities.

While the City of Victoria benefits from limited curbside pressures beyond its downtown core, it faces greater jurisdictional complexity relating to transportation and curb governance than several other municipalities in this research (Capital Regional District [CRD], n.d.). For example, Victoria is part of the Capital Regional District (CRD)—a regional government whose curb-related responsibilities include developing and operating a multimodal active transportation network (CRD, 2014) and managing waste and recycling collection (CRD, 2021). Likewise, the province of British Columbia operates transit services in the city/region under a crown corporation called BC Transit. The province also regulates mobility services including TNCs and micromobility operators. This particular governance structure requires careful coordination to develop local by-laws in sync with private mobility providers' operating licenses. To date, Victoria does not account for TNC operators in its *Vehicles for Hire By-Law* (City of Victoria, 2023a), and examples like these point to a pattern of incremental "reactive" management of the curb. Other such examples include a traffic by-law with 27 different curb zones, and a parking services feedback system that is largely complaint driven. The city's Open Data system is a positive step, but currently displays static information regarding curbside restrictions, as opposed to dynamic, real-time curb utilization data.

Despite these challenges, the City of Victoria has ambitious plans for more proactive curbside management approaches, and these efforts are beginning to appear at the community planning level.

Their high-level mobility strategy document, *GoVictoria* (2020), commits to actively managing 100% of the city's curb space by 2023. The plan also promises to implement infrastructure required for real-time monitoring of street safety and performance by 2025. While these are impressive objectives, details on their implementation and achievement are scarce, even in the strategy's appendices. This is where community-level planning documents can offer clues about how these objectives are refined from broad concept to on-street reality. Since launching *GoVictoria*, one of the city's neighbourhoods, Fernwood, developed a *Neighbourhood Plan* (2022) and developed linkages to *GoVictoria*'s curbside policies while considering local context. The *Neighbourhood Plan* proposes to reallocate permit-parking zones to better support businesses near its commercial main streets, reallocate portions of car parking near commercial hubs to accommodate bicycle parking, and adjust time restrictions along specific streets to encourage higher vehicle turnover. It directly references policy objectives found in *GoVictoria* but interprets its application with the help of local community feedback. As was the case with Hamilton, this approach is not without challenges, namely ensuring policy objectives are interpreted accurately by local communities, and solutions are developed consistently across neighbourhoods. Victoria will also need to support its community planning work with city-scale performance monitoring tools to harmonize all neighbourhood-specific curb decisions with consistent analysis. Victoria should be commended for applying its curbside management objectives at the community planning level. If the city can put a similar effort toward coordination with the regional and provincial governments, it will move much closer to meeting its ambitious curbside management commitments, as outlined in *GoVictoria*.

Table 11 (below) provides an overview of Victoria's curbside management scores. Three criteria will be examined in greater detail below.

Criterion 7c examines curbside active transportation storage facilities, including both private and shared services. Unlike criterion 6c (examined earlier in this chapter) which focuses on the regulation of micromobility services (including their terminals), criterion 7c scans street design guidelines for evidence of active transportation storage infrastructure implemented proactively along multimodal corridors. Accommodating storage for bicycles, e-bikes, and e-scooters (where legal to operate) along these corridors is a critical component to incentivize their use. From a curbside management perspective, replacing on-street parking with bicycle corrals not only boosts curb productivity—measured by the number of users per linear feet of curb that are served—but the subsequent incentivized mode shift can reduce the number of on-street vehicle parking spots required at a given destination by anywhere from 5-15% (Litman, 2023). There is also evidence that locating bicycle storage facilities near major transit

Table 11 – Victoria Results

Categories	Sub-Categories	Criteria	Scoring System	Score
Organizational Structure 6/9	1. Intra-Jurisdictional Structure	a. Coordination and/or Integration of Curb-Related Decision(s)	1-2-3	2
	2. Inter-Jurisdictional Structure	a. Level of Complexity	1-2-3	3
		b. Coordination and/or Integration of Curb-Related Decision(s)	1-2-3	1
Planning Documents 2/5	3. Curbside Management Strategy	a. Does one exist?	0-1	0
		b. If so, does it include a CM Team/ Division / Committee	0-1	0
	4. City Transportation/ Mobility Plans	a. Degree of acknowledgement of curbside complexities	1-2-3	2
Policies, Agreements, & Regulations Relating to the Curb 19/34	5. Core By-Laws	a. On-street parking pricing/ temporal scheme	1-2-3	2
		b. Passenger/ freight loading zones	1-2-3	2
	6. Private Sector Agreements	a. Car-Share	0-1	1
		b. For-hire passenger (Taxi, TNC, etc.)	1-2-3	1
		c. Micromobility	1-2-3	1
	7. Curb Interface Design	a. Accessibility standards for all active transport users	1-2-3	2
		b. Integration of competing street uses	1-2-3	1
		c. Active transportation vehicle storage	0-1	1
	8. Permitting System	a. Local residents	0-1	1
		b. Delivery vehicles	0-1	0
		c. Construction/ service/ maintenance vehicles	0-1	1
		d. Street vendors	0-1	1
		e. Motor coaches	0-1	1
		f. Location(s)/ allowances of permit schemes	1-2-3	1
		g. Enforcement system	1-2-3	1
	9. Amenity Policies	a. Street patio/ parklet policy	1-2-3	2
Performance Monitoring & Evaluation 9/27	10. Data Collection	a. Technologies used for occupancy detection	1-2-3	1
		b. Granularity of curb data	1-2-3	1
	11. Data Sharing	a. Agreement(s) with private stakeholder(s)	0-1	0
		b. Standardized data	0-1	0
	12. Stakeholder and Public Engagement	a. Curb-user and stakeholder feedback collection system	1-2-3	1
		b. Curb prioritization hierarchy reflective of adjacent land use(s)	1-2-3	2
	13. Performance Monitoring	a. Evidence of curb performance objectives and/ or targets	1-2-3	1
		b. Evidence of a curb performance monitoring system beyond recorded incident/ violation rates	1-2-3	1
		c. Evidence of proactive responses to poor performing curb elements	1-2-3	1
	14. Pilot Programs	a. Assessment capacity for new/ emergent curb technologies	1-2-3	1
		b. Functional demonstrations of new technologies/ treatments	0-1	0
			TOTAL	**36**

centers (typically with a greater mix of shared micromobility storage) provides further incentive for both cycling and transit usage for more trips (Jaller et al., 2021).

As discussed earlier in this chapter, cities like Seattle have utilized a curbside furnishing zone where bicycle storage infrastructure (along with street furniture and trees) offer functionality without impeding sidewalk traffic or commercial loading zones. Further to this point, the city of San Francisco has begun shifting its active transportation storage policies to a data-oriented approach where location is increasingly determined by its potential to serve multi-modal trips without a personal automobile (Chang et al., 2022). In SFMTA's *Curbside Management Strategy* (2020), recommendations related to active transportation storage include the proactive creation of bike corrals using bike/scooter parking demand data (supplementing individual corral requests), maintenance funding through micromobility operator fees, and optimized corral location from a safety/visibility perspective.

Victoria has long established on- and off-street bicycle parking requirements through its *Bicycle Parking Strategy* (City of Victoria, 2011), and these are now embedded in its *Zoning By-law* to inform bicycle parking minimums for private developments (Province of British Columbia, 2019). Moreover, the city's on-street guidelines have utilized a wider barrier for physically separated bike lanes with racks every few meters along the entire length of some of its corridors (City of Victoria, 2011; see also Mobility Lab, 2018). Because of these proactive initiatives in addition to a bike rack request form for businesses, Victoria receives a binary score of "1" for this criterion.

Criterion 9a examines the policies related to sidewalk patios and parklets. Specifically, this criterion reviews associated application process(es) and permit schemes to find evidence of linkages to a curb prioritization hierarchy accounting for amenity space amongst other curb uses. While many elements of a comprehensive curbside management strategy focus on street users' mobility or accessibility needs, curb productivity can also be measured by the number of street users served in an amenity setting. Parklets can improve the flow of pedestrians on the sidewalk side of the curb while discouraging private vehicle access to streets where human-scale activities are more desirable (Jaller et al., 2021). Moreover, a dedicated amenity space can serve many times more people while improving adjacent business revenues when compared to vehicle parking space (Roe & Toocheck, 2017).

Sidewalk patios and parklets grew in popularity during the COVID-19 pandemic as a measure to help struggling businesses more safely accommodate patrons, but they ultimately helped communities reimagine their streets' potential as a place-making tool once pandemic restrictions began to ease (Jacobson et al., 2021). While municipalities may have had parklet/patio policies prior to the pandemic, the explosion of applicants for outdoor spaces compelled some municipalities to streamline their

application processes while keeping mindful of competing curb/street users. The City of Boston offers an example of this approach. The city outlines its parklet/patio program and application process through a *Tactical Public Realm Guidelines* document (City of Boston, 2018), which divides public realm treatments into four categories: plazas, parklets, outdoor cafes, and temporary art installations. Each category contains detailed street considerations to determine eligibility, ranging from vehicle speeds (in adjacent travel lanes) to emergency, utility, and driveway access. Prior to the pandemic, this program's detailed regulations were accompanied by an exceedingly onerous application process, sometimes involving as many as ten city departments prior to approval. Following pandemic lockdowns, Boston addressed this issue by engaging departments to identify administrative inefficiencies and improve coordination between planning and operations departments—the latter of whom left more construction tasks to applicants with appropriate guidance (Hanzlik et al., 2021). In practice, this would mean entire streets could be shut down to general car traffic (with provisions for emergency vehicles, etc.) if enough amenity approvals were pursued on a given street block. More importantly, Boston reviewed their program changes and adjusted their policies post-pandemic by, for example, strengthening enforcement of accessibility requirements and developing street-scale amenity/access management plans.

The City of Victoria also streamlined its amenity application process to improve business access during the pandemic, but this was a parallel application stream resulting in a mismatch of permit fees and a redundancy of licenses granted. As of 2023, Victoria is transitioning to a more streamlined program accompanied by a new by-law (City of Victoria, 2023b; 2023d), however the new program provides limited linkages to a street user hierarchy (the only hierarchy is a 'blanket' applied city-wide) and there are still legacy sidewalk café license holders until the end of the calendar year. Because of these factors, Victoria receives a score of "2" for this criterion.

Criterion 12a examines curb user and stakeholder feedback collection systems accompanying curb-related policies and data-collection tools. Qualitative feedback collection systems are usually a legacy of an incremental curb policy environment, but they are not rendered obsolete by new data-driven approaches. Rather, their adaptation to an environment with publicly available curb utilization data can enhance communication of proactive policies to communities, special interest groups, and local businesses (Diehl et al., 2021). By doing so, these groups can provide more informed feedback about design, codification, and flexibility of curb usage because they are better equipped to understand competing curb demands and productive curb utilization (ITF & OECD, 2018). This feedback also contributes greatly to the body of case study examples which illustrate important considerations municipalities might miss relying on curb utilization data alone (Abel et al., 2021). Additionally, new

mobility services typically collect and aggregate their own data to understand access challenges relevant to their operations, but by developing universal feedback collection systems, all curb users—not just well-organized groups—have a greater opportunity to share how the existing system may or may not serve their mobility and/or accessibility needs (Butrina et al., 2020; Marsden et al., 2020).

An example of a qualitative feedback collection system is the ambassador enforcement program described earlier in this chapter. In this example, if a delivery vehicle makes a curb lane infraction, a curb ambassador can provide an important opportunity to assess whether an existing commercial vehicle loading policy is adequate or might be improved upon (Diehl et al., 2021). At a system-wide level, Washington D.C. integrates qualitative and quantitative feedback systems extremely well, particularly through its pilot programs. They accomplish this by involving stakeholders in setting objectives for a street (such as reduced violation rates, access search times, etc.), implementing changes alongside asset-lite data collection techniques in order to track controlled policy variables, and finally by communicating policy change implications to the public with a plan to collect feedback for final evaluation. This process has led to improved outcomes for their curb performance pricing program when compared with other cities pursuing the same policy objectives (Dey, Dock et al., 2019).

While the City of Victoria is beginning to utilize feedback through its parking ambassador program, their parking division's online feedback collection system appears to be primarily complaint driven (City of Victoria, 2023c; 2023d). Some street improvement projects are utilizing curb user feedback prior to concept designs (which is to be expected), but there is no obvious evidence that this process is drawing linkages with utilization data to evaluate a given street's performance. To that end, Victoria's Open Data web portal appears to map parking rules, but not dynamic curb space utilization data. Because of these factors, Victoria receives a score of "1" for this criterion.

Victoria's interjurisdictional governance environment poses significant challenges not seen in larger cities examined in this research, but there are still examples of simple, proactive policy successes. In particular, the integration of bicycle storage along active transportation corridors and the use of local community planning forums to contextualize city-wide curb management policy goals collectively show a desire to move beyond incremental, reactive policy actions. At the same time, Victoria's mobility strategy aspires to some lofty data-driven objectives for setting curbside rules and monitoring both street performance and user safety. Presently, these goals are accompanied by very few implementation details, and real-time utilization data does not appear in local planning documents or on Open Data systems. Victoria's scores reflect this reality, emphasizing the need for simplified by-laws and improved curb utilization data collection systems. It is important for Victoria to establish these systems because

many emerging and existing curb users are regulated by other levels of government. Without the means to understand how these users interact with Victoria's curb space, the city is reacting blindly to breakdowns in both the efficiency and safety of its streets. It is possible that the timelines of policy objectives outlined in *GoVictoria* were delayed by the COVID-19 pandemic, but the lack of implementation details to date is a significant contributing factor to Victoria's low scores.

4.6 Discussion Summary

Results from the municipal scan reveal inconsistent levels of curbside management potential across the Canadian cities evaluated. Cities show promising signs in specific categories and criteria while facing challenges in other areas—including some which local governments have less control over (see Table 12 below for a cumulative summary of city results). Looking beyond each city's numeric scores, important themes warrant further discussion in this section. Lessons from each city correlate with findings from academic literature and help inform how local officials can develop more successful curbside management strategies.

As discussed in chapter two, modern curbside management research categorized governance models using the labels 'incremental', 'performance pricing', and 'framework' (Zalewski et al., 2011). Since then, research has repositioned performance pricing as a useful component of a framework model, but not a standalone model (Diehl et al., 2021). If one concludes that curbside management must be a choice between proactive 'framework' policy or reactive 'incremental' adjustments, a major criticism of the former is that any requirement for organizational restructuring will likely be expensive and more resource intensive than the latter. Assuming these factors become less of an issue the larger a city becomes; the expectation would be for larger cities to adopt a framework model sooner than smaller ones. This is confirmed by the findings of this research, where Montréal and Edmonton launched organizational and policy initiatives in line with this approach, while the three smaller cities did not.

This contrast highlights an ongoing need for smaller cities to address fragmentation in curb-related governance, particularly those with complicated interjurisdictional governance and/or acute curbside pressures resulting from specific economic factors. One possible solution discussed by Butrina et al (2020) leverages community organizations and other stakeholders to establish a curbside management task force. This participatory process can help identify initiatives to pursue (such as pilot programs), allowing municipal staff to focus their resources on data collection and performance monitoring. The three smaller cities in this research have worked on community-level curbside management projects rather than city-wide strategies, but there was limited evidence of any standalone

Table 12 – Results Summary Table

Evaluation Criteria		Scoring System	Montréal	Edmonton	Hamilton	Halifax	Victoria
1a	Coordination / Integration of Curb-Related Decision(s)	Gradient	2	2	2	2	2
2a	Level of Complexity	Gradient	3	2	1	2	3
2b	Coordination / Integration of Curb-Related Decision(s)	Gradient	1	1	3	2	1
3a	Does Curbside Management Strategy Exist?	Binary	0	1	0	0	0
3b	If Yes, Does It Include a Staffed Team / Division?	Binary	0	1	0	0	0
4a	Degree of Acknowledgement of Curbside Complexities	Gradient	1	1	3	3	2
5a	On-Street Parking Pricing / Temporal Scheme	Gradient	3	2	2	2	2
5b	Passenger / Freight Loading Zones	Gradient	1	1	1	1	2
6a	Car-Share Operating Agreement(s)	Binary	1	1	1	1	1
6b	For-Hire Passenger (Taxi, TNC) Operating Agreement(s)	Gradient	1	1	2	3	1
6c	Micromobility Operating Agreement(s)	Gradient	1	1	2	1	1
7a	Accessibility Standards for All Street Users	Gradient	1	2	2	3	2
7b	Integration of Competing Street Uses	Gradient	2	2	3	3	1
7c	Active Transportation Vehicle Storage	Binary	1	1	1	1	1
8a	Permit System – Local Residents	Binary	1	1	1	1	1
8b	Permit System – Delivery Vehicles	Binary	0	0	0	0	0
8c	Permit System – Construction / Service Vehicles	Binary	1	1	1	1	1
8d	Permit System – Street Vendors	Binary	0	1	1	1	1
8e	Permit System – Motor Coaches / Tour Buses	Binary	0	0	0	0	1
8f	Location(s) / Allowances of Permit Systems	Gradient	3	1	2	3	1
8g	Enforcement System	Gradient	2	2	1	2	1
9a	Street Patio / Parklet Policy	Gradient	2	2	2	2	2
10a	Technologies Used for Occupancy Detection	Gradient	1	1	1	2	1
10b	Granularity of Collected Curb Data	Gradient	2	1	1	2	1
11a	Agreement(s) with Private Stakeholder(s)	Binary	0	1	0	1	0
11b	Standardized Data (Data-Sharing Standard)	Binary	1	0	0	1	0
12a	Curb-User / Stakeholder Feedback Collection System	Gradient	1	1	2	1	1
12b	Curb Use Prioritization Hierarchy (Land Use-Related)	Gradient	1	1	3	2	2
13a	Curb Performance Objectives / Targets Evident	Gradient	3	1	2	2	1
13b	Curb Performance Monitoring System Sophistication	Gradient	2	1	2	2	1
13c	Proactive Response to Poor-Performing Curb Elements	Gradient	1	1	1	1	1
14a	Assessment Capacity for New Curb Technologies	Gradient	3	1	1	1	1
14b	Functional Demonstrations of Technologies (Pilots)	Binary	1	0	0	1	0
Category Subtotals							
	Organizational Structure	/9	6	5	6	6	6
	Planning Documents	/5	1	3	3	3	2
	Policies, Agreements, & Regulations Relating to the Curb	/34	20	19	22	25	19
	Performance Monitoring & Evaluation	/27	16	9	13	16	9
TOTAL		**/75**	**43**	**36**	**44**	**50**	**36**

task force guiding these planning processes. Changing this approach could generate more thoughtful project objectives and useful MOEs, which can ultimately inform future policy development at a city-

wide scale (Abel et al., 2021). As the curb continues to become a more crowded and complex space, recognizing and leveraging these small-scale opportunities can place under-resourced cities one step closer to a framework model for curbside management.

Likewise, utilizing existing infrastructure and identifying affordable new technologies to collect curb utilization data—known as asset-lite curb data collection—greatly improves the cost effectiveness of curb performance monitoring (Dey et al., 2016; Dey et al., 2018). In order to understand how Canadian cities assess or utilize asset-lite approaches, this research reviewed staff reports, plans, and policy documents for evidence of a data-driven strategy. There are signs that this is indeed happening or being considered in the Canadian context. For example, Halifax's web portal for long-stay parking permits can tell city officials which city blocks commercial-plated vehicles are parking on. Similarly, Edmonton's *Curbside Management Strategy* recognizes the potential to gather more detailed information about curb occupancy using its ePark online/kiosk payment system via its designated fare payment zones. Despite these highlights, all five cities show substantial room for improvement in performance monitoring and evaluation systems, but asset-lite curb data collection systems provide a promising path to improved scores in this evaluation category.

While accurate curb-utilization data is important for municipalities, it is equally important to acknowledge the limitations of a purely data-driven approach. Quantitative and qualitative datasets are essential tools to measure the effectiveness of policy objectives (Abel et al., 2021), but these objectives can be influenced by specific interest groups competing for preferential use of the curb. Proactive policy must be developed on the basis that the curb is a public asset, and ultimately must serve the public interest (Marsden et al., 2020). With this in mind, curbside management strategies often employ prioritization hierarchies akin to Complete Streets design principles, and the Canadian cities examined in this research are no exception. The City of Hamilton incorporates curbside management objectives within its *Complete Streets Design Guidelines*, acknowledging the needs of specific curb users and introducing design treatments which aid them while maximizing comfort and safety for others. Alternatively, Halifax provides a 'curbside priority chart' in its *Integrated Mobility Plan* (pg. 139), applicable to most city streets but occasionally prioritizing different curb users, such as freight vehicles on designated truck routes or buses on high-frequency transit corridors. All five Canadian cities show evidence that their data-driven aspirations are steered not just by specific street user outcomes, but by broader policies aiming to reduce street user vulnerabilities.

This distinction is important, because a central goal of curbside management is to anticipate and respond quickly to new and emerging curb users. In practice, this means municipalities be able to

categorize and insert emerging users into relevant areas of their policy and by-law environment, which requires them to be well organized. Many factors can influence these assessments, including (but not limited to) jurisdictional responsibility; the 'new' user's mode (if applicable) including their respective infrastructure, spatial, and/or temporal requirements; and preexisting regulation of the industry and/or its operators. Practitioners grappling with how to manage emerging curb users are nothing new, whether gig-economy and micromobility services, or street-facing pedestrian, retail and food services. Going forward, AT could be the next frontier upending present-day demand for PUDO and vehicle storage at the curb. The strategy documents examined in this research reveal different visions and policy emphases for future curb demand. For example, Victoria's *GoVictoria* plan describes households owning (on average) fewer vehicles, and thus prescribes measures to "[f]acilitate growth in shared mobility services and systems through dedicated parking and curb space" (pg. 75). Alternatively, Montréal's AMDM envisions the technology sector having an increased role in helping individuals make informed mobility choices and plans to expand its own capacity to serve this purpose with clear and publicly accessible data (AMDM, 2021).

While both examples are noble objectives, evidence from this research suggests that Canadian cities with clearly organized administrative and legislative environments are regulating emerging mobility services more quickly than others. No city better exemplifies this theory than Halifax, whose organized by-laws and by-law catalogue provide clear linkages to relevant municipal staff reports. This allows a reader to understand administrative concerns if, for example, their parking permit application process is amended, or when data-sharing regulations for TNCs are developed. In both cases, Halifax's regulations were more advanced than the other cities examined in this research, which may be a coincidence, but is nonetheless an interesting correlation when viewed alongside less organized by-law environments of the other four municipalities.

Table 13 (below) provides a count of criteria scores based on their chosen scoring system (binary or gradient). This tabulation shows 'full marks' obtained from binary criteria revealing, for example, that Edmonton has eight binary '1' scores even despite not achieving any gradient '3' scores. Gradient criteria are categorized by scores along with information about their distribution. Ideally, a city would want a high mean value coupled with a low variance—indicating its criteria scored mainly high across the board. In contrast, a low mean coupled with a low variance would indicate little advancement. High variance indicates uneven criteria progress. By this measure, Halifax shows a competitive score, with the highest binary count (tie) and the highest mean gradient value coupled with the third-lowest variance. This suggests that Halifax's advancements in curbside management governance are fairly widespread.

Table 13 – City Results Analysis

Rubric Component	Montréal	Edmonton	Hamilton	Halifax	Victoria
Binary Count (and Point Total)	6	8	5	8	6
Gradient Point Total	37	28	39	42	30
Gradient “1” Count	10	14	7	5	13
Gradient “2” Count	6	7	10	11	7
Gradient “3” Count	5	0	4	5	1
Gradient Mean	1.76	1.33	1.86	2.00	1.43
Gradient Variance	0.69	0.23	0.53	0.50	0.36

Collectively, the five Canadian cities evaluated in this research demonstrate familiarity with curbside management concepts and are applying parts of it in creative ways. No city in this study has a fully implemented curbside management strategy (as reflected in the scores), but their existing curb governance systems are evolving quickly, particularly Montréal’s and Edmonton’s. At present, Halifax has a desirable regulatory environment whose simplicity appears to have aided its establishment of operating and data-sharing agreements with specific curb user categories. This shows how good organizational structure has a snowballing effect on by-laws and data collection, which are reflected in their comparatively high scores across all categories. Victoria and Hamilton are managing their curbs incrementally and will need to continuously draw lessons from previous projects to work towards a city-wide curbside management system. Regardless of where each city’s curb governance efforts are positioned, the lessons for city administrations are consistent across varied contexts:

- Focus on integrating organizational structure where possible,
- Clarify and simplify inter-jurisdictional relationships as they pertain to the curb,
- Utilize community and stakeholder groups to help steer pilot programs,
- Pursue asset-lite curb data collection systems wherever possible,
- Leverage policy to protect the curb as a public asset serving the public interest,
- Plan for an autonomous and increasingly multimodal future, and
- Organize a regulatory environment so new curb user categories can be added quickly and efficiently.

These are actions municipalities of all sizes and with varied levels of access to resources can take to provide a greater number of curb users with an improved overall experience. While there are valid concerns about changes to curb-related revenue streams (Diehl et al., 2021), there is also evidence that a well-organized curbside management system can recover many of those costs in creative ways (Rosenfield et al., 2016) while assigning more appropriate valuation to new mobility service activities (Chang et al., 2022).

Chapter 5 - Conclusion

This research investigated the connections between competition for curb space, the tools and policies municipal staff have to manage and mitigate these pressures, and the cumulative knowledge of best practices supported by academic literature and practitioner guidelines. These dimensions of curbside management form the basis of an evaluation framework developed to examine five Canadian urban areas—a context that has been examined very little in the body of research to date. The purpose of this rubric is to find evidence that Canadian cities are working with elements of curbside management and to provide a comparative overview of curb governance that can be helpful for transportation planners in Canada.

This research has shown that Canadian cities are in the early stages of implementing comprehensive curbside management strategies, but that the largest cities—Montréal and Edmonton—are developing plans that involve more substantial organizational restructuring and detailed proactive frameworks. In contrast, the three smaller cities—Hamilton, Halifax, and Victoria—are working with the concept of curbside management more incrementally without the same dedicated resources as the larger cities can provide.

Overall, the five subject cities have transparent plans and policies equivalent to one another, which provide a useful comparison despite their varied geographic and demographic contexts. That said, there are some limitations to this study's approach requiring further discussion. For one, assigning scores for each city's evaluation criteria is a subjective exercise, and is only as informed as the public availability of relevant documents to the evaluator. This research attempted to mitigate this issue by providing as much context as possible to enough evaluation criteria to ease concerns about scoring consistency. Another limitation to this research is the fact that some criteria in this rubric are more critical to desirable outcomes consistent with a comprehensive curbside management strategy than others. Since all criteria use the same binary or gradient numerical scoring scales—regardless of their relative importance—this might result in some cities scoring higher while accumulating points in less meaningful evaluation categories/criteria. Finally, there were a few instances where access to relevant documents proved challenging. For example, some municipal by-laws were arbitrarily archived and required additional web searches to locate. Additionally, some of Montréal's by-laws and other materials were published in greater detail in French than in English, requiring document translations.

Future research directions could focus on providing further clarity to the thresholds for specific criterion scoring, removing additional perceived subjectivity in the municipal assessment process.

Another research direction could involve refining evaluation criteria using weighted scales. This would be challenging but could involve identifying criteria whose presence, complexity, or comprehensiveness are more closely tied to objectively positive MOEs based on the academic and practitioner bodies of research (see Abel et al., 2021). Finally, this research could be enhanced through interviews with planning staff working for the subject municipalities. Conversations could improve the accuracy of municipal activities, or possible refinements to the evaluation criteria and how they are assessed.

This research highlights the tension accompanying a shift away from reactive, incremental 'management of the curb' towards a framework of proactive 'curbside management'. There is understandable inertia stemming from any transition away from structures and competencies which might keep pace with curb users today but might not be prepared for the mobility and accessibility needs of a city's population tomorrow. Cities, particularly smaller ones, must manage finite resources while chasing an increasingly complex and crowded problem of curb access desires and alternate uses. It is therefore important that research continues to help municipalities of all sizes share and disseminate research which can help them make more informed and productive decisions about their curbs going forward.

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