An Open Data Framework for the New Mobility Industry in Metro Vancouver

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Executive Summary

The New Mobility Services (NMS) industry is growing rapidly throughout the world, providing enormous opportunities to companies and individuals. At the same time NMS poses new challenges to cities. One such challenge is how to structure the industry. If Metro Vancouver takes a free-market approach, large companies may form walled gardens, providing all mobility options through a single monopolistic platform.

Walled gardens are problematic for a city as its residents will depend on one service provider for all transportation needs. This would make residents vulnerable to one corporation's pricing, data regulation, and investment strategies. The company that controls the dominant platform can decide which services will be discontinued and which users to accept, leaving users without an outside option if the monopolist fails to serve their needs.

Recent mergers and acquisitions, such as Uber's acquisition of bikeshare startup Jump, show the formation of potential monopolies. Policy makers are increasingly concerned that a large corporation may monopolize their city if the NMS industry is left unregulated.

With ride-hailing soon to be introduced into Metro Vancouver, now is the ideal time to act. We lay out the regulatory framework that will ensure that the benefits and opportunities provided by the NMS market are enjoyed not only by a few large corporations, but by society as a whole.

We evaluate four policy options, considering each policy's effects on the NMS industry itself, public transport, the taxi industry, businesses, and individuals:

1. Unregulated market
2. Mandatory open data
3. Mid-layer as public utility
4. Exclusive contract with an aggregator

To preview our results, our economic analysis suggests that option 3 will best serve Vancouver residents as it provides the benefits of market competition while guarding against the formation of monopolies in the new mobility space. Furthermore, it involves creating a new public utility that will gather and disseminate the valuable data generated by the NMS industry, providing cities with information for setting policy.

Option 1, an unregulated market, is undesirable because strong network effects will lead to walled gardens.

Options 2-4 impact the NMS market structure through the control of mobility data.

With option 2, mandatory open data, we arrive at a simple yet powerful change to regulation: **no real-time data-sharing means no business license** granted to the operator. Aggregator apps, drawing on data made available by operators, can make the NMS market more competitive, inhibiting the formation of a walled garden. An aggregator app provides route-planning, booking, and payment services for a wide array of transportation options. A competitive NMS market will lower transportation costs and encourage innovation. Option 2 also impacts the supply side of the NMS market, as it levels the playing field for all providers and allows existing operators and new innovative firms to compete against larger corporations. This policy would foster competitive markets for both aggregators and operators.

Option 3 includes the open data requirement and adds an essential feature: a mid-layer, or computer reservation system (CRS) to gather information, provide oversight, and act as a central clearinghouse for data requests. The mid-layer is an intermediary between operators and aggregators that can be run as a public utility.

TransLink can contract with a developer to design and manage the CRS. There are several advantages to adding such infrastructure. By taking data on all available vehicles from operators and disseminating that data to all aggregators, a CRS eliminates duplicate requests. In its position as the central data clearinghouse, the CRS can request additional data from operators. This can be data on the whole moving fleet of an operator instead of only available vehicles. TransLink can use this data for audit, planning, and congestion pricing. This data can also be shared with third parties for carbon offsets, research, and other purposes.

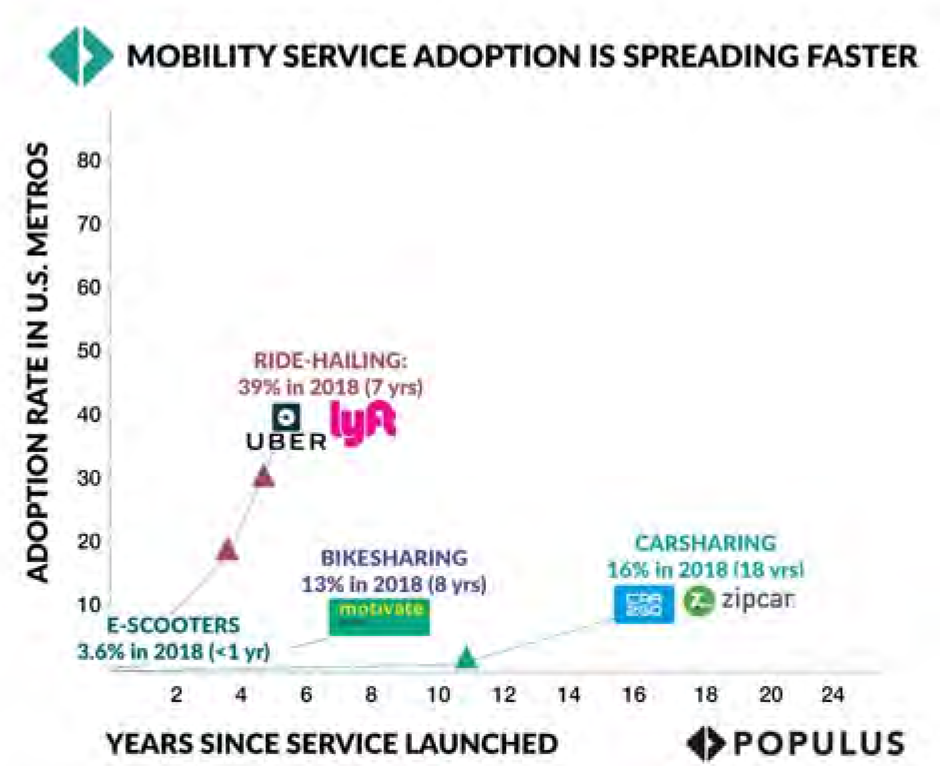
Option 4 is a strategy adopted by other cities, including LA, Denver, and Dallas. It involves an exclusive contract between the city and a single aggregator app. The intent is to give cities more control of the aggregator space. However, without competitive pressure in the aggregator space there is less incentive to provide an innovative service. This strategy also creates a single point of failure: if there is a problem with the app, all individuals using it are left stranded. We believe that cities can gain the advantages of control by running a CRS, without losing the advantages of competition among aggregators.

Introduction

This paper analyses policies to structure the flow of information within the NMS industry in Metro Vancouver. We aim to inform policy decisions so they can be maximally beneficial to the public as a whole. As our proposed policies aim to facilitate a competitive market in NMS, they serve an anti-trust function.

The NMS industry is becoming an increasingly important part of urban life. As of 2017, the Shared Mobility Market (ride-hailing, bike-sharing, ride-sharing, carsharing) was valued at USD $104.95 billion and expected to grow by 25% between 2018 and 2025[1]. Adoption of NMS in US metropolitan areas has been increasing over the past decade, as Figure 1 shows.

Figure 1: Adoption of New Mobility Services Since Their Introduction



Adoption of New Mobility Services has accelerated in the past decade, with ride-hailing very quickly being taken up by users. Sources: Populus Groundtruth; Clewlow & Mishra, 2017; Clewlow R. R., 2016

Vancouver's status quo

At the time of our research, there are a number of carsharing options available in Vancouver: Car2go, Evo, Zipcar and Modo. There is currently one bikeshare provider in downtown Vancouver, Mobi, which launched in 2016, subsidized by the city. Ride-hailing services in Vancouver are only offered by the taxi industry, but Uber and Lyft are already taking measures for their anticipated service applications in September 2019[2]. We can expect the arrival of either of these companies to have a large effect on the urban mobility landscape in Vancouver. With many NMS solutions on the rise, this is the ideal time to plan and prepare an optimal environment for the Shared Mobility Market in the Greater Vancouver Area. To judge which policy is a best fit, it is necessary to determine the affected stakeholder groups:

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[1] Shared Mobility Market Size, Share & Trends Analysis Report (Jan. 2019). Retrieved from https://www.grandviewresearch.com/industry-analysis/shared-mobility-market

[2] Nathan Caddell, (July 2018). A year early, Uber and Lyft are already battling over Vancouver. Retrieved from https://www.bcbusiness.ca/A-year-early-Uber-and-Lyft-are-already-battling-over-Vancouver

- *New Mobility Industry:* The industry itself has a strong interest in how it is to be regulated, but what benefits the industry may not be in the best interest of others, particularly if these benefits are achieved through monopolization.
- *Mobility as a Service Apps:* The companies that stand ready to enter the aggregator space in Vancouver (Transit, Citymapper, Cowlines, Moovel) benefit from policies that allow this space to thrive; particularly open data policies that allow them to connect to all operators without bi-lateral contracts with each of them.
- *Public Transit:* As the major mobility provider in Vancouver, public transit will see effects from any kind of development in the NMS market. Some policy options may benefit public transport usage more than others. It remains a highly location- and service-dependent question whether ride-hailing can be a substitute or complement to transit. Ride-hailing has been shown to act as substitute for bus and light rail services, while it is complementary to commuter rail (Clewlow & Mishra, 2017).
- *Taxi Industry:* The taxi industry has already seen disruptions in anticipation of other ride-hailing operators' entry into the market: from a high of CAD $1 million, the value of a license had dropped to about CAD $200,000 by 2016[3]. Early 2019, a few taxi operators came together to join the app Kater. With Kater, users can book taxi rides through an app, making taxi operators practically equivalent services to Uber and Lyft. Through services like Kater and UberTaxi, taxis are becoming integrated into New Mobility.
- *Policy Makers:* In addition to their role in balancing the interests of the other stakeholders, policy makers have an interest in the data available to them. Policy makers could use monthly data on traffic patterns to inform infrastructure investments. They could use real-time location data to implement congestion pricing.
- *Businesses:* Businesses in Vancouver depend on being accessible. Easy access to mobility services and low congestion rates can convince more customers to travel to a business location. Better and more affordable transportation options also broaden the labour market by allowing workers to reach more employers within a reasonable commute time, making the market more efficient.
- *Everyone in Vancouver who needs to get places:* Everyone living in or visiting Vancouver is a potential user of mobility services and thereby affected by any policy decision regarding NMS. This group outnumbers the rest, so this group's welfare must be the primary concern of any policy.

These stakeholders may have complementary or opposed interests along any given dimension. Therefore, any policy will need to balance the competing interests of all of them to maximally benefit the public as a whole.

Policy options

We evaluate four policy options:

1. Unregulated market
2. Mandatory open data
3. Mid-layer as public utility
4. Exclusive contract with an aggregator

[3] Jeff Lee (Jan. 2016). Even before Uber arrives in B.C., it has the taxi industry in disarray. Retrieved from http://www.vancouversun.com/news/even+before+uber+arrives+taxi+industry+disarray/11755601/story.html

Open API

An Application Programming Interface, or API, allows backend access to the data and functionality of a system. While private APIs allow businesses to open their backend functionality for specific developers or contractors, open APIs are designed to be accessible to a wide array of users, often ones who are completely external to the business. Open APIs and data sharing can go hand in hand when the API allows third party users to collect real time data from the organization. For example, if Uber were to adopt an open API, aggregator apps could collect real time data on the location and pricing of Uber cars in a particular area and display it to app users.

We first look into a baseline scenario, (1) an unregulated market: We ask what can be expected for all stakeholders if the NMS industry is allowed to grow without oversight.

In policy option (2) we introduce our proposal for open data sharing: no data sharing means no business licence for NMS operators. Operators can share data in real time through an API, or Application Programming Interface, enabling aggregator apps to display all NMS providers alongside public transit on a single interface. We show how such a policy will affect the degree of competition in the NMS industry and if and how that can be beneficial for all stakeholders.

Option (3) is our main proposal: In addition to an open data policy, TransLink should coordinate the development of a Computer Reservation System (CRS) or mid-layer as a public utility. Operators send data on available devices and pricing to the CRS, which then relays the information to aggregators. This has benefits in coordinating fair data sharing between operators and aggregators and it makes communication more efficient. In addition, it greatly increases the amount of mobility data available to TransLink. The CRS could request data on the whole fleet of operators' vehicles instead of only available devices, using the additional data for audit, planning, research and third-party business applications.

Option (4) does not include an open data policy; instead, it examines the possibility of an exclusive contract between TransLink and a single aggregator app. Under this policy, TransLink would contract with an app developer to create a single aggregator for Metro Vancouver, with each operator requiring a bi-lateral contract to feed data to the app. Other cities, including LA, Denver, and Dallas, have adopted this policy for the greater control it provides. However, they have run into problems that we discuss below.

We start with a discussion of our baseline scenario: laissez faire.

Aggregator Apps and Mobility as a Service

Mobility as a Service (MaaS) refers to the integration of multiple transportation options into a single, on-demand service. An aggregator is an app providing mobility as a service. Aggregators can provide route-planning, booking, and payment services for a wide array of transportation options. They allow users easy comparison between different modes and providers. However, aggregators are limited by the API access provided by operators: without API access there can be no aggregators, and with read-only access, aggregators cannot provide booking and payment.

Policy option 1: Unregulated Market

This section discusses what to expect if we let Vancouver's new mobility market develop freely as it has in many other cities without open data policies, caps, or outright bans on these services. The NMS industry has specific features that make it prone to monopolization and the development of walled gardens.

Walled Gardens

The idea of walled gardens originated in the tech sector, referring to proprietary environments that allowed a monopoly-like service provider to lock in their customers, while limiting the information and options they receive. David Zipper has applied the concept to mobility (2018). Here, a walled garden would be one company that provides multiple mobility services and also displays all the possible options of getting to a destination. There is incentive for walled gardens to skew what they show so that users choose a more expensive option. Such digital monopolies benefit from locking in their customers. When an end-user is unable to easily switch to another platform, i.e. to vote with their feet, they are also more susceptible to exploitative practices such as excessive pricing or data misuse (Van Gorp & Honnefelder, 2015).

Why do walled gardens emerge in an unregulated mobility market?

Network Effects

The NMS industry is likely to become a winner-take-all market because it features strong network effects. Stated simply, when an operator becomes more appealing to users as its userbase increases, this is a network effect. We see a strong example of network effects in the social media market: People use Facebook because their friends are on Facebook. The more users join Facebook, the more incentive there is to join.

Multi-sided platforms feature a particular structure of network effects. A multi-sided platform is a firm that connects multiple types of users, e.g. buyers and sellers (Rochet & Tirole, Platform competition in two-sided markets, 2003), (2006). Ride-hailing companies are two-sided platforms, with riders and drivers being the two sides. In that case, we can distinguish two kinds of network effects: direct and indirect.

For example, if more people started driving for a ride-hailing app, the effect on other drivers would be the direct network effect, while the effect on riders would be the indirect network effect.

In the case of ride-hailing, we can discern positive and negative direct effects, and purely positive indirect effects.

Positive indirect effects: More riders mean less waiting time for drivers, and vice-versa.

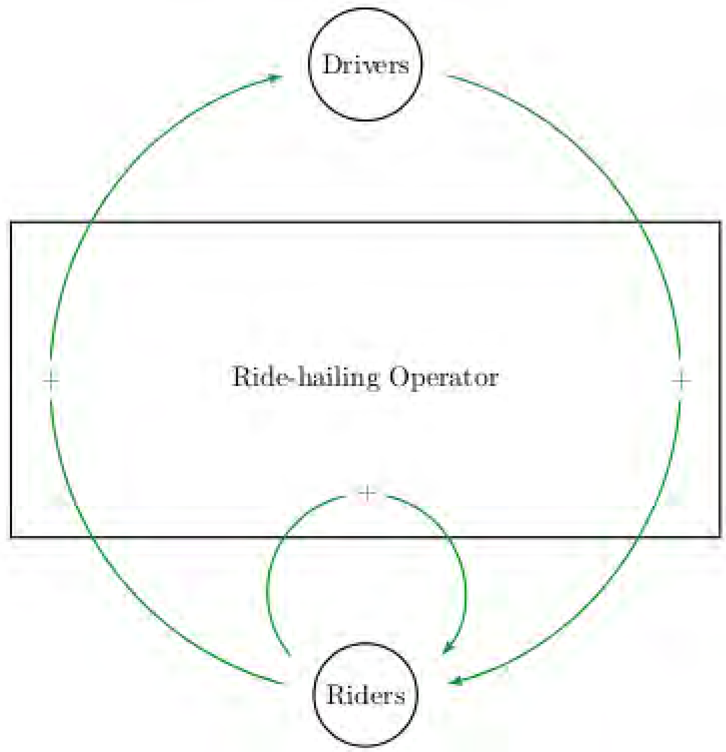
Negative direct effects: More drivers imply that each existing driver must wait longer to find a fare. More riders can lead to longer wait times, higher prices, or both. Surge pricing is an example of a negative direct network effect: a sudden spike in the number of riders forces the operator to raise prices temporarily.

Positive direct effects: The data snowball effect is one particular positive network effect (Carballa Smichovski, 2018). With more users, more data can be collected, leading to an improved service. A large userbase allows a platform to continuously run experiments to improve its algorithms. Past a certain threshold of users, it becomes impossible for competitors to maintain the same quality of service; they cannot obtain enough users to generate the necessary data.

The positive network effects in New Mobility are likely to overwhelm the negative ones, leading large competitors to grow until one captures the entire market.

The following figure serves as illustration for network effects in ride-hailing:

Figure 2: Network effects for a ride-hailing operator



For a ride-hailing operator, riders and drivers interact through the operator's platform. Long arrows indicate the positive indirect network externalities: new drivers reduce waiting times for riders while new riders increase drivers' likelihood of finding a rider close by, thereby reducing deadheading as well as reducing marginal costs and increasing environmental benefits. The direct positive effect of riders on other riders represents the data snowball effect.

Switching Costs

We've explained why network effects can cause large operators to grow, but there is another key feature of this market that makes the growth of large firms anti-competitive: switching costs.

For the customer, it is less costly to use one service provider compared to multi-homing, i.e. flipping through multiple apps and coordinating among various systems. This is particularly pronounced for trips that use multiple modes of transportation, as there are a large number of route options that have to be manually compared and understood by the user. For instance, imagine someone trying to get to Stanley Park from New Westminster. They might have some idea that they should take the Expo line downtown then switch to another mode of transportation for the last leg of the journey. But should they stop at Burrard or Waterfront? It would depend on what vehicles are available near those stations. The user might need to check multiple apps to see whether there's a bike or scooter available at both Burrard and Waterfront, comparing the distances from each to Stanley Park.

This scenario illustrates what are called "non-monetary switching costs" in the economics literature. Learning the UI of a new provider, registering into the respective payment system and gaining a reputation of being an acceptable consumer are a few prime examples of such non-monetary switching costs. Consider a consumer booking a trip home, having taken many rides on Uber and received positive passenger ratings, and without even having the Lyft app installed. This consumer is far more likely to book a trip home on Uber rather than Lyft, even if Lyft offered a lower price for this particular ride. Users rationally minimize switching costs by exclusively using one or two NMS apps. This allows each NMS operator some market power over users who only use one app, effectively granting the operator a local monopoly over these users (Srnicek, 2016).

Figure 3: China's Bicycle Graveyards

The bicycle graveyards in Xiamen, Fujian show the aftermath of a game for bicycle-monopoly. Many entered the market at first, but only very few survive today. Source: Reuters[4]

High Entry Costs

The network effects that help a provider grow large in this industry are also a reason for why it is hard to start an innovative service from scratch: one needs a large user base to attract more users. For a new firm entering the NMS market a lot of advertising effort is necessary to overcome the hurdle of starting with zero users. Similarly, the data snowball effect means that new entrants will lack the data necessary to provide the same quality of service as established firms, even if they have new ideas that would thrive with a large enough userbase.

In the end there were walled gardens…

The structure of the NMS industry just described is also referred to as winner-take-all market structure. It leads to the creation of walled gardens, where one single platform is able to lock customers into a proprietary environment.

We are seeing the early stages of this in transportation already, as Uber has purchased shared bicycles and scooters, and announced a goal of being the "Amazon of transportation"[5]. Uber's experience in Asia

[4] Alan Taylor, (March 2018). The Bike-Share Oversupply in China: Huge Piles of Abandoned and Broken Bicycles. Retrieved from https://www.theatlantic.com/photo/2018/03/bike-share-oversupply-in-china-huge-piles-of-abandoned-and-broken-bicycles/556268/#img01

[5] Olivia Zaleski, (April 2019). Uber Readies Its Pitch as the Amazon of Transportation. Retrieved from https://www.bloomberg.com/news/articles/2019-04-13/uber-is-said-to-ready-its-pitch-as-the-amazon-of-transportation

illustrates the winner-take-all nature of this market: Uber recently lost a prolonged price war in China against competitor Didi, reportedly after having spent USD $1.5 billion trying to win the market. After a similarly costly price war with Grab in Southeast Asia, Uber settled by leaving the region and selling its business to the competitor, but also acquiring 27.5% of Grab[6].

Similar mergers in Canada would likely be blocked under Canada's Competition Act. However, even if the major mobility operators don't merge into a single monopolist, significant barriers to entry for new firms can result in an oligopolistic market where a two or three large firms divide up the market between their respective walled gardens. The problems of oligopoly are similar to, but less extreme than, those of monopoly: the few firms dominating the market still wield sufficient market power which will lower quality, decrease consumer choice and raise prices above those we would expect in a healthy and competitive market with free entry from small and innovative competitors.

Furthermore, in a scenario with two or more walled gardens, we do not get the efficiency gain from having algorithms considering multi-modal trips involving vehicles from separate walled gardens. If the most efficient route between two locations involves an Uber car followed by a Lyft bike, no algorithm will be available to combine them, leading the user to use a less efficient route.

Walled gardens and monopolization are problematic for a city as its residents will depend on one or two service providers for all transportation needs, making residents vulnerable to those corporations' pricing, data regulation, and investment strategies. Whoever runs the walled gardens can decide which services will be discontinued, and also which users to accept, leaving users without outside options if the oligopolists fail to serve their needs.

Walled gardens are also more difficult to regulate than a collection of small players in a competitive market. It is difficult to get the support needed to pass legislation and regulations when the walled garden is integrated into the everyday lives of society. Users can be resistant to regulations on a service they deem to be convenient and essential to their daily lives[7] (Van Gorp & Honnefelder, 2015).

Could aggregators foster competitiveness and prevent monopolization?

Aggregator apps are important as they can mitigate the anti-competitive features of the NMS market by reducing switching costs for users. To the extent that aggregators have strong user bases, new competitors (for example a small bike rental store with only 50 devices) can gain access to a large share of the market simply by connecting to one or more aggregators. These entrants don't even need to develop their own apps: They can exclusively connect with customers through aggregator apps, similar to the way many online retailers run stores through Amazon instead of developing and maintaining their own websites.

However, in an unregulated market, aggregators depend on bi-lateral contracts with each operator in order to access the operator's data. Some aggregator apps are backed by large car makers, for example Moovel (funded by BMW and Daimler) or Transit (funded by Renault Nissan Mitsubishi Alliance). The companies standing behind such aggregators have interest in their product being displayed favourably on the app. This

[6] Jessi Hempel, (May 2018). How Grab Is Giving Uber a Run for Its Money in Southeast Asia. Retrieved from https://www.wired.com/story/ubers-grab-on-the-developing-world/

[7] Nora Young, (April 2019). No single company should have a monopoly on building smart cities, tech entrepreneur says. Retrieved from https://www.cbc.ca/radio/spark/spark-436-1.5107883/no-single-company-should-have-a-monopoly-on-building-smart-cities-tech-entrepreneur-says-1.5107889

hampers the pro-competitive effects of such aggregators and also makes it harder for aggregators to sign contracts with more operators. Furthermore, Uber and Lyft used to be friendly towards open data, but moved away from this position in 2018. It used to be possible to book Uber rides through Google maps, but that service was silently discontinued in 2018[8]. The reason for this move was never made public, but its result is that Uber services came one step closer to only being available through Uber's native app.

Their pro-competitive nature makes aggregators appealing from a public policy standpoint while simultaneously making aggregators unappealing to the companies they must contract with in order to function. This is what motivates our second policy proposal.

Policy Proposal 2: Mandatory Open API

We propose a simple yet powerful policy to protect competitiveness within the New Mobility space: *No data sharing, no business license.*

By requiring an open API from all New Mobility operators, policy makers can unleash the full potential of aggregator apps. Open APIs put the conditions in place for aggregators that give individuals access to all mobility options at fair prices, since users will be more price sensitive when they can easily compare competitors.

In order for aggregators to be viable, the minimal amount of data shared by operators should be the location and price matrix (e.g. rows for different user classes, columns for route type) of every available device.

Before we dive into the specifics of the data requirements under this policy, it is worthwhile to discuss the impact we expect aggregators to have on the mobility market.

What do aggregators bring to the table?

As discussed above, aggregators make the mobility space more competitive by allowing users to discover and compare all mobility options without the friction of switching between apps. This pushes operators to compete more on the dimensions of price and quality, while also allowing any small, new and innovative firms to gain access to a large user base as soon as they enter the market.

In addition to their pro-competitive features, aggregators also make the user experience better and can lead to more efficient route planning.

Aggregators as first- and last-mile solution for multimodal trips.

Aggregators can combine multiple modes of transportation supplied by different operators, intercomparing thousands of potential routes in a fraction of a second and offering up the fastest, cheapest, or otherwise best options. With an aggregator, planning multimodal trips is just as simple as planning a trip using only a single mode. Without an aggregator, the user has to plan out these routes manually, deciding where and when to switch between operators without the help of an algorithm.

This essential feature also increases the degree of complementarity between different forms of transportation. For instance, we would expect aggregators to increase the joint usage of ride-hailing and transit. There is currently no consensus on whether ride-hailing and transit are substitutes or complements. While some researchers have found that the arrival of Uber in a large city may increase transit ridership slightly (Hall, Palsson, & Price, 2018), others have found evidence of decreased transit usage (Graehler Jr.,

[8] Chaim Gartenberg, (June 2018). Uber booking has been removed from Google Maps for Android. Retrieved from https://www.theverge.com/2018/6/18/17474520/uber-booking-google-maps-android-feature-removed-app-updated

Mucci, & Erhardt, 2018). However, these observations apply to cities without aggregators offering multi-modal trip planning. By nudging travellers towards multi-modal trips, aggregators can change the fundamental relationship between NMS and transit; making them more complementary than they have been in the past.

Decreasing the cost of multimodal trip planning will have more benefits the more modes of transport are available in the area. Metro Vancouver has a wide array of transportation options, from buses, trains, and ferries to bike- and car-shares, with scooters and ride-hailing on the horizon. As such, it is the perfect environment for multi-modal transportation. We expect that the presence of apps to help coordinate multi-modal trips will have a significant impact on the number of people using multi-modal transportation.

Long-run effects of aggregators on car ownership

In the long run, by increasing competition between NMS operators, we expect aggregators to have important implications on consumer choices as they result in lower transportation costs and more innovative services. This will allow people to substitute away from private cars. While ride-hailing and private cars both contribute to congestion, ride-hailing alleviates the demand for parking (Henao & Marshall, 2019).

The Metro Vancouver area has some of the highest land values in the world, and the prices charged for on-street parking are far too low to justify the opportunity cost of the land required for a parking spot. In a future where people have access to inexpensive transportation options that do not require parking, the municipalities of the Metro Vancouver area could (and should) reduce or eliminate the minimum parking requirements for new developments and reclaim much of the land dedicated to on-street parking to convert it to higher-value uses: larger lots with more space for housing and businesses, wider sidewalks, and bike lanes.

Competition in aggregator space

A mandatory open API policy would allow free competition in the aggregator sector. Without the policy, few aggregator apps would be able to survive, as they would have to rely on signing bi-lateral contracts with operators who want to build their own walled garden and not be displayed on other apps. With the mandatory open API policy, aggregators will compete on the merits of their service and user experience, because all operators can be displayed on all apps.

The market for aggregators is competitive, as the cost of entry is fairly low and the aggregator market lacks the strong network effects of the NMS industry; an aggregator can offer the same number of transportation options whether it has one user or one million. As in other competitive markets, we expect the competition to produce a wide array of differentiated options serving different market segments. For example, some aggregators could be targeted to younger, more tech-savvy users, while other aggregator apps might use a simpler display or invest into accessibility options.

Major operators like Uber and Lyft may choose to enter the aggregator space. In doing this, each operator could prioritize its own services over those of other operators. We are not concerned about this outcome, as unbiased aggregators should outcompete such hybrid aggregator-operators by providing the options that are actually optimal in price and other relevant characteristics.

What data should be shared?

Functionality vs. privacy

There is a minimum of data sharing required in order for aggregators to be able to properly display all options. In order for aggregators to function, NMS operators will have to at least share locations and routes of available (unused) devices as well as a pricing matrix connected to every available route and device, specifying prices as function of usage of the device (e.g. minutes, distance) and who the user is (student, senior, person with disabilities, etc.).

At the same time, privacy concerns impose an upper bound on how much can be shared. We will first discuss data requirements and current standards to achieve a functioning aggregator service, and then address privacy concerns.

The open API policy can require either a "read-only" API or a "read-and-write" API. A read-only API allows aggregators to see the current location and pricing information of any available device in real time and use this information for route planning. The read-and-write API additionally allows for booking and payment.

MaaS in Finland
In 2016, Helsinki became the first city with a transit authority that shared not only read-data, but also payment options. Through its partnership with the read-and-write aggregator Whim, it allowed Whim users to book rides on public transportation. Since 2018, Finnish legislation has required operators to provide their data, with two options for where to provide it: Operators are allowed to provide an open interface through their own website, or they can provide real-time information to the Finnish Transportation Agency's computer reservation system.

Read-only may be restricted to planning, but will still alleviate much of the switching cost incurred by users under the status quo. Currently there exist data format standards transit agencies and mobility operators have been using that would allow a read-only API to be implemented fairly straightforwardly: GTFS and GBFS.

As for read-and-write, there currently exist no data standards that operators and aggregators may follow. In this case it is helpful to consider examples of successful implementations of such an option in the NMS sector: the prime one being the Finland model and a more recent implementation in New Zealand.

The examples of Finland and New Zealand show that it is not necessary for operators to openly share any additional information when going from read-only API to read-and-write. For aggregators to allow trip booking, the additional requirement is another line of communication that handles booking requests, cancellations, alterations, and possibly customer service. This is exemplified by Whim, the read-and-write aggregator available in Helsinki. The aggregator implements booking communication by having the user query a booking to the aggregator, and the aggregator relaying that query to the respective operator. Whim provides its booking API openly on GitHub[9].

Data standards and ride-hailing

Open APIs can be employed in many ways. First, having operators follow a common data standard will make communication with aggregators easier; the standards available now (GTFS, GTFS-flex (in development), GBFS) cover an important part of the NMS market, but cannot currently accommodate ride-hailing services.

[9] MaaS TSP (Transport Service Provider) Public API. Retrieved from https://github.com/maasglobal/maas-tsp-api

The issue with open APIs and ride-hailing is the dynamic nature of the service. For floating carshare apps such as car2go and Evo, GBFS provides sufficient information for the service: the location, pricing, and fuel level of a stationary, unreserved vehicle. For ride-hailing however, available cars can be on the move, and their availability will depend on the route. Knowing the location and pricing of available Uber cars is enough only if one has access to Uber's algorithm in estimating pick-up times and prices for a given route.

Data Standards

The General Transit Feed Specification (GTFS) is a commonly adopted data feed for public transport, providing fare, schedule, and route information as well as a real-time format including estimated arrival times and vehicle locations. GBFS, or General Bikeshare Feed Specification, is a standard for docked and dock-less bikeshares, showing location, pricing and battery level. This standard can also accommodate carshare services. GTFS-flex is a standard currently under development. It can incorporate demand responsive transport into a public transit authority's data feed.

A possible solution is to require ride-hailing operators to give aggregators access to a ride-request API. Aggregators can forward queries to ride-hailing operators each time they plan a route. Uber already provides a tool to integrate such services via their website[10].

Privacy

Mobility data is susceptible to misuse if not treated with care. Even without an open API policy in place, it is possible to track people's movements with concerning accuracy (Riederer, Kim, Chaintreau, Korula, & Lattanzi, 2016). With an open API policy in place, regulatory design must be careful to prevent such misuse from becoming even easier.

An essential step to preserve privacy is having operators not share the license plates of available devices, so that one cannot track where a specific car disappeared from the feed and then reappeared later. Even today in Vancouver, carsharing operators car2go and Evo openly display license plates of available vehicles. A way to enhance privacy is assigning dynamic IDs to devices that would be changed during trips according to a given rule.

While aggregators require data on available devices in order to operate, they do not require granular historical trip data. This type of data has been shown to present serious privacy concerns, to the point of identifying specific individuals' trips from large public datasets.[11] If granular data on specific rides and vehicles is to be shared (e.g. for policy and research purposes), access should be tightly controlled in order to prevent misuse.

Preventing malicious compliance

Operators may engage in malicious compliance to keep users from adopting aggregators. They could do this in a number of ways, for instance by showing higher prices to the aggregator, charging a prohibitive price for data requests, or simply slowing down their API to make aggregators slow and clunky.

Experience from different industries applying open API policies shows that this is indeed an issue: For example, consider travel applications like Expedia. It is unclear whether consumers are actually able to find

[10] Introduction to Ride Requests. Retrieved from https://developer.uber.com/docs/riders/ride-requests/introduction

[11] Neustar Research, "Riding With The Stars: Passenger Privacy in the NYC Taxicab Dataset." September 15th, 2014. Retrieved from https://research.neustar.biz/2014/09/15/riding-with-the-stars-passenger-privacy-in-the-nyc-taxicab-dataset/

the best offers via the aggregator; airlines and hotels can offer better prices through their own websites. Similarly, mileage programs' benefits often are only available when booking through the airline's website, not through an aggregator. It appears that withheld options as well as additional liability issues incentivize users to access an airline-operator's own application instead of the meta-platform. Such strategies encourage users to go back and forth between aggregators and operators, negating the advantages of an aggregator.

Sound incentive design can curb malicious compliance: Hotel aggregators such as Expedia and Booking.com punish hotels that discriminate between the hotel's own website and the aggregator (Hunold, Kesler, & Laitenberger, 2018). If a hotel website offers lower prices, aggregators penalize that hotel by listing it lower in search results.

Expedia can enforce compliance because a large number of users rely on Expedia. However, the aggregator market for mobility services is in its infancy. Before it gains a sufficient user base, it will be vulnerable. Maliciously compliant operators may prevent aggregators from taking off. We can't predict all the possible ways a large operator could push against open data, so we simply say that regulators must be in a position to monitor operators and detect attempts to undermine the aggregator space when they occur.

MaaS in New Zealand

The application launched by the Transportation Agency of New Zealand streams data on available devices and pricing to end-users. Similar to Whim, booking queries are relayed via the aggregator from rider to operator without interference from the aggregator. For multi-modal trips, the aggregator just separates the users' query into multiple queries corresponding to each operator used in the trip. Their aggregator does not store data on the user side, it would be stored on the user's phone. They also anonymize the operator side. They only stream operator data based on mode and type of vehicle, with the operator anonymized. This is done as some operators are concerned that competition may learn too much about their algorithms and strategies if their data were streamed openly.

To this end, our third proposal provides the platform for regulators to gather the data needed to monitor the market.

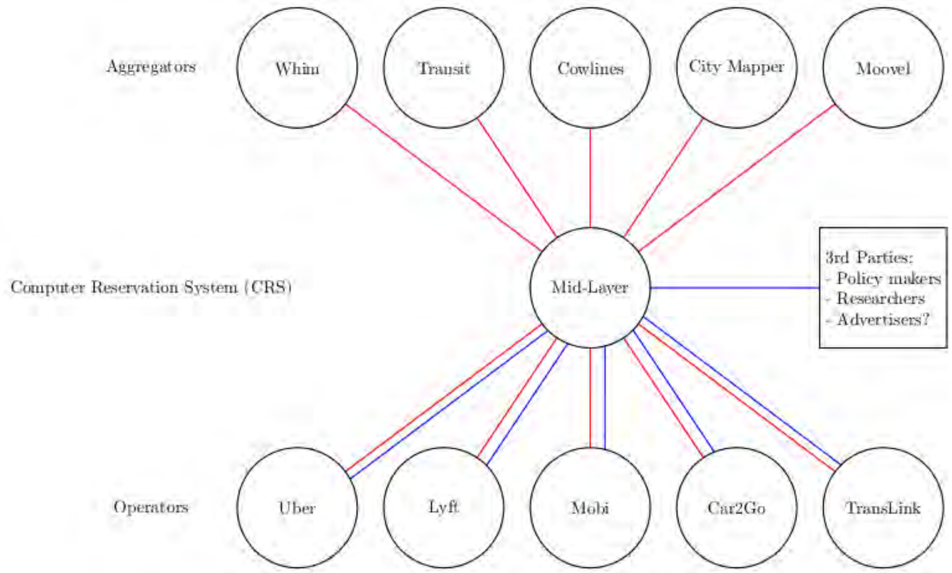
Policy Proposal 3: Mid-layer as Public Utility

This section discusses the benefits of introducing an intermediary communication structure between operators and aggregator apps, which we will call the mid-layer, or computer reservation system (CRS). This proposal incorporates all the features of mandatory open API, but adds this mid-layer as a central clearinghouse for data. We propose that TransLink or a government agency act as enabler and manager of the mid-layer, while contracting an external developer to design and maintain it.

This position will allow TransLink to reap the benefits of control over the aggregator-operator ecosystem and its generated mobility data, while outsourcing the technically demanding task of maintaining the mid-layer infrastructure.

Real time mandatory data-sharing between aggregators and operators can be bandwidth-intensive and costly. An immediate effect of introducing a mid-layer is decreasing the amount of such communication by an order of magnitude. The following graphic gives intuition of the relationship between aggregators, operators and the CRS:

Figure 4: The Aggregator Ecosystem with a Computer Reservation System (CRS) as Mid-Layer



The CRS or mid-layer acts as an intermediary between operators and aggregators. As a central clearinghouse for data requests, it can reduce the cost of data sharing. It can also gather additional data (represented in blue) beyond what is necessary for the aggregators, for use by third parties such as public agencies, researchers, and possibly private businesses.

Stronger bargaining position to prevent malicious compliance

The mid-layer serves as protection against malicious compliance in the data-pricing dimension. Without a mid-layer, it would be at the operator's bidding how much they would ask each aggregator to pay for a data request. One can imagine Uber agreeing to share their data, but then asking $100 per request and making the aggregator service infeasible.

With a mid-layer in place, this can be easily prevented: even now, all NMS operators in the Vancouver area are required to pay a licensing fee. Given a projected value of the data sent to the mid-layer, its profitability can be internalized and passed on by lowering the licensing fee for providers. The data sent to aggregators can then be charged a fair price determined by the public CRS utility.

Data is gold: The mid-layer as central data clearinghouse

The position of enabler and intermediary gives TransLink access to much more than control over shared data pricing. The mid-layer can require more data to be sent from operators than what is being released to aggregators. For example, aggregators need only know which trips and devices are available at any given moment, whereas the mid-layer can request to see all devices and all trips taken at any point in time.

This additional input grants TransLink access to a tremendously valuable database. It can be used to audit any operator on the market, make better informed planning decisions, and implement congestion pricing. Additionally, the data could be sold to third parties to certify carbon offsets, sell ads, and to facilitate urban/transportation research. However, this must be approached with caution: If TransLink sells data, it would do so in direct competition with the operators creating that data. In order to get the consent and support of operators, TransLink may want to agree to limits on what data it can share and in what contexts.

Congestion Pricing vs. Caps on Operators

In 2018, New York City passed a policy capping the number of ride-hailing vehicles allowed in the city over concerns about congestion. Caps aren't the only policy that can be used to address congestion, however, and economists favour congestion pricing as a more targeted policy for dealing with congestion. Caps are a rigid policy that will undo both benefits and costs of ride-hailing: with fewer rides supplied, users likely go back to taking their private vehicles. Thus, the effect of ride-hailing caps on cars on the road is ambiguous at best, while these caps unambiguously increase parking demand.

Efficiency gain

Real-time data is costly, and that cost scales up with the amount of data being sent and the number of places it must be sent to. The CRS reduces the number of duplicate data requests by collecting all operator data on the status of available vehicles and distributing it to all aggregators.

Using the market in Figure 4 as an example, in the absence of a mid-layer, a market with five operators and five aggregators would require live updates on all available vehicles to be sent to all five aggregators. With all operators sending their data to the mid-layer and all aggregators getting their data from this layer, each operator needs only to send the status of each vehicle to the mid-layer, which bundles the data and forwards it to the aggregators.

Read-write with a CRS

We do not believe that there is an advantage in having the mid-layer house its own booking facility for read-and-write aggregators. The additional communication necessary for bookings is more of a privacy hazard than benefit in additional, useable data. The New Zealand model is a practical option, as outlined above. The mid-layer can simply forward booking requests to operators without having its own separate booking system.

Avoiding a Single Point of Failure

The mid-layer presents many advantages by acting as a central clearinghouse for data, but the primary disadvantage is that it creates risk in the form of a single point of failure. If the mid-layer fails, the whole aggregator space fails simultaneously. This risk can be mitigated through redundant systems; replicating the data across multiple servers in order to avoid an outage should any one server fail (Ranjithprabhu & Sasirega, 2014). This adds cost to the operation of the mid-layer, but it provides the higher level of reliability required of an important public utility.

We next analyse a policy that other cities have implemented: exclusive contracts with an aggregator app. This policy shares some of the goals we hope to achieve with a combination of open data and a mid-layer, but is not ideal for reasons we will explain in the following section.

Policy Option 4: Exclusive Contract with One App

Some cities, such as Denver, Los Angeles, and Dallas, have opted to create a single exclusive aggregator app for the entire city. TransLink could follow Denver and LA in contracting with a firm to develop and run an app, or it could follow Dallas in developing its own app in-house to similar effect. An in-house app would allow for greater control, while potentially incurring a higher development cost.

This policy option does not require open data. With just one aggregator, there is no need for a mid-layer. The governing body simply needs to require NMS operators to make their APIs available to the exclusive app.

Appeal depends on negotiation outcomes

Contract design will determine the success of this policy. The read-and-write aggregator offered by the transit authority in Dallas is an example of this dependence. Uber and Lyft could be convinced to have their service displayed on the app – however, users have to specify upon login which of the two providers they want to see displayed on the aggregator. That is, Uber and Lyft will never be displayed at the same time on the app. This design undoes many of the competitive benefits that are expected from having an aggregator. In the case of GoPass, the switching costs users face when comparing multiple separate services continue to exist. Under our proposed mandatory open API policy, switching costs would disappear.

Fragility in the aggregator space

In principle, the competitive and pro-consumer benefits of aggregator apps could still apply to an exclusive aggregator. However, these benefits will only manifest to the extent that aggregators can attract a sufficiently large user base. With only one aggregator, policy success depends on the quality of that app.

A competitive market in the aggregator space provides a more robust set of options to consumers. If consumers can choose the best of many apps, instead of just one, they will get better service. A competitive market for aggregators will push each aggregator to innovate in order to attract users. A single monopolistic aggregator will not have this competitive pressure, and it will present a single point of failure for the entire aggregator space. *If it is mismanaged or fails for any reason, the entire aggregator space will fail with it, and leave users stranded.*

Exclusive aggregators have failed in the recent past. The GoLA and GoDenver apps, developed by the Xerox corporation for Los Angeles and Denver, are gone. They were released to much fanfare in 2016, then quietly removed from the internet at the end of 2017. You can't download either app. Their websites are dead links.

While it is clear that these apps have failed, we can't be sure why. Meanwhile, competitive aggregators without exclusive contracts like Transit, Cowlines, and Citymapper continue to thrive. We believe that Vancouver can achieve all of its policy goals without an exclusive app.

Conclusion

The New Mobility Services industry has the potential to transform Metro Vancouver. It's important to get the regulatory environment right in order to ensure this transformation is a positive one for the city and its residents, not only for one large corporation.

Many of the policies put in place when this industry is introduced may be difficult to change once a particular status quo has been established. Not only will the dominant firms have greater political power to oppose pro-competitive regulations, but even positive regulatory changes can be disruptive once people come to depend on this industry for their transportation needs.

In this paper we reviewed four policy options to solve the walled garden problem. Our economic analysis concludes that option 3, prescribing an open data architecture with an API mid layer, acting as a intermediary public utility, is best suited to serving the needs of Vancouver residents. We therefore recommend this policy.

Aggregators are pro-competitive and pro-consumer; by allowing users to easily access and compare different mobility services, they put downward pressure on prices and draw attention to new and innovative entrants in the New Mobility space. A CRS run as a public utility will both lower the costs of sending data and allow for data collection for public uses. The additional control the city might get through an exclusive contract with one aggregator can be achieved through control of the CRS, without sacrificing the dynamism that comes with a free market for aggregators. Furthermore, if congestion becomes an issue, there's no need to put caps on vehicles as New York City has; the data gathered using the CRS could be used to implement congestion pricing, a policy universally preferred by economists.

We believe that these policies will help make Vancouver a transportation leader among cities, with the New Mobility Services industry seamlessly integrated into the city's transportation networks.

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