MaaS (Mobility as a Service)
DISCUSSION & PLATFORM FRAMEWORK

UBC TIPS LAB

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Faculty:

AnnaLisa Meyboom

Authors:

Yuval Fogelson

Samantha Chan

Stephanie Chen

Aysia Lowell-Guy

Dylan Phuong

GOALS AND VISION

The vibrant and growing Lower Mainland requires a symbiotic transportation ecosystem tuned to the high-reaching goals of Vancouver becoming the Greenest City and striving to be the world's most livable city. A better functioning transportation ecosystem is essential to these goals and to the democratization of the city: allowing those who work in lower paid jobs and live in the less expensive zones of the Lower Mainland to efficiently access the geographies of the city where their jobs are held ensures a sustainable and livable evolution of the Lower Mainland. The development of a comprehensive MAAS App that integrates existing services with new humanized parameters not only can lead to a more equitable, comprehensive, and accessible transportation system, but one that is elevated to user's desires, unique experiences, and lifestyles unmet by the existing city connections.

PROJECT INTRODUCTION

The objective of the first part of the report is to discuss MaaS, its meaning and its possible impact in general. For this we need to put MaaS in the wider context of what is happening in cities, developments in AVs and other technologies which have the potential to merge in a later phase of MaaS development. It is important to first align on the terminology and to reach a common understanding regarding MaaS as a concept and a practice. The greater context is highlighted through the discussion about the relevance of MaaS to the context of cities internationally and a look at other relevant emerging technologies, with a focus on automation. An overview of business and governance models is brought forward through different scenarios and the case of Vancouver is being touched upon. A dedicated chapter looks at the health and sustainability impacts and questions which can be associated with MaaS.

In the second part - the report also incorporates specific case studies of different MaaS implementations (though Apps or cities) used around the world. There is additionally a rundown of potential key players in the (Lower Mainland) Vancouver region, including a possible pilot project at UBC.

The third part of the report explores how a MaaS mobile application (App) could function and how it may look like. It is important to note the difference between MaaS as a broader subject, and MaaS App. In the final part, we also have a look at the new features that may be employed to add to such an application.

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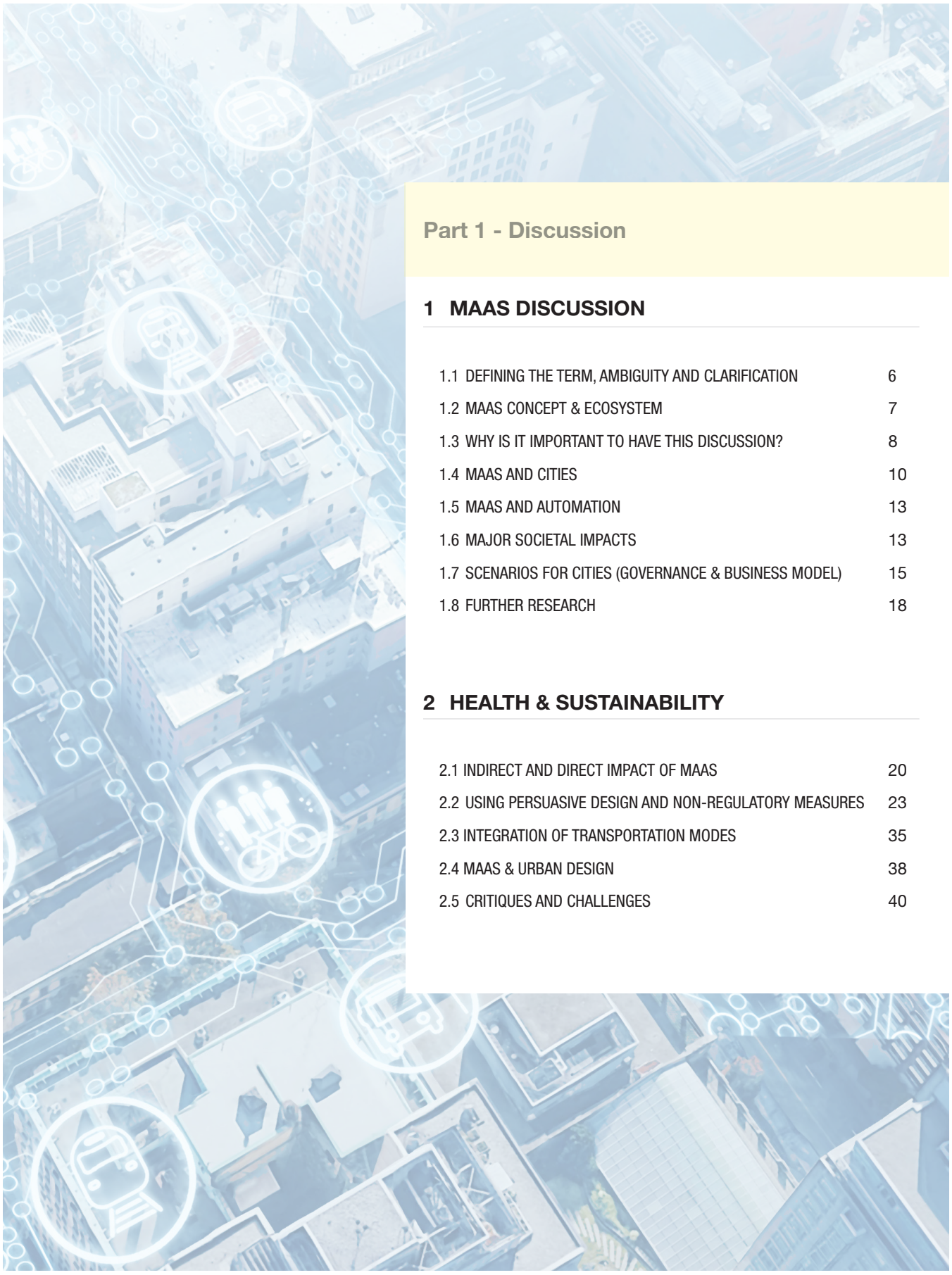

Part 1 - Discussion

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1 MAAS DISCUSSION

Mobility as a Service brings all means of travel together into a single redefining mobile experience that can reframe how society approaches the use of mobility services. Removing the hassle of planning separate uses and "one-off payments" , MaaS has the potential to increase the convenience, usefulness, and alternative lifestyle uses for transit, bike share, car share, or other mobility means. Today, with an increasing usage of shared public and private mobility services such as Uber, Evo, or public transit, there is arguably an increasing demand for MaaS and viable alternative to the traditional private single-user automotive transportation options.

The potential of MaaS to reframe mobility services, benefit lifestyle habits, and attract new consumer markets are topics with strong potential to be further explored. The potential that MaaS holds in promoting healthy lifestyle choices, greater sustainability, and new marketable visions for existing mobility services are all potential directions for future research, development, and design.

Through providing greater agency to future individuals, cities, and societies through the increased reliability, new perspective, and improved functionality of mobility services through MaaS, more choice will be given to individuals in how they can live. MaaS could be the platform that "revolutionizes" how people travel.

1.1 DEFINING THE TERM, AMBIGUITY AND CLARIFICATION

Mobility as a Service (MaaS) is a concept that is starting to reach a wider audience. MaaS initiatives and pilot projects are being tested at an increasing rate as this report is being written (August 2019), however, there is much ambiguity with regards to use of the term MaaS which requires some clarification in order for any organization dealing with the subject to be on the same page.

In the recent past, the term MaaS has been used to describe any form or vision of shared mobility, including car-share, bike-share, ride-hail and other transport services. In some cases the term has been used even for a route-planning app or any new transport related product or service. In other words a "a container term for anything seemingly new".[1]

Currently, although much ambiguity still remains, there seems to be consensus amongst some leading actors in the field of the research or promotion of MaaS on a few commonalities. In order to understand the terminology that is being widely used, we looked at four definitions by Maaslab[2], MaaS Global[3], MaaS Alliance[4] and EMTA[5].

Maaslab refers to a 'mobility management and distribution system', MaaS Global refers to it as a 'mobility distribution model', while MaaS alliance and EMTA as a 'service'. All place the user or customer in a central place and put emphasis on the seamless integration of multimodal travel, planning and payment abilities on a digital interface. Maaslab's definition was chosen as it is the most succinct and is the only one of the four to explicitly states 'multiple mobility service providers', whereas from the other definitions one may reach the assumption that a single app per city may suffice.

> DEFINITION Maaslab: " *Mobility-as-a-Service (Maas) is a user-centric, intelligent mobility management and distribution system, in which an integrator brings together offerings of multiple mobility service providers, and provides end-users access to them through a digital interface, allowing*

1. EMTA (2019), "Mobility as a Service - A perspective on MaaS from Europe's Transport Authorities, Point of View EMTA – European Metropolitan Transport Authorities", (2019) https://www.emta.com/IMG/pdf/emta_pointofview_mobilityasaservice_june2019-2.pdf
2. MaasLab - Kamargianni, M., Matyas, M., Li, W., Muscat, J., Yfantis, L., 2018. The MaaS Dictionary. MaaSLab, Energy Institute, University College London. www.maaslab.org
3. MaaS Global - Sampo Hietanen - https://maas.global/what-is-mobility-as-a-service-maas/
4. MaaS Alliance (2019) "What is MaaS?" https://maas-alliance.eu/homepage/what-is-maas/
5. EMTA (2019), "Mobility as a Service - A perspective on MaaS from Europe's Transport Authorities, Point of View EMTA – European Metropolitan Transport Authorities", (2019) https://www.emta.com/IMG/pdf/emta_pointofview_mobilityasaservice_june2019-2.pdf

them to seamlessly plan and pay for mobility. " [6] MaaS Dictionary. MaaSLab, University College London.

In this context MaaS Global puts emphasis on bundling and selling of 'mobility packages'[7], closely related to their business model with their Whim app. EMTA adds that "MaaS also generates insights into demand, needs and travel behaviour for cities and authorities, allowing for more targeted and effective adaptations of services and investments in infrastructure."[8] Meaning that there is an added importance in the role of MaaS in the public sector sphere. MaaS Alliance adds to its definition a hint at potential new business opportunities to unmet demands. Although most importantly, a desire of what it would ideally like MaaS to contribute to, which is ultimately " to provide an alternative to the use of the private car that may be as convenient, more sustainable, help to reduce congestion and constraints in transport capacity, and can be even cheaper. "[9].

1.2 MAAS CONCEPT ECOSYSTEM

1.2.1 MAAS CONCEPT VERSUS MAAS APP

Maaslab stresses that MaaS is not just an app, the app is just the digital interface [10]. It is important that this research makes this distinction and that when measuring for larger scale or societal impacts, that one takes into account the MaaS concept which englobes a far greater sphere of activity and potential impact.

According to MaaSLab, the MaaS concept covers the topics of the integration, interconnectivity and optimization of the transport services, smart and seamless mobility, and sustainability. While the topics of: mobility-on-demand, car-sharing, shared-mobility, ridesharing, bikesharing, multimodal or intermodal journey planners etc. are components or characteristics of the MaaS concept. [11]

It is important to mitigate the unrealistic expectations that MaaS brings with it, as it is a novel concept which a lot of promises are being built around, as in the desire of the statement of MaaS Alliance to provide an alternative to the car. In reality however, "MaaS is merely a concept for the integration of all existing, public and commercial modes of transport and does not create transport capacity by itself. MaaS service only integrates what is there already." [12]

While MaaS is confined to a specific city or metropolitan region, MaaS service providers could potentially provide users seamless integration of modes not only in their city, but also other cities [13], using the 'roaming' approach, providing seamless service beyond the confined geographical boundaries

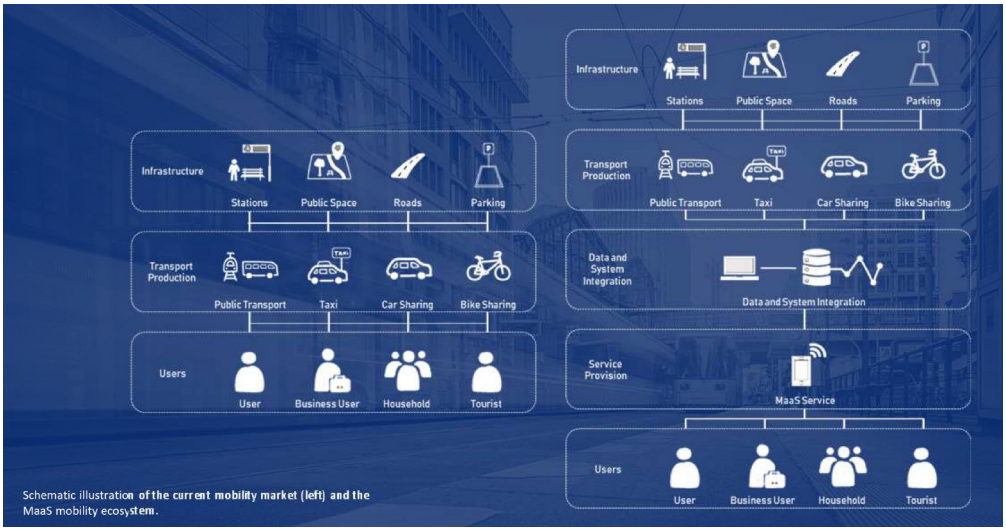
1.2.1 MAAS ECOSYSTEM

The concept of MaaS can be discussed as an ecosystem. Seen from an 'ecological lens'[14], the 'environment' of a business ecosystem[15] encompasses multiple 'organisms' (companies), which in order to produce value, advance and innovate, are connected, although in a non-binding way, and work cooperatively, yet still maintain a competition. The companies create a 'symbiotic' coexistence and 'coevolve' to the demands, including the continuous challenge from newly arrived 'species' (companies) to the environment.[16] This model of a business ecosystem is for example prevalent in the application service provider (ASP) industry, as it is based on delivering services to the customer over a network. As MaaS is a network based and enabled system, an ecosystem model is seen appropriate to best describe its functionalities. There are great challenges involved in

6. MaasLab - Kamargianni, M., Matyas, M., Li, W., Muscat, J., Yfantis, L., 2018. The MaaS Dictionary. MaaSLab, Energy Institute, University College London. www.maaslab.org
7. MaaS Global - Sampo Hietanen - https://maas.global/what-is-mobility-as-a-service-maas/
8. EMTA (2019), "Mobility as a Service - A perspective on MaaS from Europe's Transport Authorities, Point of View EMTA – European Metropolitan Transport Authorities", (2019) https://www.emta.com/IMG/pdf/emta_pointofview_mobilityasaservice_june2019-2.pdf
9. MaaS Alliance (2019) "What is MaaS?" https://maas-alliance.eu/homepage/what-is-maas/
10. Maria Karmagianni (2018) "Mobility as a Servvice" presentation, presented at IATBR2018: https://www.youtube.com/watch?v=386y0zMKDPE
11. Maria Karmagianni (2018) "Mobility as a Servvice" presentation, presented at IATBR2018: https://www.youtube.com/watch?v=386y0zMKDPE
12. EMTA (2019), "Mobility as a Service - A perspective on MaaS from Europe's Transport Authorities, Point of View EMTA – European Metropolitan Transport Authorities", (2019) https://www.emta.com/IMG/pdf/emta_pointofview_mobilityasaservice_june2019-2.pdf
13. Maria Karmagianni (2018) "Mobility as a Servvice" presentation, presented at IATBR2018: https://www.youtube.com/watch?v=386y0zMKDPE
14. Abe, Joseph M.; Dempsey, Patricia E.; Bassett, David A. (1998). Business Ecology: Giving Your Organization the Natural Edge. Boston: Butterworth-Heinemann.
15. Moore, James F. (1996). The Death of Competition: Leadership & Strategy in the Age of Business Ecosystems. New York: HarperBusiness. ISBN 0-88730-850-3.
16. Wikipedia - "Business ecosystem" https://en.wikipedia.org/wiki/Business_ecosystem

enabling such an ecosystem for MaaS to operate, and merging private and public transportation providers into this ecosystem needs to be done a way where an equilibrium is maintained.

Currently, the mobility system can be described as 'a system of detached systems'[17], where we find 'silos' where each of the different transport modes is disconnected and works in parallel to the others, even though they are all operating in the same environment with the same potential customers. We can depict the current system into three 'layers': 1. Users 2. Transport Production 3. Infrastructure (see figure 1) where there is no vertical integration, the user has direct access to a transportation provider. For the MaaS model to be enabled, two more additional layers between the user and the transport production exist, the service provision and data and system integration[18]: 1. Users 2. Service Provision 3. Data and System Integration 4. Transport Production 5. Infrastructure (see figure 1)



Schematic illustration of the current mobility market (left) and the MaaS mobility ecosystem.

Figure 1. Schematic illustration of the current mobility (left) and the MaaS mobility ecosystem. [1]

1. EMTA (2019), "Mobility as a Service - A perspective on MaaS from Europe's Transport Authorities, Point of View EMTA – European Metropolitan Transport Authorities", (2019)

1.3 WHY IS IT IMPORTANT TO HAVE THIS DISCUSSION?

MaaS is currently a topic which is extensively discussed with regards to concepts for the future of mobility. As transport is set to go through a disruption which has the potential to cause significant change to the current status-quo, it is important to have this discussion and understand the role the public sector and private sector has to play in order to mitigate potential negative outcomes.

1.3.1 SOCIETAL MEGATRENDS

One of the most significant technological advancement is related to the ubiquity of smartphones and their effect on the way we live, interact, consume and navigate. Today citizens are accustomed to having personalized services to their needs and this is extending to the flexibilization and expansion of journey choices, modes and paths.

Urbanization of large metropolitan areas increases the demand and pressure of the transportation network. Pollution levels are rising and there is large scale congestion. Many cities have reached a limit of the expansion of the existing physical network without large scale investments and better use of existing infrastructure by alternative modes of transport.

17. EMTA (2019), "Mobility as a Service - A perspective on MaaS from Europe's Transport Authorities, Point of View EMTA – European Metropolitan Transport Authorities", (2019) https://www.emta.com/IMG/pdf/emta_pointofview_mobilityasaservice_june2019-2.pdf

18. EMTA (2019), "Mobility as a Service - A perspective on MaaS from Europe's Transport Authorities, Point of View EMTA – European Metropolitan Transport Authorities", (2019) https://www.emta.com/IMG/pdf/emta_pointofview_mobilityasaservice_june2019-2.pdf

Climate change and pollution is occurring due do to unsustainable practice of resource use, of which carbon-based transport is one of the major contributors. Optimization of efficiency and electrification alone are not projected to help reach emission reduction goals. A more drastic change in behaviour and use of our cities is necessary.

Demographic trends like an increasing aging population and the influence of the value sets of Millennials in regard to preference on the importance to access rather than the ownership model, are also causing major shifts in behaviour and attitude. The collaborative economy, circular economy and shared economy concept, all play a role in changes that are happening. Disruption is on the way and "Transport is being hit by a digital Tsunami" (Sami Pipuri 2016)

It is therefore important that we condisder these societal megatrends as a backdrop to the possible adoption and implementation of MaaS in a changing situation which is unlike previous decades, in a dynamic setting prone to accept or reject new ways of mobility in unexpected or unpredictable ways.

1.3.2 INFLEXIBILITY OF CURRENT MOBILITY SYSTEM

In this context the current mobility system is seen as inflexible and favours single-mode-based system, where people are habituated to the use of a mode of transport they use frequently and find it difficult to undertake a journey using another mode of transport. We can see this playing out amongst users purchansing a month or year pass to a public transportation service. However, nowhere is it more prevalent than with the purchase of an automobile and the lock-in and long term commitment effect it brings with it. As the financial investment is very high, any transport choice which is beyond the commitment is seen as an additional financial burden. This long term based solution, causes the system to be inflexible and unprepared for the adaptation of disruptions in infrastructure (for example the introduction of bike lanes) or change in service patterns. "In times of disruptions, the easiest thing to do for travellers stuck in their habitual transport choices is to wait (for example in congestion) and complain."[19]

Through MaaS, there is a possibility to respond to the users different needs in a flexible way that adapts to changes in times, modes and uses. It is also expected to reduce the overall cost of transportation, as transportation assets like vehicles and bikes are being used by multiple users at different times with the same existing infrastructure.

1.3.3 THE ROLE OF THE PUBLIC SECTOR

A vision and perspective is needed from the public sector in a time where the discussion is being led mostly by the private sector players including technology start-ups and consultancy firms. These often portray a bright future with a promise that MaaS may be the solution to urban congestion and rural transport depletion [20]. However, as Sampo Hietanen[21] points out, the biggest innovation in the field needs to happen in regulation. He says that cities and governments need to own the market vision and not entrepreneurs or the private sector, as we all utilize the city and it is up to the city to define the rules. The relationship between the different players relevant to the setting up of a MaaS enabled ecosystem should be well defined in understanding the consequences of having a closed system or opting for an open ecosystem.

Finally, it is also important that governance and regulations, as well as legal implications are being put forward in anticipation of a wider adaptation of MaaS technology, before AV technology becomes widespread.

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19. EMTA (2019), "Mobility as a Service - A perspective on MaaS from Europe's Transport Authorities, Point of View EMTA – European Metropolitan Transport Authorities", (2019) https://www.emta.com/IMG/pdf/emta_pointofview_mobilityasaservice_june2019-2.pdf

20. EMTA (2019), "Mobility as a Service - A perspective on MaaS from Europe's Transport Authorities, Point of View EMTA – European Metropolitan Transport Authorities", (2019) https://www.emta.com/IMG/pdf/emta_pointofview_mobilityasaservice_june2019-2.pdf

21. Sampo Hietanen (2019), MaaS Global, "Impact'19 Keynote Speech: Sampo Hietanen, MaaS Global" : https://www.youtube.com/watch?v=WNPlQ5fxjwQ

There may be a potential window of time for this to occur before legislation will become reactionary rather than pre-emptive.

1.4 MAAS AND CITIES

1.4.1 CITIES IN THE 21ST CENTURY

If the 19th Century was considered the century of empires and the 20th century the century of the nation states, then the 21st century seems to be heading for the title the century of cities[22].

In a highly urbanised world where consistently more of humanity is living in urban areas, where cities are competing against each other, in an effort to: promote a well functioning transportation system, be attractive for investment from outside and within, and stand out with their image branding worldwide. This holds true to a greater degree in the case of Vancouver which has leveraged from past events such as the Expo 86 and winter Olympics 2010, in order to promote its international reputation, its attractiveness and the investment in large scale transportation projects (such as the Canada Line).

Most challenges of the 21st century will be dealt with in the scale of cities, or large metropolitan regions, and to a greater significance on a global scale. The nation state is in many ways standing in the way of aspirations for this to unfold, with a network of highly connected (physically, virtually and by sharing similarities) cities blurring the difference between national divide and geographical constraints. The challenges of the future of energy, future of housing, the future of mobility and future of jobs will be played out in cities.

1.4.2 OPPORTUNITIES AND WEAKNESSES

More specifically to this research, Mobility as a Service in its early days seems to be confined to urban centers, although there is a lot of talk about MaaS and connecting rural areas. In this way, cities themselves are major players, if not the most important beneficiary, in the MaaS implementation endeavour.

Cities, municipalities, mobility apps and transport operators are all in one boat when it comes to MaaS. It is therefore important to understand the relationship between these very different organizations, municipalities, corporations and start-up companies. This is crucial to getting the MaaS equation right. In this sense, cities have to act like start-up companies, rolling out try-outs of MaaS systems which can fail and be rapidly readapted and 'pivot' along the implementation strategy. Furthermore, finding the most appropriate local context solution for MaaS demands that municipalities, private companies and corporations, and transit operators sit around the same table and understand every stakeholders role and if they play a complementary or competitive role within the MaaS ecosystem. The possibility of monopolization from either private or public is very real and has to be taken into account.

Though MaaS may have the real potential to create a new model not only for mobility needs, but also for access to services and activities which can be widely available to a greater proportion of the public that currently is excluded by physical limitations for example. Hence not only is mobility a service (as in the term MaaS), but also access to daily services and the way people, products and objects are connected to each other may have the potential to completely restructure.

1.4.3 MACROECONOMIC PICTURE

MaaS may have the potential to cause a significant shift in economy for our cities and challenge the

22. Wellington Webb former Mayor of Denver and past president of the U.S. Conference of Mayors

current neoliberal model which favours a liberal market and praises efficiency with minimum state intervention.

The other challenge is the discussion of whether MaaS has the potential to shift the ownership model, disrupting a whole industry and the relationship of car manufacturing direct to the consumer, which is the current model.

On the flip side, neoliberal vision of (GDP) growth being the main driver in the measuring of development, looking at Harvey's compound theory[23]. Put in this context, the untapping of market which may be created by the disruption that MaaS can potentially help unlock. According to Sampo there is an estimate of market of nearly 10 Trillion Euros[24] . One can identify a link between how this new model can be adopted by the current emphasis on GDP growth, as a crucial proponent of development and growing the economy. In this particular scenario we can imagine an alignment between business interests and a new mobility model propelled forward by MaaS.

1.4.4 COMMUNITY

The effect MaaS can have on the community may also be difficult to predict. However speculating on the way MaaS hubs will be set up in existing centralized and neighbourhood centers, which are walkable and connected, may have the potential to serve as community hubs. As the way we move and interact can change through MaaS, the community will also be prone to changes.

1.4.5 MATURITY OF CITIES TO NEW MOBILITY

In a study 'The Future of Mobility 3.0' by consultancy firm Arthur D. Little[25] , a ranking system has been created to measure the potential of mobility in the city, efficient public transport system, car share, bike share, ride hail use and bike lanes and infrastructure. It may be possible to use this study as a guideline to measure the readiness of cities around the globe to adaptation of new technologies and may in some sense highlight a maturity stage to adapt a MaaS system.

In the urban mobility index city ranking graph (fig 2), most cities are below the potential that could be unleashed in their urban mobility system.

The consultancy divided the cities into three general categories:

- The ones below average are considered "Emerging" cities can invent their own sustainable mobility solutions. They have the opportunity to become test beds for the urban mobility systems of tomorrow.
- The average cities are called "Individual mobility-oriented" cities, with high proportions of private vehicles. These cities must rethink their systems towards more common and sustainable solutions.
- The above average cities are called "Public" mature cities, with high proportions of public transport and where walking and cycling are practiced. These cities must further network their mobility systems by fully integrating mobility solutions (for people, vehicles and goods) and interacting with their citizens to engineer changes in attitudes to sustainable mobility.

Although Vancouver is not on the list, we can refer to Toronto which lies in the medium range of average cities. Vancouver has been thriving to become the 'greenest city' and to improve walkability, and cycling networks. It will have great interest in thinking of how to be competitive and fare against other major cities.

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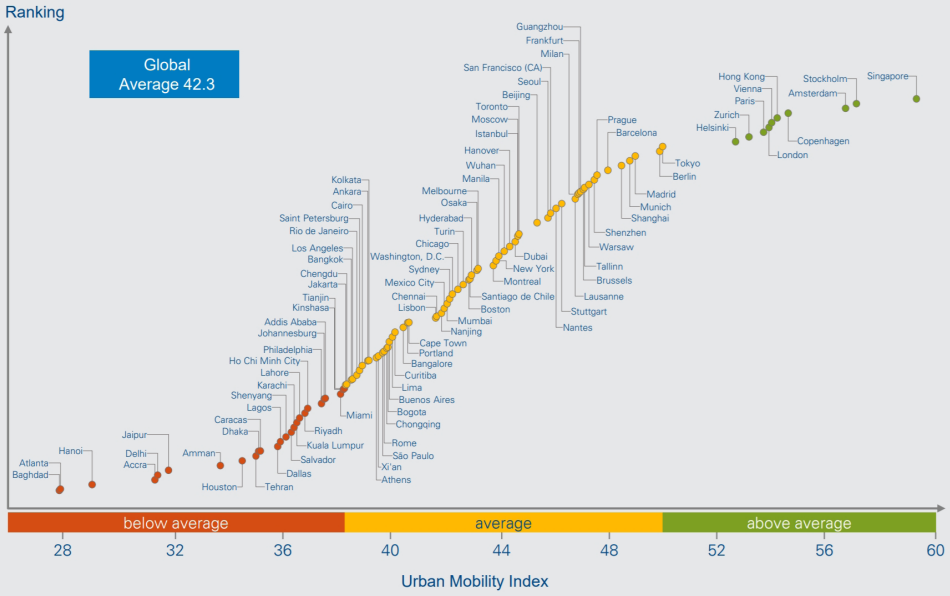
23. Harvey, D. (2008). The Right to the City. New Left Review, 53, 23-40.
24. Sampo Hietanen (2017) "Mobility as a Service", Sampo Hietanen CEO MaaS Global Ltd, Sustainable Innovation Summit 2017 BCCD - https://www.youtube.com/watch?v=PA53dfOF8VM at 8:50mins
25. Arthur D. Little (consultancy firm) (2018) "The Future of Mobility 3.0" https://www.adlittle.com/sites/default/files/viewpoints/adl_uitp_future_of_mobility_3.0_1.pdf

Figure 2. Ranking of cities 'Urban Mobility Index' [1]

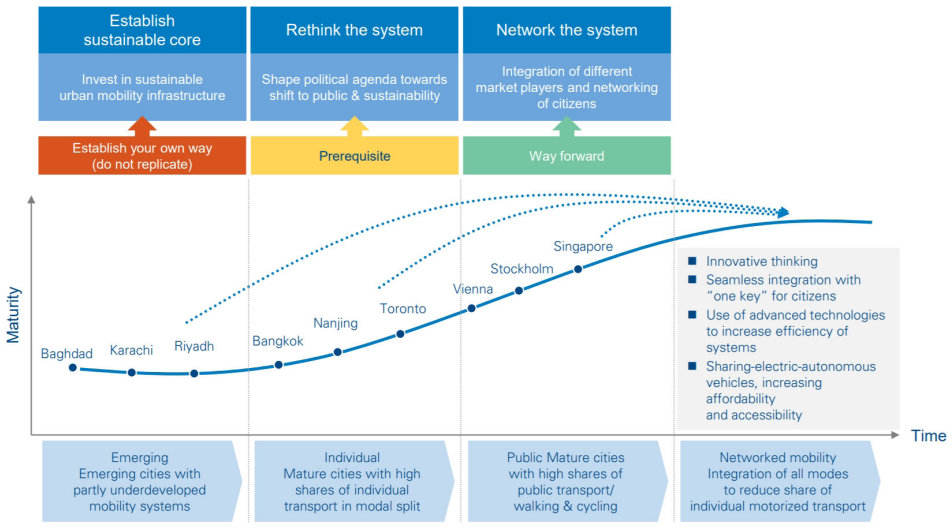
1. Arthur D. Little (consultancy firm) (2018) "The Future of Mobility 3.0" https://www.adlittle.com/sites/default/files/viewpoints/adl_uitp_future_of_mobility_3.0_1.pdf



The results of the Urban Mobility Index 3.0 show that the average score of the 100 cities surveyed was 42.3 out of a possible 100 points. This means that, worldwide, the average city has unleashed less than half of the potential of its urban mobility system, a state of affairs that could be remedied by applying best practices across all its operations. Cities need to work intensively on improvements to their mobility systems if they are to cope with the challenges ahead.

Figure 3. Three strategic directions for cities at different maturity stages[1]

1. Arthur D. Little (consultancy firm) (2018) "The Future of Mobility 3.0" https://www.adlittle.com/sites/default/files/viewpoints/adl_uitp_future_of_mobility_3.0_1.pdf



Source: Arthur D. Little & UITP, Future of Urban Mobility 2.0, 2014

1.5 MAAS AND AUTOMATION

If we want to envision a future scenario, or imagine the future we are planning for, what can be said is that no component relevant to future change should be analyzed as a standalone phenomenon. Yet much of the discussion today is narrowed to a single aspect, for example the talk about AVs which overshadows the talk about MaaS. In the media we often see a some-what simplistic, easy-to-digest projection of today's situation, only to be substituted by the fill-in-the-blanks future technology. In this way, when we try and imagine such a hypothetical situation, we 'transplant' the new technology at hand in the current scenario which we are familiar with and understand. Yet we fail to acknowledge that the future scenario will be a culmination of a whole array of changes that society will pass in many different fields. Therefore transplanting a future situation with the current status-quo model (of car use and ownership) may be unproductive to the real impact AVs can have. This is due to the rate of accelerated technological change, thanks to the advancement in the fields of AI, Batteries, Energy IoT, blockchain, etc. Yet not only technological factors are at hand, consider the social, economical and environmental situations we can expect in the next decade or two. One can try to imagine a future where a significant proportion of the workforce has been replaced by automation, there is an unbridgeable gap between classes, a deepened global climate change crisis is at hand, and we are trying to imagine ourselves using AVs, this may be too difficult to grasp. Yet while AVs are a concept which has been in our imagination for long (think flying cars), we can at least have a visual of this in our minds and we can imagine ourselves sitting in one. AVs have a sense of novelty to them which excites the imaginations of not only entrepreneurs and people on the forefront of technological developments, but also regular people which have unrealistic expectations negatively and positively of what AVs may mean in their lives. However, when the discussion is shifted about MaaS, it becomes something much more intangible and more difficult to grasp, being merely a 'service' or a network. This may offer a possible explanation as to why AVs overshadow MaaS in the discussion, at least in relation to more popular media.

It is important to state that MaaS and AVs are not mutually dependant, however a scenario where AVs happen before MaaS is currently unlikely. It may be argued that the current agreement in the field of transportation is that MaaS is happening now and it is preparing the ground for AVs. Prior to AVs becoming widely used, MaaS is already set to be potentially widely available in the coming years, with new cities and applications being added in an accelerated pace. However, with the conversion to electric and autonomous, all modes of transport can be utilized and managed in a completely different way, if the underlying assumption is that they adhere to the logic of a MaaS economy, thus paving the way to autonomous MaaS, sometimes referred to as SEAMless (Shared, Electric, Autonomous, Mobility). In addition, Maas can set the framework to a shared multi modal transportation system, in the hope that people adopt to this form of mobility, prior to the (mass) adoption of AVs, thereby people

1.6 MAJOR SOCIETAL IMPACTS

MaaS is not merely an adjustment or improvement to the efficiency of getting from A to B. MaaS is a facilitator or enabler of services which can be provided by combining any mobility related activity with a service distribution. As such, at this moment it may be impossible to predict the services which will have an impact on our day to day lives and activities in the future. This is especially true when we consider the sheer size of the potential new mobility market talked about below, amongst other serious implications which should be taken into consideration by any government, municipality, mobility service provider, transport operator, technology

company, peripheral supporting business and service providers and indeed any citizen and potential user or consumer.

- **Economic growth** - The impacts for society may be far-reaching. According to Hietanen, the new mobility market has the potential to be the largest new market, through a reshaping of the existing car ownership model. Hietanen talks about a reshaped market of about a trillion euros, taking into account the entire automotive industry, including real estate related costs of parking. Making an analogy to the disruption in the telecom industry over the last 30 years, Hietanen suggests this disruption will be ten fold in size (measured in ARPU average revenue per user) and will be faster. This prognosis may be seen as extremely optimistic from the entrepreneurs perspective, and has an underlying assumption of mass adoption of MaaS coupled with a transition away from the model of ownership. Going back to the assumption on a growth-based economy[26] (see 1.4.3), we can imagine that an untapped market may have the potential to play a large role in the development of the public and private sector alike which may lead to new alliances and dominance shift which we can not predict.
- **New Jobs / Job loss** - It may be a predecessor of the 'autonomous revolution', and prepare the grounds for AVs to be incorporated in an exponential manner. Potentially a whole array of new jobs and an expanding market will be created in a very rapid way and demand currently unexisting job titles. However, one must be conscious for the alarming projections[27] regarding the loss of jobs and its negative impact to society. In this context MaaS and Automation may be inseparable.
- **Emissions** - According to a report by the OECD: "*Strong access restrictions for single-occupancy vehicles in dense urban areas combined with a robust and compelling MaaS ecosystem have the potential to reverse the trend of increasing private car use. This would benefit society by reducing many of the negative externalities associated with single car use in dense urban environments and, more generally, the emission of pollutants and CO2. It would also benefit individual citizens by putting more reliable, convenient, comfortable, and affordable travel options at their disposal.*" [28] However, if AVs are adapted
- **Health and Sustainability** - If MaaS manages to promote less use of the automobile and more active transport like bike riding and walking, it may have positive health effects. However, there may also be another behaviour of the MaaS app actually incentivising people to use car share over public transportation leaving opposite effects.
- **Lifestyle changes** - we tend to think of the lifestyle changes in terms of modality and use of bike or walking, as a healthier means of getting around and a more sustainable one. However, with MaaS, a new emerging market is potentially opening up, including anything that involves the movement of people or objects to be coordinated with any other activity, and then the potential connectivity of all these activities. This is arguably bound to change lifestyle patterns much more than focusing the question on the modal split, staying within the transport field. Therefore, we need to look at other fields of innovation and make speculative hypothesis on what these might be, in order to design adequate solutions and preemptively prevent negative ethical impacts.
- **Accessibility** - MaaS is seen (find reference) as an enabler for a part of the population that is physically challenged to get reliable service, potentially door to door. This specific group of population should be taken into account in the design of the interface and in the algorithms defining special preferences to cater to their specific needs.
- **Ethical impacts:**
  - Inequality - one must question if MaaS may have the potential to widen inequality gap or if there is no correlation. In a scenario of massive job loss caused by disruptive waves of transformation which is occurring in the transport sector, a further polarisation of the population, may lead to higher inequality.
  - Political polarisation may also be associated with the access to goods and services which through

26. Harvey, D. (2008). The Right to the City. New Left Review, 53, 23-40.
27. Moshe Vardi, Rice University, Houston
28. ITF (2019), ITF Transport Outlook 2019, OECD Publishing, Paris, https://doi.org/10.1787/transp_outlook-en-2019-en.

MaaS can be highly selective.

- Privacy data - Data privacy is a major concern due to the sheer size of potential users in overlapping networks where a data breach can have potential severe effects not only around privacy, but also as a threat to lose customer base of any MaaS transport service provider or operator.
- Tracking and surveillance - MaaS has the potential to make it easier to track everywhere a user has been and what services have been used. This may be of interest to corporations for their monetization model. However, potentially, this can also be used to track down and surveillance and security of the users data becomes a very challenging issue.

1.7 SCENARIOS FOR CITIES (GOVERNANCE & BUSINESS MODEL)

1.7.1 SCENARIOS

There seems to be a consensus that there is no single governance or business model to accommodate MaaS, therefore it can be seen as a spectrum of scenarios with centralized and decentralized options.

MaaS Global (Whim app) head Sampo Hietanen talks about three scenarios [29], two of which are unfavourable of 'the winner takes it all' approach of either a private company, the likes of Uber or of the actual public transportation provider takes it all. Moreover, he stresses the importance of a third option, of an open ecosystem which will allow the entrance of multiple service providers, where Whim would be just one of them. He sees mobility service providers functioning in a similar way to mobile phone providers. In this sense he is referring to a 'roaming' ecosystem for different MaaS operators (aggregators) to tap into all the different transport providers, including public transportation, and provide packages which match their users. (see fig. 4)

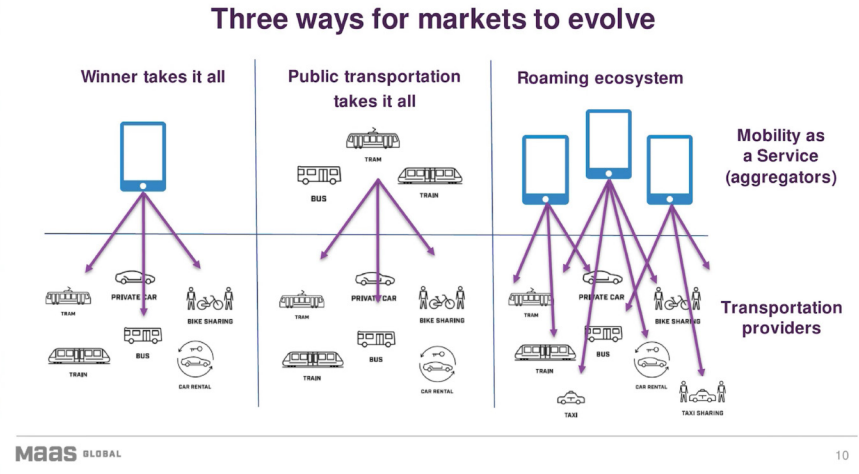


Figure 4. Three ways for markets to evolve[1]

1. Sampo Hietanen (2017) "Mobility as a Service", Sampo Hietanen CEO MaaS Global Ltd, Sustainable Innovation Summit 2017 BCCD - https://www.youtube.com/watch?v=PA53dfOF8VM at 10:50mins

29. Sampo Hietanen (2017) "Mobility as a Service", Sampo Hietanen CEO MaaS Global Ltd, Sustainable Innovation Summit 2017 BCCD - https://www.youtube.com/watch?v=PA53dfOF8VM at 8:50mins

Figure 5. MaaS market evolution scenarios[1]

1. Arthur D. Little (consultancy firm) (2018) "The Future of Mobility 3.0" https://www.adlittle.com/sites/default/files/viewpoints/adl_uitp_future_of_mobility_3.0_1.pdf

Figure 44: MaaS – market evolution scenarios

	Aggregated public MaaS platform "Public MaaS operator takes it all"	Aggregated liberal MaaS "Free market – Operator(s) driven	Disaggregated public MaaS platform "Public authority enabler"
Characteristics & requirements	■ Public actor (generally PTA) develops and operates a unique MaaS platform and app ■ PT data and APIs closed to third parties ■ Aggregated platform and app (closed to third parties' B2C apps) ■ Integration of public transport and aggregation (or not) of private modes	■ Free market: Several aggregated platforms and apps (closed to third parties' B2C apps) are competing, integrating and aggregating public and private transport modes ■ PT data and APIs open to third parties ■ Roaming ecosytem	■ Public actor (often PTA in cooperation with PTO) develops a MaaS B2B platform ■ PT data and APIs closed to third parties ■ Disaggregated platform open to third party (against a fee) ■ Several front-end apps can compete with public and private transport modes
Advantages	■ Simplicity: access to multiple (public) modes of transportation through one single app ■ Public mastery of public transport sales channels (no risk of disintermediation by private players)	■ Free-market dynamics fostering development of new mobility solutions and price competitiveness ■ Ability to realize comprehensive MaaS concepts, as all transport modes can be integrated	■ Abilty of PTA to set strong governance to guarantee system optimum ■ Free-market dynamics fostering development of new mobility solutions and price competitiveness ■ Ability to realize comprehensive MaaS concepts (all transport modes)
Disadvantages	■ Inability to realize comprehensive MaaS concept in case most private modes are not aggregated ■ Development and operating cost borne by PTA – risk to become outdated ■ Stronger competition from suppliers; less cooperation and co-development	■ Risk of loss of mastery of public transport flow by public – Strong PTA governance required to ensure system-level optimum ■ Risk of private monopolistic situation if one private player takes it all ■ Risk of disintermediation for operators that do not have their MaaS platforms	■ Development and operating cost borne by public, requiring sufficiant funding over time to secure development of back-end ■ Risk to become outdate, however more limited than with aggregated pulibc MaaS platform
Examples	■ Moovel Transit by KW (Karlsruhe) ■ S'Hail by RTA (Dubaï) ■ HannoverMobil by Ustra (Hannover)	■ Whim by Maas Global (Helsinki, Antwerpen) ■ HelloGo / Keolis (Utrecht)	■ Upstream B2B platform (Vienna, Graz, Hambiurg) ■ Gothenburg (Ubigo)

Source: Arthur D. Little

Arthur D Little consulting also talks about three scenarios[30], being:

- Aggregated public MaaS platform where the public MaaS operator 'takes it all'.
- Aggregated liberal MaaS system where favours a free market approach which is driven by different oppeartor, similar to Hietanen's third scenario.
- Disaggregated public MaaS platform where a public authority is the enabler of the platform.

While finally the EMTA report classifies into four scenarios[31], with two nuances on the mixed variable scenario.

- Pure Public Initiative scenario - where the development of MaaS is enabled and controlled by a public authority, which could be in charge of Data Systems integration, as well as being a service provider.
- Decentralized Commercial Initiative scenario where MaaS services are being developed by commercial market parties in an open competition.
- Standardized Ecosystem scenario which is based on the standardization of technology which allows both public and commercial MaaS entities to integrate their products and services.
- Public Infrastructure for open market scenario which is based on the public domain being in charge of only the Data and System Integration providing an infrastructure. While the service providers are commercial or semi private organizations.

Each option has its strengths and weaknesses and goes beyond the scope of this report, therefore underpinning the need for further research in this particular question.

30. Arthur D. Little (consultancy firm) (2018) "The Future of Mobility 3.0" https://www.adlittle.com/sites/default/files/viewpoints/adl_uitp_future_of_mobility_3.0_1.pdf

31. EMTA (2019), "Mobility as a Service - A perspective on MaaS from Europe's Transport Authorities, Point of View EMTA – European Metropolitan Transport Authorities", (2019) https://www.emta.com/IMG/pdf/emta_pointofview_mobilityasaservice_june2019-2.pdf

1.7.2 CITY BY CITY APPROACH

Ultimately, the models are a reflection of cities specific composition and specific socio-economic, political and development aspirations. While each city has its own mix and balance of these issues, no city is identical, yet cities learn and adapt from each other and will take on different models that have been tested by pioneering cities. Some cities may choose a more proactive approach and will pave the way to its MaaS policies and the creation and operation of reconfiguration of its transport system and the development of new technologies such as the MaaS App to begin with. Other cities might end up taking a more passive approach by, for example, letting private companies (such as Uber or MaaS Global) implement a system. In such cases it will still be crucial to find out the optimal method of integration of public and private transportation, and even passive cities may be pushed towards taking a proactive approach. Public transportation is an essential component of any MaaS system or App, as it serves the basis of most partial trips that are to be incentivized and can then be combined with complimentary last mile solutions to complete the remaining section of the trajectory.

Private companies may enter multiple cities, as is the case with Uber trying to implement a world-wide coverage and dubbing itself as 'the Amazon of mobility' (reference). Or in the case of Whim (Helsinki, Antwerp, and UK Midlands)[32] (as of July 2019). In these cases it is important to stress that even though a single company is entering multiple cities, it will have to adapt to a different configuration in each city and have different payment models and combinations of services available locally.

1.7.3 SUITABLE SCENARIO FOR VANCOUVER REGION

Taking into account the different potential models for setting up a MaaS system in cities, further research would have to be done to study the specificity of Vancouver. Each model should be laid out as a hypothetical scenario in Vancouver's case while keeping in mind its key stakeholders (TransLink, the City of Vancouver, other municipalities, car share companies, bike share); new entrants (Uber, scooters, other possible future entrants). After evaluating each scenario, it will essentially be a political matter on what is first implemented as a pilot. It is difficult to say if switching between models, i.e. 'pivoting', will even be possible once a choice has been made. Therefore, local policy on MaaS provision should be flexible and focus on circular pilot implementation and adoption process, before it is widely rolled out and creates facts on the ground. Finally, to conclude, while it is still early days in the MaaS discussion, changes are happening in a very rapid way. It is important that further research is done before and in parallel to pilot implementation.

There is a need for further research on the specific viability of a MaaS system, in the case of Vancouver region, whether for the whole region or whether on a smaller scale, such as the UBC pilot (see 4.3). In this context, which combination of business and governance model should be chosen for the specificalities and legal restrictions and local legislation that are in place in the Lower Mainland context

32. MaaS Global - https://maas.global/

1.8 FURTHER RESEARCH

Within the scope of this report, it has been identified that currently most research being done regarding the impact and implementation of MaaS, is mostly in the field of transport and mobility, it is being conducted by consultancy firms, and transport operators, public and private mobile applications for mobility. In the academic field, current research is being done mostly with respect to the implementation and evaluation surveys for MaaS trials directed at cities and operators. In particular stands out the work of MaasLab[33] at UCL (University College London) by Maria Karmagianni. However, more needs to be researched in fields like urban planning, urban design, architecture, social sciences, psychology, behavioural sciences of consumption, policy and governance, ethical implications, as well as health and sustainability which has been highlighted in this report in chapter 2. Furthermore, scenarios and speculation can be a tool to identify potential problems ahead while designing a solution, speculative design of possible urban design solutions for MaaS may identify different ways of incorporating mobility solutions and integrations in the physical realm.

Below, there is a listing of areas and questions which can be taken into account for further research

1.8.1 MAAS + HEALTH AND SUSTAINABILITY (This will be discussed further in chapter 2)

- Positive and negative Correlation - Healthier if MaaS manages to promote less use of cars and more bike and walking. However, there may also be another behaviour of the MaaS app actually incentivising people to use car share over public transportation leaving opposite effects.
- Lifestyle changes regarding active mobility promoted by incorporating MaaS into daily routine
- Integration of health consciousness into an App through nudging and promotion
- Authorities can monitor health by using some data on users usage, (privacy issue)

1.8.2 MAAS + BEHAVIOURAL SCIENCES

- Gamification
- Nudging
- Behavioural consumption
- New business opportunities in new MaaS ecosystem

1.8.3 MAAS + AV

- Timing - sequence of events and critical points with the inter-related MaaS vs. AVs
- How MaaS prepares the ground for Automation
- Job Market (MaaS Job loss vs. MaaS + Av Job loss vs. new jobs)

1.8.4 MAAS + CITIES

- Innovation maturity index of cities, as shown in section 1.4.5
- Learning from each other - what works for one city does not work for another, as more and more cities go on-board with implementing MaaS systems, it may be predicted that in coming years there will be much more material to be used as case studies of different systems in order to “crack the MaaS success formula” - the dangers of generalization, and the potentials of an exponential roll-out of service in cities not ready for the disruption.
- Cities readiness for disruption and how this can be measured

33. MaasLab - Kamargianni, M., Matyas, M., Li, W., Muscat, J., Yfantis, L., 2018. MaaSLab, Energy Institute, University College London. www.maaslab.org

- Implementation of MaaS in megacities of developing countries may lead to an array of solutions and also problems of scale, yet also may fill in gaps left by public transportation.

1.8.5 MAAS + PUBLIC SPACE

- Design and transformation of public space to accommodate transitional period into MaaS and AVs
- Redefining the public-private dialectic of public space, for example parking spots leased by private mobility providers (such as car2go, evo, or bike/scooter share companies) are considered private appropriation of public space. In today's society, a public parking spot is used to park a private car, but it is considered freely open to the public with charges for parking by the municipality. Will this relationship change?
- Mobility hubs are being talked about as solution around transit stations and areas of concentration of activities or communal focal points. More needs to be researched regarding:
    - The validity of this idea
    - The physical design layout of these hubs
    - The Implementation of hubs / organic / planned / in phases / tactical urbanism methodology

1.8.6 MAAS + STANDARDS & POLICY FRAMEWORKS

The following have been highlighted by MaaSLab as key research questions (2018)[34]:

- What MaaS products do citizens prefer?
- What persuasive techniques / incentives could be included in the MaaS products?
- How MaaS may change travel behaviour?
- What is the impact on MSP's market share and revenue?
- What commercial agreements are needed between the MaaS operators and MSPs? Do we need to offer incentives to MSPs to join MaaS services?
- Could public sector's subsidization to public transport modes be used more effectively?
- What MaaS business models are needed to avoid monopoly?
- Could MaaS meet the strategic objectives (vision) of the cities?

1.8.7 POSSIBLE RESEARCH HYPOTHESIS FOR VANCOUVER SCENARIO:

- The condition of the open ecosystem is seen by Hietanen[35] as a preferred business model where it is possible to avoid monopolies either by a private provider or by the public transportation controlling MaaS. Hietanen sees this as an essential element for a successful MaaS system. The question is whether it is possible in the Vancouver context. What is the possibility of the implementation of an open ecosystem (which requires the shared API) while currently this is not common practice.
- Hypothetical scenario of Translink initiating the development of a MaaS system and its consequently possible bias towards not implementing open ecosystem, leaving no competition - monopoly. Although on the positive side, it may allow for uncomplicated regulation and the protection of public value[36]. Governments' and authorities' access to relevant data to generate valuable insights for policy making and infrastructure adjustments is assured[37]. The close connection between a public MaaS provision and public transport potentially allows a fast reach of the vast customer base of public transport[38].
- Finally, a scenario must be played out where the stakeholders cannot agree on way to go forward unanimously. Therefore there may be the potential for MaaS to not get developed in time before other disruptions emerge, including the rise of AVs. Different scenario planning methods could be used to speculated here on different outcomes, and whether there is in fact a correlation.

34. Maria Karmagianni (2018) "Mobility as a Servvice" presentation, presented at IATBR2018: https://www.youtube.com/watch?v=386y0zMKDPE
35. Sampo Hietanen (2017) "Mobility as a Service", Sampo Hietanen CEO MaaS Global Ltd, Sustainable Innovation Summit 2017 BCCD - https://www.youtube.com/watch?v=PA53dfOF8VM
36. EMTA (2019), "Mobility as a Service - A perspective on MaaS from Europe's Transport Authorities, Point of View EMTA – European Metropolitan Transport Authorities", (2019)
37. EMTA (2019), "Mobility as a Service - A perspective on MaaS from Europe's Transport Authorities, Point of View EMTA – European Metropolitan Transport Authorities", (2019)
38. EMTA (2019), "Mobility as a Service - A perspective on MaaS from Europe's Transport Authorities, Point of View EMTA – European Metropolitan Transport Authorities", (2019)

2 HEALTH AND SUSTAINABILITY

There may be the potential for MaaS to reframe or enhance existing mobility services as a means of achieving healthy and sustainable goals. By providing potential future customers with greater attainment of their desired health outcomes and desire for sustainable life choices through it's capability, a well designed Vancouver MaaS app can help change Vancouverites' transportation habits. The potential of MaaS apps is arguably untapped and has many avenues of exploration in it's development in benefiting mobility services. What benefit MaaS may bring in context to health and sustainability is a rich field to explore.

This section aims to introduce the potential of MaaS (Mobility as a Service) applications in generating positive environmental and health outcomes among its users. It seeks to evaluate the effectiveness of existing or potential future digital design incentives and deployment of persuasive interventions and measures for inducing sustainable urban mobility behaviors. Furthermore, we look at the potential of framing user benefits within a health-related lens where awareness of positive health outcomes might resonate more among users than environmental benefits, and its potential to be used as an incentive for altering travel behaviors to more sustainable and active health positive lifestyles.

Looking at various studies, trials, and literature on urban mobility as well as digital application design and incentive-driven design, it is possible to extract certain conclusions. It is argued that the MaaS app may have potential to change user behavior in promoting greater alternative mobility service use through its ability to facilitate and provide a more sustainable healthy user lifestyle through existing transportation services.

The integration of the different modes of transportation which MaaS enables will be looked at, as a way of evaluating health and sustainability outcomes generated by switching modes of transportation. This would require a change in choice to either a less emitting mode, or a mode requiring active transportation (walking, biking) either for full trips or partial trips. As a MaaS App has the potential to eliminate the additional expenses and logistics of having multiple apps to switch between modes, it is plausible to assume mode shifts will be part of the changing user's behaviour. However, there is also a possibility to shift to a less healthy or sustainable mode.

Finally, the intersection between MaaS as a digital or virtual entity and the design of the physical space will be looked at, dealing with urban design and the question of translating integration between modes into physical design principles, as well as linking MaaS to already walkable urban environments for potential positive health and sustainability outcomes.

2.1 INDIRECT AND DIRECT IMPACT OF MAAS

It is difficult to difficult to assess the the contribution of MaaS to positive health and sustainability outcomes as a stand-alone factor of its own. MaaS may have an active role within the anticipated disruption to mobility, although outcomes are unlikely to be directly linked to MaaS in isolation and more probable as a whole array of factors. The effects that MaaS has in this context can be indirect and secondary, therefore further research can be done by looking into the most significant contributors to sustainability and health, in a macro general sense, and contemplating what role MaaS can play to generate positive or negative outcomes.

Nevertheless, in a context where we measure sustainability against today's emissions, and health statistics, we can narrow down and research the effect of MaaS on health and sustainability. However, we would have to still look at the major sustainability and health issues from a broader perspective and see if MaaS has a secondary role in causing any positive (or negative) contribution to these main issues. In this sense we can look at it as an indirect effect.

- **Collective level** - MaaS is posited to have the potential to increase the marketability of alternative mobility services in context to sustainability and health. Today, transportation accounts for one third of energy consumption in the United States and in the European Union. As commuting rates of single-occupancy vehicles (SOV) are still high, many challenges and obstacles will have to be overcome in order to reduce levels of pollution worldwide and extreme road congestion. Much of that challenge lies in the adoption of sustainable mobility choices and ways in which to encourage modes such as walking, cycling, public transit, other high occupancy transport modes among urban traveler., or lower emissions options such as e-bikes and e-scooters.
- **Consumer / individual level** - People make choices about their mobility based on many factors, but in broad terms this determination can be deemed on its value to the user. Technology by definition, aims to reduce uncertainty with regard to an outcome. MaaS is in effect a new technology whose goal is to reduce uncertainty in transportation outcomes. With regard to the users transportation experiences, if a users' certainty about mobility options other than single occupancy vehicles (S.O.V.s) can be increased, it stands to reason that they may choose other options. This has not, however, be proven in practice; but is the potential of the MaaS app to increase the use of modes other than the S.O.V. (single occupancy vehicle) thereby potentially increasing sustainability and health outcomes.

Reduction of GHG emissions targets (in the case of Canada by 30% by 2030) will become increasingly relevant as time progresses, especially if targets are projected to be missed and not enough is being done in responses to climate change emergency. In such a context, MaaS may have a greater role to play but an indirect one.

According to a report by ITDP and UC Davis, a combination of '3 revolutions' which include Electrification, Automation and Sharing, can reduce emissions from transportation sources by 80% by 2050. In comparison to other scenarios, the '3 revolutions' project 700megatons of emission in 2050, while Electrification+Automation without the Sharing regards expects to achieve 1700megatons, while business as usual 4600megatons. When the 3 revolutions are combined there is also a substantial reduction to the number of vehicles on the road. MaaS would play an important role in the 'sharing' revolution, however the reduction talked about is in conjunction with Electrification and Automation, therefore we can conclude that indirectly, MaaS may have a positive influence on positive sustainability outcomes.[1]

Looking at the greater picture of sustainability and climate change we can talk about the paradox of 'green-growth' where the shift towards automation, electrification and use of renewable energy and non-fossil fuels, is nevertheless fueling economic growth, on a large scale involving the automotive, energy and other sectors. This growth in turn requires more resources and contributes to an unbalanced sustainable approach. Therefore we can ponder whether no-growth is more sustainable than green-growth and if there is a need to consider such a hypothesis with regards to MaaS.

Reduction of automobiles may at some point be insufficient to achieve emission goals and other more drastic measures such as car-free zones, zero emissions or outright bans may become options cities will consider. However when we talk of zero emissions zones, we are opening up for green growth by electrification. Electrification on its own will not solve the emissions problem, as finally the total number of cars is growing. Depending on the energy source, electrification can mean 'offshoring' emissions in potetially carbon resources, although in places like British Columbia 90% of electricity is produced by hydroelectric generation[2]. Another concern is the increase in mining materials and metals for batteries required for electric vehicles. In either

1. Institute for Transportation and Development Policy. 'Three Revolutions in Urban Transportation'. https://www.itdp.org/publication/3rs-in-urban-transport/.
2. 'Generation System'. https://www.bchydro.com/energy-in-bc/operations/generation.html.

scenario of car-free or emissions-free zones in cities, MaaS can play a potential role as it can mitigate by making the different modes of transportation available at the time being and can be used to prioritize or de-prioritize specific clean modes in a flexible way. In such a scenario, MaaS could be a valuable part of any policies cities will implement regarding reduction of emissions.

There are numerous large scale health related issues which can be indirectly linked to MaaS, requiring association of MaaS with wider trends. If we can associate MaaS with reduction of emissions and pollution, then we can look at an improvement in respiratory diseases. Associating MaaS with reduction in car dependency and the switch to active transportation and walkability, will have a positive effect on heart diseases and mental health related issues associated with a sedentary lifestyle. Associating MaaS with safer and more reliable street design and vision zero policies, can affect positively on traffic injuries.

However, all of the above-mentioned, cannot be looked at through MaaS directly. On the other hand, MaaS as an efficient and intelligent trip planner and mobility assistant may have the potential to contribute to the reduction of stress, reduction of clutter associated with time management and predictability of journey sections, having a positive effect on mental health.

The process of electrification, zero emission vehicles/ zones and the use of renewable energies are large scale overarching concepts, where MaaS could play a supporting role. Other ideas which can be related to MaaS can be the optimization of shorter trips, carpooling and other sharing options as well as active mobility, can be smaller scaled activities which can contribute to positive health outcomes.

Finally, we can look at the more direct effect of MaaS in the context of the different travel modes it promotes, as well as in the context of the application environment from a user's perspective.

The major macro aspects relating to health and sustainability can be linked to MaaS in an indirect way through a collective effort. However, other aspects which are more closely related to MaaS by means of the individual user's choice can be further elaborated.

One of these aspects relate to the choice of mode of transportation incentivized by the facilitation of the modal integration which is inherent through MaaS. In this context research needs to be done regarding the likelihood of switching to a healthier or less emitting mode of transport directly related to MaaS creating positive (or negative) health and sustainability outcomes.

The other aspect which needs to be more thoroughly researched is the behavioural economics behind the MaaS app and how it can be put to use, through nudging tactics, in order to have positive health and sustainability choices (personal and collective) of the user's behaviour using mobility as unified a service rather than an array of scattered services.

Both of these are dealt with in the following discussion.

2.2 USING PERSUASIVE DESIGN AND NON-REGULATORY MEASURES

Incentive-driven design, social marketing and other "nudge" theories have shown to be effective in altering behavior.[1] However, approaches such as these have been questioned in their ability to bring long-lasting changes in practices. Persuasive measures' effectiveness may depend largely on the target audience and their environmental condition; conditions that may encompass transit service conditions, availability of transit services, or proximity to an urban core for example.

Persuasive design may need to be implemented alongside other supporting factors to achieve desired outcomes. Evidence supports the conclusions that non-regulatory or regulatory measures used in isolation are often not likely to be effective and the challenges of promoting sustainable mobility and fostering a sustainable society necessitate political and policy changes that tackles the underlying social and economic context of current practices. Non-regulatory measures, such as persuasive design, in general are not effective if not paired with substantial regulatory measures such as policy change.

There are also persuasive design measures that are less explicit, less economic, and incorporate gamification which has arguably been proven as a viable business concept in practice.

Another question is whether nudging or gamificafication can be used to introduce alternative modes that people would intitially not try, this may then lead to more frequent usage of 'non taken' modes.

2.2.1 STRUCTURED BUNDLES: ASSOCIATIVE PROMOTION

One potential measure that MaaS apps can take to potentially entice users to take more active modes of transportation is the introduction of structured bundles, in other words, monthly subscription plans. In a recent research paper "The potential of mobility as a service bundles as a mobility management tool," Melinda Matyas and Maria Kamargianni aimed to provide initial insights into whether MaaS product bundles can be used as a mobility management tool to promote shared transportation modes. It was found that over 60% of tested users indicated that they would be willing to try transportation modes that they previously did not use if their MaaS plans included them.[2] These initial results show evidence that MaaS bundles can indeed be used as a mobility management tool to introduce more travelers to shared modes and shift them away from the use of single occupancy vehicles (SOV). This suggests the untapped potential MaaS apps have in promoting alternative mobility services to user through passive promotive means through the app.

Through bundling products, MaaS systems may be able to make a way for people to opt for more active modes of transportation, incentivize more environmental and health benefit rich options. In particular, MaaS could be a means to increase consumer acceptance and aid diffusion of currently utilized products and services. MaaS can bundle less popular transportation modes such as bike sharing and car sharing and public transport for new potential market demographics and users. Importantly, MaaS is a soft mobility management tool that repackages the way travel services are presented to users, could critically alter the way they are perceived by individual, and let existing mobility services reach new markets through the bundling/abilities of the app. These research potentials are overviewed in later sections of this chapter.

1. Ridder M, Kim J, Jing Y, Khadra M, Nanan R "A systematic review on incentive-driven mobile health technology: As used in diabetes management" Journal of Telemedicine and Telecare. Volume 23. Issue 1. Pag 26-53.
2. Matyas, Melinda, and Maria Kamargianni. "The Potential of Mobility as a Service Bundles as a Mobility Management Tool." Transportation, August 6, 2018. https://doi.org/10.1007/s11116-018-9913-4. P1.

2.2.1.2 Incentive driven design: active promotion

With analogous apps to MaaS programs that consolidate services, it can be argued that MaaS apps have the potential to integrate greater amounts of incentive driven design to better facilitate the use, attachment, and customer-understood value of it's hosted mobility services.

In particular, study by Ridder on Incentive driven mobile health technology has analyzed the use of incentive driven technologies by customers on an analogous mobile app called mHealth. Understanding that the core technologies of the smartphone era, such as apps, the Internet, Short Message Service (SMS) and sensors, have been utilized by incentive driven tecnology (IDT) mHealth tools as they became available, the study then determined which IDTs are used in mHealth for diabetes management and how effective each one is. The study found that there are seven core incentive driven technologies (IDTs) and each has two aspects encompassing the content delivery medium and content generation technique. These techniques can also be applied to MaaS apps and be researched further in this specific application to mobility services, health, and sustainbility.

The 7 incentive driven technologies include reminders, alerts, feedback, social, education, financial, and gamification[3]. Their implementation is divided by Ridder into two frameworks. First is persuasive systems design (PSD) and the second is behavioral intervention technologies (BITs) framework. The following section overviews the study's outline on the seven core IDTs necessary and reflects the potential research that can be done for MaaS apps in context to promoting its proposed health and sustainability function through its hosted mobility services.

1. Reminder: This IDT refers to sending a message or alarm to the user. This includes getting a regular notification of personal goals that has been set. This IDT is commonly combined with education as the objective of most reminder systems. This is hinted to empower users to improve their management, similar to the argued empowerment gained by more educated users by this study. [4]

2. Alert: The alert IDT is similar to a reminder except that it is considered to be "practitioner-facing". It can be implemented to warn the medical practitioner that something could be wrong.[5]

3. Feedback: This IDT is a case where, for example, a practitioner or a software algorithm can send a message to the user stating whether their management has been good or bad. This provides analysis of how well the user is meeting their stipulated goals and can help users better achieve their goals. [6]

4. Social: This connects users with each other so they can talk and provide support to one another through the (mHealth) tool. An example is a chat service. One study used the social aspect as the only incentive of their product. The other studies analyzed combined social IDT with other techniques. In general, it is thought that peer support networks are thought to improve adherence to self management tasks somewhere to turn for advice/support from others in a similar situation. Social was commonly combined with education, where users could, for example, have a buddy to assist each other with their learning, and with two of the three gamification IDTS, which also aimed at younger users.[7]

5. Education: This IDT is the most widely used. This can be described as using technology to present instructional and informational content to the user with a common view of minimizing the need for visits to

3. Ridder, Michael de, Jinman Kim, Yan Jing, Mohamed Khadra, and Ralph Nanan. "A Systematic Review on Incentive-Driven Mobile Health Technology: As Used in Diabetes Management." Journal of Telemedicine and Telecare 23, no. 1 (January 2017): 26–35. https://doi.org/10.1177/1357633X15625539.

4. Ridder, Michael de, Jinman Kim, Yan Jing, Mohamed Khadra, and Ralph Nanan. "A Systematic Review on Incentive-Driven Mobile Health Technology: As Used in Diabetes Management." Journal of Telemedicine and Telecare 23, no. 1 (January 2017): 26–35. https://doi.org/10.1177/1357633X15625539.

5. Ridder, Michael de, Jinman Kim, Yan Jing, Mohamed Khadra, and Ralph Nanan. "A Systematic Review on Incentive-Driven Mobile Health Technology: As Used in Diabetes Management." Journal of Telemedicine and Telecare 23, no. 1 (January 2017): 26–35. https://doi.org/10.1177/1357633X15625539.

6. Ridder, Michael de, Jinman Kim, Yan Jing, Mohamed Khadra, and Ralph Nanan. "A Systematic Review on Incentive-Driven Mobile Health Technology: As Used in Diabetes Management." Journal of Telemedicine and Telecare 23, no. 1 (January 2017): 26–35. https://doi.org/10.1177/1357633X15625539.

7. Ridder, Michael de, Jinman Kim, Yan Jing, Mohamed Khadra, and Ralph Nanan. "A Systematic Review on Incentive-Driven Mobile Health Technology: As Used in Diabetes Management." Journal of Telemedicine and Telecare 23, no. 1 (January 2017): 26–35. https://doi.org/10.1177/1357633X15625539.

educators or practitioners.[8]

6. Financial: The financial IDT is the incentive of providing financial remuneration, or an equivalent reward system, to users. An example can be the provision of vouchers or iTunes redemption codes. [9] One study provided a financial incentive to cover the costs associated with increased text messaging which was required by the study as part of the intervention.

7. Gamification: This IDT involves providing a platform with digital rewards, such as unlockable video content, levelling up, or activity-based experiences, to make management more fun and rewarding to users. [10] This is generally aimed at teens and adolescents in an attempt to attract the younger generation that may be not well equipped to deal with the recurring, complex tasks involved in diabetes management. Gamification is commonly designed to reduce food intake, increase physical exercise, and improve the regularity of monitoring.

Again, there is potential for the MaaS app to explore all these metrics in terms of providing active incentives to use MaaS app for mobility services. This study has shown that while the technologies used to deliver and generate mHealth content have developed over time, the core IDT mechanisms have remained the same and presumably is applicable to MaaS.[11] All of these serve as incentives to motivate, retain and empower the user, however the study emphasizes it is technological innovation that has driven change, not new incentive techniques. Through these incentive driven technologies, existing sustainable and healthy mobility services and modes can be actively marketed to potential users using business tools to support their use.

Gamification is also used in Apps to create engagement mechanisms, to incentivize recurring visits to the App, to promote advertising or promote the usage of a paid feature of the app (especially in free apps). Gamification may also be used as a working model for the App (like language learning Apps). In the case of MaaS App, we could imagine the gamification aspect in relation to health and sustainability, as a promotion of health awareness related to health indicators like step-counting, and active mobility registry by the App to award the user with points or other benefits which are usable on the App or outside of it.

An example for health and sustainability gamification features in an App can be seen with 'GoEco!' an App in Switzerland, that *" leverages ecofeedback and game elements to motivate them to modify their mobility behaviour. The GoEco! app tracks their routes, provides them with feedback on their mobility styles (kilometers travelled, means of transport used, energy consumption and CO2 emission) and suggests them meaningful low-impact, alternative modal options. Building on individual achievement and competitive game mechanics, the GoEco! App also nudges them to define personal goals and targets for change and to take part in individual mobility challenges, providing them with weekly feedback on their progress, virtual rewards for good performances and possibilities to compare their achievements with the other participants."* [12]

For the mobility service provider, incentivizing walking which is unprofitable, may be counterintuitive. For this to be economically sound, active transport should be rewarded with points or another gamification system to then be redeemable in some economic translatable way, for example discounts, gift cards or vouchers. Theoretically for a user to spend less is economically preferable. However, in such a case, the user may lean towards less sustainable options if the price difference is negligible.

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8. Ridder, Michael de, Jinman Kim, Yan Jing, Mohamed Khadra, and Ralph Nanan. "A Systematic Review on Incentive-Driven Mobile Health Technology: As Used in Diabetes Management." Journal of Telemedicine and Telecare 23, no. 1 (January 2017): 26–35. https://doi.org/10.1177/1357633X15625539.
9. Ridder, Michael de, Jinman Kim, Yan Jing, Mohamed Khadra, and Ralph Nanan. "A Systematic Review on Incentive-Driven Mobile Health Technology: As Used in Diabetes Management." Journal of Telemedicine and Telecare 23, no. 1 (January 2017): 26–35. https://doi.org/10.1177/1357633X15625539. (32)
10. Ridder, Michael de, Jinman Kim, Yan Jing, Mohamed Khadra, and Ralph Nanan. "A Systematic Review on Incentive-Driven Mobile Health Technology: As Used in Diabetes Management." Journal of Telemedicine and Telecare 23, no. 1 (January 2017): 26–35. https://doi.org/10.1177/1357633X15625539. (35)
11. Ridder, Michael de, Jinman Kim, Yan Jing, Mohamed Khadra, and Ralph Nanan. "A Systematic Review on Incentive-Driven Mobile Health Technology: As Used in Diabetes Management." Journal of Telemedicine and Telecare 23, no. 1 (January 2017): 26–35. https://doi.org/10.1177/1357633X15625539. (33)
12. Cellina, F., Bucher, D., Rudel, R., Martin, R., & Rizzoli, A.-E. (2016). Promoting sustainable mobility styles using eco-feedback and gamification elements: Introducing the GoEco! Living lab experiment.

2.2.1.3 'Nudge': passive promotion

Nudge is "any aspect of the choice architecture that alters people's behavior in a predictable way without forbidding any options or significantly changing their economic incentives.[13] Again, to count as a mere nudge, the intervention must be easy and cheap to avoid. Nudges are not mandates. Putting the fruit at eye level, for example, counts as a nudge while banning junk food does not"[14]. Alerts, notifications, and similar programmatic means could be used by and researched for the MaaS app in it's potential function for health, sustainability, and promotion of mobility services.

A study[15] also noted that prompting choices without allowing people to consider their options consciously results in a ethically questionable set of manipulations, and therefore do not include openly persuasive interventions such as media campaigns and the straightforward provision of information. In general, nudge in MaaS is a topic of research that has potential, the ethical implications of 'unconscious' nudging are further explored in Section 2.2.3.

Success of nudges depends on decision-making process. Following the 'Choice of Architecture' for 'First Best Choice', if the app always first shows the healthy less emitting option (i.e. walking) first option and visually 'hides' the other options, this may be an example of the first method. Following the 'Choice of Architecture' for 'Limited Attention', a relatively healthy alternative will be shown amongst the top route possibilities, however the user has the choice. In this case the mobility service providers can use the data to see the effect of nudging and constantly change the nudging strategies.

Another form of nudging is by 'Automaticity' or 'By Default'. In a study done by Sunstein[16] there is a talk about 'opting out' versus 'opting in', with regards to consumers in Germany choosing to use green energy. In the 'opting in' model, between 0-5% of users chose to use green energy, whereas in the 'opting out' 95% chose to use green energy by virtue of not choosing to opt out and accept the default option chosen for them, or as Cass puts its, "the case of automaticity on choice is massive" . Another example is a university in Sweden trying to reduce the use of paper, where communicating or raising the price had no effect, setting the printers to double-sided by default had a much greater effect.

2.2.1.4 Social promotion

The potential for social networking to facilitate the adoption of more healthy and sustainable mobility options through MaaS is another avenue of potential research. Indeed, existing studies have shown the application could have other unique social features that encompass assets for supporting sustainable mobility systems and objectives, especially those related to motivating users to change. These particular social persuasion features include social comparison, social facilitation, normative influence, social learning, competition, and praise in the use of the application. [17]

In particular, it has been found that a multi-modal journey planner's persuasive features, of which included reporting of disruptive events, allowing goal setting, self-monitering, and rewarding features, could be made more effective with embedded social influence elements, fit the user's travel preferences, and fit the behavioral profiles of the different users. Indeed, it was found that participants were somewhat unwilling to share data and scores with unknown users but felt more motivated with sharing to personal contacts.

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13. Barr, Stewart, and Jan Prillwitz. "A Smarter Choice? Exploring the Behaviour Change Agenda for Environmentally Sustainable Mobility." Environment and Planning C: Government and Policy 32, no. 1 (February 2014): 1–19. https://doi.org/10.1068/c1201.(2)
14. Barr, Stewart, and Jan Prillwitz. "A Smarter Choice? Exploring the Behaviour Change Agenda for Environmentally Sustainable Mobility." Environment and Planning C: Government and Policy 32, no. 1 (February 2014): 1–19. https://doi.org/10.1068/c1201.(2)
15. Barr, Stewart, and Jan Prillwitz. "A Smarter Choice? Exploring the Behaviour Change Agenda for Environmentally Sustainable Mobility." Environment and Planning C: Government and Policy 32, no. 1 (February 2014): 1–19. https://doi.org/10.1068/c1201.
16. Starr Forum: Behavioral Science and Nudges: Environmental Protection and Sustainability. (2017, March 3). https://www.youtube.com/watch?v=li_jChiZmc8
17. Gabrielli S, Maimone R, Forbes P "Design Challenges in Motivating Change for sustainable urban mobility" Conference: CHI '13 Extended Abstracts on Human Factors in Computing Systems. 2013. < 262408764_Designing_motivational_features_for_sustainable_urban_mobility>

Another study on designing a means to decrease private vehicle dependence and promote sustainable travel also found that a successful promotion meant campaigns centered around social motivation and making the proposed behavior the norm.[18] While there was a need for implementing hard measures, such as modifying the environment or promoting new roads for example, the potential to influence people's behavior without physically changing the conditions is present and of high potential. The study encouraged and suggested following a strategy of positive incentives (carrots vs sticks) rather than discouraging or punishing users for altering behavior from the intended norm.[19] Indeed, in another 19 studies by Scheepers, it was concluded that soft measures have positive results in shifting people from the use of cars to active modes. But, once the convenience of the car was discovered, it was difficult to alter behavior. Soft social measures could play a key role in keeping people who have not yet developed private car dependence from doing so.

2.2.1.5 Emotional driven promotion

Studies show that people care about the environment, but this concern is not enough of an incentive for people to change their transportation behavior. However the desire to use more environmentally friendly options is present.[20] This research also asks if health can be an incentive to adopt sustainable modes of transportation. This can also be researched further.

2.2.1.6 Personal notifications: long-term educational promotion

A potential avenue of further research for the MaaS apps includes the role of educational programming in promoting healthier and more sustainable mobility choices. Studies on this potential have already started; existing studies in MaaS-similar applications have learnt that personalized notifications were not effective in changing user behavior in the short term but contributed together with social and individual motivational strategies to improve user attitude and behavior in the long term for sustainable mobility. [21] It was posited that diversified set of persuasive techniques can, when targeting different user groups to match user preferences, keep them engaged with an app and its usage until stable effects are achieved.[22]

These findings are supported in a Helsinki pilot study on automatic journey tracking and persuasive challenges aimed at motivating sustainable behavior with a set of actionable mobility challenges. [23] The main obstacles, however, encountered during this study related to the automatic tracking and related usability issues such as high battery consumption. It was found that there were a number of factors that were implied to be helpful to increase user behavior in the long term with educational means. For one, a level of personalization and hints on how to complete challenges were requested by users[24] . As well, interest in sharing completed challenges and collected points with others in a social network could motivate users to achieve the stipulated behaviors through the app.[25] The ability to compare travel history and achievement with friends is also implied to help with this goal.

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18. Matyas, Melinda, and Maria Kamargianni. "The Potential of Mobility as a Service Bundles as a Mobility Management Tool." Transportation, August 6, 2018. https://doi.org/10.1007/s11116-018-9913-4.
19. Matyas, Melinda, and Maria Kamargianni. "The Potential of Mobility as a Service Bundles as a Mobility Management Tool." Transportation, August 6, 2018. https://doi.org/10.1007/s11116-018-9913-4.
20. McMakin A H, Malone Elizabeth L, Lundgren R E "Motivating Residents to Conserve Energy without Financial Incentives" Environment and Behavior Volume 34 Issue 6 Pg. 848-863 2002 Nov. Web Accessed April 30th 2019 < https://journals.sagepub.com/doi/abs/10.1177/001391602237252>
21. Noar SM, Benac CN, Harris MS "Does tailoring matter? Meta-analytic review of tailored print health behavior change interventions" Psychol Bull. 2007. Volume 133. Issue 4. Pg. 673-93. < https://www.ncbi.nlm.nih.gov/pubmed/17592961> (419)
22. Noar SM, Benac CN, Harris MS "Does tailoring matter? Meta-analytic review of tailored print health behavior change interventions" Psychol Bull. 2007. Volume 133. Issue 4. Pg. 673-93. < https://www.ncbi.nlm.nih.gov/pubmed/17592961> (419)
23. Noar SM, Benac CN, Harris MS "Does tailoring matter? Meta-analytic review of tailored print health behavior change interventions" Psychol Bull. 2007. Volume 133. Issue 4. Pg. 673-93. < https://www.ncbi.nlm.nih.gov/pubmed/17592961> (419)
24. Noar SM, Benac CN, Harris MS "Does tailoring matter? Meta-analytic review of tailored print health behavior change interventions" Psychol Bull. 2007. Volume 133. Issue 4. Pg. 673-93. < https://www.ncbi.nlm.nih.gov/pubmed/17592961> (419)
25. Noar SM, Benac CN, Harris MS "Does tailoring matter? Meta-analytic review of tailored print health behavior change interventions" Psychol Bull. 2007. Volume 133. Issue 4. Pg. 673-93. < https://www.ncbi.nlm.nih.gov/pubmed/17592961> (419)

2.2.2 FACILITATING SUSTAINABLE AND HEALTHY USES

MaaS apps can provide a platform that allows existing mobility services to be used more easily in a healthy and sustainable context. This can increase the marketability of existing mobility services simply through reframing it in new contexts depending on the MaaS app. A number of potential means of which the MaaS app can do this can be researched and developed.

2.2.2.1 Creating added hybridized value

There can be more research into how MaaS can facilitate the addition of new functions, additive programs, and additional value to existing mobility services in context of it's application environment. In existing studies, it can been found that even though individuals do not prefer certain mobility modes, including shared modes, the MaaS product can, in fact, provide enough added value to respondents that they would buy or at least consider using these [26]. There are promising results for MaaS bundles as a mobility management tool to introduce more travelers to shared modes and this is a strong avenue of exploration.

2.2.2.2 Creating reliability

Mass apps also have the potential, as a consolidating technology, to help increase the reliability, familiarity, and use of alternative newer mobility services it hosts. This potential can be seen with tested psychological interventions such as access to real-time arrival data, through dynamic LED screens at stations or through applications on smartphones, that enable commuters to feel more calm and in control of their travel plans.[27] New York City's Metropolitan Transit Authority's decision to install LED boards displaying train arrival times on select train platforms was received positively by the public and was hinted to increase the reliability, possible use, and customer confidence in the service:[28] The following quote by Montgomery summarizes this finding:

> "People at light board-equipped stations were less likely to lean precariously out over the track, peering down the tunnel. Everyone could make a logical decision whether to wait or head up the street to walk or catch a cab- becoming, in effect, slightly more like the rational, informed actors that economists tell us we are." [29]

Greater ease and convenience of app use itself is also critical in facilitating the success of the MaaS app in context of increasing urban mobility. These are intended to influence users by motivating them to adopt and return to the tool. However, many of these tools presented in many of the articles were not positively perceived by users. In some studies, it was found that "technological difficulties were the main reason for a decline in the use" [30] Correspondingly, tools that aimed to reduce manual labor, such as by simplifying operational tasks, were found to be appreciated by users.

In another study on ride-sharing and the influence of the public transit networks on commuters' travelling choices, when the studied subjects were asked explicitly why they opted for ride-hailing services over public transit, the most popular reason was slow service, in addition to unreliability and lack of stops. [31] [32] These reasons point to an increase in use of transit if reliability increases. However, to facilitate this, users would need to trial and compare these alternative mobility service to the ones they currently use. Again, the MaaS app could

26. Matyas, Melinda, and Maria Kamargianni. "The Potential of Mobility as a Service Bundles as a Mobility Management Tool." Transportation, August 6, 2018. https://doi.org/10.1007/s11116-018-9913-4. (15)
27. Montgomery, Charles. 2013. Happy city: Transforming our lives through urban design. First ed. New York: Farrar, Straus and Giroux., 202
28. Chen, thesis, 39.
29. Montgomery, Charles. 2013. Happy city: Transforming our lives through urban design. First ed. New York: Farrar, Straus and Giroux., 202
30. Ridder, Michael de, Jinman Kim, Yan Jing, Mohamed Khadra, and Ralph Nanan. "A Systematic Review on Incentive-Driven Mobile Health Technology: As Used in Diabetes Management." Journal of Telemedicine and Telecare 23, no. 1 (January 2017): 26–35. https://doi.org/10.1177/1357633X15625539. (33)
31. Chen, "Moving Forward The Future of Urban Mobility and Infrastructural Space", 72.
32. Clewlow, Regina R, Gouri Shankar Mishra, Regina Clewlow, and Stephen Kulieke. "Disruptive Transportation: The Adoption, Utilization, and Impacts of Ride-Hailing in the United States," n.d., 38.

have a role in this. In addition a MaaS app could increase overall reliability of other modes and the certainty that a trip can be taken sustainabily by modes other than single occupancy vehicles (S.O.V.s).

2.2.2.3 Test trials: advertising mobility options.

MaaS apps have the potential to promote mobility services in health and sustainability contexts through advertising their benefits and services through test trails. In places with lacking public transporting services for example, MaaS apps can help advertise and integrate viable potential alternative transportation options to users. For example, Mass can facilitate the previously decried SOV users into more sustainable healthy transportation options such as ride-sharing through increasing awareness and facilitating their trial. The MaaS application Ubigo, as described in chapter one, started out as a trial in Sweden to test its viability and features to the community. Today, it is officially launched in Stockholm and has arguably promoted alternative mobility services such as car share or transit in the city for the community. The effect of MaaS apps on promoting the use of mobility options and increasing awareness is not without precedence. Some studies have shown evidence that trials on bike-sharing programs, that are implied to promote the alternative mobility options, could significantly reduce private vehicle use in certain areas. [33]

2.2.2.4 Feedback and metrics

MaaS has the potential to facilitate greater user utility of alternative mobility services with better user feedback of metrics. A relevant example is the UbiGreen application. This application runs on and adapts its graphics to the personal devices of the user to provide visual feedback that aims to reduce driving and encourage greener transportation alternatives; these alternative transportation means encompass carpooling, public transportation, and pedestrian means of transportation. [34] In particular, the application makes use of automatic tracking which is beneficial in a number of ways; it enables personalizing behavior recommendation that can lead to the user to act towards the more alternative transportation methods and provides a mechanism for validating the user's actual behavior. However, there are a number of challenges that the app currently faces in this specific aspect.[35] The accuracy of tracking is seldom sufficient to serve as a standalone solution and the possibility to supplement and correct tracking errors needs to be provided.

Another relevant example includes a study into the Wattsup app through an 18 day trial. This app demonstrated that enabling comparison of energy consumption in a social network resulted in significant reduction of energy consumption by the user. Interventions combined along with a greater level of user interactivity in the app seemed to increase success rate of the interventions and correlated with people remaining engaged with the app for longer. [36] The MaaS app, through an interface that better provides relevant user metrics, use, and consequences of activities in mobility service use can better facilitate a healthier-sustainable lifestyle while promoting transportation services.

2.2.2.5 Integrated mobility service system

There is potential for an integrated mobility service system such as MaaS to promote alternative mobility services, health, and sustainability. This is particularly critical in terms of promoting mixed transportation modes and utilizing existing services as one holistic network. Indeed, many studies have shown evidence that

33. Fishman, E.,Washington, S. & Haworth, N. (2014). Bike share's impact on car use: Evidence from the United States, Great Britain, and Australia. Transportation Research Part D. 31: 13–20.
34. Gabrielli S, Maimone R, Forbes P "Design Challenges in Motivating Change for sustainable urban mobility" Conference: CHI '13 Extended Abstracts on Human Factors in Computing Systems. 2013. < 262408764_Designing_motivational_features_for_sustainable_urban_mobility>
35. Gabrielli S, Maimone R, Forbes P "Design Challenges in Motivating Change for sustainable urban mobility" Conference: CHI '13 Extended Abstracts on Human Factors in Computing Systems. 2013. < 262408764_Designing_motivational_features_for_sustainable_urban_mobility>
36. Gabrielli S, Maimone R, Forbes P "Design Challenges in Motivating Change for sustainable urban mobility" Conference: CHI '13 Extended Abstracts on Human Factors in Computing Systems. 2013. < 262408764_Designing_motivational_features_for_sustainable_urban_mobility>

both bike and car sharing significantly reduce private vehicle use and VMT (vehicle miles travelled)[37]. If younger generations who do not currently own a vehicle are able to solve all their door to door journeys without one, they may delay or abandon purchasing a vehicle in the long run[38]. This demonstrates the untapped potential to promote car sharing in junction with public transit through a new MaaS system app. As a result of this trend in opting more mixed transportation modes, shared services lead to a significant reduction in GHG emissions and bike sharing, in particular, lead to a number of health benefits for society as well.[39] Here, the adoption of shared modes and particularly more active ones increases health benefits as well as increases the potential use of transportation services such as car sharing or public transit. MaaS, through it's integration of mobility systems as one network, has the potential to facilitate this. This effectiveness and impact should be researched.

Indeed, alternative efforts to consolidate mobility services in other contexts have similar based results. It was found that soft measures are enough to reduce private vehicle use and this has the implication to reduce CO2 emissions. There are ticketing schemes which allow one to buy bulk tickets, passes, or cards for public transport or across modes. Together with smart cards there is a significant impact on the use of public transport modes. [40]. Introduction of inter-modal Travelcard season ticket introduced in London showed a resulted car use decrease by 9% while bus and underground trips showed a use increase up by 7% (White 1984) [41]. This is the same for Paris and CArte Orange, where increased overall ridership by 33% was seen (NEA 2003) [42]. There is strong substitution between these two mobility tools. Introducing smart cards have positive effects on public transport patronage by easing the transitions at stations as well as the payments (Blythe and Holm 2002) [43]. This particular research demonstrates the potential of the MaaS system.

2.2.2.6 Regulation and context

By focusing evermore closely on the factors which influence individual behavior, researchers and policy makers are arguably avoiding difficult but important challenges. Accordingly, authors have questioned incrementalist approaches like social marketing and 'nudge' theory can deliver the major and long-lasting changes in practices that are required [44] Evidence supports the conclusions that non-regulatory or regulatory measures used in isolation are often not likely to be effective. Indeed, there are challenges of promoting sustainable mobility and fostering a sustainable society necessitate political and policy changes that tackle the underlying social and economic contexts for current practices. [45]

Indeed, such a framework also suppresses wider questions of social organization, urban form, and the possibilities for radical political changes to tackle issues such as climate change. In other words, how can we come to appreciate the wider significance of social and economic structures in the ways that policy is formulated for encouraging behavioral change, so often framed as only an issue of individual choice. There could be more examination of how a MaaS app might function in this context.

37. Matyas, Melinda, and Maria Kamargianni. "The Potential of Mobility as a Service Bundles as a Mobility Management Tool." Transportation, August 6, 2018. https://doi.org/10.1007/s11116-018-9913-4. (2)
38. Matyas, Melinda, and Maria Kamargianni. "The Potential of Mobility as a Service Bundles as a Mobility Management Tool." Transportation, August 6, 2018. https://doi.org/10.1007/s11116-018-9913-4. (2)
39. Matyas, Melinda, and Maria Kamargianni. "The Potential of Mobility as a Service Bundles as a Mobility Management Tool." Transportation, August 6, 2018. https://doi.org/10.1007/s11116-018-9913-4. (2)
40. Matyas, Melinda, and Maria Kamargianni. "The Potential of Mobility as a Service Bundles as a Mobility Management Tool." Transportation, August 6, 2018. https://doi.org/10.1007/s11116-018-9913-4. (4)
41. Matyas, Melinda, and Maria Kamargianni. "The Potential of Mobility as a Service Bundles as a Mobility Management Tool." Transportation, August 6, 2018. https://doi.org/10.1007/s11116-018-9913-4. (4)
42. Matyas, Melinda, and Maria Kamargianni. "The Potential of Mobility as a Service Bundles as a Mobility Management Tool." Transportation, August 6, 2018. https://doi.org/10.1007/s11116-018-9913-4. (4)
43. Matyas, Melinda, and Maria Kamargianni. "The Potential of Mobility as a Service Bundles as a Mobility Management Tool." Transportation, August 6, 2018. https://doi.org/10.1007/s11116-018-9913-4. (4)
44. Barr, Stewart, and Jan Prillwitz. "A Smarter Choice? Exploring the Behaviour Change Agenda for Environmentally Sustainable Mobility." Environment and Planning C: Government and Policy 32, no. 1 (February 2014): 1–19. https://doi.org/10.1068/c1201.(4)
45. Barr, Stewart, and Jan Prillwitz. "A Smarter Choice? Exploring the Behaviour Change Agenda for Environmentally Sustainable Mobility." Environment and Planning C: Government and Policy 32, no. 1 (February 2014): 1–19. https://doi.org/10.1068/c1201.(4)

2.2.2.7 Marketing to new customers

MaaS apps also have the potential to utilize marketing strategies to frame existing mobility services for new customers and markets; where techniques derived from mainstream marketing are applied in this case to promote health, sustainability, a social 'good'. This underscores the importance of strategically delivering programs so that they target specific segments of the public and overcome the barriers to the segment engaging in the behavior. [46] Accordingly, social marketing for sustainable lifestyles has become a major policy driver in delivering behavior change initiatives at both the national and local scales. [47] The MaaS app, as a means of marketing existing mobility services in new ways remains a field to be explored further.

2.2.2.8 Trip Journey Psychology

One aspect which is often overlooked, is what happens in those moments of the decision-making of choosing an action as in how to get from A to B. For car owners, this is usually a 'no-brainer' as the automobile can take them to almost anywhere they want. For this group, the choice of mode is usually a given, however they have the dilemma between what route to take, time of departure and parking possibilities at destination. For this group, if they used a MaaS App as a trip planner and parking solution rather than for the rest of the modes, they could also be targeted by the app as potential users which are to be nudged towards making choices which promote health and sustainability outcomes. However, how does one do that?

For users which choose public transportation, in particular busses, there are many other elements at play. For example in a hypothetical situation where a user is waiting at the bus stop and has more than one choice and does not know which is the best option, while additionally not knowing the exact arrival time of the bus, this is one of the aspects that make a mass transit system more attractive and reliable. In such cases, a MaaS App which can be seen as a 'glorified trip-planner' can have more reliable times and options because it will already take into account the users package allowance depending on the plan which they are subscribed to. This may have the potential to eliminate the stress factor related to the uncertainty of the choice of the trip and throughout the trip regarding traffic and the transfer moments between modes. The reduction in stress can be seen as positive health outcome.

2.2.3 DISCUSSION ON ETHICAL IMPLICATIONS OF 'UNCONSCIOUS NUDGING' / SURVEILLANCE CAPITALISM

Another avenue of research into the MaaS app to help it promote its mobility services in a health and sustainability context is through the technique of 'nudging'. This concept was described in a study that critiques the focus on studying at individual scales for understanding responses to environmental problems and suggests a focus on studying other social scales to better "achieve major social change".[48] This study suggests that government neoliberal policies that focus on the paradigm of an individual, rather than that of relationships or at scales of groups, are inadequate for understanding and "promoting widespread behavioral changes".[49] In particular, the study describes the concept of a 'nudge' as a way in which individual behavior can be "changed through manipulation of contexts" that doesn't forbid any of the individual's options, change their economic

46. Barr, Stewart, and Jan Prillwitz. "A Smarter Choice? Exploring the Behaviour Change Agenda for Environmentally Sustainable Mobility." Environment and Planning C: Government and Policy 32, no. 1 (February 2014): 1–19. https://doi.org/10.1068/c1201.(4

47. Barr, Stewart, and Jan Prillwitz. "A Smarter Choice? Exploring the Behaviour Change Agenda for Environmentally Sustainable Mobility." Environment and Planning C: Government and Policy 32, no. 1 (February 2014): 1–19. https://doi.org/10.1068/c1201.(4)

48. Barr, Stewart, and Jan Prillwitz. "A Smarter Choice? Exploring the Behaviour Change Agenda for Environmentally Sustainable Mobility." Environment and Planning C: Government and Policy 32, no. 1 (February 2014): 1–19. https://doi.org/10.1068/c1201.

49. Barr, Stewart, and Jan Prillwitz. "A Smarter Choice? Exploring the Behaviour Change Agenda for Environmentally Sustainable Mobility." Environment and Planning C: Government and Policy 32, no. 1 (February 2014): 1–19. https://doi.org/10.1068/c1201.

incentives, and is easy and simple to avoid.[50] Notably implied is that nudges offer choices to individuals without the allowing people to "consider their options consciously" through means of acquiring attention and rearticulating their personal context. Nudge is generally described by the study as a potential means to facilitate behavioral change and increase in use of the promoted entity.

The study[51] also noted that prompting choices without allowing people to consider their options consciously results in a ethically questionable set of manipulations, and therefore do not include openly persuasive interventions such as media campaigns and the straightforward provision of information. In general, nudge in MaaS is a topic of research that has potential, the ethical implications of 'unconscious' choice are discussed here. In theory when more aggressive nudging tactics are being used, without the full awareness of the user (unlike cigarette boxes notice for example) this undermines the free will of the user and enters in the realm of ethics.

Nudging has been proven to have an influence on the choice of the customer, however it is difficult to measure and be precise of the decision taken as it cannot be isolated and decisions may have been caused by other motives. *"When it comes to assessing nudges, however, this model is problematic, since nudging manipulates precisely the behavior that is supposed to shed light on a person's preferences. The researchers therefore looked to alternative behavioral models to determine the assumptions under which a nudge can be assessed in a meaningful way."*[52] On the other hand, having registered all of the behaviour of the customer, makes it possible to follow up and try to understand through big data.

Big data on user / Surveillance Capitalism

The idea behind big data combined with increasingly more sophisticated algorithms with machine learning, deep learning and AI causing an unprecedented disruption, as this discussion is gaining greater concerns in the wider community. If we look at this in the context of MaaS, the gathering of the information of every single trip of a user performs could be possible and this data could be used to create different profiles of user types where different nudging strategies could be applied to and tested. Therefore, the writing of the rules for these algorithms are perhaps one of the most crucial elements in MaaS in terms of governmental interference, if it wishes to promote positive health and sustainability outcomes. This could be done by increasing supply of both healthier and more sustainable options, while limiting options which cause negative outcomes.

A 'big brother' style scenario could emerge, however, as data privacy policy around the users' data is currently unclear. The collection of users' data of movement and whereabouts at all times can be a serious privacy issue, when combining or crossing the data on the location and movement with data already available through social media about the user, there is a potential for whoever has the data to use it to potentially a negative outcome, ethically speaking. As seen in the case of Cambridge Analytica[53] where it is alleged that it is possible to influence users and to 'nudge' them in favor of a particular choice (in the case of Cambridge Analytica in election campaigns). However, by the same logic, translating to the MaaS context, if an entity (a government or corporation) owned the data it assessed as needed to nudge a population to use less emitting modes of transport for example, there is a possibility that it could be misused.

If we extrapolate what we can learn from cases such as Cambridge Analytica and the power of access to social media and it's collateral effects, we can hypothesize that if enough data was collected about each MaaS user and this user could be narrowed down into specific profiling, there is a greater chance that this individual is 'manipulable' to the apps suggestions, directions, choice of travel mode and deviation from

50. Barr, Stewart, and Jan Prillwitz. "A Smarter Choice? Exploring the Behaviour Change Agenda for Environmentally Sustainable Mobility." Environment and Planning C: Government and Policy 32, no. 1 (February 2014): 1–19. https://doi.org/10.1068/c1201.

51. Barr, Stewart, and Jan Prillwitz. "A Smarter Choice? Exploring the Behaviour Change Agenda for Environmentally Sustainable Mobility." Environment and Planning C: Government and Policy 32, no. 1 (February 2014): 1–19. https://doi.org/10.1068/c1201.

52. Reck, D. J., & Axhausen, K. W. (2019). How much of which mode? Using revealed preference data to design MaaS plans. In Arbeitsberichte Verkehrs- und Raumplanung (Vol. 1445) [Working Paper]. IVT, ETH Zurich. https://doi.org/10.3929/ethz-b-000356141

53. Cambridge Analytica. (2019). In Wikipedia. https://en.wikipedia.org/w/index.php?title=Cambridge_Analytica&oldid=974886145

the users customary use. In such a scenario, it would essentially come down to the question of who controls the algorithms and if governmental agencies such as health services can actively be involved in this process. Serious implications regarding privacy derive from this model, however, in the 21st century it is increasingly a reality that control over data of the individual is the soul main power struggle[54], which is currently in the hands of giant tech corporations. These giant tech corporations is called by Zuboff the 'Surveillance Capitalists' which are being the new for of economy known as 'Surveillance Capitalism.[55] In Surveillance Capitalism, data on users is extracted as raw material. Then it can be analysed across innumerous data sets which are used (with the help of AI) to create predictions on behaviours of users, most effectively through a form of unconscious nudging. These are traded in the predictive behaviour markets to businesses which want to target users with their services or products.

The 'Data Economy' enables Surveillance Capitalism, but it itself is enabled by the digitization and automation revolution which Rifkin[56] and Schwab[57] talk about. Rifkin asserts that the sharing economy combined with the automation revolution makes it possible to disrupt mobility through offering near-zero marginal cost services.[58] From this, we can hypothesize a future scenario where you could essentially get near 'free' service in exchange for your data. This is also congruent with the vision for the future business model of automobiles being essentially a vessel providing services and made feasible through selling trip or user related data to third paries. This is discussed in the 'Zero Dollar Car'[59] where Ellis argues that through this mechanism of the trade in big data can reduce the costs of vehicles to essentially zero dollars, he stresses the idea of trading privacy for the service of car use or even ownership.

If MaaS choses to go this direction, it could have disruptive consequences, both positive and negative, including serious positive health and sustainability outcomes, providing that this is a major goal which MaaS sets to achieve, alongside with reduction of car ownership.

According to Sunstein, one of the best examples to explain an economical 'nudge' is a GPS device. "It gives the user a means that they can override the option (chosen by the GPS) if they choose to. That is it respects people's ends, it preserves freedom of choice, and steers them in a direction which is consistent with their own destination."[60] However, as navigation apps like 'Waze' make increasingly better predictions for faster and less congested routes, users may follow without questioning. This trend may progress in the future with AVs when humans are no longer concerned with the driving and perhaps with the chosen route. Additionally they may be increasingly nudged to suggested destinations, once the operation system of AVs can be synchronized to our personal assistants, the like of 'Alexa' or 'Siri'.

Another GPS consideration comes from game apps such as Pokemon Go by Niantic Labs which use the GPS to connect reality with augmented reality in a form of a game. Zuboff[61] points out however, that this entertaining game which incentivises walking in public space hides beneath it another motive. This motive is in the business model in which 'lure models' direct players through incentives and rewards of the game towards destinations of business customers (Starbucks and McDonald's are mentioned) nudging them physically into their commercial establishments. Zuboff argues that this a new advanced form of surveillance capitalism where one can predicting where a user will go to, which she calls the 'footfall' and is the physical equivalent of predicting what a user will click online (known as the 'click-through-rate')[62].

In the case of MaaS, the continuous connectivity and knowledge of location of users, connected to services which are part the data economy, there is every reason to believe that businesses supporting or

54. Harari, Y. N. (2016). Homo Deus: A Brief History of Tomorrow. Random House.
55. Zuboff, S. (2019). The Age of Surveillance Capitalism: The Fight for a Human Future at the New Frontier of Power. PublicAffairs
56. Rifkin, J. (2011). The Third Industrial Revolution: How Lateral Power Is Transforming Energy, the Economy, and the World. St. Martin's Publishing Group.
57. The Fourth Industrial Revolution: What it means and how to respond. (n.d.). World Economic Forum. from https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond/
58. Rifkin, J. (2011). The Third Industrial Revolution: How Lateral Power Is Transforming Energy, the Economy, and the World. St. Martin's Publishing Group.
59. Ellis, J. (2017). The Zero Dollar Car: How the Revolution in Big Data Will Change Your Life. Barlow Book Publishing.
60. Starr Forum: Behavioral Science and Nudges: Environmental Protection and Sustainability. (2017, March 3). https://www.youtube.com/watch?v=li_jChiZmc8
61. Zuboff, S. (2019). The Age of Surveillance Capitalism: The Fight for a Human Future at the New Frontier of Power. PublicAffairs
62. Zuboff, S. (2019). The Age of Surveillance Capitalism: The Fight for a Human Future at the New Frontier of Power. PublicAffairs.

advertising within the MaaS App may have an interest in unconsciously nudging users to consume a service or physically redirect a user to a location for their profits. Although this ethical concern revolves around a business model which surveillance capitalists (like Google or Facebook) apply, there is a way to see how health and sustainability outcomes may be undermined in such a situation. However, unconscious nudging towards more positive health and sustainability outcomes may also be beneficial or taken advantage of by possible third parties, these may have commercial interest in exploiting this.

For final consideration and future research an ethical question can be posed. In theory, unconscious nudging tactics may also be used by authorities or organizations to promote healthier and less emitting choices, the question that rises here is whether there is a difference between unconscious nudging for profit gains versus unconscious nudging for what is generally widely considered a positive societal and environmental purpose. In both cases there is user unawareness while the outcome can used for different ends.

Further research in this field has great potential and as there are more precedents, the attention focuses on real-life case studies that go beyond the hypothetical theoretical ethical framework.

2.3 INTEGRATION OF TRANSPORTATION MODES

What are the possible effects of the integration of modes through a MaaS App on the choice of modes by its user?

When taking into consideration that one of the main ideas behind MaaS is the integration of different modes of transportation, then we can discuss how this may affect the users' choice of mode. The integration may incentivize users to try a new mode, which they previously (before using MaaS) had not used or tried before, as they would have considered it an additional expense. The idea of MaaS implies that the users are paying for mobility as a service in the form of a 'bundle' or subscription, which means payment (or in some cases also price comparison) may be taken out of the equation in the decision-making process by a user choosing a mode or combination of modes.

Furthermore, the integration may also incentivize the user to try a different mode because it is recommended by the trip planner feature of the App.

Additionally, associated with the multitude of modes, the user will have more possibilities and alternatives to get from A to B, which may affect the modal split in a different way. This may also cause an 'option overload', in which case the user might decide to rely on the recommended option shown first (nudging).

The table below asks how does the integration of modes affect health & sustainability outcomes

Effect of switching modes (from columns to rows) on health and sustainability outcomes

- `+` Positive health and/or sustainability outcome
- `-/+` Positive or negative health and/or sustainability outcome
- `-` Negative health and/or sustainability outcome
- `*` Not taken into consideration by a MaaS App
- `1` See matching paragraph for explanation

How does → Affect ↓	Walking	Low Speed – Personally Powered	Low Speed – Electrically Powered	Car Share	Ride Hail	Public Transport
Walking		+	-	-/+	-	-/+ 1
Low speed - Human	*		-/+	-	-	-/+
Low speed - Electric	*	*		-	-	-/+
Car-Share	*	*	+		?	+
Ride Hail	*	*	+	+		+
Public Transport	*	*	+	-	-	
Carpool with Private Car	+	+	+	+	-	+
Private Car (SOV)	+	+	+	+	+	+

2 3 4 5 6

1 Walking

In terms of health and sustainability walking is healthy and carbon free, all modes except human power low speed (bikes, scooters) can be seen as 'lowering' of level of health (non-active) or sustainability (requiring power and therefore emitting).

In the case of e-scooters, it is possible that these take away from trips previously done by foot, in which case it could be technically seen as less healthy and sustainable, however, it is also possible that due to the awareness of the user of the e-scooter option, they might make a choice where they walk more and take the e-scooter for part of their trajectory instead of opting for a motorized option.

Car-share can incentivize walking short distances instead of parking in one's garage or in front of the destination, and therefore can have a positive, yet limited effect on walking. These effects are small per trip but can accumulate to positive health outcomes.

Ride-hail is usually an on-demand on-location activity which disincentives even short distance walking, depending on convenient drop-off.

Some users may be shifting from walking to public transport as an integrated feature of MaaS, however usually walking is combined with any public transport trip.

2 Walking + low speed personally powered

Inarguably walking and cycling are both healthiest and zero emitting, therefore are always 'better off', in terms of outcomes, than other modes of transportation. However for a user to make these choices, they may not need to use MaaS service or a MaaS App and might pursue an independent choice outside of the traceable functionalities provided by the app, consequently the data on the behaviour of these users will not be integrated in the analytics of the MaaS app.

3 Low Speed – Electrically Powered

Some studies have shown that e-scooter users are more likely to have walked before than driven a car. A move from walking to e-scooter or e-bike, is considered a negative health and sustainability impact, although one has to finally measure if this change will prevent using modes which are even less sustainable or healthy, which has to be further researched.[1]

4 Car share

The ease of use of car-share programs, combined with better allocation in the public space and dedicated parking spaces and permission to use resident permit spaces, may on the one hand cause a shift from car-ownership to car-sharing, on the other hand may cause public transportation or bike users which cannot afford or choose not to own a car to use car-share over these modes which are healthier and more sustainable. Nevertheless, car-share still may require walking, on both ends of the trip, arguably detaching parking needs to near-zero distance from actual origin and destination to a distance of walking 'a block' considered, which could be reasonably acceptable by typical users.

1. Putting Scooter Emissions in Perspective—Micromobility Industries. (n.d.). from https://micromobility.io/blog/2019/11/26/putting-scooter-emissions-in-perspective

5 Ride hail

Ride hail has a mainly negative influence on all modes except private cars, as it is more emitting and is a real door-to-door solution. However, this can be mitigated slightly by sharing the vehicle (such as Uber pool) and making shuttle-like transportation. Nevertheless, ride hailing has a potential key role to play within a service economy if MaaS eventually reduces significantly private cars and sharing fleets can be reorganized and optimized. This will be especially true once AVs come into play.

Although ride-hail and taxis serve a similar service, the difference in a connected MaaS environment can be influential on the mode choice. With fluctuating on-demand prices, and for specific short distances,often the difference between public transportation and ride hail can influence the user's choice of trip, leading to an eventual less sustainable trip.

6 Public transportation

Public transportation is generally seen as the main alternative for mass mobility. Authorities have control over the fleet, scheduling, routes and physical dedicated space, they also have control on electrification and emissions of the fleet. Therefore an increase in ridership and reduction in time and increase in convenience and efficiency of the system is beneficial for the overall population.

While shifting users from walking or bike riding to public transportation may be considered as a negative health and sustainable outcome, MaaS has the potential to use the integration of parts of the trip as complementary between public transportation and active modes, thereby making the journey from A to B more reliable and predictable, one of the elements which deter users from using public transportation. If MaaS can help in the inclusion of volume of users per bus or train, it could also redirect users to less crowded options in real life, this reliability aspect can make public transportation more attractive to the population that prefers automobile use eventhough reasonable public transportation option are available between their origin and destination.

Questions for further research

When we think of the effects of the integration of modes relating to the MaaS App we can think of the following questions, the first question was dealt with above, however, there is need for further research in the matter:

1. In what ways can the MaaS App influence the use to choose to use a modal choice or trajectory associated with positive health and sustainability outcomes?

1. Is a user of an integrated MaaS App more likely to use modes which they do not currently use (because of additional payment, unawareness of the option, or other reasons)?

2. How can MaaS promote public transportation, walking and bike use in ways that are not already explored in the current pre-MaaS context? What is MaaS additive factor?

2.4 MAAS & URBAN DESIGN

MaaS + Urban design rationale

The potential of MaaS to gain traction and to positively affect health and sustainability outcomes, as well as reduce car ownership are all currently uncertain. However, if we look at health and sustainability as a question of the built environment and essentially one that can be translated into urban design by measures such as walkability and the street layout and design which define largely what modes of transportation are available and can be chosen to commute and move around in the urban environment. If the public space would be designed with MaaS in mind, theoretically, there is a greater chance of having positive health and sustainability outcomes.

Active design

There may be potential for greater opportunities to incentivize the use of active mobility, as the design features to encourage the use of bicycles or walking, are rooted in the real physical space. If these spaces are to be incentivized in the digital space as well (of the connected MaaS ecosystem), they could result in positive health outcomes. In this case, we understand that there may be no economic incentive for the MaaS operator to do so if it is seeking profit. However if a governmental institute can 'impose' measurements on these operators, this becomes easier to imagine.

Example of MaaS + Urban design : Bus stop + bike-share docking

When MaaS is taken into consideration in the redesign of a curbspace, the allocation of the different uses which are part of a MaaS system can benefit from the fact that they are all part of the same system. For this we can imagine that for example a bike-sharing dock station and e-scooters standing adjacent to a bus-stop may incentivize and enable the seamless integration from one mode to another, characterized by the idea of MaaS.

Furthermore, as MaaS could potentially Integrate all modes in real time, it could already 'book' a slot in bike docking station if you are arriving by other mode like a bus and you secured that when you get off that bus stop, that the bike dock indeed has a bike available just for you. This can also avoid 'crowd hurdling' imagining 10 people getting off at a bus stop and all 'fighting' for the handful of bikes available.

Relating to the health and sustainability factor, it could be that due to this convenience in the trajectory, people may indeed use a combination of bus+bike/scooter over a car trip, they are creating a less emitting journey that is also healthier as it involves more active transport.

Bus stops 'Portals to Places'

From the 'Portals to Places' initiative by PPS (Project for Public Spaces)[1], we can learn of an approach to make bus use more sustainable socially and consequently environmentally, or the choice to take a bus over the car for that matter. The idea behind it is grouping elements which relate to community life, like local shops and public space activation elements to the immediate vicinity of the bus stop, thereby making it the center of focus.

How does this relate to MaaS? The idea that prioritization for public transportation can be built in to MaaS is apparent in the way that MaaS promoters (such as Global MaaS) are pitching their ideas. If they can

1. How a Humble Bus Stop can Anchor a Whole Neighborhood. (n.d.). from https://www.pps.org/article/how-a-humble-bus-stop-can-anchor-a-whole-neighborhood

achieve this only through the digital means, is however questionable. However if these digital measures are coupled with physical design solutions there may be a path to the creation of a potentially healthier and more sustainable design outcome. If these measures communicate (in the physical space) the same hierarchy of modal prioritization, including the prioritization of walkability (which is a large urban design issue), then it has the potential to affect the commuters choice and way of moving in the city. For example, if around the express bus stop, someone can grab a coffee on the way to work, or alternatively buy some groceries on the way home before switching to another lighter mode for the 'last mile', then there would have been created a situation where the use of the car does not seem more attractive or convenient.

Future - Electric or Carfree?

Hypothetically, there could be a formation of two camps in regards to the future of mobility. One direction is the electrification of everything, which can be interpreted in relationship to sustainability as an effort to reduce emissions, and ultimately achieve emission neutrality. The electrification 'party' has no stand on the car-ownership model, as long as cars are electric, it does not matter if they are shared or privately owned, the logic goes. On the other hand, the carfree 'party' sees the reduction of emissions to be linked to the reduction in physical numbers of cars and finding solutions to make cities as least-possible automobile-reliant as possible. In this case their stand on car ownership does matter.

As the MaaS 'community' explicitly emphasizes that the reduction of car ownership is one of their main goals, there is a general uncertainty in the market whether MaaS has this potential at all. However, the stance on the ownership model with the car-free divergence may lead to a greater connection between carfree ideals which are essentially an urban design model, more than a mobility model. Therefore, a model where MaaS and urban design are thought together may ultimately be more beneficial for the type of non car-reliant environments that MaaS promoters are talking about and urban designers can visualize.

Testing

In theory, to test if there is a positive correlation between MaaS and urban design solutions towards positive health and sustainability outcomes would be a difficult task to perform, as it may require the exclusion of other contributing factors and the isolation of determined factors. in theory one could compare a current user without a MaaS App, a user with a MaaS App in a currently non-altered or purposely designed situation, and thirdly a situation where there is use of a MaaS App as well as physical alterations of the space.

Another possibility is the comparison of two different locations, one which has the integration and walkability factors in the current layout of a specific street and one street which does not have this layout. However, in such a case, it would be difficult to isolate a possible change in usage pattern and attribute it to MaaS and urban design.

Conclusion on MaaS + Urban Deisgn

To conclude, the success of MaaS in achieving positive health and sustainability outcomes is inconclusive, however, if MaaS is to be positioned in the context of making part of a complex variety of factors that when working in unison, may have the potential to positively affect health and sustainability outcomes by design. There is reason to believe that a MaaS network combined with physical urban design solutions that promote walkability and the use of active transport, may help to encourage users to use public transport and integrate this use with active modes rather than opting to use a private automobile. However there is a need for further study and real-life testing and comparison in order to come to more solid initial conclusions.

2.5 CRITIQUES AND CHALLENGES

In general, if we look at MaaS in isolation, it is difficult to identify a clear understanding on whether it actually has the potential to create positive health and sustainability outcomes. The first argument therefore would be that in order to assess potential positive outcomes, MaaS will have to be looked at from an indirect angle or in conjunction with other factors such as the physical design of cities and the way transportation is integrated within this physical fabric.

Research questions

There are a number of implications for MaaS apps in the findings of the articles starting below. In particular questions raised is:

1. Can MaaS positively influence health and sustainability outcomes for transportation in cities?
2. How are health and sustainability outcomes reached?
3. What conditions optimize the above?
4. What are potential negative outcomes?

2.5.1 NEED FOR RESEARCH

Despite the potential, the existing potential of MaaS systems are untapped and not thoroughly researched. Studies even mentioned that "... the current MaaS implementations are limited, (and) there is little evidence... that MaaS could actually be used as a mobility management tool to influence people's uptake of shared modes."[1] Most advanced applications of MaaS product bundles such as Whim and Ubigo are in field trials. There are many various approaches to bundling mobility services that could cater to different socio-demographic groups such as families, students, or elders. However, there is no study about how these could impact potential uptake of new modes and shared services.

Nudge proven only short term

It was also discussed that social marketing and "nudge" theory can alter behavior but not enough in the long term if environmental conditions and policies don't change as well.[2] The non-regulatory measures that a MaaS app can provide used in isolation are not likely to be effective if regulatory measures such as changes in policies do not happen. [3] In general, more study on the effects of nudge in MaaS is needed.

Success depends on context

It is argued that non-regulatory measures can still effectively change consumer psychology in terms of awareness of levels of energy consumption and the impact of everyday choices. It is argued that there are definitely long term benefits for engaging MaaS apps that use educational measures and "nudging" strategies such as a carrots system. But, in the end, if the needs of a commuter are not met environmentally and financially,

1. Matyas, Melinda, and Maria Kamargianni. "The Potential of Mobility as a Service Bundles as a Mobility Management Tool." Transportation, August 6, 2018. https://doi.org/10.1007/s11116-018-9913-4. (2)
2. Barr, Stewart, and Jan Prillwitz. "A Smarter Choice? Exploring the Behaviour Change Agenda for Environmentally Sustainable Mobility." Environment and Planning C: Government and Policy 32, no. 1 (February 2014): 1–19. https://doi.org/10.1068/c1201.
3. Barr, Stewart, and Jan Prillwitz. "A Smarter Choice? Exploring the Behaviour Change Agenda for Environmentally Sustainable Mobility." Environment and Planning C: Government and Policy 32, no. 1 (February 2014): 15. https://doi.org/10.1068/c1201.

such as if there are no suitable sustainable alternatives that are available, environmental and health incentives will likely be disregarded. Hypothetically, the MaaS app would be successful in changing urban mobility habits among people who have viable options, most likely, people who live in dense urban areas with proper public transit and other shared mobility services and infrastructure.

Modes of transportation

In terms of the integration of modes, there is a possibility of incentivizing users to have more healthy or sustainable trips than they previously had solely from the ease of integration of modes and a single payment system. A combination of public transportation in combination with an active mode of transportation, rather than using a private car, can become a more attractive or viable option due to the integrational feature of the MaaS app.

Research is being done with regards to the uptaking of MaaS by users, this is important in this earlier stage of early adopters to the technology. For MaaS to be used more widespread, the move towards uptaking MaaS is essential. However, once there is a 'critical mass' of users, looking into the behavioural economics of MaaS and its 'architecture of choice', may have more potential in maintaining users and user retention may be the main focus of MaaS Apps rather than acquiring new users.

It is difficult to relate nudging experiences specifically to MaaS, and then come to any conclusions regarding achieving positive health and sustainability outcomes by nudging users through various techniques to make more positive choices. These do have the possibility to influence small but important decisions, and may change the behaviour of users by reminding them of health outcomes, gamification through a reward system, as well as smart trip planner highlighting sustainable choices.

Users currently are experiencing an App fatigue and an overload of information on all levels, leading to an inability to make simple decisions. On top of that, algorithms are getting more accurate and often prove their effectiveness as in the example of navigation app Waze, where even users which are very familiar with a certain locality and its road system, would still use waze as it provides real-time route re-calculation according to traffic conditions and unexpected occurrences on the route. In this context, nudging can be used to take advantage of the situation and positive health and sustainability values to trips can be prioritized through different methods of nudging discussed. If nudging is to be taken seriously as a way of changing users habits rather than merely giving them more choice, it can be used to 'manipulate' choice trips so that healthier and more sustainable choices are clearly given priority, while unsustainable and unhealthy options are difficult to access by the user interface.

What is potentially needed for effective nudging is a large user base and a detailed collection of every aspect of thousands of individual trips. With this data, nudging can be more effective and personalized to the individual level, probing thousands of nudging tactics in a continuous manner on a large database of users, could collectively lead to extremely powerful algorithms which may become of public value and importance. Therefore, governmental and municipal involvement are crucial in order to achieve positive health and sustainability outcomes, which may not be achievable if left to corporations and the industry's interests.

MaaS + Urban design

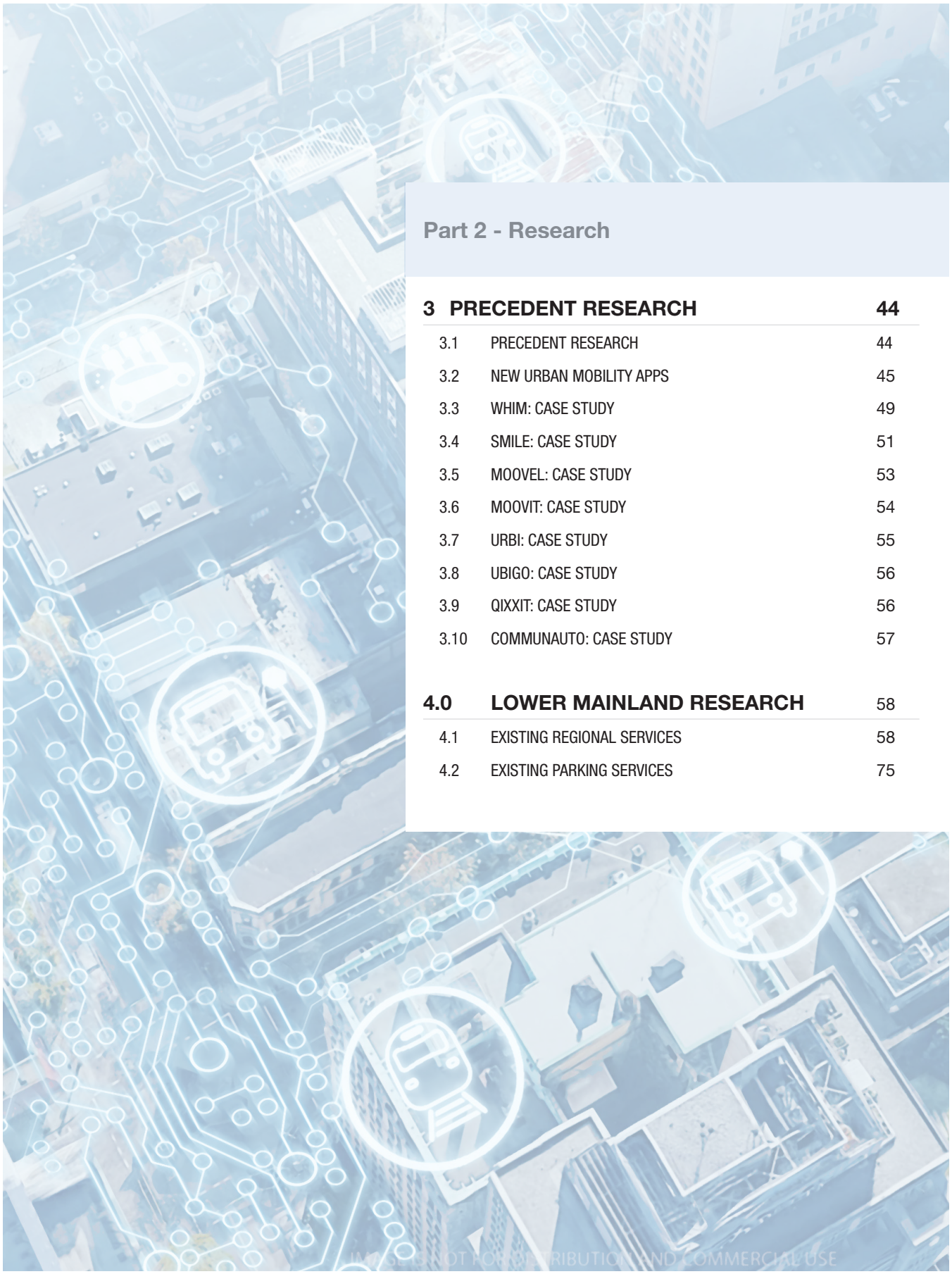
The connection between the physical design of the public space and MaaS is an area which requires more research and more on-ground testing of design solutions. The idea of seamless modal integration which is a cornerstone of the MaaS concept may be more relevant and effective if physical design is combined with app convenience. An example given to illustrate this is the bike-share integrated in a bus stop to complete the

'last mile', as a physical design solution. Although ths can be combined with a virtual solution of MaaS already reserving a bike on the given bus stop while automatically performing a bike availability query.

To conclude, the success of MaaS in achieving positive health and sustainability outcomes is inconclusive, however, if MaaS is to be positioned in the context of making part of a complex variety of factors that when working in unison, may have the potential to positively affect health and sustainability outcomes by design. There is reason to believe that combined with physical urban design solutions that promote walkability and the use of active transport, may help to encourage users to use public transport and integrate this use with active modes rather than opting to use a private automobile. However there is a need for further study and real-life testing and comparison in order to come to more solid initial conclusions.

Conclusion

MaaS could potentially have a role in facilitating healthier and more sustainable mobility lifestyles and also help increase use of alternative mobility services other than S.O.V.s. There are general indicators showing directions where MaaS needs more research, such as in using incentive driven design, nudges, creating reliability in technology, or developing a favorable regulatory context to achieve a desired health and sustainability outcome. More research, particularly however, in regards to the components of MaaS as an application itself is also required in tandem to support this.



Part 2 - Research

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3 PRECEDENT RESEARCH

Mobility as a Service, or MaaS, combines all means of separate transportation services into a single mobile service. Removing the hassles of paying separately, planning, and judging the validity of using many different existing service providers separately, MaaS promotes a greater usage of existing alternative transportation services in a city as a holistic system for the user. This may allow potential users to achieve a more environmentally friendly, flexible, healthy, and convenient lifestyle.

The precedent research analyzes the current state of MaaS apps, their strengths, and also what could be further developed for a more developed MaaS App. What type of app it is, who funds and operates the app, where the app is operable, what mobility options the app provides, what the breadth or area of operation is, what options are present to sort your route options, do they have access to an API, how user data is used, wether one can pay through the app, and what regulations are in place to facilitate the MaaS App were explored.

3.1 PRECEDENT RESEARCH

3.1.1 MAAS INDEX FROM KPMG

In approaching the precedent research, a helpful quantification for the use of MaaS models in a given location was the MaaS index as outlined by KPMG. KPMG is an adviser to the world's transport and local authorities[1] who provides audit, tax and advisory services. In their report Reimagine Places: Mobility as a Service, they outline the six questions of their index:

1. What is the complexity of modal choice in your area?
2. How easy is it to achieve key policy objectives, such as good air quality, reduced congestion, public health, and the avoidance of over-crowding
3. What is the mix of public- and private-sector operators in your context? What is the balance of commercial, economic and policy objectives?
4. How seamless is journey planning and payment within your region and neighbouring regions? To what extent does inertia in payments and planning impact mobility choices?
5. What happens when things go wrong? Is your transport ecosystem resilient? If one mode fails, can others take up the slack? Does this apply to all customer segments?
6. What is the critical path of initiatives and interventions that you will need to deliver your target MaaS ecosystem?[2]

These six steps informed how we approached our precedent research and the categories we considered when comparing different MaaS precedents.

‘

1. Foulser, Ben. “Reimagine Places: Mobility as a Service,” 2017, 26
2. Ibid, 27

3.2 NEW URBAN MOBILITY APPS

Figure 1. Mobility Apps used in Analysis.

Generating a framework for a MaaS app well-suited to Vancouver's particular context required the review of mobility apps from around the world. The apps reviews ranged from fully functional MaaS apps, to trip planning apps, and alternate mobility platforms. The cross section of apps reviewed represents a sampling of all the things an app in Vancouver could do and aspire to be. It serves as a launch pad for TIPSlabs' own investigations into the regulations, app interface, and functionality that will govern Vancouver's MaaS app.

A precedent study also helps understand what problems and opportunities have existed for other organizations who are implementing maas. It helps to understand why they developed the part, what worked, what didn't, and how it was implemented.

3.2.1 PRECEDENT COMPARISON (TABLE AND DESCRIPTION)

The Whim app, "the world's first ever all-inclusive mobility service" according to MaaS Global[3], has been the most insightful precedent for our investigations into what MaaS could look like in the Lower Mainland. Whim is the MaaS app that has been operating longest and represents the pinnacle of what a MaaS app can be in 2018. Further, because of its success and the fact that it is the most established of its competitors, despite being a young app-- it is the go to case study for MaaS research in general. 1.2.1.

To form a common language to relate the various mobility apps to one another, the apps were all placed a table and weighed against common categories. This is shown in Figure 2 and 2.1 in the following pages. The selected app precedents were places along the Y axis, while the categories each app were weighed against populated the X axis.

The categories along the X axis are layed out as follows:

1. Function: This category defines whether a selected app was a fully integrated MaaS app (operator) with the ability to plan and pay all built into the app, or whether it was an

3. MaaS Global. "Whim, the world's first all-inclusive mobility service, promises to change urban travel forever," 2013. Accessed September 12, 2018. https://maas.global/whim-the-worlds-first-all-inclusive-mobility-service-promises-to-change-urban-travel-forever/

aggregator/planner of services that allowed you to plan your route but does not allow for seamless payment and integration of services on the app.

2. Run by/ backed by: Refers to who finances and operates app.
3. Location: Where the app is operable.
4. Services: What mobility services are available through the app? Public transportation, taxis, and bikeshare etc.
5. Service Providers: The aim of this was to look at whether the service providers operate in the public or private sector. In all cases the service providers were privately owned with public transport as the unique exception.
6. Scope: What is the scope of the app? Does it operate in one city, or multi-city? Or is it just a trial run and is not fully operable?
7. Filtering Options: How are your routes sorted?
8. Data Collection: How is data shared between the service providers and the app operator? Is it a business to business partnership where partnerships are set up between each service provider and the operator, or is certain service provider information such as pricing, routing etc… available openly via open API (Application Program Interface)? Business to Business (B2B) is a business model that focuses on selling products and services to other companies. Data collection through business to business model can be done through tracking website activities, implementing lead magnet tools, conducting research, conducting integrated surveys through the service, and using social media. [4] Businesses themselves may provide data directly for use and integration within a MaaS application. Open API (Application Program Interaction) on the other hand may allow open availability of data by mobility services to the MaaS application.
9. User Data: How the data is stored? How is user data used? Is it for internal purposes? Is it sold (external)?
10. Payment and Ticketing Integration: Is the payment for your route and the associated ticketing integrated into the app (centralized) so you can seamlessly pay and access your bookings/tickets/reservations on the app, or does the app only function as a planner and redirect you to the service provider's app?
11. Regulation: Are their regulations in place in the region to support MaaS platforms?

As MaaS apps are relatively new and in many cases proprietary, the information to fill in all these categories were hard to come by in some cases and have yet to be determined. In these instances the table cell was left blank.

4. Deshpande Indrajeet "5 Amart Ways to Capture B2B Customer Data" martechadvisor.com Web. Accessed Feb 25th 2019

PROJECT APP	FUNCTION	RUN BY/ BACKED BY	LOCATION	SERVICES		SERVICE PROVIDER SECTOR	SCOPE
				PUBLIC	PRIVATE		
SMILE	OPERATOR	Wiener Staftwerke in cooperation with Wiener Linien (Vienna's public transport provider), Austrian Federal railways, private car sharing, taxi, and bike sharing service providers.	Vienna			Private: charging station, bikeshare, carshare, taxi, parking station. Public: metro, bus,tram, train, ferry.	TRIAL/CITY
WHIM	OPERATOR	MaaS Global (private)	Helsinki, Finland UK Midlands Antwerp		$$	Private: bikeshare, car rental, taxi, Public: tram, metro, bus, ferry, commuter train,	TRIAL/CITY
MOOVEL	OPERATOR	Daimler BMW Group (private)	Germany (active) Boston Portland Helsinki (trial)			Private: Trains, Carsharing, Taxi, Ridehailing, bikesharing. Public: Buses, trains.	MULTICITY
MOOVIT	AGGREGATOR	SeqUoia Capital BRM Group Gemini Israel Fund BMW	1200 cities in Metro areas across 70 countries.				MULTICITY
URBI	AGGREGATOR	Partner: Moovit	Italy Germany Spain Netherlands Austria Denmark				LOCAL
GOOGLE/ GOOGLE MAPS	AGGREGATOR	Alphabet Inc. (private)	(Global)				MULTICITY
UBIGO	OPERATOR	Go Smart	Gothenburg		$$		TRIAL
QIXXIT	AGGREGATOR	Deutsche Bahn	Germany to International				MULTICITY
COMMUNAUTO BIXI	OPERATOR AGGREGATOR	-	Montreal				MULTICITY

Figure 2. MaaS App Precedent Comparison Table (part 1 of 2)

FILTERING OPTIONS	TO OMIT	DATA COLLECTION	USER DATA	PAYMENT AND TICKETING INTEGRATION	REGULATION	SPECIAL FEATURES	STATUS	PROJECT APP
travel time price CO2	masterdata and geoinfo routing info	PARTNERSHIP B2B	INTERNAL DATA	CENTRALIZED	None.	A standardized interface enables all mobility partners to link their technical systems via specific adaptors to provide all their data.	Ended.	SMILE
Travel Time Price CO2		PARTNERSHIP B2B & OPEN DATA OPEN API	INTERNAL DATA (USER PREFERENCES)	CENTRALIZED	Obligatory data availability of private mobility services.	Synchronizes with the user's calendar, helping to plan journeys in advance. Also learns about the user's preferences.	Launched.	WHIM
Fastest route Cheapest route	Calculates best trip and best fare with real-time traffic	PARTNERSHIP B2B		CENTRALIZED			Active.	MOOVEL
Least walking Best route Least transfers Transit type Favorite stations	Crowd-sourced info for transit itineraries Real-time arrival	OPEN DATA OPEN API		REDIRECT			Active.	MOOVIT
By provider Transmission Engine % Driving Range Size Baby Offers	Best trip or fare with real-time traffic			REDIRECT			service discontinued after the pilot ended, mainly due to difficulties finding a cooperative model that worked for both the region PT-provider and UbiGo as an emerging private, commercial service	URBI
								GOOGLE/ GOOGLE MAPS
		PARTNERSHIP WITH FLUIDTIME B2B	USER BEHAVIOR PREFERRED COMBINATIONS	CENTRALIZED			Ended Trail.	UBIGO
Fast and cheap Duration Price Number of stops Outbound Departure		PARTNERSHIP SKYSCANNER B2B		REDIRECT			Different to other MaaS service concepts, Quixxit integrates almost all transport modes and respective organizations that are available in Germany and thus provides rather a mobility consultancy service providing intermodal transport information on a meta-level by linking different digital mobility services on a virtual level to form one common information platform and so enabling easier mode access and transfers.	QIXXIT
							Active.	COMMUNAUTO BIXI

Figure 2.1. MaaS App Precedent Comparison Table (part 2 of 2) Continued.

3.3 WHIM: CASE STUDY

Of the precedents reviewed in our table, Whim app was the most successful MaaS App row category and offered the most robust information and therefore was the main case study mined for insights into how a successful Vancouver MaaS platform could come to be. Whim is private company that is commercially operated mainly in Finland (where it started), while trials are currently underway in the UK as well as Belgium using the same platform. It is operated by MaaS Global.[5]

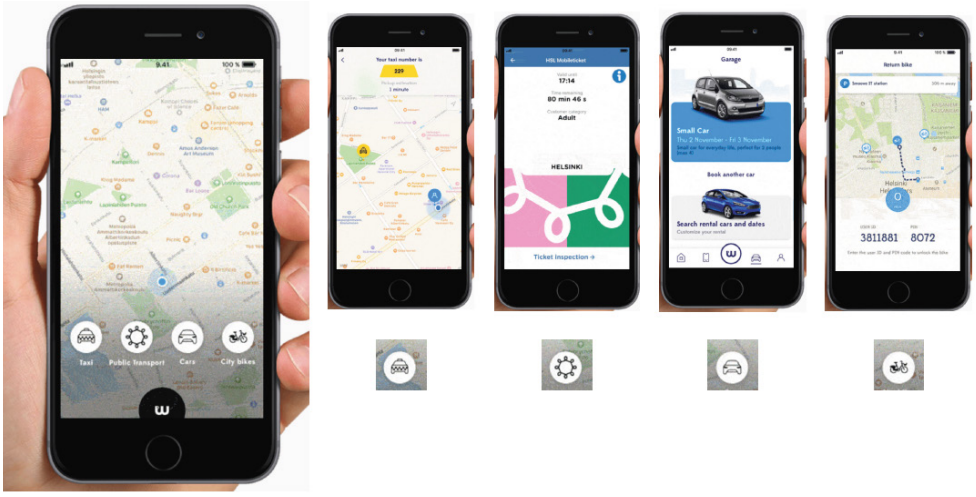

Figure 3. Phone Image For Whim App. Whim. "Travel Smarter" whimapp.com Web. Accessed Dec 20th. 2018 < https://whimapp.com>

3.3.1 SERVICE PROVIDERS:

Whim is consolidated with a wide range of providers. In the Finland area, the app is linked up with car rental, public transit, and taxi. Sixt Rent a Car, a car rental company founded in 1912 in Munich, Germany and now operates in 105 countries with 2200 branch locations, provides car rental services. [6]Also offering 1-3 day car rentals for this app is Mercedes-Benz, Citroen, DS, Ford, Honda, Peugot, Skoda, and Smart car is GO by VEHO. Vehicles are picked up at the Sixt office also. Yet another car rental service provider is Toyota Rent a Car. Toyota is also a significant investor in MaaS Global.[7]

Helsinki Region Transport (HSL or HRT) is a joint local authority since 2010 offering public transport on bus, tram, metro, ferry, and commuter train services. The municipalities involved are Helsinki, Espoo, Vantaa, Kaunianinen, Kerava, Kirkkonummi, Sipoo Siunto, and Tuusula. [8] The taxi providers in the Helsinki area are Lahitaksi[9], and Taksi Helsinki-- Finland's largest taxi service.[10] Today the Finnish MaaS app Whim has started its trail runs in Antwerp and the West Midlands.[1112]

3.3.2 FARE STRUCTURE:

Whim provides different payment plans for different types of users. There is "Whim to Go" which allows users to pay per ride with no surcharges, no subscription, and no commitment.[13] For more regular users, there is "Whim Urban" and "Whim Unlimited" that allows app facilitated "access" to transportation services in a

5. "MaaS Global." Accessed August 7, 2018. https://maas.global/.
6. "Sixt Rent a Car | Rental Cars at Affordable Prices." Sixt. Accessed August 7, 2018. https://www.sixt.com/.
7. "Welcome to Toyota Rent! Rent the best car for your trip." Accessed August 7, 2018. https://www.toyota.fi/palvelut/rent/in-english.json.
8. "HSL." HSL. Accessed August 7, 2018. https://www.hsl.fi/en.
9. "Lähitaksi - Lähitaksi." Accessed August 7, 2018. https://www.lahitaksi.fi/en.
10. "Taksi Helsinki | Taksihelsinki.Fi | 0100 0700." Accessed August 7, 2018. https://taksihelsinki.fi/.
11. https://newmobility.news/2017/10/02/finish-maas-global-starts-testing-one-mobility-app-antwerp/
12. https://maas-alliance.eu/maas-provider-launches-midlands-trial/
13. **Whim. "Travel Smarter" whimapp.com Web. Accessed Dec 20th. 2018 < https://whimapp.com>**

city with a monthly subscription at 49 and 499 Euros respectively. [14] For example Whim To Go, unlike the other two fee-required options, requires users to "pay as you go", does not include city bike services, and seems only facilitate ticketing and organization of trip. Currently, HSL Internal tickets are provided to users through Whim for public transportation. Figure 4 below shows their options as indicated on their website.

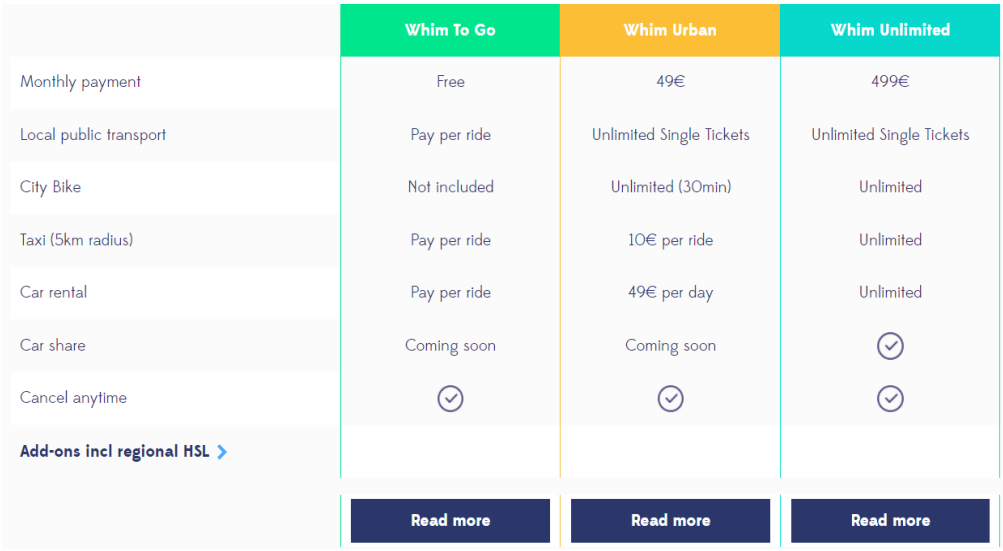

Figure 4. Fare table for Whim. "Whim - Travel Smarter. Live in Helsinki Region, More Areas Coming Soon!" Accessed August 7, 2018. https://whimapp.com/.

3.3.3 DATA ACCESS:

The data access for Whim is higher government regulated and this regulation is what has made the platform so relatively easy to set up. As legislated by the Finnish government, all service providers (regardless of mode of transport) are required to provide access to data.[15] Data of interest includes access to routes, stops, timetables, price/fares, and availability/accessibility. The modes of transport required to provide data are passenger transport services, stations, ports, other terminals; transport mode rentals and services for commercial ridesharing services; general commercial parking services; and brokering and dispatch services.

Also important is the access to sales interfaces for the ticket payment system. This applies to road and rail passengers transport operators who manage a ticket and payment system. All transport modes are obliged to provide access to allow for purchase of a standard-rate single-journey ticket.

3.3.4 REGULATION:

The Act on Transport Services is a key piece of legislation that came into effect July 1st, of 2018. [16]As defined in Ertico's brief Finland's Transport Code Focuses on Digitalization of Transport, the act encourages

> "new operators to enter the market by opening up data access to rivals. As Berner explained, 'We want to see one holistic, totally integrated transport system. We regulate the market over data, we don't regulate anymore over price.The intended outcome it to promote fairness of competition in the passenger transport market and competitiveness of the service providers of both passenger and goods transport. A second intention is to create a

14. Whim. "Travel Smarter" whimapp.com Web. Accessed Dec 20th. 2018 < https://whimapp.com>
15. "Obligation to Provide Access to Data - Finnish Transport Agency." Accessed August 7, 2018. https://www.liikennevirasto.fi/web/en/transport-system/access-to-data#.W2CxGi0ZP0Q.
16. Dec 5, and 2017 | Policy News. "Finland's Transport Code Focuses on Digitalisation of Transport." ERTICO Newsroom, December 5, 2017. http://erticonetwork.com/finlands-transport-code-focuses-digitalisation-transport/.

framework for a more efficient arrangement of publicly subsidised passenger transport by utilising digitalisation, combined transport, and different fleet types. And thirdly to improve efficiency of transport services helping to achieve environmental and climate goals. Berner explained that this new law "requires to open an API (Application Programming interface) for public and private service providers so that all can be integrated into one seamless travel chain that can be paid by one mobile system and all transport modes can be Austrian Insintegrated into one holistic system'."[17]

Another outcome of the updates regulations in Finland allows for the current passenger transportation (PT) license to be replaced with a PT license that allows any type of vehicle to be used as a taxi, limits number of actual taxi licenses, and all price regulations for taxis have been removed. [18]

3.3.5 BUSINESS MODEL

Whim's business model focuses on providing value through its integration and repackaging of mobility services for users through one convenient searching, reserving, paying mobile application.

3.4 SMILE: CASE STUDY

Smile was a trailed integrated mobility platform with a smartphone app designed to allow the user book, pay, and use all available means of transportation as a holistic system. [19] In particular, this case study of the MaaS App trial hinted at the potential for MaaS apps to facilitate more environmentally friendly user transportation behavior and greater use of intermodal or alternative transportation services present in their city. This reflects the potential of MaaS platforms to encourage greater use of local existing transportation services and better attainment of desired environmental sustainability by constituents. Smile was a pilot operation in 2014 that has since ended to simulate the viability, impacts, and successes of a MaaS mobility app.

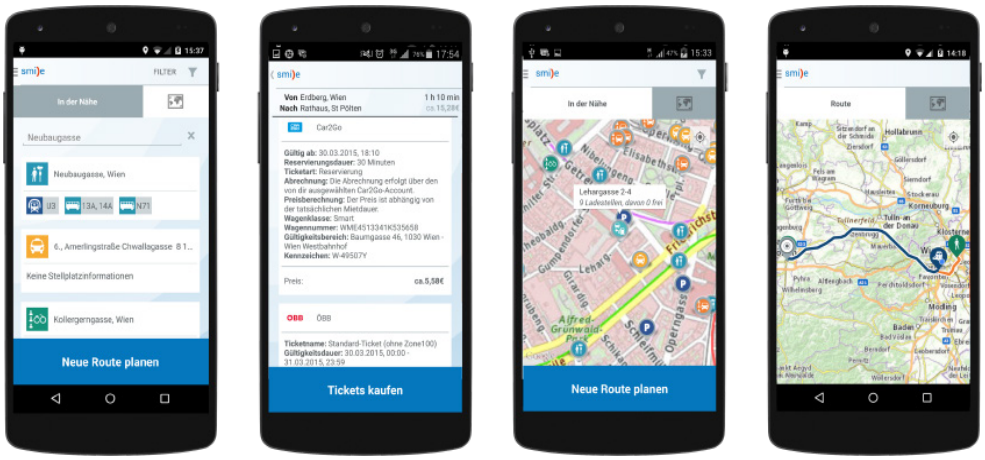

Figure 5. Smile App Use Screenshots.
Smile. "Smile- simply mobile" smile-einfachmobil.at Web. Accessed Dec 22th. 2018. <http://smile-einfachmobil.at/index_mobile_en.html>

The app aimed to offer a wide range of different transportation providers with all functions, including information, booking, payment, usage, and billing, in a standardized single interface. [20] Users were able to book an entire trip with several mobility providers without changing between different apps and payments. The Smile prototype

17. Ibid
18. SMITH, GÖRAN, and JANA SOCHOR. "Mobility as a Service: Comparing Developments in Sweden and Finland," 2017, 17.
19. Smile. "Smile- simply mobile" smile-einfachmobil.at Web. Accessed Dec 20th. 2018. <http://smile-einfachmobil.at/index_mobile_en.html>
20. Smile. "Smile- simply mobile" smile-einfachmobil.at Web. Accessed Dec 20th. 2018. <http://smile-einfachmobil.at/index_mobile_en.html>

MaaS app was tested by over 1000 users in Vienna and its trial ended in May 2015. [21] A result of a post-trail survey found that all test users were very content or content with Smile and researchers found potential that Smile MaaS App could help facilitate more environmentally friendly behavior by users.[22] In particular 48 % of respondents stated to use public transport more often, 21 % reduced private car use as a result of the App, and 26% used more intermodal transportation with a combination of bike, car, and public transportation. [23]

3.4.1 SERVICE PROVIDERS:

The Smile app consolidates many mobility service providers. In particular, Austria's two largest mobility service providers Wiener Linien (public transport provider of Austria) and Austrian Federal Railways were at the core of the project team. [24] Other contributors to the Smile app services encompass VAO verkehrsauskunft for connections, AIT for e-mobility, and toursprung for bikes.[25] To overview, for public transportation, Wiener Linien, OBB, Linz Linien were contributors.[26] Taxi 31300 provided taxi services and TwinCity Liner Wien provided ship services.[27] For Bike Sharing services, Citybike Wien, nextbike, and Grazbike were the contributors. [28] Flinkser, EMIL, emorail, and e-Carage provided for Carsharing services. Wipark, Wien Energie Tanke, Energie Steiermark, and Parkgaragen Elbl provided for park houses and charging points. Finally, Verkehrsauskunft Osterreich, AIT, and tourspring were routing partners.[29]

3.4.2 FARE STRUCTURE:

Smile considers "season tickers", discounts, and membership for users through their app.[30] For considering fixed and distance or time dependent travel prices, Smile calculates an overall orientation price and price for each travel segment. Payment in the case of a distance or time dependent mobility service, such as a taxi ride, will occur at the end of the individual ride; a push notification appears on the user's mobile phone in which is acceptance by the user confirms and pays for the service. [31]

3.4.3 DATA ACCESS:

During the trial run for Smile, all mobility partners linked their technical systems via "specific adaptors" to provide all their data including ticketing information. [32] Through Verkehrsauskunft Osterreich, AIT Router for e-car and bikes, and toursprung route for bike routes, all routing services were connected to Smile.[33] Data of the user then was used, upon specific user request, and selected and combined to provide the most suitable options for a requested trip.[34]

3.4.4 REGULATION:

The Smile App project was initiated by Wiener Stadtwerke, a company in Vienna Austria that encompasses Austrias public transporation provider. The Smile App pilot operation was thus a cooperation between Autrai's two largest service providers Wiener Linien of Weiner Stadweke and Osterreichische

21. Smile. "Smile- simply mobile" smile-einfachmobil.at Web. Accessed March 02 2019. <http://smile-einfachmobil.at/index_mobile_en.html>
22. Smile. "Smile- simply mobile" smile-einfachmobil.at Web. Accessed Dec 20th. 2018. <http://smile-einfachmobil.at/index_mobile_en.html>
23. Smile. "Smile- simply mobile" smile-einfachmobil.at Web. Accessed Dec 20th. 2018. <http://smile-einfachmobil.at/index_mobile_en.html>
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28. Smile. "Smile- simply mobile" smile-einfachmobil.at Web. Accessed Dec 20th. 2018. <http://smile-einfachmobil.at/index_mobile_en.html>
29. Smile. "Smile- simply mobile" smile-einfachmobil.at Web. Accessed Dec 20th. 2018. <http://smile-einfachmobil.at/index_mobile_en.html>
30. Smile. "Smile- simply mobile" smile-einfachmobil.at Web. Accessed Dec 20th. 2018. <http://smile-einfachmobil.at/index_mobile_en.html>
31. Smile. "Smile- simply mobile" smile-einfachmobil.at Web. Accessed Dec 20th. 2018. <http://smile-einfachmobil.at/index_mobile_en.html>
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33. Smile. "Smile- simply mobile" smile-einfachmobil.at Web. Accessed Dec 20th. 2018. <http://smile-einfachmobil.at/index_mobile_en.html>
34. Smile. "Smile- simply mobile" smile-einfachmobil.at Web. Accessed Dec 20th. 2018. <http://smile-einfachmobil.at/index_mobile_en.html>

Bundesbahnen OBB (Austrian Federal Railways) as well as related groups that are necessary for a MaaS app simulation. In general, this reserach project was funded by Climate and Energy Fund of the Austrian Federal Government and potentially garnered support due to it being part of the Autrain Electric Mobility Flagship Projects Programme.

3.5 MOOVEL: CASE STUDY

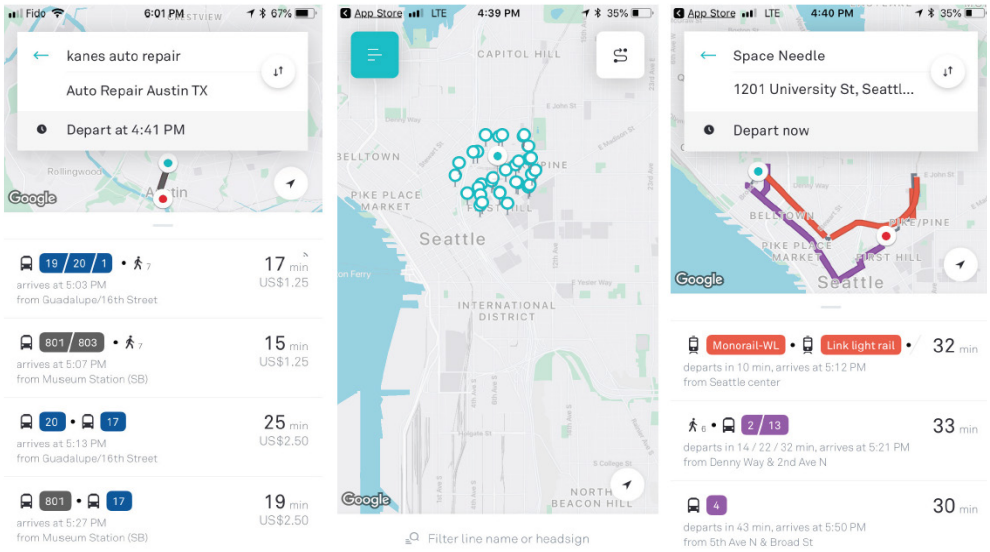


Figure 6. Moovel App Use Screenshots.
Moovel "The mobiltiy app for you city" moovel.com. Web Accessed Dec 24th. 2018. < https://www.moovel.com/en/featured-apps/moovel-mobility-app >

Moovel is a private mobility management platform that describes their mission to use new technologies to simplify urban mobility, encourage people to switch to shared mobility, and transform cities with more convenient sustainable mobility solutions.[35] As a case study, Moovel is significant as they show an example of advertising their app and services to mobility services and public transportation agencies or civic municipalities. Moovel shows how their underlying MaaS app framework can be flexible, grow with time, and can be shaped to fit any city context globally and remain effective. Moovel is currently in service in Germany and is undergoing trial in Boston, Portland, and Helsinki. Moovel has a number of featured apps including their Moovel Mobility App.[36] The Moovel app is available in Germany and Austria and are renaming themselves to "Reach Now".

3.5.1 SERVICE PROVIDERS:

Service providers for Moovel include Car2Go, mytaxi, NorisBike, NextBike, Stadtmobil Carsharing, and DB Bahn.[37] Public transportation providers include Trimet, Portland StreetCar, Valley Metro, Ladot, Metro Transit, cta, VRE, OCTA, pace, VIA, Metro, Atlanta Streetcar, SFMTA, Metra, Caltrain, MTS, Northern County Transit District, Santa Clara Valley Transportation Authority, Bart, MDOT Haryland Department of Transportation. [38]

Moovel was founded by Daimler, the company to "invent" the automobile and owner of Mercedes-Benz of Germany, to "reinvent the concept of urban mobility" [39]. Providing what they describe as a service to make rider experience more "convenient" and providing advantages to business or operations, they have encompassed a number of public service providers in their service provided. They describe by having a "seamless and efficient integrations" with the cities they are in, they allow attracted mobility service providers to "reach" more users and "expand into new regions".[40]

35. Moovel "Our Vision is a world without traffic jams" moovel.com. Web Accessed Dec 24th. 2018. < https://www.moovel.com/en/about/mission-vision>
36. Moovel "The mobiltiy app for you city" moovel.com. Web Accessed Dec 24th. 2018. < https://www.moovel.com/en/featured-apps/moovel-mobility-app >
37. Moovel "Private Trnasportation Partners" moovel.com Web Accessed Dec 26th 2018. < https://www.moovel.com/en/partners/private-transport-partners>
38. Moovel "Public Trnasportation Partners" moovel.com Web Accessed Dec 26th 2018. < https://www.moovel.com/en/partners/public-transport-partners>
39. Moovel "Mission and Vision" Web Accessed April 20th 2019 < https://www.moovel.com/en/about/mission-vision>
40. Moovel "Our Partners: Mobility Service providers" Web Accessed April 29th 2019 < https://www.moovel.com/en/partners/mobility-services-partners>

3.5.2 FARE STRUCTURE:

Payment is integrated and centralized through the app for the user and for the mobility providers; through providing different mobility choices to the user through the app, the use can confirm routes, book, and then confirm transactions. [41] To book with the app, users must register with the application and pay through a number of options such as PayPal or credit card. Users also have the option to pay through "modern payment sources" such as Apple Pay and Google Pay. [42]

3.5.3 DATA ACCESS:

The app provides accurate data for public transit and real-time data of city traffic and transportation departures in the city.[43] This allows for greater optimization and better trip-planning for Moovel app users with relevant mobility services. The application itself store and use the data users enter to help broker the services offered. [44]

3.6 MOOVIT: CASE STUDY

Moovit is a mobility as a service provider application that is is notable described to combine "live information" from the user and information from participating public transit providers to provide a "real-time picture" service for best journey routes.[45] As a case study, Moovit is significant as it is "an early pioneer" of mobility as a service, has been described to amass up to "five billion anonymous data points a day", has "400 million users", is well awarded, and has a system with grassroot local editors called "Mooviters" that help "map and maintain local transit information in cities" for the app that may be unserved. [46] Moovit has offices across the globe, including cities such as Calgary, San Francisco, Buenos Aires, Milan, Delhi, Kuala Lumpur, and Jakarta.

3.6.1 SERVICE PROVIDERS:

Moovit is described to be available free on web browsers, Applie iOS, and Android in more than "2700 cities", 90 countries, with the use of 45 languages. For more than 100 cities, "global events, organizations and cities" have made Moovit their official public transit application. [47] Notably, Moovit has partnerd with Microsoft Azure Maps, Uber, and other private mobility services in local or regional locations in tandem with its free transportation application.

Moovit was founded by Nir Erez, Roy Bick, and Yaron Evron [48]. Moovit advertises their services with how their system combines information from "public transit operations" and "live information" from the user community; Moovit users, for example, are described to send current reports about their "travel experience". Users are able to access a live map with GPS navigation that is updated with data from authorized public transit operators and crowdsourced information from users.

3.6.2 FARE STRUCTURE:

Moovit is mainly a crowed sourced public transportation navigation application that requires no fees for users to use to track and find best routes as per the service purpose. However by partnering with multiple other private mobility services such as Lyft, Moovit links to and provides the option for users to respectively see,

41. Moovel "The mobiltiy app for you city" moovel.com. Web Accessed Dec 24th. 2018. < https://www.moovel.com/en/featured-apps/moovel-mobility-app >
42. Moovel "City-branded Mobility App" moovel.com Web Accessed April 20h 2019. <https://www.moovel.com/en/our-products/for-public-transit-agencies-operators/mobility-app>
43. Apps "Moovel" play.google.com Web. Accessed Dec 30th 2018. < https://play.google.com/store/apps/details?id=com.moovel.na.mint&hl=en>
44. Moovel "Moovel App" Web. Accessed April 21st 2019. < https://www.moovel.com/en/featured-apps/moovel-mobility-app/faq>
45. Moovit "About Moovit" company.moovit.com Web. Accessed April 23th 2019 https://www.company.moovit.com/about>
46. Moovit "About Moovit" company.moovit.com Web. Accessed April 23th 2019 https://www.company.moovit.com/about>
47. Moovit "Moovit: At a Glance" docs.wixstatic.com Web. Accessed April 26th 2019 < https://docs.wixstatic.com/ugd/c729fe_d9b60792127a497390617948bdac3b71.pdf>
48. Moovit "Moovit: At a Glance" docs.wixstatic.com Web. Accessed April 26th 2019 < https://docs.wixstatic.com/ugd/c729fe_d9b60792127a497390617948bdac3b71.pdf>

pay, and use private mobility services showed in their map-based application[49].

3.6.3 DATA ACCESS:

Moovit uses data from regional public transportation authorities and users of the application to create real-time map services, data, and transportation journies for its users. Notably, Moovit has a system using grassroot local editors called "Mooviters" that help "map and maintain local transit information in cities". [50]

3.7 URBI: CASE STUDY

Urbi is a mobility as a service phone application where users are able to find mobility options for their intended route, choose and compare possible mobility service prices, and reserve that service to use through one applicaation. [51] Notably, Urbi tracks the history of past user reservations, can check the availability of nearby vehicles that become available to use, and allows users to buy and subscribe through the application. [52] Urbi is available to certain cities in Europe including Paris, Barcelona, Rome, Kobenhavn, Helsinki, or Wein. [53]

3.7.1 SERVICE PROVIDERS:

Urbi partners with local mobility service providers to provide services to users in the respective cities. Urbi in Paris, for example, is partnered with car2go, Coup, City scoot, zipcar, ubeeqo, Smovengo, OFO, Lime, wind, Mobike, Donkey Republic, Bird, Voi, moov-in, TIER, RTP. Urbi in Stockholm is partnered with Lime and Voi and urbi in Stuttgart encompasses car2go, stella, Call a Bike Stuttgart, and VVS. [54]

3.7.2 FARE STRUCTURE:

Urbi allows users to pay for their chosen mobility service through credit card, Apply Pay, or Google Pay [55] Notably, Urbi gives users "exclusive offers" for specific offered mobility services on their website store at discounted rates. [56] For "the sharing services of car/scooter/bike sharing" that can be found through Urbi, users must register with the respective services "in advance" before being able to book the resepctive vehicle; for booking car2go services in a foreign country, for example, urbi users need to book the vehicle "in advance" through the latest offical car2go app. [57] For taxi services, users are able to find, reserve, and book all through the application without any additional registration outside the app. Accepted payments include Visa, MasterCard, American Express, Diners Club, JCB, and Discover. [58]

3.7.3 DATA ACCESS:

Urbi collects "information about the location" of the users phone and data from the user through "URBANnext".59 Users name, address, age, nationality, information from a "driver's license", to "access and use services" of a moblity provider partnered with Urbi.[60] Urbi also uses users personal information for "data

49. Bertoni Steven "Lyft Partners With Moovit As Car- Sharing Battle Continues" forbes.com Web. Accessed April 23rd < https://www.forbes.com/sites/stevenbertoni/2014/06/09/lyft-partners-with-moovit-as-car-sharing-battle-continues/#115dea1e2766>
50. Moovit "Moovit: At a Glance" docs.wixstatic.com Web. Accessed April 26th 2019 < https://docs.wixstatic.com/ugd/c729fe_d9b60792127a497390617948bdac3b71.pdf>
51. Urbi "Welcome to Urbi" urbi.co Web. Accessed April 19th 2019 <https://www.urbi.co>
52. Urbi "Welcome to Urbi" urbi.co Web. Accessed April 19th 2019 <https://www.urbi.co>
53. Urbi "Welcome to Urbi" urbi.co Web. Accessed April 19th 2019 <https://www.urbi.co>
54. Urbi "Welcome to Urbi" urbi.co Web. Accessed April 19th 2019 <https://www.urbi.co>
55. Urbi "Urbi Mobility Shop" shop.urbi.co Web. Accessed April 25th 2019 < https://shop.urbi.co/en/product/>
56. Urbi "Urbi Mobility Shop" shop.urbi.co Web. Accessed April 25th 2019 < https://shop.urbi.co/en/product/>
57. Urbi "Frequently Asked Questions" urbi.co/faq Web. Accessed April 25th < https://www.urbi.co/faq>
58. Urbi "Frequently Asked Questions" urbi.co/faq Web. Accessed April 25th < https://www.urbi.co/faq>
59. Urbi "Terms and Conditions" urbi.co Web. Accessed April 25th < https://www.urbi.co/toc/>
60. Urbi "Terms and Conditions" urbi.co Web. Accessed April 25th < https://www.urbi.co/toc/>

collection, storage, and processing" to statistical analysis.[61]

3.8 UBIGO: CASE STUDY

Ubigo is a mobility service app that offers users paid subcriptions for mobility service use encompassing public transportation, car rental, car sharing, taxi, biking that is implied to be able to replace the need for "owning a car" for a user.[62] UbiGo emerged from a pilot test of application in Gothenburg and is now actively launched in Stockholm with the support of the EU H2020 CiViTAS Eccentric project in the Swedish Government's Innovation partnership program. As a case study, Ubigo is significant as they show an example of an MaaS app that relies and focuses on a subscription model where users don't need to manually pay for the partnered mobility services.

3.8.1 SERVICE PROVIDERS:

Ubigo users have access to all public transport at SL, TaxiKurir, TopCab, pool cars from Move About, car hire from Hertz, and Citybike.[63]

3.8.2 FARE STRUCTURE:

Ubigo is a mobile subscription for mobility services that offered fixed or more flexible options for the 'whole household'.[64] The user must sign for a household subscription with estimate of how many days/hours of public transport and car per month is needed; unused hours by the subscribing users are cumulated to the next month.[65] Users pay at the end of each month for the next month's subscription and the previous months taxi fares, extra days, extra car hours, or upgrades done in addition to their subscription.[66]

3.9 QIXXIT: CASE STUDY

Qixxit is a MaaS app that describes itself to aspire to reduce the hassle of planning trips so its users can be "free" to do other things.[67] The app seems to focus on 'medium" and "long-distance" travel trips with emphases on transportation modes such as through aviation, "long-distance" bus or trains between countries.[68] Like other MaaS apps, Qixxit allows for intermodality between different mobility services and showing users optimized trip options. [69]

3.9.1 SERVICE PROVIDERS:

Qixxits service providers encompass services such as Skyscanner FixBus, and Deutsche Bahn.[70]

3.9.2 FARE STRUCTURE:

Qixxit users can purchase Deutsche Bahn train tickets directly through the application. For other transportation modes, users are directed to the respective mobility service's website for manuel booking there;

61. Urbi "Terms and Conditions" urbi.co Web. Accessed April 25th < https://www.urbi.co/toc/>
62. Ubigo "About UbiGo" ubigo.co Web. Accessed April 19th 2019 <https://ubigo.me/about-ubigo-english/>
63. Ubio " Sa har fungerar det" ubigo.me Web. Accessed March 20th 2019 < https://ubigo.me/sa-har-fungerar-det/>
64. Ubio " Sa har fungerar det" ubigo.me Web. Accessed March 20th 2019 < https://ubigo.me/sa-har-fungerar-det/>
65. Ubio " Sa har fungerar det" ubigo.me Web. Accessed March 20th 2019 < https://ubigo.me/sa-har-fungerar-det/>
66. Ubio " Sa har fungerar det" ubigo.me Web. Accessed March 20th 2019 < https://ubigo.me/sa-har-fungerar-det/>
67. Qixxit "The places we want to go are what brought us here." Web Accessed March 15th < https://www.qixxit.com/en/about/>
68. Qixxit "Frequently Asked Qiestions" qixxit.com Web. Accessed March 15th < https://www.qixxit.com/en/contact/#question_ticket_cancellation>
69. Qixxit "Frequently Asked Qiestions" qixxit.com Web. Accessed March 15th < https://www.qixxit.com/en/contact/#question_ticket_cancellation>
70. Qixxit "Frequently Asked Qiestions" qixxit.com Web. Accessed March 15th < https://www.qixxit.com/en/contact/#question_ticket_cancellation>

the app itself does not mediate the booking and is "always between" the user and the app's partner.[71] Tickets booked will be provided by email and can be paid with credit cards, Apply Pay, and PayPal. Qixxit itslef is free to use by users.[72]

3.10 COMMUNAUTO: CASE STUDY

Communauto is a subscription based MaaS application where users gain access to a group of "thousand cars" that can be reserved at "low cost" for half hour, hour, day, or longer increments.[73] These company owned cars are described to be available at any moment in a city "station" and can be found through the phone application.[74] Communauto is available in Montreal, Quebec, Sherbrooke, Gatineau, Ottawa Kingston, Toronto, Southwest Ontario, Halifax, and Paris.[75] These cars can be booked in advance and are described to great for "planned trips"[76]

3.10.1 FARE STRUCTURE:

Communauto offers a no-fee subscription plan, called Auto-mobile vehicles, and Open Plan costing 40 dollars per year; there is also the option of value plans which allow users to have the "best hourly rates".[77] Costs for the free subscription Auto-mobile plan costs 40 cents per minute or 12 dollars per hour. With full subscription, the costs are reduced to 2.35 dollars per hour with 24 cents per kilometer traveled. Users start with booking a car online, by app, or phone and accessing the vehicle with a opus card or key. Users are able to pay fees using the cars credit card in the glove compartment through activation by the app. [78]

71. Qixxit "Frequently Asked Qiestions" qixxit.com Web. Accessed March 15th < https://www.qixxit.com/en/contact/#question_ticket_cancellation>
72. Qixxit "Frequently Asked Qiestions" qixxit.com Web. Accessed March 15th < https://www.qixxit.com/en/contact/#question_ticket_cancellation>
73. Communauto "Communauto in a nutshell" communauto.com Web Accessed March 16th th 2019 < https://www.communauto.com/en/how-it-works.html>
74. Communauto "Communauto in a nutshell" communauto.com Web Accessed March 16th th 2019 < https://www.communauto.com/en/how-it-works.html>
75. Communauto "Communauto in a nutshell" communauto.com Web Accessed March 16th th 2019 < https://www.communauto.com/en/how-it-works.html>
76. Communauto "Communauto in a nutshell" communauto.com Web Accessed March 16th th 2019 < https://www.communauto.com/en/how-it-works.html>
77. Communauto "Subscription Plans and Rates" communauto.com. Web. Accessed March 16th 2019 < https://www.communauto.com/en/rates.html>
78. Communauto "Communauto in a nutshell" communauto.com Web Accessed March 16th th 2019 < https://www.communauto.com/en/how-it-works.html>

4 LOWER MAINLAND

4.1 EXISTING REGIONAL SERVICES

The existing regional mobility service providers are overviewed in this chapter. There are many potential mobility services with their own systems, customers, and strengths that could synergize better with each other and encompass greater market and service potential. Currently, there could be a holistic MaaS app or service that consolidates Greater Vancouver's existing mobility services as one convenient, interconnected, and integrated system. Currently to use each service, customers have to engage independently with each provider.

This section will overview structures, hierarchies, partnerships, financial models (such as partnerships, fares, etc.) of key players. Currently no ridesharing mobility services are present in Vancouver but is subject to change in the future.[1]

1. Zimmer Eric "Final government report on BC rideshare recommends no Class 4 licence requirement " Urbanized. dailyhive.com. Web. Accessed Feb 25th. <https://dailyhive.com/vancouver/ridesharing-bc-committee-recommendations-march-2019>

4.1.1 TRANSLINK[1] (The South Coast British Columbia Transportation Authority)

Translink is the statutory authority managing and providing Metro Vancouver's public transportation system through it's transportation services, contractors, and subsidiary companies encompassing SkyTrain rapid transit, SeaBus passenger ferries, West Coast Express commuter rail, Coast Mountain Bus Company, and HandyDART. They are dedicated to meeting transportation needs of residents, businesses and goods movers "in a manner that protects the environment" and supports the economic-social objectives of the region.[2]

1. Translink "TransLink." Accessed August 7, 2018. https://www.translink.ca.
2. Translink https://www.translink.ca/About-Us/Corporate-Overview.aspx

Figure 7. Translink Skytrain at a skytrain station. Accessed 2018 Oct 28th < https://www.translink.ca/About-Us/Media/Photo-Assets.aspx>

LOCATIONS

- Translink provides public transportation services in Metro Vancouver.

SERVICES

- SkyTrain (Rapid Transit Company Ltd.)
- SeaBus passenger ferries
- West Coast Express commuter rail
- HandyDart
- Coast Mountain Bus Company

FARES

Fares are based on mode of travel, time traveled, and amount of zones traveled in; with discounted rated using their compass card and passes. There are fares based on single use, monthly use, day use, and through their compass card. Translink's zone based system can be summarized as follows:[1]

Zone 1: City of Vancouver, University Endowment Lands

Zone 2: Village of Lions Bay, Bowen Island, District of West Vancouver, District of North Vancouver, City of North Vancouver, City of Burnaby, City of New Westminster, City of Richmond, Annacis Island

Zone 3: Annacis Island, Barnet Highway at the Petro-Canada refinery, Corporation of Delta, City of Surrey, City of White Rock, City of Langley, Village of Belcarra, Village of Anmore, Electoral Area "C" east of Indian Arm, City of Port Moody, City of Coquitlam, City of Port Coquitlam, City of Pitt Meadows, City of Maple Ridge.

DATA AVAILABILITY

- API2
- Read only, no ticket purchasing, etc.
- Provides: Regional traffic data, real-time transit info(stops, buses, stop estimates, route details

GOVERNANCE MODEL

Translink is a regional transportation authority created by the South Coast British Columbia Transportation Authority Act. The organization is organized and led by a Translink Board of Directors. This board appoints a Chair and CEO, supervises the management of Translink, plans long-term financial and organizational strategies, actively assesses Translink effectiveness and public satisfaction, responds with changes to customer complaints, and establishes subsidiaries and appoints their board chair and members. The Translink Board of Directors itself is composed of seven members which is appointed by the Mayor's Council through a candidate list presented by a screening panel. The Mayor's council approves the long-term transportation strategies, financial strategies , and fare changes proposed by the Translink Board of Directors. They also sanction the changes to customer satisfaction surveys and customer complaint processes exercised by the Translink Board of Directors. In general, they oversee the sale of major facilities and assets, compensation to the Board of Directors, and Translink's Executive Compensation Plan.

MAAS POTENTIAL

Translink is open and has expressed interest in a MaaS app for it's existing transit services; notably mentioning how automatic and dynamic route planning and booking of services can permit a concept of "mobility as a service" application with "on demand" or "subscription pay based model. [3] Notably, in the Future of Driving report, Translink notes that they produced a *"preferred scenario for a Mobility as a Service (MaaS) system linked to structured mobility pricing to manage increased potential for vehicle distance travelled and support increased use of public transit."*[4] TransLink provides open API to registered developers and this data has the potential to integrate into a real-time updated map of translink services. [5]

1. https://www.translink.ca/Fares-and-Passes/Fare-Pricing.aspx
2. "TransLink Open API." Accessed August 9, 2018. https://developer.translink.ca/.
3. Translink" The Future of Driving" buzzer.translink.ca Web. Accessed April 20th 2019 < https://buzzer.translink.ca/wp-content/uploads/2016/09/Future-of-Driving-Policy.pdf>
4. Translink" The Future of Driving" buzzer.translink.ca Web. Accessed April 20th 2019 < https://buzzer.translink.ca/wp-content/uploads/2016/09/Future-of-Driving-Policy.pdf>
5. Translink "TransLink Open API" developer.translink.ca Web. Accessed March 20th < https://developer.translink.ca>

4.1.2 CAR2GO[1]

Car2Go is the worlds largest car-sharing rental company with 2,500,000 registered members, a 14000 eco-friendly vehicles fleet, and based in 26 locations globally based in Stuttgart Germany.[2] Car2Go operates in Vancouver as with in many countries around the world. Its boundaries are limited to an area in Vancouver where users are able to borrow and deposit their vehicles as shown in Figure 9. Rather than through a central office or phone, rentable cars are user accessed through a downloadable smartphone app at the location where car2go cars are parked in the city. Car2Go aims to providing "on demand" services that bridges a city's existing transportation "gaps".[3]

1. "Hourly Car Rental & Carsharing | Car2go Vancouver." Accessed August 7, 2018. https://www.car2go.com/CA/en/vancouver/.
2. https://www.prnewswire.com/news-releases/car2go-brings-new-mercedes-benz-vehicles-to-denver-300474437.html
3. https://www.car2go.com/NA/en/press/

Figure 9. Left. Car2Go Vancouver Home Area Map. <https://www.car2go.com/CA/en/vancouver/>

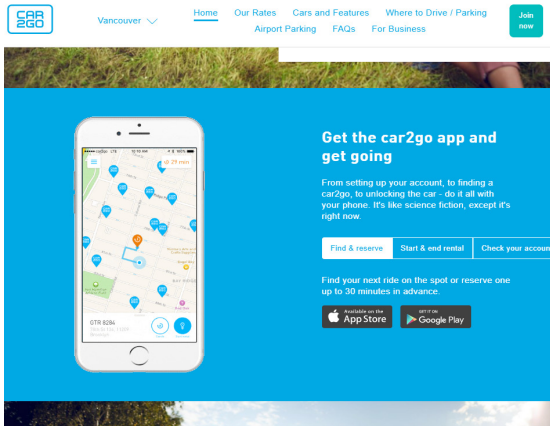


Figure 8. Right Image. Car2Go Vancouver Website Snapshot. Accessed 2018 Oct 2nd < https://www.car2go.com/CA/en/vancouver/>

LOCATIONS

- Vancouver plus satellite parking locations. The City of North Vancouver.

SERVICES

- Car share, 2 classes of vehicles
- Begin and end trips within home ares, but can travel up to 300km outside of the home area.

FARES

- Dependent on type of vehicle; 2 person Smart Car or Mercedes-Benz
- Time based: Per minute, hour, 3 hour, 6 hour, 1 day
- Per minute for smart car: $0.32 plus taxes.

DATA AVAILABILITY and STRUCTURE

- API not available
- Includes car locations, operation area, gas stations, parking spots
- Private Company

MAAS POTENTIAL

- Other existing MaaS apps, such as Urbi described earlier in the report, already incorporate Car2Go car share mobility services in its application for users for its locations serviced. Car2Go's potential to engage with a local Vancouver based MaaS application is likely high.

4.1.3 EVO[1]

Evo is a car sharing service with hybrid cars in Vancouver created by BCAA. Its area of operation is limited to an area in Vancouver and the City of North Vancouver as shown in Figure 10. Described to be simple to use and a convenient way to get around the city by picking up, driving, and parking anywhere in the "Home Zone", users can access cars through a downloadable smartphone app.[2]

1. "Car Sharing Vancouver | Evo Car Share." Accessed August 7, 2018. https://www.evo.ca.
2. BCAA "About BCAA" bcaa.com/about -us Web. Accessed Oct 30th 2018. <https://www.bcaa.com/about-us>

Figure 10. Evo Vancouver "Home Zone" Map. Accessed 2018 Oct 2nd <https://www.evo.ca>

LOCATIONS

- Vancouver plus outside parking zones. The City of North Vancouver.

SERVICES

- Carshare: Single care model.
- Can travel anywhere in Canada but must end in the home zone.

FARES

Fares are subject to PST, GST, and a daily 1.50 $ Passenger Vehicle Tax. A registration fee of 35 dollars is required for non BCAA members.

- $0.41/min $14.99/hour $89.99/day
- plus $0.45/km after first 200km

DATA AVAILABILITY and STRUCTURE

- No API
- Private Company

MAAS POTENTIAL

- Other existing MaaS apps, such as Urbi described earlier in the report, already incorporate similar car share mobility services in its application for users. Evo's potential to engage with a new Vancouver based MaaS application is likely high.

4.1.4 MODO[1]

Modo, the first carshare in BC and second in North America. Modo operates in various cities in British Columbia and it is a "local member-owned" carshare service that is described to be "people" driven, rather than "profit" driven, to transform communities through affordable, convenient, inclusive, and sustainable transportation connections.[2] They are the only co-operative in the municipalities they serve.

1. "Welcome to Modo." Modo. Accessed August 8, 2018. https://www.modo.coop/.
2. https://www.modo.coop/about/#tile-about-modo

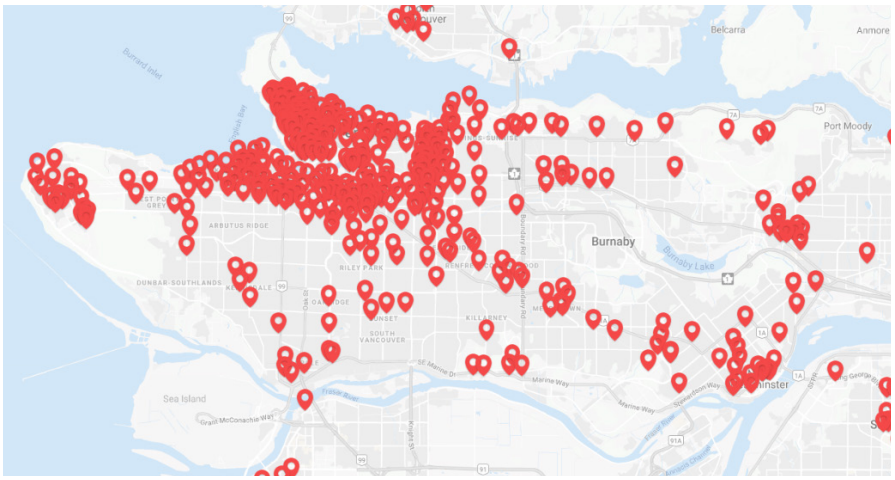


Figure 11. Modo Website Snapshot of Parked Car Locations. Accessed 2018 Oct 3rd< https://www.modo.coop/about/#tile-about-modo>

LOCATIONS

- The Lower Mainland, Vancouver Island, Okanagan, Whistler.

SERVICES

- Carsharing.
- Large assortment of vehicles.
- Must return car to location it was picked up at.

FARES

- 2 packages for individuals and one for businesses.
- Monthly membership. $9/hr for daily drive, $72/day. Monthly fee $8.
- Modo plus membership. $500 refundable share purchase, $5/hr daily drive, $50/day.
- Business membership. $250 security deposit, $10 reg fee per driver, $9/hr daily drive, $72/day.
- Large and oversized vehicles add premium to rates across all plans.

DATA AVAILABILITY

- API[1]
- Allows for: descriptions and accessories of all cars in the fleet, where the cars are based, which cars are available now and in the future, price plan info, booking cost info.
- Api is read only, no creation or change of booking possible.
- API[2], terms of use[3]
- Includes car locations, operation area, gas stations, parking spots

STRUCTURE

- Private Company

MAAS POTENTIAL

- Modo sees itself as part of a "sustainable transportation ecosystem" which is included in a sustainable integrated mobility system in greater Vancouver. [4] Other existing MaaS apps, such as Urbi described earlier in the report, already incorporate similar car share mobility services in its application for users. Given that Modo expresses interest in MaaS, other MaaS applications already encompass similar car sharing services, and that Modo has the potential to integrate in new ways in Vancouver means the potential with a new MaaS application is high.

1. API." Modo (blog). Accessed August 9, 2018. https://www.modo.coop/api/.
2. Documentation on the OpenAPI of the Car2go System. 2015. Reprint, car2go, 2018. https://github.com/car2go/openAPI
3. "Car2go APIs Terms of Use." Accessed August 9, 2018. https://www.car2go.com/api/tou.htm.
4. modo "Living Car Free: 5 Questions with City of Victoria Mayor, Lisa Helps" modo.coop Web. Accessed April 20th < https://www.modo.coop/blog/car-free-living-mayor-helps-1/>

4.1.5 ZIPCAR[1]

Zipcar operates in cities globally including the city of Vancouver. It is the "largest car sharing service" in the world with locations in "cities, airports, and campuses" globally that requires monthly membership to reserve automobiles billable by minute, hour, or day.[2] Zip car users, after signing up through a phone app, mail or online, are provided a Zipcard which they can unlock booked cars to access, drive, and park back in it's original reserved location shown in figure 12.[3]

1. "Car Sharing: An Alternative to Car Rental with Zipcar." Accessed August 8, 2018. https://www.zipcar.com/.
2. https://www.zipcar.ca
3. https://www.zipcar.ca

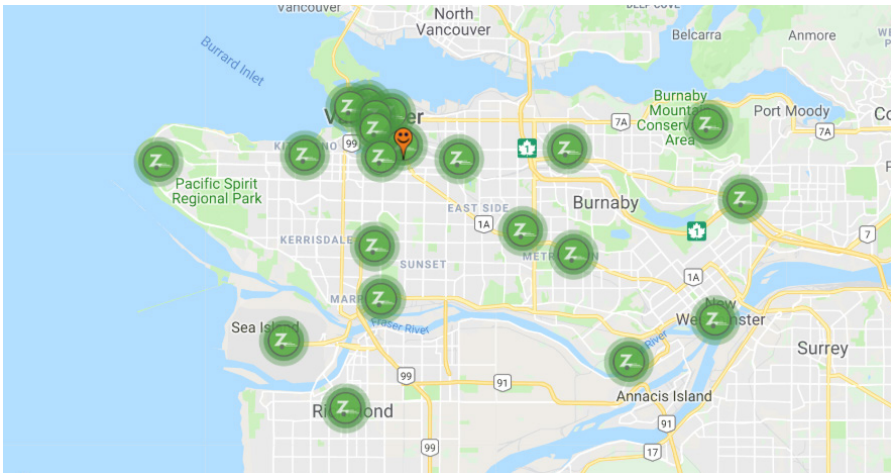


Figure 12. Zipcar Car Location Map Snapshot from Website. Accessed 2018 Oct 9th <https://www.zipcar.ca>

LOCATIONS

- Globally in Europe and North America. For locations in Metro Vancouver: Vancouver, North Vancouver, Richmond, Sea Island, Burnaby, Coquitlam, New Westminster

SERVICES

Zipcar provides particular target services to airports, universities, and businesses. Their general services and rules include:

- Car share with numerous vehicle types.
- Vehicle must be returned to designated Zipcar location.

FARES

- Monthly rate of $7/month plus $8.29/hr and up depending on vehicle.

DATA AVAILABILITY and STRUCTURE

- No API
- Private Company

MAAS POTENTIAL

- Other existing MaaS apps already incorporate similar car share mobility services in its application for users. Evo's potential to engage with a new MaaS application is likely high.

4.1.6 MOBI[1]

Mobi is a bicycle sharing system implemented by the City of Vancouver and owned-operated by CycleHop.[2] Mobi operates in an area of the City of Vancouver centering around Downtown and it's surrounding areas. Purchasers of a pass after registering an account through the Mobi Bike Share App are able to access bicycles at "secure" locations around the city, ride through the city, and park their bikes at available stations.[3] The city website describes the goal to "reduce" need for personal vehicle use, encourage interest in cycling transit practices, and extending reach of transit-walking trips.[4]

1. "Vancouver Bike Share | Mobi." Accessed August 9, 2018. https://www.mobibikes.ca/.
2. https://vancouver.ca/streets-transportation/public-bike-share-system.aspx
3. https://www.mobibikes.ca
4. https://vancouver.ca/streets-transportation/public-bike-share-system.aspx

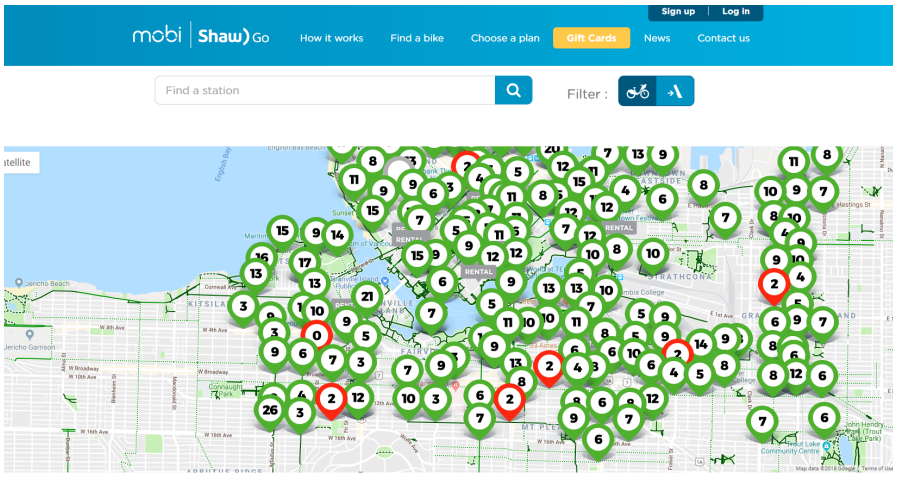


Figure 13. Mobi Website Snapshot of Vancouver Station Locations. Most locations are located around the Downtown Core and Broadway St. in Vancouver.

LOCATIONS

- Vancouver

SERVICES

- Bike Share
- Station system. Pick up bike at a station and return to any station.

FARES

- Single trip: $3/30min interval
- 24hr pass: $9.75 plus overage, unlimited 30 min rides
- 90 days pass: $75 plus overage, unlimited 30 min rides
- 365 days standard: $129 plus overage, unlimited 30 min rides
- 365 days plus: $159 plus overage, unlimited 60 min rides

DATA AVAILABILITY

- No official api, but location data is able to be pulled from the html
- API[1], terms of use[2]
- Includes car locations, operation area, gas stations, parking spots

STRUCTURE

- Private Company

MAAS POTENTIAL

- Mobi is interested in MaaS and provides a bike sharing service that already has precedence in being incorporated in existing MaaS app services.[3] Urbi, described earlier in the report for example, already partners with bike sharing providers in its localized services. Mobi, in this context, has high potential for engagement with a MaaS application localized for Vancouver.

---

1. Documentation on the OpenAPI of the Car2go System. 2015. Reprint, car2go, 2018. https://github.com/car2go/openAPI
2. "Car2go APIs Terms of Use." Accessed August 9, 2018. https://www.car2go.com/api/tou.htm.
3. Ohm Ken "Paradigm Shift in Transportation" Price Tags pricetags.ca Web. Accessed April 28th 2019. < https://pricetags.ca/2019/01/07/paradigm-shift-in-transportation/>

U-bicycle

4.1.7 U-BICYCLE[1]

U-Bicycle is a bike sharing service that is located in the Victoria and Vancouver Metropolitan region that describes their goal of "improving city living through eco-friendly transportation options" that are affordable and convenient to use in growing cities.[2] Users download an app to deposit funds to access and use stationed bikes in a city.[3]

1. "U-Bicycle Homepage." U-bicycle North America. Accessed August 9, 2018. https://www.u-bicycle.ca/.
2. https://www.u-bicycle.ca/about/
3. https://www.u-bicycle.ca

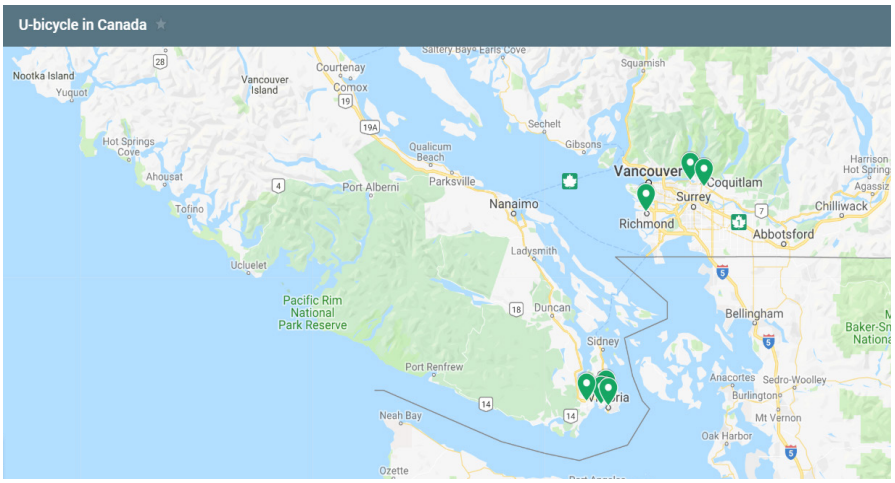


Figure 14. U-bicycle Website Snapshot of Bike Locations Accessed 2018 Oct 9th <"U-Bicycle Homepage." U-bicycle North America. Accessed August 9, 2018. https://www.u-bicycle.ca/.>

LOCATIONS

- Port Coquitlam, Port Moody, Richmond, started in Victoria.

SERVICES

- Bike Share
- Dockless, can park bike anywhere and end trip

FARES

- $1/30min
- $15 day pass, unlimited 30 min rides
- $150 year plass, unlimited 60 min rides

DATA AVAILABILITY and STRUCTURE

- No API
- Private

MAAS POTENTIAL

- Urbi, described earlier in the report for example, already partners with bike sharing providers in its localized services. U-bicycle, in this context, has high potential for engagement with a MaaS application localized for Vancouver.

4.1.8 DROPBIKE[1]

Dropbike is a smart bike sharing service operating at several Canadian University Campuses. The service is utilized through a smartphone app and has no physical stations with bikes being able to be parked alone in designated areas.[2] Users can download an app to locate, register, and use bikes found in a city region. Dropbike describes themselves to strive for stainability.

1. "Dropbike." Dropbike. Accessed August 18, 2018. https://www.dropbike.co/.
2. https://www.dropbike.co/faq/

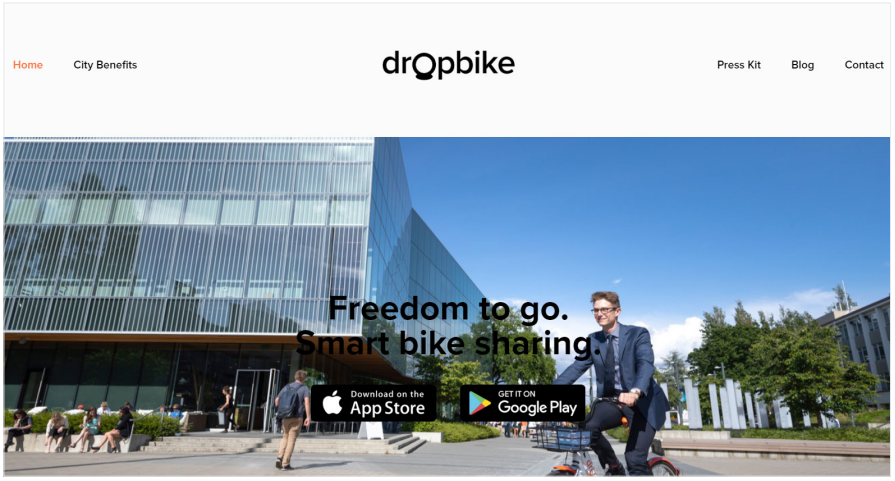


Figure 15. Dropbike website snapshot. Dropbike "Freedom to go. Smart Bike Sharing" dropbike.co Web. Accessed Nov 10th 2018. <https://www.dropbike.co>

LOCATIONS

- UBC, UBC Kelowna, University of Manitoba, Westmount Montreal, Oshawa Ontario, Waterloo, Elgin Ontario, TRCA, Universities in Toronto, Kingston. [1]

SERVICES

- Bikeshare.
- No stations. Can be locked anywhere, although there are specially marked "havens". A QR code can be used to unlock bikes.

FARES

- $1/hr and package deals.

STRUCTURE

- Private company.

MAAS POTENTIAL

- Existing MaaS apps already incorporate localized bike sharing services into their services. Mobi, in this context, has high potential for engagement with a MaaS application in Vancouver.

1. Dropbike "Freedom to go. Smart Bike Sharing" dropbike.co Web. Accessed Nov 10th 2018. <https://www.dropbike.co>

4.1.9 WEST COAST SIGHTSEEING[1]

West Coast Sightseeing is a Vancouver tour company operating in downtown Vancouver offering the city's only hop-on hop-off transportation vehicle service with guided tours, charters, and electric harbour tours.[2] Paying customers, after reserving in advance, are able to repeatedly hop on, ride, and hop of certain vehicle rides repeatedly during the time purchased. This hop-on and off rides are shown in figure 16. They aim to have a "greener" and more sustainable future by using all electric vehicles in 2023.

1. "Vancouver Sightseeing + Hop-On, Hop-Off - WESTCOAST Sightseeing." Accessed August 13, 2018. https://westcoastsightseeing.com/.
2. https://westcoastsightseeing.com/our-history/

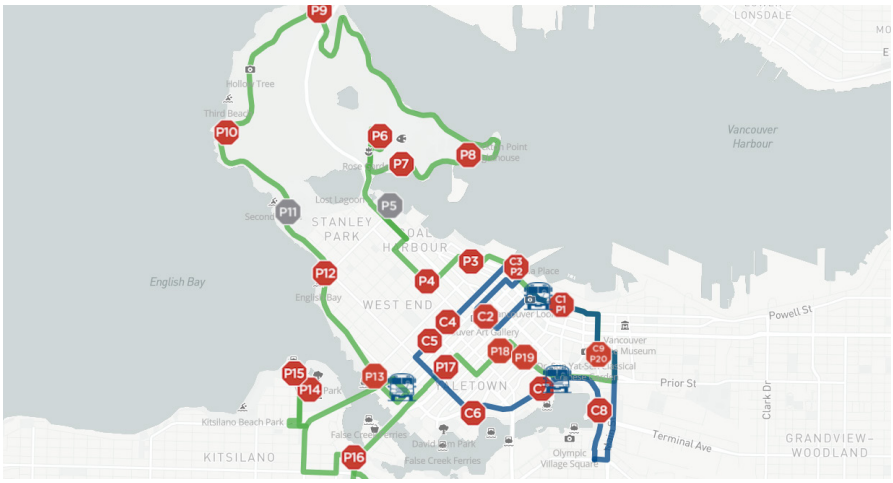


Figure 16. West Coast SIghtseeing Website Snapshot of Active Current Route Maps. <hhttps://westcoastsightseeing.com/live-bus-map/>

LOCATIONS

- In Vancouver. Located in the Downtown Region.

SERVICES

- Hop on, hop off buses.
- Two routes: Park Route with pickups starting from 9:05am to last pickups starting at 3:05 pm and City Route with pickups strating from 9:25am to last at 3:25 pm.

FARES

Fares are based on age groups and location of the bus loop. These fares are based on a day pass.

- Dual pass: $54 adult, $27 child
- Park route: $49 adult, $25 child
- City route: $39 adult, $20 child

DATA AVAILABILITY and STRUCTURE

- Live bus map and No API

MAAS POTENTIAL

- Existing MaaS applications such as Moovel already include bus services and circuitous metro transit. West Coast Sightseeing, being a circuitous bus service has high potential to engage with a new MaaS application for Vancouver.

EXISTING REGIONAL & GLOBAL SERVICES

This section shows regional mobility services that connect the city of Vancouver and its metropolitan region with other bordering areas. Exisitng MaaS applications already engage with taxi services in their serviced cities and Taxi services has high potential in engaging with a new Vancouver MaaS app.

4.1.10 VANCOUVER TAXI PROVIDERS[1]

Greater Vancouver is provided by a number of taxi companies throughout it's many cities and areas. These taxi companies require city-provided taxi licenses, which are limited in number and are currently facing a shortage in supply to city demand for it's services, to operate individual taxis.[2] Vancouver's taxi companies currently have a number of separate apps that provide a mobile platform to provide their services to users; these apps include eCab app which include Mac Lure's Cabs, Black Top and Checker Cabs, Yellow Cab, and Vancouver-Taxi or Zoro.

1. "Vancouver Bike Share | Mobi." Accessed August 9, 2018. https://www.mobibikes.ca/.
2. Hara Associates "Modernizing Taxi Regulation" th.gov.bc.ca < http://www.th.gov.bc.ca/rpt/Documents/20180718_Modernizing%20Taxi%20Regulation.pdf>

Figure 17. Table of Standard Taxis in Metro Vancouver.

NORTH AND WEST VANCOUVER	VANCOUVER	RICHMOND DELTA AND TSAWWASSEN
• North Shore Taxi Ltd. • Sunshine Cabs Ltd.	• Black Top & Checker Cabs • Burnaby Select Taxi Ltd. • Maclure's Cabs Ltd. • Vancouver Taxi Ltd. • Yellow Cab Co. Ltd.	• Delta Sunshine Taxi • Garden City Cabs • Coral Cabs Ltd. • Kimber Cab Ltd. • Richmond Cabs Ltd. • Tsawassen Taxi Ltd.
BURNABY & NEW WESTMINISTER	**COQUITLAM & PORT MOODY**	**SURREY & WHITE ROCK**
• Bonny's Taxi Ltd. • Burnaby Elite Cabs • Capitol Hill Taxi • Queen City Taxi Ltd. • Royal City Taxi Ltd.	• Bel-Air Taxi Ltd. • Coquitlam Taxi Ltd. • Driving Alternative • Port Coquitlam Taxi Ltd. • Port Moody Taxi Ltd. • Queen City Taxi Ltd. • Syd's Taxi Ltd.	• Clover Cabs • Executive Cabs of Surrey • Guildford Cab Ltd. • Pacific Cabs • Surdell-Kennedy Taxi Ltd. • White Rock Taxi
LANGLEY & MAPLE RIDGE	**eCAB[1]**	
• Langley Taxi Cabs. • Alouette Taxi • Haney Taxi Ltd. • Maple Ridge Taxi Ltd. • Meadow Ridge Taxi Ltd. • Pitt Meadows Taxi.	• eCab is a app born from an "international alliance of taxi companies" and services 100 cities in 10 countries including Vancouver. • The 4 primary cab companies in Vancouver within one app include: MacLure's, Yellow Cab, Vancouver Taxi, and Black Top & Checkers Cabs.	

1. "Vancouver | ECab." Accessed August 13, 2018. https://www.e-cab.com/en/vancouver/.

4.1.11 U-BICYCLE[1]

Helijet is a helicopter based transportation company that services British Columbia with bases in Richmond, Vancouver harbour, Victoria Harbour, Prince Rupert, or Sandspit-Haida Gwaii.[2] Encompassing both helicopter and jet service, they provide both regular schedules airline service and chartered flights in the region.

1. "U-Bicycle Homepage." U-bicycle North America. Accessed August 9, 2018. https://www.u-bicycle.ca/.
2. https://helijet.com/home/about-helijet/

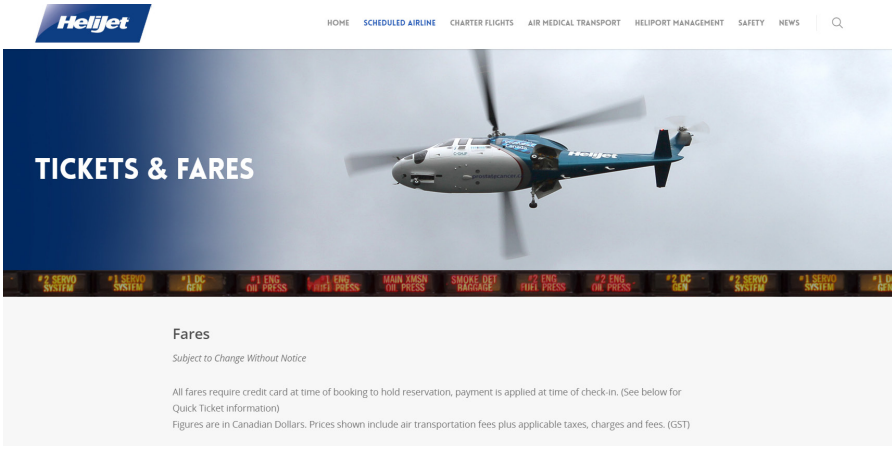


Figure 18. Helijet Website Snapshot. < https://helijet.com/scheduled-airline/tickets-fares/>

LOCATIONS

- Bases in Richmond-YVR, Vancouver Harbour, Victoria Harbour, Prince Rupert or Sandspit-Haida Gwaii.

SERVICES

- Helicopter Operator
- Charter flights
- Helicopter ambulance in association with the British Columbia Air Ambulance Service

FARES

- Regularly scheduled airline between:
  1. Vancouver Harbour Heliport and Victoria Harbour Heliport ($230)
  2. Vancouver Harbour Heliport and Nanaimo Harbour Heliport($129)
  3. Vancouver International Airport and Victoria Harbour Heliport (Monday-Friday, limited flights)($230)

STRUCTURE

- Private company

MAAS POTENTIAL

- Existing MaaS app precedents, like Qixxit, already engages with long distance travel and planes in its service. Helijet will have high potential to engage with a Vancouver and region based MaaS application for local and regional users.

4.1.12 HARBOUR AIR[1]

Harbour Air is a seaplane transportation company with a broad range of locations in British Columbia that provides regular routes and charter services.[2] Encompassing more than 40 aircraft, the company provides more than 30000 flights yearly to destinations and freight services.[3]

1. "Harbour Air Seaplanes: World's Largest Seaplane Airline - Since 1982 - Harbour Air." Accessed August 30, 2018. https://www.harbourair.com/.
2. https://www.harbourair.com/about/corporate-information/
3. https://www.harbourair.com/about/corporate-information/

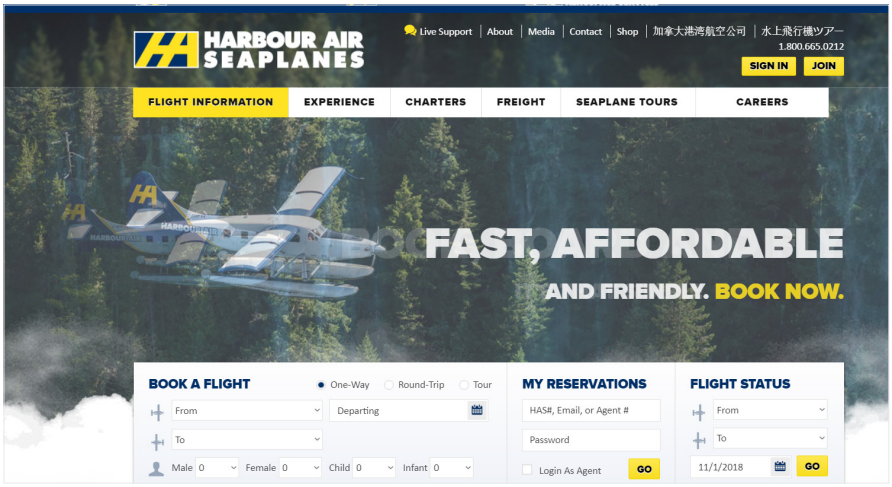


Figure 19. Harbour Air Seaplane Website Front Page Snapshot. < https://www.harbourair.com/about/corporate-information/>

LOCATIONS

- Vancouver, Pitt Meadows, Whistler, Victoria, Salt Spring Island, Maple Bay, Nanaimo, Tofino, Comox, Sechelt, Earl's Cove, Chatterbox Falls, Seattle

SERVICES

- Seaplane airline
- Freight shipping
- Private charters
- Tours

FARES and STRUCTURE

- Fares vary with route, plane, and time of flight. Price also varies if its chartered or scheduled. An example of route price from Vancouver to Victoria is $207 flex and $242 gold. Harbour air provides customers the option of having goFares with more customer service.
- Private company

MAAS POTENTIAL

- Existing MaaS app precedents, like Qixxit, already engages with long distance travel and planes in its service. Harbour Ait will have high potential to engage with a Vancouver and region based MaaS application for local and regional users.

4.1.13 BC FERRIES[1]

British Columbia Ferry Services Inc., formerly a provincial Crown Corporation, is a publicly owned independently managed company that provides passenger and vehicular ferry services for British Columbia residents.[2] Ferry routes provide connections to coastal communities along British Columbia's coast as seen in Figure 20.

1. "Home | BC Ferries - British Columbia Ferry Services Inc." Accessed August 30, 2018. https://www.bcferries.com/.
2. "Home | BC Ferries - British Columbia Ferry Services Inc." Accessed August 30, 2018. https://www.bcferries.com/.

Figure 20. BC Ferries Route and Terminal Maps.< https://www.bcferries.com/files/images/maps/bcf-all_routes_map.pdf>

LOCATIONS

- Terminals locations for BC Ferries include the following locations:

MAINLAND-VANCOUVER ISLAND:	SUNSHINE COAST:	NORTHERN GULF ISLANDS/POWELL RIVER
• Departure Bay • Duke Point • Horseshoe Bay • Swartz Bay	• Langdale • Earls Cove • Saltery Bay • Snug Cove • Keats Island	• Little River • Buckley Bay • Campbell River • Quadra Island (East) • Quadra Island (West) • Port McNeill • Westview-Powell River • Alert Bay • Sointula • Blubber Bay • Denman Island (West) • Denman Island (East) • Hornby Island

SERVICES[1]

- Ferry Services for Pedestrian passengers, cars, automobiles between designated harbours.
- On board ferry amenities, retail services, food services.

FARES[2]

- Fare prices holistically vary with route/distance travelled and time. More specifically to each route, fares are divided to individual passengers, groups, BC special resident groups, by vehicles, and commerical vehicles. For physical passangers, prices are divided by age. As an example, for the Tsawwassen to Swartz Bay Route, the prices are as follows:

    1. Passengers: 12 years and older 17.20 $; 5-11 years at 8.60$; and for under 5 years free.
    2. Group Fares for 10 or more passengers: 12 years and older 14.70 $; 5-11 years 7.35 $.
    3. BC Resident Assistance Program: Student for school event 8.60 $ and 4.30 $ for 12-18 years old and 5-11 years old respectively. For accessibility requiring and escorted users 8.60 and 4.30 $ for 12 years-above and 5-11 years respectively. Seniors from Monday to Thursday can ride free.
    4. Standard Vehicles (Excluding drivers and passengers): Vehicles up to 20 feet cost 57.50$ and every feet beyond costs 6.50$. A motorcycle costs 28.75 $.
    5. Buses: Buses cost 4.75$ per foot.
    6. Commerical Vehicles: 6.62$ per feet up to 13 ft wide. For vehicles wider than 13 ft, cost 13.25 $ per feet.
    7. Bicycles cost 2 dollars for storage.

STRUCTURE

- Private company

MAAS POTENTIAL

- Existing MaaS app precedents, like Qixxit or others, already engages with long distance travel and ferries in their service. BC Ferries will have high potential to engage with a Vancouver and regional based MaaS application for users. Potential integration with region or local based alternative mobility services can potentially increase the user base, use, and popularity of the service.

1. BC Ferries “Home | BC Ferries - British Columbia Ferry Services Inc.” Accessed August 30, 2018. https://www.bcferries.com/.
2. BC Ferries “Fare Index” bcferries.com Web. Accessed Dec 29th 2018.<https://www.bcferries.com/files/fares/pdf_format/BCF_Fares.pdf>

4.2 EXISTING PARKING SERVICES

4.2.0 PARKING MANAGEMENT PROVIDERS

Greater Vancouver is provided by a number of parking companies throughout it's many cities and areas. In particular the City of Vancouver, working with BC Hydro and government, is supporting the adoption of plug-in electric vehicles with the inclusion of charging stations in the city.[1] The city of Vancouver manages 76 electric vehicles charging stations in the City of Vancouver and it is estimated that about 175 electric charging stations are available in parking garages, shopping malls, and other private services. [2] Apps, such as Plugshare and Chargehub, allow electric vehicle users to find electric car charging stations in the city.[3] Honk!, Park 'in' Spot App, PaybyPhone are more general parking apps used to find parking in Vancouver. The parking companies in Vancouver are as follows:

1. EasyPark "Electric Vehicle Parking Stations" easypark.ca Web. Accessed Dec 29th 2018. <https://www.easypark.ca/products-services/electric-vehicle-charging-stations>
2. City of Vancouver "Electric Vehicles" vancouver.ca Web. Accessed Dec 29th 2018. <https://vancouver.ca/streets-transportation/electric-vehicles.aspx>
3. City of Vancouver "Electric Vehicles" vancouver.ca Web. Accessed Dec 29th 2018. <https://vancouver.ca/streets-transportation/electric-vehicles.aspx>

Figure 21. Table of Parking Services in Vancouver

PARKING SERVICE	OPERATION AREA IN VANCOUVER	APP	ELECTRIC CHARGING STATION
IMPARK	In all Metro Vancouver municipalities.	hangTagTM	Present where available.
EASYPARK	The City of Vancouver and Richmond Sea Island	EasyPark	Present where available.
ROYAL PARKING	Canada Place in downtown Vancouver	-	-
WESTPARK	In most Metro Vancouver municipalities	-	Present where available.
ADVANCED PARKING SYSTEMS LTD.	The City of Vancouver	-	-
METRO PARKING	The City of Vancouver	-	-
DIAMOND PARKING SERVICE	In most Metro Vancouver municipalities	Paybyphone	-

SERVICES

- Public Fee Parking
- Pay-By-Phone or Mobile Applications
- Wireless services
- Automobile services: Tire inflation, key retrieval, battery boost, fueling.[1]

FARES

- Varies with location of parking site and duration of parking time.[2]

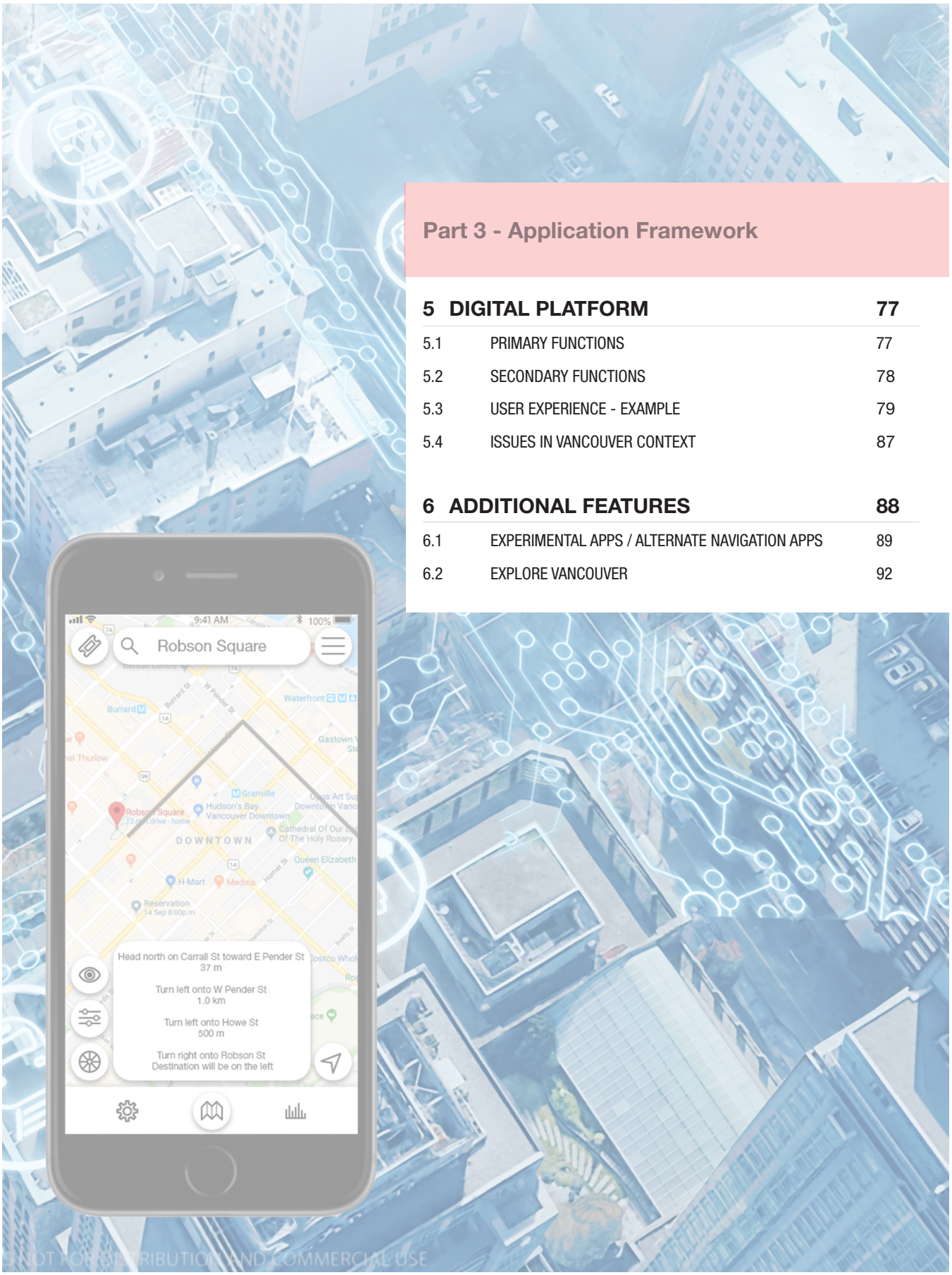
STRUCTURE

- Private company

MAAS POTENTIAL

- Parking services has the potential to synergize with carshare services and MaaS users.

1. https://westpark.com/page.php?page_id=11
2. https://westpark.com/sign_in.php?page_id=10



Part 3 - Application Framework

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NOT FOR DISTRIBUTION AND COMMERCIAL USE

5 DIGITAL PLATFORM

The framework for the digital platform discussed in this chapter is a description of what the app would do, how it would work, and what components, data, features, structure and chronological services are required. As well, it acts as a test to determine the feasibility of the functions proposed; wether they can be accommodated on the same server and how the functionality can be made clear to the user. The app provides an example of how a MaaS app in the region may function.

5.1 PRIMARY FUNCTIONS

A typical MaaS platform requires the following primary processes: registration, journey planning, booking, payment, and journey[1]. There are many existing map and trip planning applications that feature some of these functions, but it is the aggregation of all of them into a single application that allows a MaaS system to be the sole tool for a travelling user.

5.1.1 REGISTRATION

The registration process should provide the user access to all of the available transportation services within the application. There are two main methods that can be used for this purpose.

The first method requires the user to already have existing memberships with the various service providers. The user would have to provide basic information for their MaaS application profile and then log into each service provider. This method is the easiest to implement as the registration for each service provider is done on their respective ends and users with existing memberships will understand that they are not creating duplicate accounts.

The second and more user friendly method requires the user to sign up only once. It is then the MaaS application's responsibility to connect the user to the service providers. This includes providing any necessary information about the user to the service provider.

The signup process can be completed to various degrees. Standard information such as name, email, and phone number would be the most basic and allow for all travel that doesn't require a driver's license. The next step is driver verification and would provide the user access to the various carshare services. If a user chooses not to register they will still have the ability to plan a trip through the application, but would not be able to book any of the services involved with that trip.

The final step of the registration process would ask the user to provide a method of payment. This step could be skipped for those users that do not wish to book any services at this point in time and can be modified at a later time through the user settings.

5.1.2 JOURNEY PLANNING

The user should be able to plan a trip from point A to point B. This process should take into account the user's preferences in terms of service providers and display multiple route options that prioritize preferences such as time, distance, and price. A key component in this planning is the use of multiple modes of transportation where appropriate. This will create more effective routes, especially for longer trips and those that struggle with "the last mile".

1. MaaS Alliance. "White Paper. Guidelines & Recommendations to Create the Foundations for a Thriving MaaS Ecosystem," September 4, 2017.

5.1.3 BOOKING AND PAYMENT

Once the user has chosen their desired route, it is now the MaaS application's responsibility to make all of the necessary arrangements with the needed service providers. This includes everything from booking a carshare vehicle to purchasing a bus ticket. The user simply has to pay a single cost within the application for the entire trip while the MaaS application is responsible for sharing that revenue with the respected service providers. The user is then provided with all of the necessary tickets and codes needed for their journey, including NFC tapping for Translink.

5.1.4 JOURNEY

The application will provide step by step directions for the user's chosen route. Additionally, the user will be notified of potential delays in service and rerouted if a significant disruption has occurred.

5.2 SECONDARY FUNCTIONS

5.2.1 ROUTE FILTERS

While time, distance, and price are the primary filters used to determine a user's best route, there are times when a user will want to prioritize a different option. These other filters could include CO2 emissions or sustainability ratios in some manner, calorie burn, steps taken, accessibility, elevation change, sound levels, and exploration such as the functionalities discussed in the previous chapter.

5.2.2 LIVE BUS ROUTES

While the search bar is typically used for finding a location, the user should also be able to search for a bus route. The map should then be updated with the route, bus stop locations, and the live location of the active buses.

5.2.3 MAP FILTERS

The user should have the ability to manipulate what appears on the map. This should include standard options such as satellite view, traffic conditions, parking lots, and bike lanes, but should also allow the user to view the operating areas of the various carsharing services as well as the live locations of available shared vehicles and docking stations.

5.2.4 MULTI-STOP PLANNING

The user should have the ability to add additional stops to their trip with desired stop durations and the application should be able to choose service modes appropriately. This should take into account whether or not to hold a carshare vehicle and also notify the user when the next part of their trip needs to begin.

5.2.5 PARKING

On top of the user being able to see parking lots through the map filters, the application should present the user

with the option of getting directions to the nearest parking lot to their chosen destination once they have decided on driving as their mode of transportation. This feature can be strengthened by providing live spot availability for supported parkades and potentially live updates for street parking.

5.2.6 TRAVEL STATISTICS

The application should present the travel data to the user and provide comparisons to the general population and possibly comparisons on a friend to friend basis. The user should be able to sort the data over various time frames, the various route filter options, by service provider, and general transportation mode.

5.2.7 HEALTH APPLICATION INTEGRATION

There are many health tracking applications for mobile devices and all iOS devices come with Apple's own Health app[2]. The Health app requires the user to manually add events such as walking and cycling, but also has the ability to add other applications as inputs. The MaaS application will already be keeping track of a user's trips, making it an ideal input for the Health app. This will make it easier for users that are more fitness oriented to manage their fitness data.

5.2.8 INCENTIVES

The application has three main goals in providing easy access to transportation and efficient routing, decreasing the negative environtental impact through smart travel choices, and increasing the health and well being of the users. There are times where the first goal is in opposition with the latter two and thus the application needs to provide incentives to the users for choosing healthy and environmentally positive choices.

5.3 USER INTERFACE EXAMPLE

Aiming to include all of the above features into a mobile application does create usability concerns. The user must be able to easily plan and execute their trip while having the ability to customize their travel settings. Payment needs to be seamless and the trackable data must be presented in a way that is easy to navigate and sort. The following is a possible layout for the application. It features a primary navigation bar along the bottom that allows the user to switch between three primary screens: one for settings, one for the map, and one for statistics.

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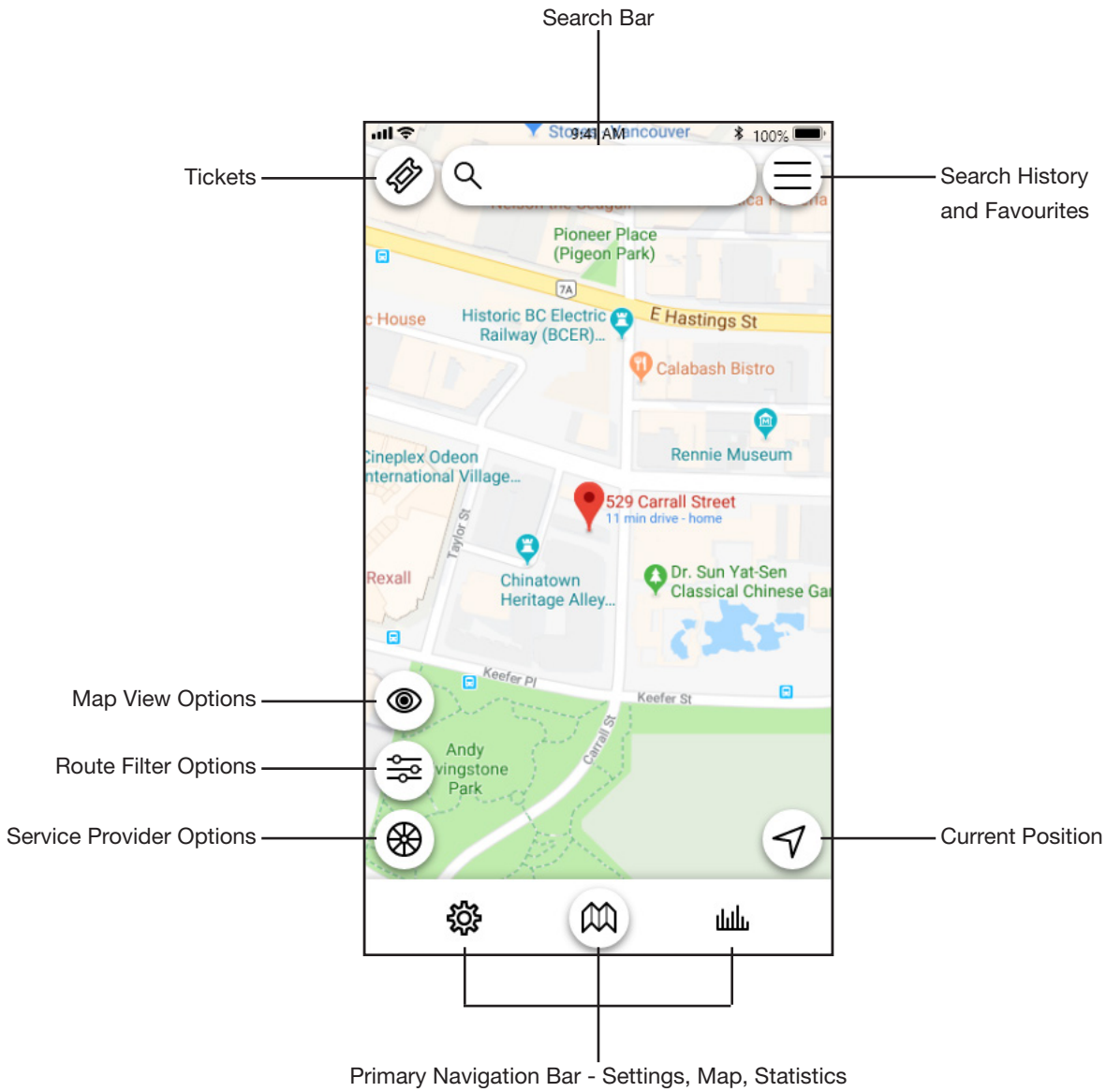
2 "IOS - Health." Apple (CA). Accessed September 19, 2018. https://www.apple.com/ca/ios/health/..

Figure 25. Primary Map Screen



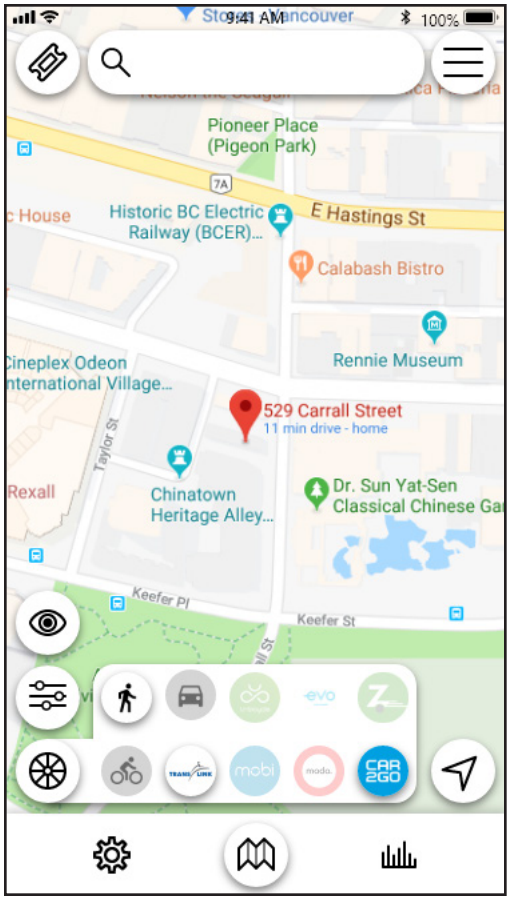


Figure 26. Service Provider Options.
The service provider options allow the user to enable and disable the various service providers and modes of transit that will be used to plan their trip.

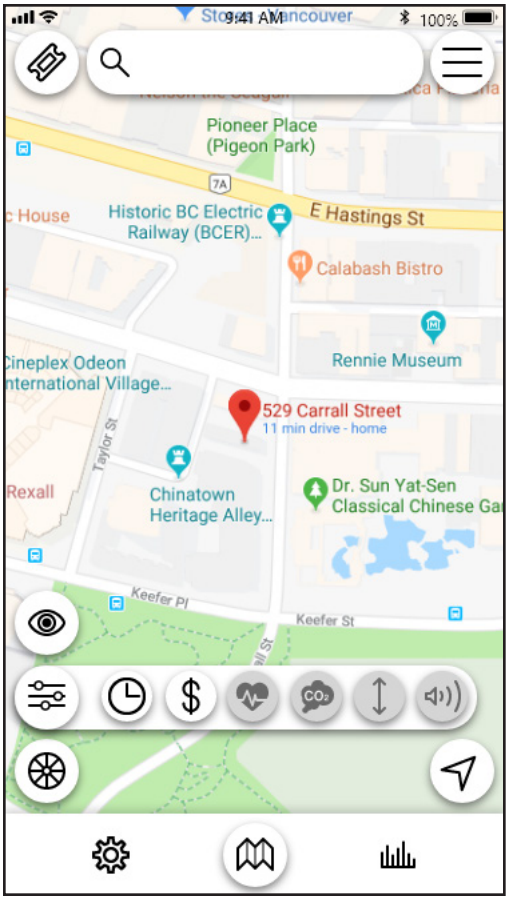


Figure 27. Route Filter Options.
The route filter options allow the user to select the priorities for route planning. The options can also be dragged into a preferred order that will be reflected when the route suggestions are displayed.

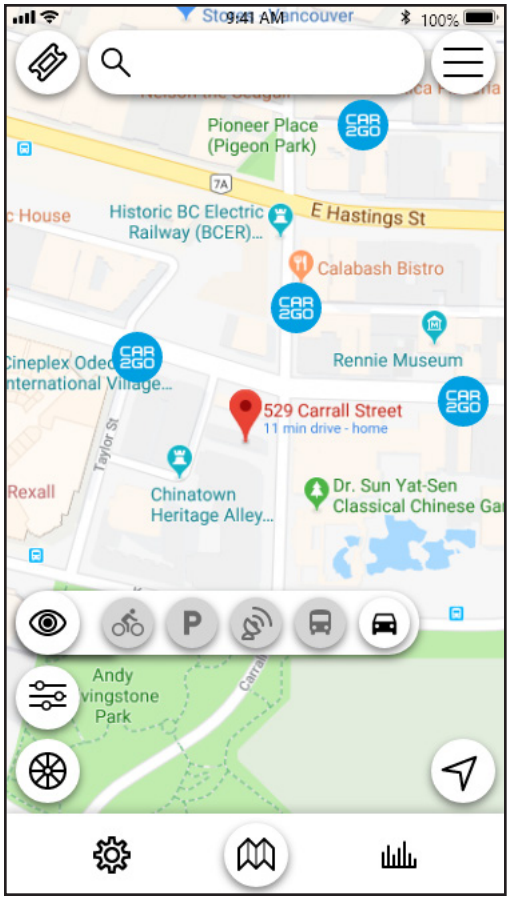


Figure 28. Map View Options.
The map view options allow the user to enable and disable different overlays depending on what is important to them at the time. A driver may want to see traffic congestion and parking lots, while a cyclist will just want to see bike lanes.

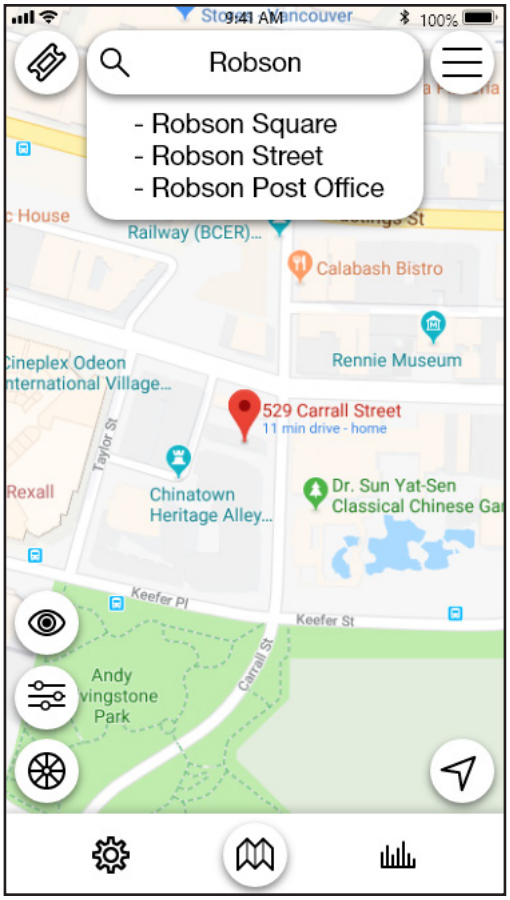


Figure 29. Location Search.
As the user types, a list of suggestions will be provided. Recent searches and favourites are easily accessible through the button at the top right.

Figure 30. Route Suggestions.
A variety of routes are listed based on the parameters selected by the user in the route filters and service provider options. Each route is displayed with it's price, time, mode of transit, and a brief overview of the directions.

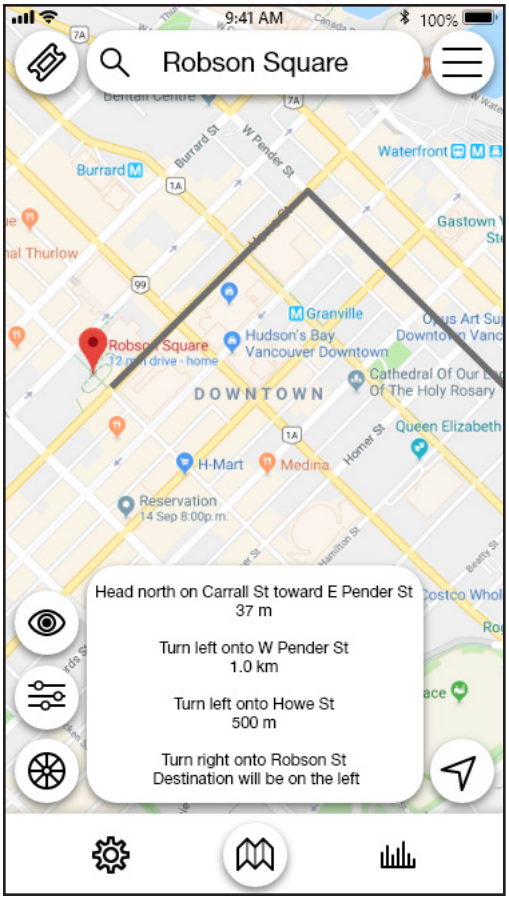


Figure 31. Route overview.
Once the user has selected their desired route, a full list of directions is displayed before they start their trip.

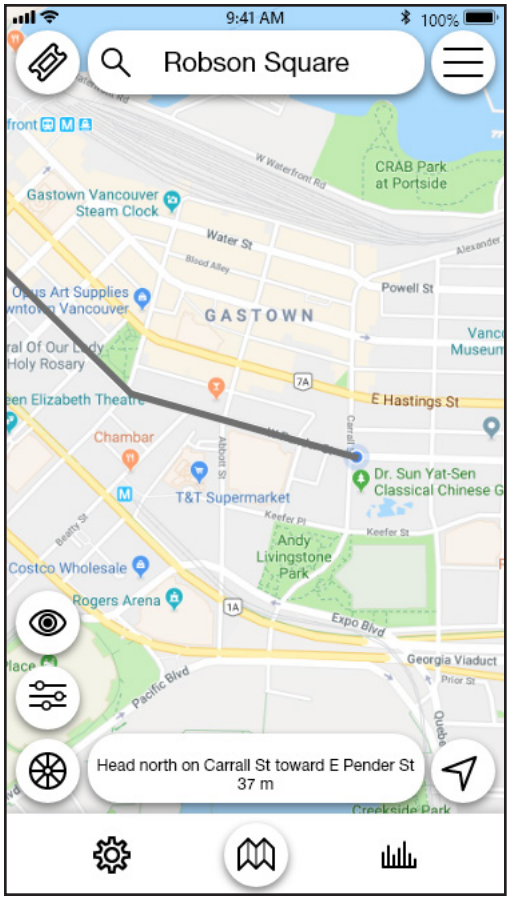


Figure 32. Live Directions.
Once the user has started their trip, the route overview is removed and replaced by the current instruction, giving the user a larger view of the map.

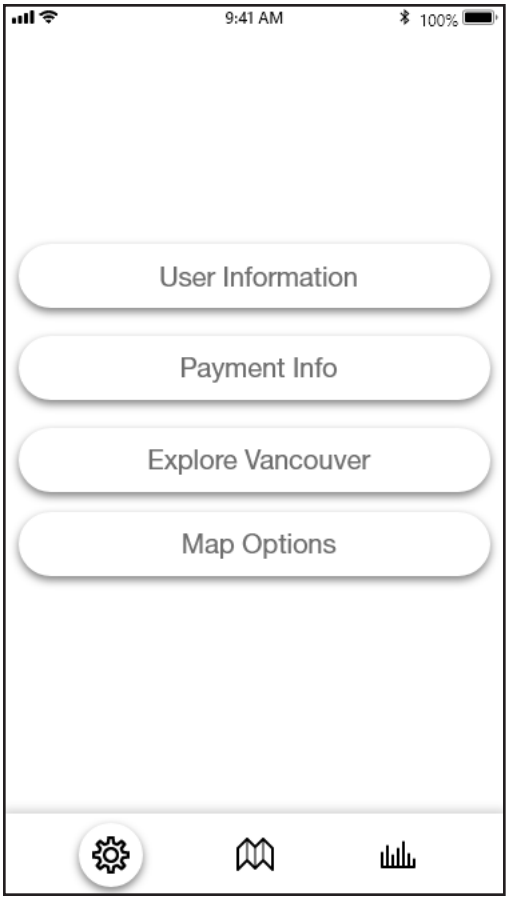


Figure 33. Settings Page.
The primary settings page acts as a portal to all of the settings that do not need to be easily accessed for each trip. It is here that basic account information can be updated, payment information can be added, and overall adjustments to the main map page can be made.

Figure 34. Tickets.
With a variety of service providers being used at any given time, users will need to have easy access to all of the tickets, barcodes, and passcodes required for their trip. A single tap on the ticket button at the top left of the map screen will provide access to all of their current passes.

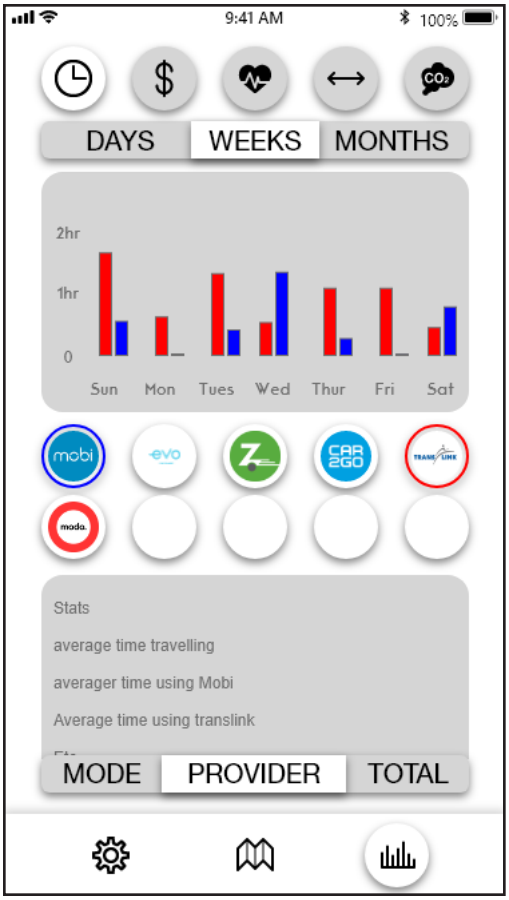


Figure 35. Statistics.
The statistics page allows the user to examine their usage habits and compare to the general population. They can filter by time frame, route filter, service provider, and mode of transportation. Seen here is the service provider page that allows the user to compare their usage between selected service providers. The page can scroll upward to reveal more data.

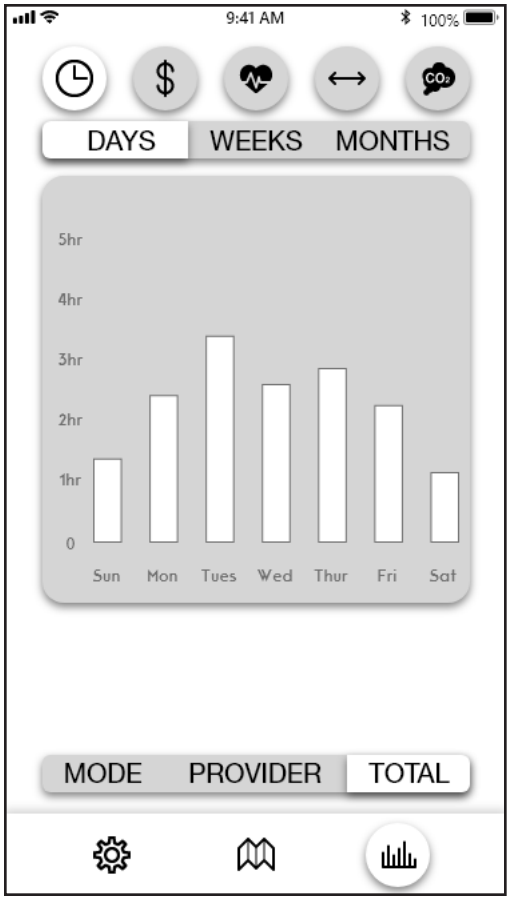


Figure 36. Total Statistics.
Here the user can track their overall transportation usage across the various route filters and time frames.

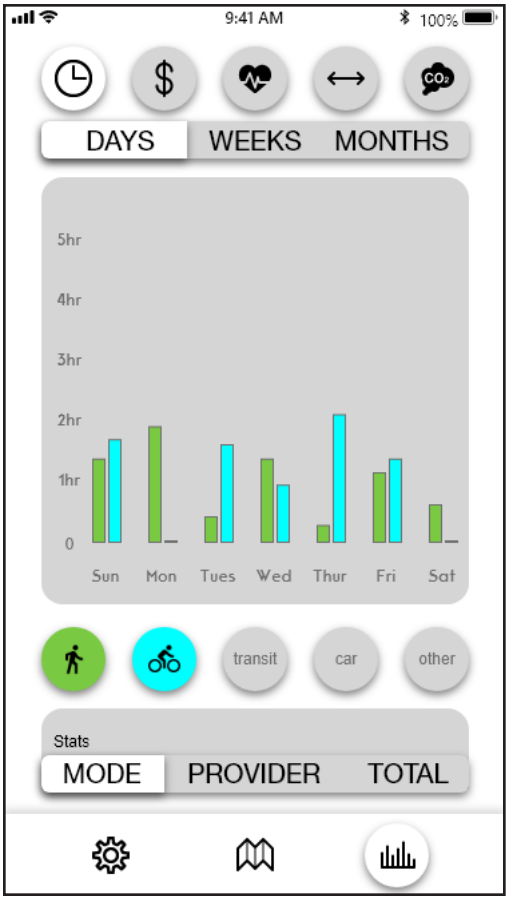


Figure 37. Mode Statistics.
Here the user can view generalized statistics per transportation mode instead of per specific service provider.

5.4 ISSUES TO ADDRESS IN CREATING A MAAS APPLICATION FOR THE LOWER MAINLAND

5.4.1 DATA SHARING AND API ACCESS

The essential hurdle to overcome in the execution of this application is gaining access to the API (application programming interface) for each service provider and creating a data sharing agreement. API access is necessary for communication between this application and those of each service provider. This must provide the ability to book the service, whether that is a car share, a ride along public transit, or a short term bike rental. While several service providers have an accessible API, they typically do not provide access to booking or ticket selling and only offer data such as vehicle locations and route information.

There is value in sharing data between parties as well. Sharing customer data is essential on some fronts such as registration and booking, but anonymous, analytical data regarding service usage, travel habits, and problematic locations and times, is a valuable asset for every party. This information can allow the involved parties to create better user experiences and more efficient services, but cooperation is needed to share such data.

5.4.2 BRAND AND CUSTOMER SERVICE CONTROL BY PROVIDERS

Another key concern in bringing service providers on board is dealing with customer service and brand control. Customers would now be dealing with each service provider through a single application, eliminating each providers' control over that interaction. This removes the initial customer interaction which could have been used to separate a service provider from it's competitors. Each service becomes homogenized in regards to the digital platform, which will be a difficult thing for many of them to agree to. At the same time, service providers would no longer need to spend as many resources on their own applications.

5.4.3 TRANSLINK TICKETING

Public transportation plays a vital role in the success of a MaaS system, and paying fares through the MaaS application is essential for the ease of use. The Compass Card[1] is Translink's all in one payment card that allows users to load money onto their account and simply tap the card to access all of Translink's services. They have also added support for Tap to Pay[2] using Visa and Mastercard. While this does allow for the use of NFC capable phones loaded with a user's credit card, Translink has not created a way for users to load their existing compass cards onto their phones.

While the majority of local transit users will have a physical Compass Card, making it a requirement for the use of the MaaS application is far from ideal. Tourists and others without a Compass Card would then have to leap over that hurdle every time they wished to use public transit. This defeats the purpose of and all in one, easy to use system. A possible solution is to build a digital card system for Translink.

1. "Compass - Home." Accessed November 10, 2018. https://www.compasscard.ca/.
2. "Tap to Pay." Accessed November 10, 2018. https://m.translink.ca/Fares-and-Passes/Tap-to-Pay.aspx.

6 ADDITIONAL FEATURES

MaaS applications promotes the use of mobility services through the help of geo hastagging of a city's urban spaces by its users. This creates a real-time crowdsourced user-defined picture of a city's condition that goes beyond only transportation related topics to encompass features that may relate to entertainment, health, sustainability, or other unexplored synergistic functions. This crowdsourcing that allows the possibility for users to identify geographical city conditions other than that related to transportation, has the potential to promote mobility service uses in new unexplored ways. Users in a MaaS application may indentify conditions like the relaxation an area provides, the health benifits of key routes, the architectural tourism qualities of a city intersection, or commerical stores that can be used for grocery shopping along a route which can incite moblity service uses in other means than purely for transportation. Notably, there have been health and sustainability findings for additional MaaS application functions that can promote use of Vancouver mobility services though a MaaS app; this is decribed in greater detail in section 6.

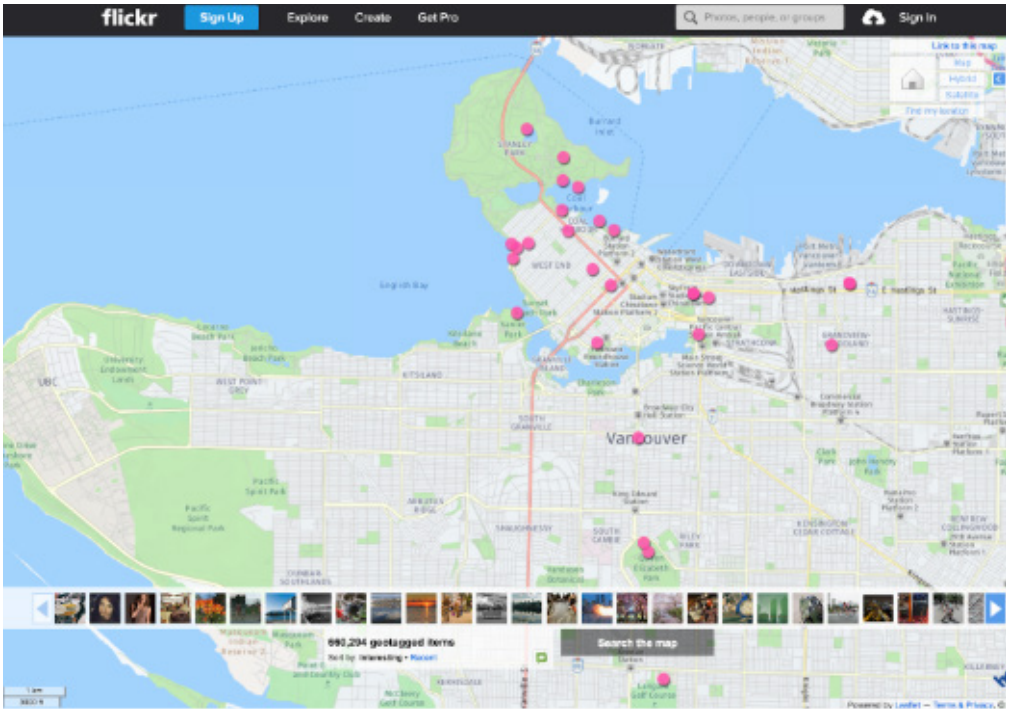


Figure 25. Flickr website map showing Vancouver geotagged images. Geotagging in the proposed MaaS app would also be geographically link user-defined experiences, definitions, and conditions to locations in the city.<flickr.com>

6.1 EXPERIMENTAL APPS/ ALTERNATE NAVIGATION APPS

The overviewed navigation apps used as precedents and inspiration to support the development of Explore Vancouver help show the potential viability of the MaaS App to reframe existing mobility services for new markets, functions, and desirable urban experiences. These case study apps show the potential of incorporating or emphasizing the experiential value that mobility services can facilitate for users. These examples inspired the development of Explore Vancouver and are outlined as follows:

6.1.1 HAPPY MAPS

Daniele Quercia's Happy Maps project was one of the alternative navigation apps that helped inspire the MaaS app through its development. For the Happy Maps project, Daniel Quercia and his team as Yahoo labs began with the idea that mapping apps always showed the shortest, most efficient route, but that for an additional minute or two of travel time a person might be able to enjoy the more emotionally pleasant route. This

idea inspired his team to try and quantify what a "more pleasant route" might look like.[1] The way they set about defining "beautiful," "quiet," and "happy" was to show a hundred images of urban settings two at a time to participants and have them choose which of the two images conveyed "beauty." The same approach was used for crowdsourcing a definition of "quiet" urban scenes and "happy" urban scenes. All the photos shown were from around London, UK and corresponded to geographic locations. In this way, a map of London was created that charted happy, quiet, and beautiful places. This is important as it provided supply for a potentially unmet demand for mobility services that are also experiences, enjoyable, or providing more than just their functional service.

In their research, Quercia's team then tested whether places could be defined positively using metadata on geotagged Flickr images to determine "happy route"; of the 7 million geo-referenced Flickr pictures in London used in their research, 5.1 million had at least one tag while 3.7 million were able to be used for their purposes.[2]

The team then gathered statistics for each location. Statistics from the metadata gathered were: "number of pictures taken in that location (density), number of views, of favourites, of comments, and of tags."[3] Then the team "cleaned the data (converted them to lowercase and remove those that are stop-words), and processed them using a dictionary called "Linguistic Inquiry Word Count" which sorts the words into 72 categories relating to positive and negative emotion words, school words, work words, leisure and more. Some words would fit into multiple categories.

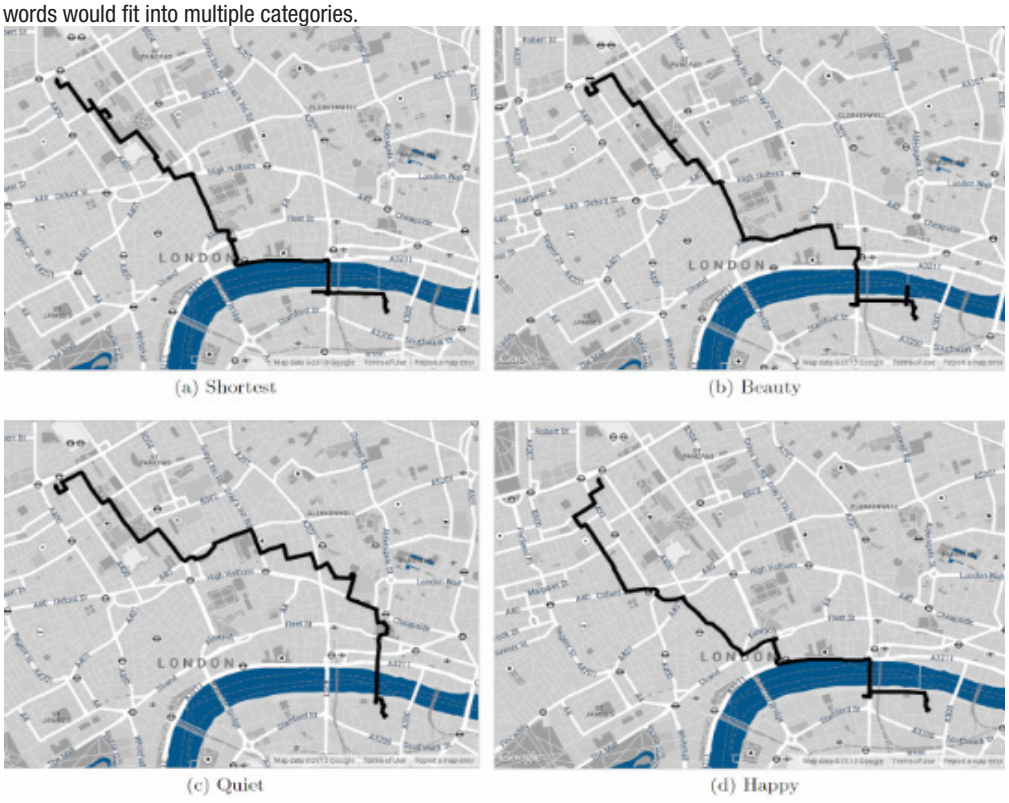


Figure 22. Happy Maps Example Routes. Quercia, Daniele, Rossano Schifanella, and Luca Maria Aiello. "The Shortest Path to Happiness: Recommending Beautiful, Quiet, and Happy Routes in the City." ArXiv:1407.1031 [Physics], July 3, 2014. http://arxiv.org/abs/1407.1031, Page 5.

1. Quercia, Daniele, Rossano Schifanella, and Luca Maria Aiello. "The Shortest Path to Happiness: Recommending Beautiful, Quiet, and Happy Routes in the City." ArXiv:1407.1031 [Physics], July 3, 2014. http://arxiv.org/abs/1407.1031 , 1.
2. Quercia, Daniele, Rossano Schifanella, and Luca Maria Aiello. "The Shortest Path to Happiness: Recommending Beautiful, Quiet, and Happy Routes in the City." ArXiv:1407.1031 [Physics], July 3, 2014. http://arxiv.org/abs/1407.1031 , 7.
3. Quercia, Daniele, Rossano Schifanella, and Luca Maria Aiello. "The Shortest Path to Happiness: Recommending Beautiful, Quiet, and Happy Routes in the City." ArXiv:1407.1031 [Physics], July 3, 2014. http://arxiv.org/abs/1407.1031 , 7.

6.1.2 DERIVE APP

Dérive app, an smartphone app developed by Babak Fakhamzadeh and Eduardo Cachucho and is available for both iOS and Android providers, is designed to "allow users to explore urban spaces in a carefree and casual way" with incorporating ideas of gamification into functional urban travel[4]. It provides users a gamified way to see the city as an entertaining experience through the use of activity spurring crowd sourced

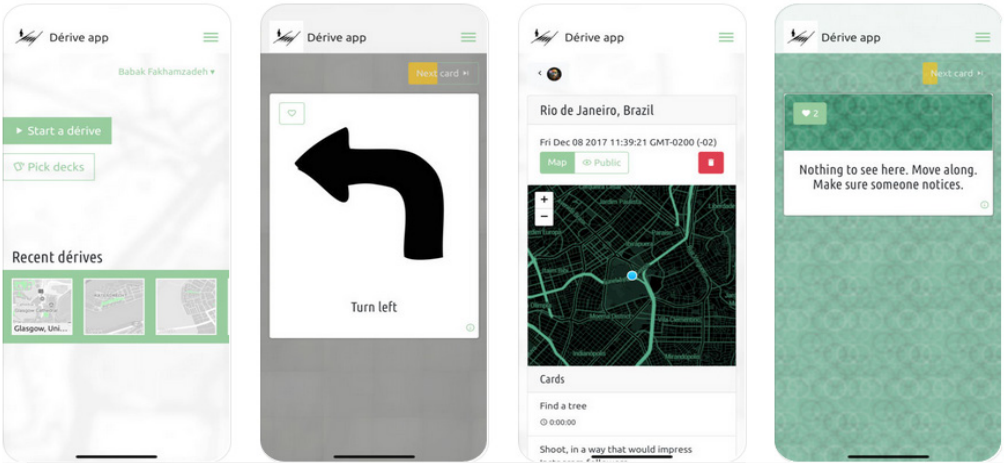


Figure 23. Derive app screenshots. App Store "Drive app: Get Lost in you city" itunes.apple.com Web Accessed Dec 31st 2018. "https://itunes.apple.com/us/app/derive-app-get-lost-in-your/id1159726913?ls=1&mt=8

The app is described to be generated around the ideals of the situationists and provides a spontaneous and quirky manner of navigating about a city.[5] The app presents cue cards such as "turn left," "find a crowd," "look up for a balcony," "find someone warmly dressed and get ahead of them" to guide your experience of the city. These cue cards can be user defined, shared, and generated for curating custom experiences, portraying more experiential perspectives, and creating entertaining experiences in an otherwise functional travel through a city. [6]

This case study shows the potential of how mobility services, through a MaaS app, can also be hybridized with concepts of gamification, be marketed with user-desired experiences, and have entertainment game-like value to potential users. Here, mobility services, through a MaaS app, could become more than just a utilitarian service gamification er desires.

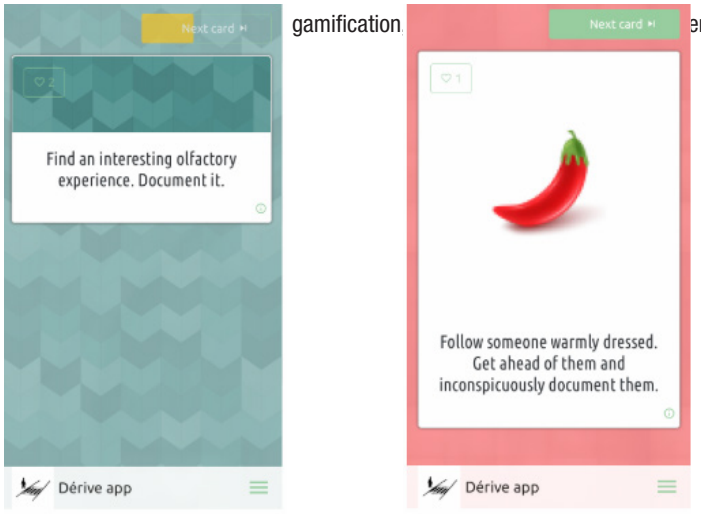


Figure 24. Derive App Screenshots of cue cards with action-inciting messages. These arguably reframe the city and travel through it as an entertaining experience.

4. "What Is Dérive App." Dérive App (blog). Accessed September 13, 2018. http://deriveapp.com/s/v2/about/.
5. Derive app "What is Derive app" deriveapp.com Web. Accessed Feb 29th 2019 < http://deriveapp.com/s/v2/about/>
6. Dervie app "Make Your Own Deck" deriveapp.com Weh Accessed Feb 29th 2019 < http://deriveapp.com/s/v2/make-your-own-derive/>

6.1.3 SERENDIPITOR APP

Serendipitor is another app that bills itself as an "alternative navigation app... that helps you find something [while] looking for something else."[7] It is a project of Creative Capital and created by Mark Shepard as part of a joint artist residency with Eyebeam Art+Technology Center.[8] Using a user generated route with a start and destination, it introduced "displacements" and divergences to the user defined route to presumably help the user discover and experience the city in their travel. This case study shows another example of how gamification and inclusion of experiential entertainment assets with urban travel, such as with existing mobility services, can transform urban travel. This suggests the potential of mobility services to also provide

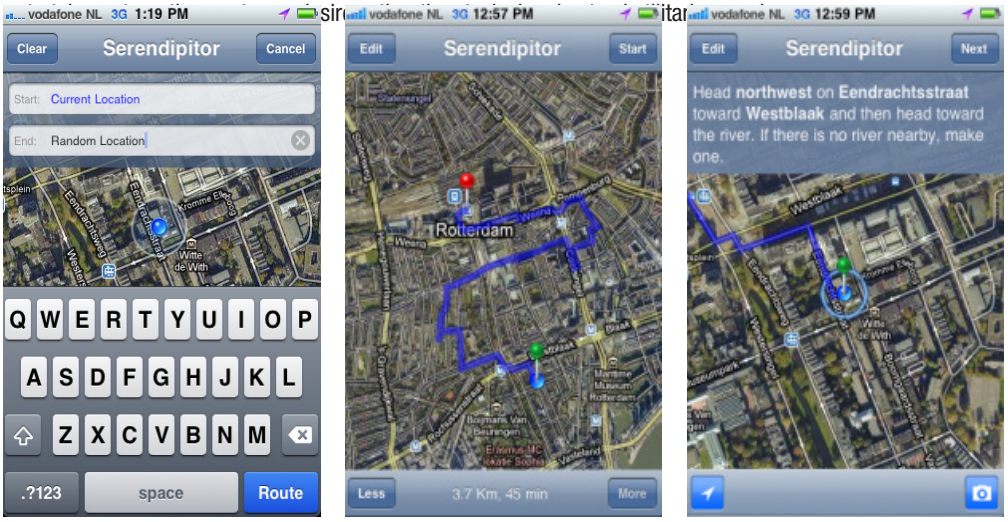


Figure 24. Serendipitor App Screenshot. "About « Serendipitor." Accessed September 13, 2018. http://serendipitor.net/site/?page_id=2.

This app combines directions to your chosen destination, or a randomly selected destination, with instructions such as "walk toward the heart of the city. If the city has no heart, give it one."[9] Directions/ routing service are generated from Google's open API while the "instructions for action and movement are inspired by Fluxus, Vito Acconci, and Yoko Ono."[10] As shown in figure 24, the routes deviate from the most time-efficient route to help the user 'experience' the city in their travel or transportation through their vehicle.

7. "About « Serendipitor." Accessed September 13, 2018. http://serendipitor.net/site/?page_id=2.
8. "About « Serendipitor." Accessed September 13, 2018. http://serendipitor.net/site/?page_id=2.
9. Ibid
10. Ibid

6.2 EXPLORE VANCOUVER

Explore Vancouver is the proposed function for the app which adds functionalities which may be appealing to a wide variety of users. The original idea started as a function that could allow tourists and locals alike to explore Vancouver through build your own tours and pre-packaged tours (outlined below), and has evolved into two functionalities, one that allows for pit stops (for example: cocktails, grocery store, ATM) on the way to a destination, and one that suggests an alternate route that is, for example, within 5 minutes of the fastest route, but allows you to take a more enjoyable route. The working titles for the two Explore Vancouver functionalities are "On my way (OMW)" and "Scenic."

The proposed MaaS app, however, does not aim to provide build your own tours through it's Explore Vancouver program. The move away from the build your own and pre-packages tours in early development came as a response to the fact that Google has similar functions to the "build your own tours" function our research generated, while Tripadvisor offers pre-packaged tours which are similar in purpose to the "pre-packed tours" function looked at for the Vancouver MaaS app. Although the Explore Vancouver functions TIPSlab proposed were better suited to the local context and offered more than what is currently on the market, it was deemed that the Google and Tripadvisor's expertise would be better suited to the development of these kinds of app extensions. For TIPSlab to develop such extensions would be tangential to the main functionality of the this transportation app.

These functions were through to very fitting for Vancouver because of the diverse audiences they would bring to the area. Vancouver has many students and tourists who may spend less time than residents in Vancouver but also want to explore the city and epxerience more of it. These factors facilitate this and would bring more users to the app.

6.2.1 PITSTOP/'ON MY WAY' AND SCENIC

As an idea initially inspired by Daniele Quercia's "Happy Maps" project,[11] the Explore Vancouver extension of the Vancouver MaaS app is based around allowing tourists and locals a playful and adventurous way to further engage with Vancouver. "On My May (OMW)" and "Scenic" are the outcome of the Explore Vancouver research and are important aspects of the proposed MaaS app: Both are more fully described as follows:

6.2.1.1 'ON MY WAY'

"On My Way" provides an option to users to detour to indicated destinations that are along their desired route through the MaaS app. It is imagined to be a list of highly ranked possible places to stop on the way along the user's chosen route. This is added functionality which facilitates exploring the city and enjoying what it has to offer along your route. The following describes 'On My Way' in greater detail:

How to Use: Choose the category you would like to explore and plan your route by choosing between suggested locations on your Map. Map starts at the scale of the Lower mainland and shows you the most highly rated overall suggestions, and then you can zoom to the given geographic region that most interests you and select your stops/ layovers. Select your stopovers and end location and the app will route you and show your your ticketing and payment options. The categories are as follows:

- Drinks: Beer, Wine, Cocktails (beverage establishments with better Google ratings appear with larger location icon beside them. Zoom in to choose your specific stopovers.)
- Food (establishments with better Google ratings appear with larger location icons besides them. Zoom in to

11. "Happy Maps." Accessed August 27, 2018. http://goodcitylife.org/happymaps/.

choose your specific stopovers.). These options include:

-Food Trucks (Update their location on the app for live location on map)

-Gourmet

-Healthy

-Cheap and Delicious

- Public Art (information on Public Art locations and popularity is based on instagram hashtags and geotags. The most hashtagged locations are considered the most popular.) This includes sanctioned public art locations, murals, and community-driven installations in the city (instagram and facebook)
- Best View Points (locations and popularity based on instagram hashtags and geotags. The most hashtagged locations are considered the most popular.)
- Free Events (locations updated on app by event organizers for live location on map)

Other possible categories include: Food, Groceries, Beer-Wine-Cocktails, Coffee, Dessert, Gourmet, Brunch, Healthy, Takeaway, Public Art, Free events, Best View points , Gym, Post, Convenience Store, Clothing, Hospitals and Clinics, Attractions, Drugstore, Electronics, Sporting Goods, and Banks and ATMs. After selecting the route and the desired stop, these options would be shown as starred locations along the way. Any options can be selected.

6.2.1.2 SCENIC

The 'Scenic" function is a function that allows the user to see something interesting along their route to a desired destination. This option suggests an alternate route to the fastest route, within 5 minutes of travel time difference, with interested entities selected by the user. How this function works and possible categories of selection are outlined as follows:

How to Use : Scenic offers packaged tours (with determined routes) that allows you to visit significant sites in Vancouver accompanied by a geotagged audio recording that explains the significance of the site. Additional information and routing information is available on the phone screen in the Augmented Reality interface. The categories of Scenic are as follows:

-> Architecture (choose locations where architecturally significant buildings and sites are located in the city)

-> Public Space (Both exterior and interior public spaces are indentified through city data and identified locations. Private public spaces, interior public spaces, shopping spaces, public parks, plazas, and greenways are all identified).

-> First Nations History and Culture (First Nations Territory and sites of interest are chosen with consultation and tentative permission from First Nation stakeholders and communities. As such, the parameters are tentative to their permission).

-> Nature (Nature parks, environmentally sensitive areas, wildlife hotspots, and nature paths are indicated) Routes with the most trees or plants, routes with the least automotive traffic and enhanced views are provided.

-> History (Relatively recent history of Vancouver is encompassed. Historical sites, buildings, areas of interest are indicated to provide popular locations. Data from the city, users, and organizations/companies are consolidated to provide a enchanced timeline of not only sanctioned places, but user-defined events, narratives, and stories arguably not yet recognized by the city)