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Nordic Experiences with Smart Mobility: Emerging Services and Regulatory Frameworks

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Abstract

In a time where emerging technologies bundled within "smart mobility" represent a new transformation of the mobility system, it is critical that governments pro-actively take part in these developments. This means steering measures to ensure that the benefits of innovative technologies contribute towards a sustainable mobility system and avoiding the risk of increased attractiveness and use of private motorized transport, such as private cars. New technologies, largely accelerated by the ongoing digital transformation in mobility, have the potential to disrupt existing market structures entirely. Existing legal and regulatory frameworks may not be prepared for accommodating new and innovative services. It is therefore critical to gain more a thorough understanding of how new smart mobility services need and may be governed through regulatory frameworks.

This paper looks into approaches and experiences in Finland and Norway, focusing on the role the public authorities have adopted in the two countries with respect to smart mobility solutions and emerging Mobility as a Service (MaaS) offerings in particular. The paper first presents a typology of new mobility services and a review of emerging services. An analysis is then presented of the interplay between the government as a regulatory authority and the new MaaS initiatives, drawing on the frameworks by Docherty et al. (2018) on elements and challenges related to the transition to smarter mobility. Our main finding is that the services available on the street and challenges faced by the authorities in the short run are surprisingly similar, but that the toolbox available and the long run challenges may prove more diverging.

Keywords: smart mobility; governance; MaaS; Norway; Finland

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1. Introduction

"The future is smart, electric and automated" is a key message in the public and academic debate about the future of transport (e.g. UITP, 2019). The key thinkers of this smart transition describe a future in which mobility is framed as a service available on demand, as citizens in the future will have access to a "seamless system of clean, efficient and flexible mobility to meet all their needs" (see Docherty et al., 2018, 115; Wockatz and Schartau, 2015). Smart mobility services, such as car and bike sharing are growing rapidly globally, especially in large cities (e.g. Olsson, 2019; Schaller, 2017; Aarhaug and Olsen, 2018). So-called aggregator services, offering access to public transport together with other transport modes, such as city bikes, rental cars and taxis, are also increasingly emerging within the transport systems around the world (Kamargianni et al., 2016).

A growing body of scientific and non-scientific literature is delving into smart mobility (e.g. Groth, 2019; Smith et al., 2018a; 2018b). According to Docherty et al. (2018, 116), the knowledge on governance and regulation of smart mobility is still very limited. Our paper contributes to two pressing knowledge requirements around the smart mobility transition. First, there is a need to better understand the new roles of various actors. Second, it is unclear how regulation best may contribute to creating a smart *and* sustainable mobility.

Our interest lies particularly in the following questions:

- What types of, and what, smart mobility services have emerged in Finland and Norway?
- What role have the regulatory frameworks played in the MaaS developments in Finland and Norway?
- What can local and national governments learn from these experiences when planning regulation for smart mobility?

We address these research gaps and expand the scientific discussion on smart mobility by investigating the interaction between emerging smart mobility services, particularly Mobility as a Service (MaaS) and the regulatory frameworks in two Nordic countries, Finland and Norway. First, we assess a number of different services in these countries, with a glance to developments in Sweden and around the world. Second, we focus on aggregator services (MaaS) and two different MaaS initiatives as cases of our study: the privately-owned Whim in Helsinki, Finland, and the public transport authority (PTA) Kolumbus in Stavanger, Norway.

2. Theoretical background

2.1. Smart mobility

Smart mobility is a concept that aims to capture the many faces of the digital transformation in transport and mobility systems. One way of summing it up is "Zero Emissions, Zero Accidents, Zero Ownership" (Neckermann, 2015). However, a clear and established definition is lacking. Our scope aligns with that by Groth (2019, 56), characterising smart mobility as a lever in the transition from an automobile society to a multimodal society through use of "information and communication technologies (ICTs) – e.g., the smartphone – to switch flexibly between new interconnected mobility services (such as carsharing, ridesharing, bikesharing, bus or train)."

Docherty et al. (2018, 118-119) present four core elements of smart mobility: First, there will be a transition from *ownership* to *usership*, so that the users of the mobility system to a lower extent than earlier have to own their own means of personal transport. Second, there will be a change in the *definition of the mobility marketplace*, since "the traditional business model for public-private allocation of tasks across the mobility system will evolve." Third, there will be a transition from a "*modal-centric*" to a "*user-centric*" system, where the users' needs will get the main focus instead of the various modes of transport. Fourth, there will be a *new role of the citizen* in the transport system. The citizen is increasingly both a "source and recipient of information" and services. They are "one of many actors feeding information into the mobility system," including to provide on-demand services such as ride services through companies like Uber and Lyft. This reduces the role of the government as the prime source of information.

2.2. Mobility as a Service (MaaS)

Looking beyond separate, stand-alone transport services and digital solutions, the concept of MaaS envisions a system where MaaS operators provide a comprehensive range of mobility services to the users (Heikkilä, 2014). Over the past few years, MaaS has become a common term for describing the general idea of providing the end-user a single service to search, access and pay for a wide variety of transport options (MaasiFiE, 2016). In this paper, we use the definition provided by Smith et al. (2018a, 593): "An integrative concept that bundles different transport modalities into joint, seamless service offerings, as means to provide tailored mobility solutions that cater for end-users' travel needs," but focuses on: "bundled offerings that facilitate intermodal use of PT [public transport] and other transport services."

There are many different ways to establish a MaaS provider, and pilots and real-life cases are increasingly launched around the world. UITP (2019) presents four models for setting up MaaS offerings. These are (1) a commercial MaaS provider as a service integrator, (2) an open back-end service platform set up by a public entity, (3) MaaS run by public transport authority and (4) a shared platform operating via decentralised ledger technology (blockchain).

2.3. Regulating and governing smart mobility

The recent discussion on the challenges of smart mobility has mainly focused on technical challenges in accessibility, interoperability and interfacing. Other key challenges include regulation and governance, user acceptance, and the business case for the smart mobility services (Kostiainen and Tuominen, 2018; Lund et al., 2017). We have chosen one of them, *regulation and governance*, as our focus.

Regulation and governance relate to several issues, such as how, and to what extent governments should regulate entry, requirements and rights of new mobility service providers, operating permits, transport data and interfaces, public service obligations, taxes and auditing, certifications, and reporting. The public sector needs to support the realization of new services while avoiding a situation where services compete against public transport in an unsustainable manner (Kostiainen and Tuominen, 2018).

Docherty et al. (2018, 119-122) point out several challenges in governing smart mobility. The first one is "the tension between supporting the uptake of innovations, which offer benefits in the short-run, but which may create bigger governance challenges as they scale," e.g. service providers generating as much transport as possible to maximise returns on their capital investment. The second challenge is how the transport system will be taxed to reduce e.g. negative externalities of private car ownership like road wear, congestion and local pollution and paid for in the future as the actors' roles change. The third relates to data, which is a critical asset to control and have power over the mobility marketplace. Open data offers many opportunities to different actors, but shifts in the control of data, for example positional information provided by mobile data to the mobile phone operators, will make governing mobility more difficult. The fourth challenge relates to equity and inclusion and the fact that a smart mobility transition will "not occur at the same pace or degree across different areas and will not be similarly accessible to all members of the society." Smart services will first occur in central areas and where population density is high.

3. Methods and data

Our research methods and data are comprised of several elements. A literature review on research literature, press material, research reports, policy documents, existing regulations and materials from transport providers and public authorities in relation to smart mobility has been carried out. As for the theoretical framework, we have applied the elements and challenges of smart mobility transition by Docherty et al. (2018). Three representatives of Kolumbus and MaaS Global (owner of Whim) have been interviewed. In addition, material from a previous study has been reused

(Ydersbond and Veisten, 2019). Web page data, press coverage and other data from a number of providers of smart mobility in Finland, Norway, Sweden and the rest of the world have been scrutinized, compiled and analysed.

Finland and Norway are suitable countries for our analysis for several reasons. These include being global leaders in MaaS and similar combined mobility innovations, being highly interconnected through high-level internet penetration, seeking to attain technological leadership in sectors related to smart mobility and MaaS, and opting to be sustainable (Boyer et al., 2019, 19; Eurostat 2019a; 2019b; European Commission, 2019; Karlsen, 2017; Ministry of the Environment, 2018).

For a detailed analysis we have chosen two cases within our cases: (1) Whim, which represents the first model presented by UITP (2019, see above), a commercial MaaS provider as a service integrator; and (2) the Norwegian PTA Kolumbus with MaaS ambitions, which represents the third UITP (2019) model, i.e. MaaS run by a public transport operator. Whim and Kolumbus have been chosen for the following reasons: Whim, launched full-scale in Helsinki in 2018, is an early MaaS provider globally. It offers subscription-based and ticket-based services to bikes, taxis and rental cars in addition to access to the public transport services run by the PTA Helsinki Regional Transport (HRT) (Hartikainen et al., 2019; Kamargianni et al., 2016). Whim utilizes an open service platform provided by Finnish transport authorities. Kolumbus offers the most or one of the most developed MaaS solutions in Norway. It was the first PTA in Norway with electric buses, electric bikes and will likely be the first with an electric express ferry. Kolumbus is also relevant because it was the first PTA in Norway with electronic tickets and is offering a number of services that may be coined "smart," including an on-demand bus service and automated buses.

Therefore, we could call the research design, with Finland and Norway as countries of comparison a most-similar systems design (Lijphart, 1971; 1975). In such studies, the cases are similar on most variables except for one, or a very few, and these latter variables could then arguably explain the outcome. Here, the outcomes that are different, are that Finland's governance, regulations and political decisions have provided a privately operated MaaS type, while Norway's governance, regulation and political decisions have provided its citizens with MaaS offered by public transport authorities.

4. Regulatory settings and cases in Finland and Norway

4.1. Finland's regulatory settings

Finland is an international frontrunner in advancing regulation for smart mobility services. The Act on Transport Services (first stage effective in 2018, second stage in 2019) requires opening of essential data on mobility services and ensuring the interoperability of ticketing and payment systems (Ministry of Transport and Communications, 2017). The essential information to be provided in an electronic format by service providers who provide passenger transport services, as well as providers of brokering and dispatch services or integrated mobility services, include information on licences, routes, schedules and sales or ticketing application programming interfaces (APIs). The service providers required to open interfaces and service providers with right to access the interfaces are equally obliged to ensure the security and data protection of their information and services.

In the first stage of the legislation, passenger service providers were obliged to open their sales APIs for regular single tickets. In the second stage, the sales APIs were required to offer the ability for acting on behalf of the user, and to allow the mobility or integrated mobility service provider with a right of access to purchase ticket products on the user's behalf using the identification and user information of the service user's existing user account with the mobility service provider. Acting on behalf of a user is considered as an enabling element and catalyst for MaaS offerings by private and commercial providers.

The Finnish government had several aims for the reform of transport regulation before its enforcement in 2018, including: to promote "market functioning" and free competition by dismantling restrictive regulation of business models, to increase the opportunities for small and medium sized enterprises (SMEs) to participate in procurement processes by reducing the administrative burden on companies, to lower the threshold for entry into the transport sector, and to ensure that increased competition does not lead to a deterioration in consumer rights or in access to services for specific groups.

4.2. Norway's regulatory settings

Norway's transport regulations mostly follow traditional and sectoral lines. For land passenger transport there are primarily two relevant acts. The Railway Act regulating railways (Ministry of Transport and Communications, 1993/2017), and the Vocational Transport Act (Ministry of Transport and Communications, 2003/2019) that regulates scheduled and unscheduled passenger transport by road vehicles. These acts stipulate the overall structure of the Norwegian transport sector.

In Norway, railways are regulated nationally, with some exceptions regarding metros and trams. The Norwegian Railway Directorate has an overall coordinating role and manages contracts with operators (which are increasingly competitively tendered), the state infrastructure company BaneNor and others. Local and regional bus services are regulated and contracted by the regional county authorities, for the most part organised trough competitive tendering on gross contracts. Express coaches are de-regulated, and commercial (Aarhaug et al., 2018). Both rail and scheduled bus services have data sharing obligations to the national travel information agency Entur. Taxis and private hire vehicles (PHVs) are presently regulated at regional level with a need based ("*behovsprøving*") licencing system. This is due to be reregulated: a revision of the vocational transport act was passed by Parliament in 2019 and was planned to come into force in July 2020 (Ministry of Transport and Communications, 2019a). This revision removes the needs testing and simplifies the licensing structure. It also removes regulation requiring sole proprietorship for taxi operations and include a list of other changes.

In the Norwegian transport regulations there are no specific requirement for open APIs and data sharing, but the supplementary regulation (*forskrift*) (Ministry of Transport and Communications, 2013/2015) states that relevant information on scheduling and so on, must be announced and that this is specified in circulars from the Ministry of Transport and Communications (*rundskriv*). The current circular, N-2/2019 (Ministry of Transport and Communications, 2019b) stipulates how real time data is to be shared through the national coordinating entity for data, Entur. Entur is a publicly owned company set up to coordinate travel information. A new regulation for multimodal travel information and National Access Point (NAP), cf. (EC) 2017/1926, was, as of autumn 2019, subject to a public hearing. In this, the Norwegian Public Roads Administration has been named the Norwegian NAP.

4.3. Whim, Helsinki, Finland

Whim is a service and mobile application developed by Maas Global Ltd, one of the first fully functioning MaaS operators globally. The company was founded in 2015, and the first commercial Whim ride took place in late 2016. The Whim app was fully launched in Helsinki in November 2017. Birmingham (UK) and Antwerp (Belgium) followed in 2018 (MaaS Global, 2019a). The core idea of Whim is to provide an alternative to car ownership by offering access to various transport services that aim to cover all journeys and mobility needs of the user.

Whim in Finland operates in the Helsinki region. The city of Helsinki has about 650 000 citizens (City of Helsinki, 2019), while the greater Helsinki region has circa 1 500 000 citizens. The bundled service in Helsinki includes public transport, taxi, city bikes and car rental. It covers travel planning, routes, bookings, tickets and payments. Different plan options exist to meet different user needs, the most renown being "Whim Urban" that offers unlimited use of public transport and city bikes for a monthly fee. Special deals for short taxi rides and car rental days are provided for this subscription option with additional fees. Other plans include "Pay as You Go" for non-subscribers and "Whim Unlimited", where unlimited use of all listed transport services is included (public transport, city bikes, taxi and rental cars). The newest addition is "Whim Weekend" that sits between "Whim Urban" and "Whim Unlimited," offering unlimited car rental only on weekends (MaaS Global 2019b; 2019c).

In its first full year of operation in Helsinki in 2018, 95 % of the trips made using the app were done by public transport. Taxi rides accounted for 3,8 % and bike rides for 1,0 %, whereas the share of car rental and car sharing was close to 0,0 % (Hartikainen et al., 2019). The number of registered users in late 2018 was over 70 000, and the total amount of trips made using the app at that time was over 2,5 million (MaaS Global, 2019d).

4.4. Kolumbus, Stavanger, Norway

The PTA Kolumbus is responsible for passenger transport services in the regional county of Rogaland, whose population is around 475 000. In 2017, the Rogaland County Council decided that Kolumbus would go from being a provider of boats and buses to becoming a *mobility provider*. The same year, Kolumbus and the Norwegian Railway Directorate agreed that there should be seamless operation between buses and train from 2019 (Henriksen, 2018). From November 2018, single tickets were valid for both services. February 2020, the electric city bikes (organized through Bysykkelen) was launched for all Kolumbus customers, including in their apps. The PTA argues that it, "will work towards making trains, bikes, walking and car sharing seamlessly connect with bus and boat," so people "get from A to Z without using their own car" (Kolumbus, 2019a) in an environmentally friendly and affordable way.

Kolumbus currently offers tickets to buses, ferries, the local trains, and to electric city bikes to all customers. Tickets cover travel planning, routes, bookings, tickets and payments. They have a pilot on electric kick scooters, and plan to have these as part of their offers permanently in the future by cooperating with a commercial electric kick scooter provider. In August 2019, the municipality of Stavanger decided that those commercial kick scooter providers that in the future have been accepted to offer their services by the municipality, also can cooperate with Kolumbus and offer their electric kick scooters as part of Kolumbus' service (Stavanger municipality, 2019). October 2019, a pilot on car rental in cooperation with the commercial car sharing provider Hyre, was launched.

In 2018, there was a strong growth in passengers with buses, e-bikes and other passenger services. The growth was in particular a result of a rush-hour fee at road toll stations (to staunch local opposition). This was launched in October 2018 (Kolumbus, 2019b), which made it much more expensive to travel by car during peak hours. In 2018, there were 25,3 million trips totally, of which 24,3 million were by bus and 1 million by boat (Kolumbus, 2019c), in addition to around 80 000 e-bike trips.

5. Analysis and results

5.1. Typology of smart mobility services

Using existing literature as the starting point (e.g. Cledou et al., 2018; Tuominen et al., 2016), we compiled a list of smart mobility concepts. Table 1 shows the typology and examples of prioritised and categorised smart mobility services, excluding concepts left outside the scope of our study, such as: driver assistance services; services related to infrastructure, road charging and parking; location-based real-time services related to traffic jams, weather and warnings; gamified walking and cycling; and conference calling and other non-transport services.

Table 1. Typology of smart mobility services: category, type, description, with examples from Finland, Norway, Sweden, and internationally.

Category	Type	Description	Examples
Aggregator service	Trip planners (journey planners)	Search engines for planning, booking and paying with multi-service and multi-modal outreach (but no packaging)	Rome2Rio, Entur, HSL app, Ruter app
	Mobility as a Service	As above, and in addition packaging services by different operators, both public and private, under one account (e.g. monthly subscription)	Kolumbus, Whim, Ruter, UbiGo
Ride service	Ride-sourcing (ride-hailing)	Taxi-like peer-to-peer services, where the driver chauffeurs the passenger	Uber, Lyft
	Ride-sharing	As above, but the driver and passenger share the destination	GoMore, Skjutsgruppen
	On-demand public transport	Demand-responsive service combining taxi-like features to public transport (e.g. a bus with a flexible route based on customer requests)	Flextur, HentMeg (Kolumbus)
Vehicle service	Vehicle rental	Vehicle rental for daily mobility; vehicles are owned by a public or private organisation (e.g. car clubs)	Bilkollektivet, Voi, Tier, Circ, HSL city bikes
	Vehicle sharing	As above, but as a peer-to-peer service; vehicles are owned by individuals	Blox Car, Nabobil

5.2. Emerging smart mobility services in the Nordic countries

We catalogued and analysed over 60 smart mobility services, using academic and professional literature and personal communications. This sample covers all categories and types in our service typology in Norway (28), Finland (11), Sweden (14), and also international ones (14). The review does not aim to fully cover all emerging services in these markets, but rather to capture some of the most advanced, largest in terms of customers, or prominent, examples and some of the variability within. The chosen 66 services were analysed, inter alia, in terms of:

- type of service provider
- country and location of operation
- outreach (local / national / international/ urban / rural)
- maturity (development / pilot or test / operational)
- service type and category
- transport mode(s)

Aggregator services are predominantly multimodal; at least intending to "get there," even if starting off with road transport only. Aggregator services are found in all development phases, and a pattern appears that they are being launched as local or regional and then grow larger, even nation-wide. In the international sample, also trip planners with international, cross-border outreach was identified, like Rome2Rio. Most typical trip planners are, however, seemingly the well-established regional journey search engines provided by local PTAs. MaaS initiatives are in development or testing phases, with a few having reached early operational phase, depending on how they are defined. Service providers for MaaS vary from private to public, and whereas in Finland the MaaS provider is typically a private company, in Norway what may be termed MaaS providers are PTAs or other publicly funded organizations.

The *ride services* in our sample contain fully operational services, as well as some that are in the piloting and testing phase. These are mainly car-focussed services provided by private companies, covering only road transport. Their outreach varies from local to national and even international, addressing to some extent urban as well as rural environments. Ride-sourcing services are strongly characterised by the presence of the international giants (such as Uber), but also include local and national start-ups. In each country, also at least one ride-sharing service was identified, one of these having grown fairly popular in a part of Sweden, i.e. the non-profit organization Skjutsgruppen, where the driver and the passenger either share travel costs equally, or the passenger rides free of charge. These appear

less popular in Finland and Norway. On-demand public transport services were also found in our sample, like Kolumbus' service HentMeg ("PickMeUp") in the village Sauda, but the scale was generally small, and several pilots have been discontinued.

Vehicle services are found in the operational phase in large numbers, most often provided by private companies. In Norway especially, non-profit models, such as co-operatives, are increasingly popular forms to organise car sharing and renting (George and Julsrud, 2018). The transport mode of vehicle services is limited to road, but vehicles range from electric kick scooters, bikes and e-bikes, to cars. Electric fleets and newly launched micro-mobility schemes (e.g. electric kick scooters) have emerged fast in all countries in the past few years, not least since 2019. The outreach of these vehicle services varies from local to national and international, serving both urban and rural areas. Each Nordic country has at least one peer-to-peer car sharing service identified, but they are seemingly marginal in terms of popularity and size, apart from Nabobil in Norway.

5.3. Assessment of the services against the smart mobility transition

Here, we reflect on how the reviewed 66 services align with the key elements of a socio-technical transition in smart mobility (Docherty at el. 2018), as outlined in section 2.1.

Move away from ownership to usership: Aggregator services, ride services and vehicle services do all promote an access-based approach to transport and mobility. By definition, they provide access to use a mobility, ride or vehicle service, and may thus free the user from owning their own vehicle. Peer-to-peer sharing of existing, privately owned vehicles is supported by ride sourcing and – sharing, as well as vehicle sharing, but they are generally unlikely to encourage purchasing new assets.

Transition in the definition of the marketplace that is "mobility:" Most of the reviewed initiatives still operate in a traditional way, either as a for-profit business or as a not-for-profit public sector service. There are, however, many that mix the two, bringing in multiple service operators and stakeholders or also involve the citizens. New business models, organizational forms, etcetera, involve concepts such as platform economy, sharing economy, public-private-people partnerships, co-operatives and peer-to-peer.

From the current "modal-centric" to future "user-centric" transport system: Aggregator services, like Mobility as a Service providers aim to be multi-modal and cover entire trip chains. Therefore, they align with the user-centric trajectory. Moreover, the PTAs in the sample include more types of mobility in their offers than previously, including local railway, boat tickets, city bikes, and so on. Ride and vehicle services, on the other hand, are usually modal-centric, and are typically offered as a stand-alone, one-mode, non-connected service. However, when ride and vehicle services are embedded in a MaaS subscription, the user-centric element of the transition comes to fruition. Whim and Kolumbus (through Bysykkelen and HentMeg) already do this. It seems to be an international trend that the PTAs offer increasingly more types of mobility.

Transition in the role of the citizen in the transport system: In aggregator services, the user still remains a rather passive recipient of services, although their individual needs are being better catered to. A personal account and preferences are managed in information systems, for example via a smart phone app. Ride and vehicle services involve the user taking a more active part also in the design of the tailorable mobility service, either as a passenger, driver, asset provider, or sub-contractor. For example, citizens can register and drive for instance for Uber or other ride services. For MaaS operators, citizens may also provide services in certain niches, such as when private citizens share cargo e-bikes with kindergartens in Rogaland, organized by Kolumbus. If and when automated vehicles are launched large-scale, this may change the role of the citizens in the transport system fundamentally. They may, for example, provide their own automated vehicles for others to use as taxis.

In summary, the full range of smart mobility services reviewed do align with the elements of the transition in smart mobility, but one service alone does typically not contribute to all elements. The currently emerging services, when mature and offered in combination with one another, could ultimately cater to all of the elements in full, for example in a form of a MaaS "package" that involves also the other types of services listed in our typology.

5.4. Smart mobility challenges in the context of Mobility as a Service

This section assesses the Finnish and Norwegian services identified in our overview in light of the four challenges in addressing the necessary governance transition to meet the shift towards smart mobility, as defined by Docherty et al. (2018) and as outlined in Section 2.3.

5.4.1. The short versus the long game

After the new regulation in Finland had taken effect, five MaaS operators have started their services, but there are still many challenges. The responsibilities and roles of new service providers are some of the key issues that have raised concerns. Service operators (especially taxi services) are challenged by a lack of communication, cooperation, understanding and agreeing on the roles of public and private actors in providing mobility services, ensuring service levels and managing subsidies. Commercial smart mobility providers vary from small local businesses to branches of international large firms like Uber, Herz and Voi. Long-term social and environmental targets that generally are guiding publicly provided services are much less relevant for them. A majority of smart mobility operators prefer to make their own decisions on technical solutions and commercial terms. Consequently, there are few strong references to smart mobility ecosystem development. That would most probably require standardized technical solutions.

In taxi services, a lot of new services, service providers, applications and drivers have emerged in the short term. Permits are easy and cheap to obtain. For consumers, the prices were cheaper in the beginning, but have gradually raised above the level before the Act. It is also difficult to navigate the numerous services. There have been problems with the supply in remote and rural areas and in services for special groups.

The inclusion of cheap taxi rides and car rental, as enabled by the new Finnish regulation, has raised environmental and societal concerns within the context of Whim too, although the different plans and pricing schemes place these parts of the service differently relative to public transport. The stated intentions and early results of the user study from 2018 (Hartikainen et al., 2019; MaaS Global, 2019e) also talk in favour of public transport being the core and taxi and rental services being its complements. Besides public transport, the availability of city bikes in its service mix has been a prerequisite, when implementing the service beyond Helsinki (MaaS Global, 2019f). However, little is known about what transport modes Whim use is replacing, i.e. whether it is replacing car use or not.

In Norway, PTAs have a strong role in managing and supplying local and regional passenger transport services. They enjoy considerable public support in terms of legitimacy, and also enjoy strong financial support from the public. All major PTAs in Norway have clear ambitions to take a lead role in becoming *mobility providers* in the widest sense, which means they want to be in the driver's seat in developing smart mobility services, including micromobility and MaaS, in their regions.

While such goals are broadly considered legitimate and politically expected, such strategies and ambitions may come at costs which materialise in the longer run. Firstly, a PTA top-down approach to smart mobility may fail to provide user-centred and market-oriented services in the way a private, flexible and profit-driven company might do. Secondly, the PTAs are large and highly subsidised actors in their respective local mobility markets. Entry from newcomers may prove difficult and, in this way, their innovations may not reach the Norwegian urban transport markets. For example, the Greater Oslo PTA Ruter is currently building its own MaaS concept rather than inviting established MaaS providers into their market. Although the PTAs' ambitions may pose this kind of challenges, the contrary view would be that public entities are *guarantors that social welfare is a guiding principle*, such that societal goals of, for example reduced congestion, reduced greenhouse gas emissions, and sound land use planning, is reflected in their strategies and mobility offers – as opposed to the profit-oriented rentier approach of maximising mobility in order to maximise return on capital, as suggested by Docherty et al. (2018, 119).

Norway's regulation of taxi services provides a different example of how the tension between short- and long-term goals creates regulatory challenges. The recent revised Act on occupational transport (see section 4.2) aimed to liberalize the taxi market, but in doing so, created several major challenges (Aarhaug and Skollerud, 2019).

5.4.2. Who pays? Taxation and value sharing

In Finland, the OpenMaaS API, where Helsinki Region Transport (HRT) for example provides access to single tickets to public transport, can be used by MaaS providers and other actors free of charge. The ticket prices via the API are the same as on HRT's travel cards and mobile channels, and HRT pays no commission or compensation to resellers using the API (HRT, 2019). This is the situation for Whim, as well as other similar service providers. However, HRT had paid and was still paying commissions for ticket resellers operating in the non-mobile, physical sale points. MaaS Global even appealed to Transport Safety Agency Trafi on this, but Trafi concluded that there was no discrimination and HRT was free to negotiate its pricing schemes this way (HPP Asianajotoimisto Oy, 2018).

The above situation shows that on the one hand, it could be argued that resale of tickets in the digital environment, using the API, suffers in the competition against those resellers getting a commission. On the other hand, it can be argued that it would be unreasonable to expect a public transport operator to be prepared to reserve funds to pay commissions to all API using resellers, the volume of ticket sales that could expand unexpectedly. In HRT's financial planning, the future expectation is that ticket sales will indeed move towards the online and mobile interfaces, and this shift is taken as an opportunity to reduce spending on commissions paid to resellers (HRT, 2017).

In Norway, the "who pays?" question has for several reasons not yet become acute. The national travel information (and also ticket sales) entity Entur is state financed and therefore not reliant on a revenue stream from its activities. The Norwegian model with strong PTAs has in fact proved quite well-suited to safeguard revenue streams. For example, Kolumbus' acquisition of the electric city bike system, Bysykkelen, may help align the revenue streams across mobility solutions. In this way, potentially unprofitable services (e.g. branch routes), which feed traffic to profitable services (e.g. trunk routes), can be decided within one organisation and without raising the question of how to align and allocate revenues. Again, however, an integrated, publicly owned and strongly subsidised entity may effectively deter entry from new mobility service providers – a strategy which potentially violates competition legislation (see, e.g., Valdani Vicari & Associati, 2019). Entry barriers are not only related to the market dominance of a large monopolistic PTA. The potential inability to secure revenues is also a major barrier. PTAs will likely not allow others in general to resell their tickets, and if so, not at a lower price than their estimated value. Moreover, entrants will find their negotiation power limited in the Norwegian setup.

5.4.3. Data and information asymmetry

The availability of data and APIs for accessing and sourcing third party services is a necessity for new data-driven smart mobility solutions. Information provision and communication are also very important, particularly when complemented with lock-in in attitudes and preferences to old ways of doing (public) transport business.

After the enactment of the new regulation in Finland, especially small service providers were not fully aware of what was expected from them with regard to essential data provision. Currently regulations on data and APIs are in place, but implementation and surveillance are weak. During the first year, only a (small) part of the service providers has provided the essential minimum information into the National Access Point (NAP). Also supervising the data provision by national authority, Traficom, has started slowly. The authority chose to take more of an advising role during the first year. However, it announced the first sanctions to some public transport providers in spring 2019 on not opening their APIs as requested by the Act.

Ticket sales interfaces are slowly opening up in Finland. Helsinki Region Transport (HRT) is here as a forerunner. However, acting on behalf of the user has raised many questions (e.g. authentication). There is a possibility that challenges in supervising the essential data provision can even slow market development and prevent the entry of newcomers into the market (MaaS Global, 2019f).

In Norway, the Norwegian Public Roads Administration has been issued the role of being the Norwegian National Access Point (NAP) according to the EU ITS Directive (Directive 2010/40/EU). According to its own strategy for the period 2018-2023, it works to establish a portal that functions as such an access point, being harmonized with the rest of Europe. There, data will be made available for transport companies alike in a standardized and easily accessible way. Already, all providers of scheduled passenger transport are required to submit their timetables to the state-owned travel information entity Entur, whose APIs are open and public. Hence, travel information data are largely made

openly available in Norway. Commercially sensitive data remain, however, inherently difficult to get hold of from all actors in the mobility market, including PTAs, the railways, taxi companies and buses.

In 2018, MaaS Global Ltd and HRT struggled with the introduction and implementation of the OpenMaaS API. The new API, that was in compliance with the new regulation open for all users, was running parallel to the old one that had been founded in 2016 based on a trilateral contract. MaaS Global had been using the old API for the Whim app and reported the new OpenMaaS API to Transport Safety Agency Trafi that was responsible for monitoring. Several rounds of communications and decisions were given by all parties, and Trafi concluded first that OpenMaaS was compliant, but then retracted this decision and required HRT to present a plan of an updated, improved API solution (HRT, 2018).

The above chain of events shows how complicated the implementation of the data and API requirements is, when the regulation cannot give all too specific descriptions how to do it and supervise the use and there are little or no previous examples in practice. Even the established partnership between Maas Global and HRT did not enable smooth introduction of the new API, and in fact how and in what way collaboration is required or allowed between specific API providers and potential users remains unclear. The new regulation is nevertheless an important step in enabling interfacing, and experiences and learnings from practice can be expected to clarify the situation.

5.4.4. Business models, equity and inclusion

Like any innovation, smart mobility has equity impacts. Most fundamentally, it is well established that early adopters are advantaged (high income, high education, urban dwellers, males, and so on; see for example Figenbaum et al., 2015, for an overview). Based on the first experiences in Finland, smart mobility services seem to provide, on one hand, more choices and better services to the customers, but on the other, the supply is (at least in the beginning) heterogeneous and use may be complicated. The capabilities and access of certain societal groups to use required devices, like smart phones, or applications vary.

As for the Norwegian Kolumbus case, one of their services that goes furthest in direction of a MaaS scheme, was previously the HomeWorkHome (*HjemJobbHjem*) offer. This is targeted at local employers and employees and combines city bike access and public transport in one ticket. This scheme, as mentioned, February 2020 broadened up to include all Kolumbus' customers. Regarding spatial equity and distribution, the Norwegian model of regional PTAs help safeguard minimum services even in remote areas. One example is the "PickMeUP" scheme, their mobility-on-demand bus service. In general, there is considerable cross-subsidising between routes and modes within a PTA like Kolumbus. Profitable routes help finance unprofitable ones, which likely makes it easier to provide mobility services of a high quality in rural areas and for disadvantaged persons.

Regarding micromobility, taxi and car-clubs, the evidence so far in Norway, like elsewhere (cf. Docherty et al., 2018), is that these services so far have been opened up in central districts, where the population base and the transport system is the most suitable for establishment of such services. So far, no regulation exists to spread micromobility and car-clubs more evenly out geographically. This issue is also identified by the service providers, but they do not see a way to address as the markets are deemed too thin (Klimek et al., 2019). The new taxi regulation will, from 2020, remove the geographical restrictions on licenses and allow any taxi to operate anywhere at their own discretion, while the current regulation require taxis to operate within their districts and have a service obligation also when this is not profitable. This amendment will likely benefit urban centres, but not more remote markets. As a safety clause, exclusive rights may be granted in areas where the market fails to provide sufficient taxi services.

6. Discussion and conclusion

Both Finland and Norway have seen many "new" and "smart" mobility solutions emerge the last decade. Some of these come from global actors, establishing themselves in the Nordic markets, but many are also home grown (Klimek et al., 2018). From our data, it is difficult to point at systematic differences in the types of services that are introduced to the market. Both countries show examples of aggregator, ride and vehicle services, including MaaS, car-sharing,

bike-sharing, micro-mobility, ride-sharing, ride-sourcing, etc. However, there are clear differences in the process leading up to these services emerging on the markets.

A key difference is the different role taken by the national authorities in terms of changing the legal framework. Here, the Finnish central authorities have been the enabling push factor, in changing the law, focusing on data and harmonizing the regulation across modes as opposed to mode-specific and regional regulation, which is still retained in Norway. In this context the Finnish transport act can be seen as an attempt to facilitate the entry of new services. Meanwhile, the changes made in the Norwegian transport act with respect to data sharing are a made in order to comply with EU regulation.

Looking at the market entrants branded as MaaS operators, there is clear difference where the Finnish actors are predominantly private companies, mostly marketing their services directly to the public, as the case of frontrunner Whim. In Norway, MaaS proposals have generally originated from publicly owned PTAs, in part using independent companies for technical support in creating platforms. As such the Norwegian case is further from the Finnish case than the Swedish (Smith et al., 2018b).

Using the Docherty et al.'s (2018) challenges as a framework. We recognize the tension between the short-run benefit of supporting new services versus the longer run challenges that may come into play with new services entering the market (in particular automated vehicles). However, how this relates to MaaS is not straight forward. This is in part due to lack of data regarding the longer-term effects. MaaS actors are essentially platforms that aggregate physical services that are either provided mostly in-house, as is the case of the PTA run schemes, or by market actors, in the case of commercial MaaS operators. Therefore, it is unclear how MaaS as such influence the provision of physical transport services.

Most recognized externalities from the transport systems are related to the physical services (pollution, congestion, etcetera), not the aggregation of these services. In other words, creating an optimal transport system, which takes e.g. pollution, financing and equity challenges of the system into account, is likely similar, regardless of which actor is the MaaS operator. However, there are many potential cases where this assumption can be challenged. This can be if the MaaS operator has clear private incentives to push traffic from one mode to another. Or on a general note if the MaaS operator's incentives do not align with the wider objectives of society.

A reoccurring challenge with the Norwegian model, with strong involvement of the PTAs, is that it seemingly reduces the scope for private initiatives. This has earlier been the case with commercial coach services. In this case PTAs have included services in direct competition with private initiatives in their tendered contracts (Aarhaug et al., 2018). A similar development seems likely for the electric kick scooters (e-scooters). This practice is detrimental for newcomers, but may still be sound in terms of optimizing the local transport network, given the technology available. The Finnish MaaS model does not have these challenges to the same extent, as the PTAs have a less dominating role. Instead it may be a challenge to address negative externalities of new transport services adequately within the commercial framework, in particular the negative externalities related to congestion of private services in city centres and the inclusion of transport services that are societally beneficial, but not profitable to provide. Both systems share challenges related to the increasing need for digital competence in the population and equity in terms of regional and socio-economic accessibility, and as such create the possibility for social exclusion cf. Groth (2019).

From the technical side, lacking standards, insufficient interoperability of the individual systems, data and interfaces have been the challenges faced by both the public actors and businesses in the Finnish case during the first year of the new regulation. Clear communication on the requirements towards the service providers of different size and capabilities has also been noticed as an issue of high importance. Based on the experiences, other aspects to be carefully considered in planning future regulation are the commercial terms of ticket sales, procedures for supervision within opening technical interfaces and monitoring of market situations e.g. to prevent market dominance of one service provider, public or private.

Transferable lessons from these cases is that neither solve all issues. The Finnish regulatory framework is very friendly for new market entrants, but may have long-term challenges in keeping the objectives of the MaaS operators and society aligned. The Norwegian regulatory framework on the other hand, is less open to innovations, primarily due to the strong market position of the PTAs limiting the scale and scope of alternative offers, not the legal framework. This may result in challenges in the long run, in terms of generating new services (Klimek et al., 2019), but it solves the problem of aligning the welfare objectives of society and the MaaS operator.

Focusing on MaaS, our study concludes that both privately owned and publicly owned MaaS operators may provide successful MaaS. On the one hand, the PTAs may have a profound competitive advantage locally when they are allowed to enter the MaaS market, as they have public funding and an established customer base. On the other hand, privately owned MaaS may benefit from easier access to private high-tech resources of all kinds and may have an easier job in integrating new services, and less of a challenge related to existing service provision.

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