Smart and Mobile Work in Growth Regions

Current socio-technical regime in the chosen regions

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1 Introduction

1.1 Project

The Smart and Mobile Work in Growth Regions (Smart Commuting) project explores new ways of combining work and life with new intelligent transport system services and new concepts for supporting sustainable commuting. The mobility of workforce is increasing due to technology development, commuting and the nature of work. This has many consequences as long commuting may decrease the productivity of work and leave less time for relaxation. Cities also have to address commuting when planning technical solutions, developing services and calculating finance schemes. The first objective of this project is to identify the changing needs of mobile workers. The second objective is to increase the sustainability of mobility by supporting the implementation of sustainable and intelligent transportation services. The consortium collected data with observations, surveys, interviews, and workshops in Austria, Finland, and Switzerland to evaluate how these new services meet the evolving needs of mobile workers. Mobile workers are considered lead users in this project with many new mobility solutions available for them before broader end-user base. However, the considered mobility solutions are expected to benefit other travelers as well. In addition, simulations shall help to provide decision support for stakeholders address urban planning and governance structures challenges. Implementations in large commuting areas are pivotal aspects of this project. Implementations in different areas help to scale up our partners' operations, get experiences about the needs of users and also discover some common ground for governance and city planning policies.

This project is a part of the ERA-NET Cofund Smart Cities and Communities (ENSCC), which was established by the Joint Programming Initiative (JPI) Urban Europe and the Smart Cities Member States Initiative (SC MSI). The project started 1.4.2016 and is planned to last for two years.

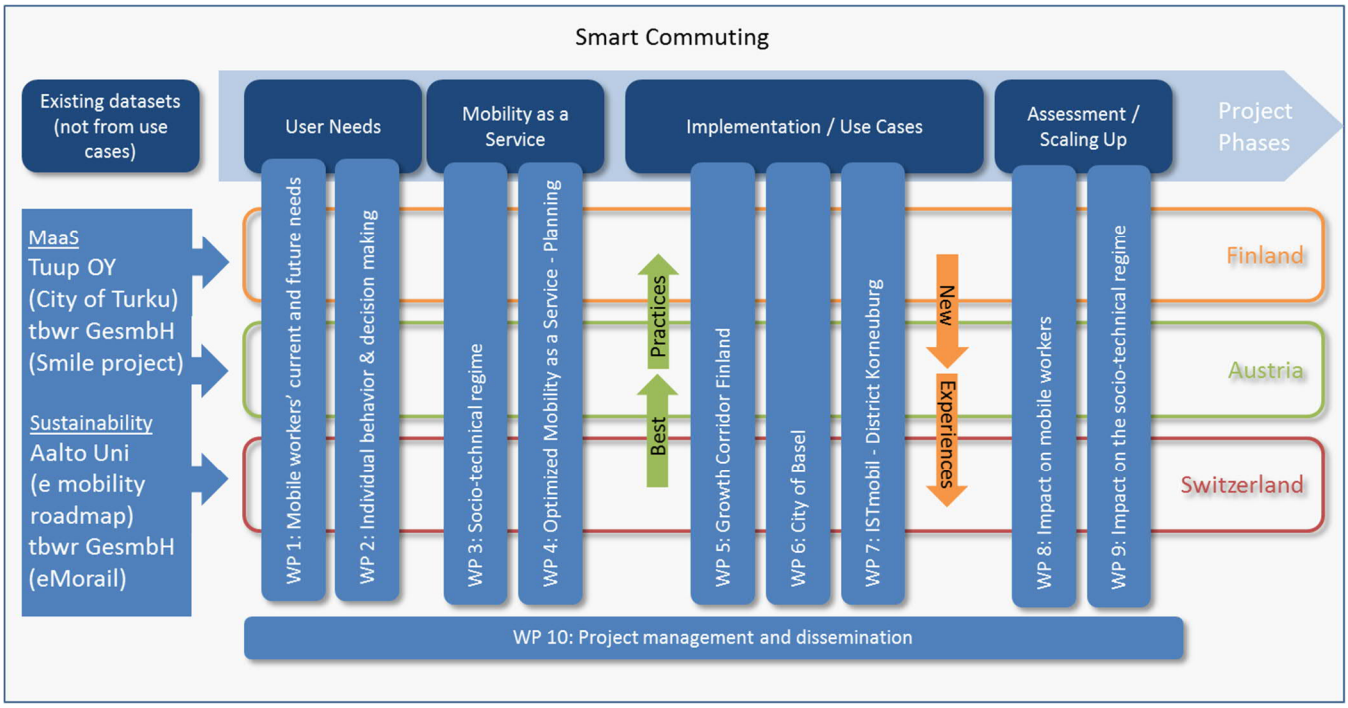

Figure 1 The relationship of WP3 with the other parts of the project

1.2 Work Package and Tasks

The work package three creates by means of applied research the description of the socio-technical regimes in the participating countries. This information is used when analyzing the empirical results about the user needs in these countries, when estimating the impact and success factors of different business models and when formulating policy recommendation for different stakeholders. This deliverable reports the results of the first three tasks of this work package:

Task 3.1 aims at describing the socio-technical regimes affecting the development of new mobility concepts in the three countries in this project. Based on this information and expert interviews, the objective of task 3.2 is to describe the most probable near-future state of sustainable and intelligent transport services in the implementation regions. In task 3.3, the transition paths towards these near-future situations are described in respect to different regime level changes in each participating country.

1.3 Report structure

This report starts with a short description of the objectives and context of our research. Then, chapter 2 provides other background information, and chapter 3 presents basic information and comparison of the countries. Chapter 4 discusses different technologies that have an impact on mobility and commuting in the near future. Chapter 5 discusses country by country policies and legislation affecting commuting and mobility. Chapter 6 discusses the pilot regions in each country. Chapter 7 presents examples of resulted mobility services from each country. Finally, chapter 8 presents the conclusions.

As the mobility and related services are currently developing at enormous speed, also information in this report will become outdated fast. To partly avoid this, the major changes and revisions will be updated again in early 2018 to this report. Then, also a short chapter related to stakeholder analysis will be included to complement the current sociotechnical analysis[1].

[1] The stakeholder analysis will be discussed otherwise in more detail in WP2 deliverables.

2 Background

2.1 Work-related mobility

The mobility of the workforce is continually increasing. A Eurofound study[2] from 2012 shows a high share of mobile workers in Europe. By mobile workers, Eurofound survey means people who do not work all the time at their employers' or their own business premises and habitually use computers, the internet or email for professional purposes. The incidence of mobile workers varies considerably between countries, ranging from just above 5% in Albania, Bulgaria, Romania, and Turkey to more than 40% in the Netherlands, Denmark and Sweden, and 45% in Finland.

In addition to the nature of work, commuting distances are also increasing (e.g., HSY, 2014[3]). The commuting distance is influenced by a large number of factors, such as the income of the residents of the central city[4] and the quality and the cost of living. Commuting and the overall increased work-related mobility can be described as a spatiotemporal strategy of individuals (households and workers) in which both home and workplaces are not single locations anymore. This means that local infrastructure and services also need to be considered when re-conceptualizing multi-locality[5]. Also, the ever-increasing mobility of workers brings along the increase in CO_2 emissions, if low emission transport services are not available.

While we have chosen to focus on mobile workers as the lead users in mobility solutions, we are considering the change in mobility from broader socio-technical context and we expect the developed mobility solutions to benefit broader traveler base eventually. These mobility solutions need to fit in their local contexts, as different geographical areas are facing different challenges ranging from the infrastructural capacity bottlenecks in urban areas to declining service levels in the rural areas. Regardless of the population density of the area, digital networks, new ICT technologies, shared mobility concepts, and new types of mobility solutions are also needed for efficient and sustainable resource utilization in the transportation system.

Further reading:
Eurofound and the International Labour Office (2017) *Working anytime, anywhere: The effects on the world of work*. Publications Office of the European Union, Luxembourg, and the International Labour Office, Geneva. Available at: https://www.eurofound.europa.eu/sites/default/files/ef_publication/field_ef_document/ef1658en.pdf

2.2 Mobility services

Many of the innovations addressing social and business needs such as accessibility of people and mobility of workers are systemic by nature. Mobility-as-a-Service (MaaS) is an example of such new systemic concept that proposes a new way of thinking in terms of how the delivery and consumption of our everyday mobility is managed. MaaS Alliance (2017) defines mobility-as-a-service as "the

[2] Eurofound (2012) Fifth European Working Conditions Survey. Publications Office of the European Union, Luxembourg. Available at: https://www.eurofound.europa.eu/sites/default/files/ef_publication/field_ef_document/ef1182en.pdf
[3] HSY (2014) Commuting. Web page (In Finnish), accessed 18.5.2017. Available at: https://www.hsy.fi/fi/asiantuntijalle/seututieto/tyopaikat/Sivut/Sukkulointi.aspx
[4] Shenn Q. (2000) Spatial and Social Dimensions of Commuting. Journal of the American Planning Association, Vol. 66 (1), pp 68-82.
[5] Huning S., Bens O. & Hüttl R. F. (2012). Demographic change beyond the urban-rural divide: Re-framing spatial differentiation in the context of migration flows and social networks. DIE ERDE–Journal of the Geographical Society of Berlin, 143(1-2), 153-172.

integration of various forms of transport services into a single mobility service accessible on demand."[6] The systemic nature becomes clear when thinking about the MaaS ecosystem. Typically, there is some interdependence between the operator (i.e., the party offering the MaaS service to the end user) and the individual mobility or content providers (i.e., the parties offering the data, mobility services, ticketing and payment services, or other value-adding content to the transportation offering). The individual content providers can sell their services through the operator and the operator needs content providers to make the offering worthwhile and to attract a critical mass of users. The more users the operator has, the more attractive the operator will be for possible new content providers as a means to offer their content.

This might imply a power difference; once content providers are linked to the operator, it becomes an important resource for connecting to users, but this resource may not be under their control. Furthermore, parties invest in their own systems and interfaces with the operator, making switching to other operators relatively costly (the 'lock-in' effect). For these reasons, becoming a de facto operator is a business strategy that many companies desire for competitive advantage and hence much literature on service platforms concerns strategies that aim for such competitive advantage[7]. On the other hand, some content or data providers may have access to resources vital to the functioning of the service offering, and an operator may need them more than they need the operator. MaaS Alliance, a public-private partnership working to establish foundations for a common approach to MaaS and to facilitate a single and open market of MaaS services in EU, call for open pro-market approach without exclusive bilateral agreements, regardless of the size of the operator or transportation provider.

To build a viable MaaS offering in such a setting, the development of the standards and interfaces used in the service offering may have to be separated from the actual technology development and interaction with the end users[8]. Furthermore, if the MaaS offering is meant to supplement public transportation, public organizations responsible for organizing public transportation may step in by subsidizing parts of the basic infrastructure and on the other hand by pushing for open standards to ensure flexibility. For these reasons, managing relationships with all stakeholders (both on the side of the content providers and on the side of end-users) is probably more important for MaaS operators than the actual applications[9].

Many of the mobility providers remain relevant to mobile workers even though they offer only one or two transportation modes. For example, the rise of sharing economy has also resulted in an institutional development, where car manufacturers like Daimler and BMW have moved into the service business (e.g., into car sharing). These service providers have their own customer service channels in addition to service platforms promoting their services and possibly service contracts with the employers of the mobile workers. Similarly, mobile workers may have personal preferences for the personalized traveler information service providing accurate and multimodal information before and during the journey. For this reason, ENSCC Smart Commuting project looks at the whole mobility ecosystem, with both MaaS operators such as Tuup Oy and individual mobility providers such as ISTmobil GmbH represented in the consortium.

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[6] MaaS Alliance (2017) What is MaaS? Web page, accessed 18.5.2017. Available at: http://maas-alliance.eu/#MAAS

[7] Gawer A. & Cusumano M. A. (2008). How companies become platform leaders. MIT Sloan management review, 49(2), 28.

[8] Klievink B., Janssen M. & Tan Y. H. (2012). A stakeholder analysis of business-to-government information sharing: the governance of a public-private platform. International Journal of Electronic Government Research (IJEGR), 8(4), 54-64.

[9] Gawer A. & Cusumano M. A. (2002). *Platform leadership: How Intel, Microsoft, and Cisco drive industry innovation* (pp. 29-30). Boston: Harvard Business School Press.

Further reading:

König D., Eckhardt J., Aapaoja A., Sochor J. & Karlsson M. (2016). Deliverable 3: Business and operator models for MaaS. MAASiFiE project funded by CEDR. Available at: http://www.vtt.fi/sites/maasifie/PublishingImages/results/cedr_mobility_MAASiFiE_deliverable_3_revised_final.pdf

Maas Alliance. (2017). Guidelines & Recommendations to create the foundation for a thriving MaaS Ecosystem. White Paper, September 4, 2017. Available at: https://maas-alliance.eu/wp-content/uploads/sites/7/2017/09/MaaS-WhitePaper_final_040917-2.pdf

2.3 Sustainability of work-related mobility

MaaS is regarded as a possible transport paradigm shift, resulting more environmentally friendly and efficiently used transport modes by reducing the need to own a (second) private car. However, there is still relatively little evidence on the overall sustainability of these services. For example, economic viability is especially important when planning and implementing new services in rural areas, which gives also rise to questions about the social sustainability of MaaS offering if the accessibility of these rural areas cannot be guaranteed. However, the sharing economy aspects of mobility services are recognized as a socially accepted global phenomenon enabling new means of connecting people to share opportunities and markets with far more personal motives than just cost savings or altruism[10]. As far as the urban transport sector is concerned, the sharing economy appears in the form of car sharing, carpooling, ride sharing and bike sharing as standalone service offerings or as part of a larger MaaS offering.

One aspect of environmental sustainability is the promotion of emission-free transportation in passenger transportation. With many of the railroads already electrified, electric vehicles charged with low-emission electricity are one of the key options to reduce emissions in passenger road transport and achieving the long-term EU GHG goal (2050) of a cross-sectoral emission reduction by 80-95% compared to 1990[11]. In Finland, the number of electric vehicles has doubled in recent years[12], but the starting point has been modest to say at least compared to other Nordic countries[13].

When the popularity of electric vehicles reaches higher levels, the demand response and relevant incentives in smart electric grid become relevant factors[14]. In the context of ENSCC Smart Commuting project, Liikennevirta Oy develops smart charging infrastructure for electric buses and electric vehicle charging concepts for property owners, work organizations and private homes to mitigate the possible unwanted effects of electric vehicle popularity.

Further reading:

Choe T., Garza M., Ural R. & Woolfolk J. (2016). The rise of the sharing economy - Impact on the transportation space. Deloitte. Available at: https://www2.deloitte.com/content/dam/Deloitte/us/Documents/consumer-business/us-cb-the-rise-the-sharing-economy.pdf

[10] Wilhelms M-P., Henkel S. & Merfeld K. (2017). You Are What You Share: Understanding Participation Motives in Peer-to-Peer Carsharing. In Meyer G., & Shaheen S. (Eds.) Disrupting Mobility: Impacts of Sharing Economy and Innovative Transportation on Cities. Springer.

[11] Kasten P., Bracker J., Haller M. & Purwanto J. (2016) Electric mobility in Europe – Future impact on the emissions and the energy systems. Öko-Institut e.V. Available at: https://www.oeko.de/fileadmin/oekodoc/Assessing-the-status-of-electrification-of-the-road-transport-passenger-vehicles.pdf

[12] https://www.trafi.fi/tietopalvelut/tilastot/tieliikenne/ensirekisteroinnit/ensirekisteroinnit_kayttovoimittain, In Finnish

[13] Lodberg J. (2016). INSERO QUARTERLY, Q4 2016. Insero. Available at: http://insero.com/media/4031/iq-q4-wip-faerdig-pdf.pdf

[14] Rautiainen, A. (2015). Aspects of Electric Vehicles and Demand Response in Electricity Grids. Doctoral dissertation, Tampere University of Technology. Available at: https://tutcris.tut.fi/portal/files/3707357/rautiainen_1327.pdf

Karlsson M., Sochor J., Aapaoja A., Eckhardt J. & König D. (2017). Deliverable 4: Impact Assessment. MAASiFiE project funded by CEDR. Available at: http://www.vtt.fi/sites/maasifie/PublishingImages/results/CEDR_Mobility_MAASIFIE_Deliverable_4_Revised_Final.pdf

2.4 Effects of commuting and new mobility services on urban planning and other stakeholders

As we do not have the possibility to increase road transport infrastructure capacity indefinitely, and there are even indications that sub-optimizing road transport increases problems in transportation systems in the longer run[15], we need more efficient transport solutions, for example, in the form of ride-sharing and also proper incentives for people to use these solutions.

These new solutions in individual mobility have inevitable effects on urban planning and on the collaboration with different stakeholders. For example, the majority of streets in European city centers are not designed for door-to-door services and the increasing popularity of ride-sharing services need more pick-up and drop-off points for not to cause serious congestion on roads[16] – especially with peer-to-peer ride-sharing solutions which are not required by regulation to use public transportation (PT) stops for their operation. In addition, the placing of electric vehicle (EV) charging infrastructure can have a significant impact on the desired traveling behavior of EV drivers as these cars become more and more popular.

In the context of ENSCC Smart Commuting project, the urban planning theme connects this WP to WP4 (Optimization of transport system/services) and to the analysis made by AC2SG Software Oy. Due to these dependencies, this theme will be discussed more in the next deliverable. In addition, this deliverable illustrates the (power) relations between the stakeholders as far as they are relevant to the socio-technical analysis, but the detailed stakeholder analysis is done in WP2 of this project.

2.5 Socio-technical analysis in the context of transportation systems

It is clear that sustainable and intelligent transportation service offerings need to be embedded in a socio-technical context that is nurturing its development and keeping it aligned with the dynamics of its environment. Especially mobility solutions such as Mobility-as-a-Service do not survive in a contextual vacuum, but are dependent on changing needs of its users and providers.

Governance embeds different stakeholders through **mechanisms of market, network and hierarchy** to drive the decision-making[17]. In market-driven governance, the stakeholders decide through transactions and competing alternatives. In network-driven governance, different stakeholders work together to decide through the development of shared solutions. In hierarchy-driven governance, more traditional organizational structures, temporary or permanent, are set up to steer the development. The expectation is that the governance of a transportation offering will differ

[15] Sisson, P. (2016). Fixing the American Commute: We blame cars for transportation woes, but can new technology turn them into saviors? Blog entry, Vox Media. Available at: https://www.curbed.com/2016/4/27/11511150/transportation-commute-autonomous-cars

[16] Sisson, P. (2017). As self-driving cars hit the road, real estate development may take new direction: Planners are anxious about automated vehicles and their potential to reshape development patterns and the urban landscape. Blog entry, Vox Media. Available at: https://www.curbed.com/2017/5/16/15644358/parking-real-estate-driverless-cars-urban-planning-development

[17] Powell W. W. 1990. Neither market nor hierarchy: Network forms of organization. In B. M. Staw & L. L. Cummings (Eds.), Research in organizational behavior, Vol. 12: 295- 336. Greenwich, CT: JAI Press.

from country to country. For example, Finland (and MaaS alliance) is promoting market mechanisms, and this has resulted in more than dozen new MaaS related companies, such as Kyyti, or distinctive revenue streams for existing companies, such as Kätevä Seinäjoki by Sito. In Austria, public and private partnerships have resulted in the market expansion of ISTmobil (GUSTmobil in the surroundings of Graz) and widely used cloud-based platform FluidHub for connecting different stakeholders in MaaS ecosystem. In Switzerland, the public transportation is orchestrated by two strong public transportation organizations.

To analyze the situation, we apply the sociotechnical framework of Geels[18] to different areas.

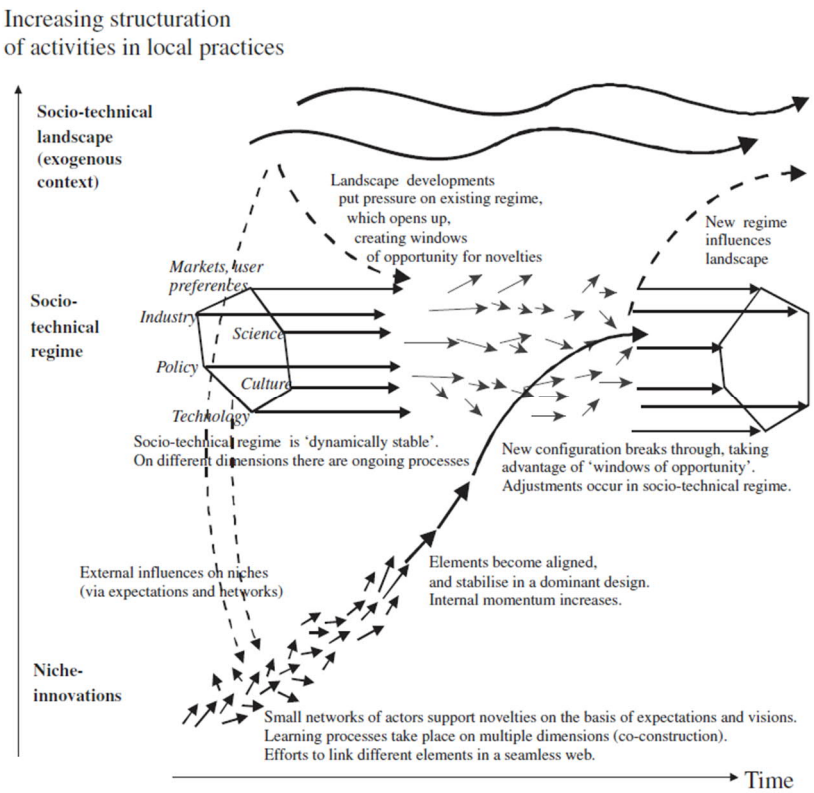

Figure 2 The socio-technical framework of Geels (2002)

The purpose is to investigate from several viewpoints the change that has happened so far within these areas. The three aspects described in this deliverable are:

- Technology and innovations
- Policies and legislation
- Markets and companies

Particularly, we try to describe how the geographical and historical differences in socio-technical regimes of each country have led to development and adaptation of different kinds of transport solutions, and especially what kind of new innovations and services these regimes have fostered. This is also of importance in understanding how the different concepts could be applied successfully in other regions. Users and culture are also essential. However, they are mostly omitted in this report as the topics are discussed in more detail in the deliverables of the work packages 1 and 2.

[18] Geels, F.W. (2002). Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study, *Research Policy,* vol. 31, pp. 1257-1274.
Geels, F.W., J. Schot (2007). Typology of sociotechnical transition pathways, *Research Policy,* vol. 36, pp. 399-417.

3 Comparison of the countries

It is important to analyze the different aspects that affect and have had an influence on the development of transport systems in each country – geography, technology, society, politics, and culture. All the countries are welfare countries and among the richest in the world according to the nominal or purchase parity corrected gross domestic product. Related to the commuting and transport, the countries also have many common features:

- Good or excellent public transport. All the countries have a high-quality public transport, especially in the largest cities.
- Every government and the biggest cities in each country put emphasis on supporting sustainable transport by different programs, legislation, new services and technology platforms.
- Environmentally conscious countries: according to the World Economic Forum[19], all these countries are environmentally very conscious.

Despite the previous facts, use of a private car is still common in each country, and while the mobility services have improved in each country, there is still no sign of change in this matter.

The following table summarizes the basic geographical and transportation network statistics of the case countries. These partly define what kinds of alternatives are currently available and what kinds of services may have potential in each country.

Table 1 Geographical and transportation network statistics of the case countries

	Austria	Finland	Switzerland	
Area	84 000	338 000	41 000	km^2
Population	8 800 000	5 500 000	8 400 000	people
Population density	105	16	205	people/km^2
Rail length	6 123	5 919	5 300	km
Motor highways	2 200	900	1 800	km
GDP per capita, nominal	44 000	43 000	78 800	USD
GDP per capita PP	50 000	43 000	62 900	USD

Population density: the average and local level

One significant difference between the countries is the population density, which is significantly larger in Austria and Switzerland than in Finland. This makes arranging the public transport easier in both Central European countries. The population density measure does not yet describe how the population is scattered in the local level. While Switzerland and Austria have significantly higher population density, also the rural area population consists mostly about villages of different sizes. In Finland, people in the countryside usually live in the middle of their own arable land and forests instead of villages. Therefore, services developed to suit another country do not necessarily fit another as such.

[19] http://epi.yale.edu/sites/default/files/2016EPI_Full_Report_opt.pdf

Climate differences
All the countries have four seasons from sunny summers to winter with snow. This causes many issues that have to be taken into account in designing commuting, and this is also one significant obstacle concerning the early adoption of autonomous vehicles. The winter is longer in Finland than in most other western countries. Therefore, the city bikes are set to their stations even in the Southern Finland only in the beginning of May. Thus, the last-mile solutions in Finland need to be robust enough for the Finnish winter conditions.

Transport networks: railways and highways
Each country has a good and solid railway network. In comparison with the land area, Switzerland and Austria have a significantly denser network of rails. In all countries, the major city areas are connected with high-speed rails. The problem in Finland, however, is the lack of dual rails and too old control mechanisms on the two main transportation corridors. Therefore, it is difficult to reduce the travel times without significant investments.

Highway networks in Austria and Switzerland are double in size in comparison with Finland. This means that there is a highway connection between each significant city in Switzerland and Austria. This does not hold in Finland, yet the three largest city areas are connected by highways. The maximum speed limit in Switzerland and Finland is 120 km/h while in Austria it is 130 km/h. The high-quality highway network with accompanied park-and-ride facilities may be one reason for the substantial use of personal cars in Austria for commuting.

Cities: drivers of development with good public transport
All the major cities in these three countries have been praised for their public transport. The service intervals are short, the vehicles arrive on time, they are clean and it is safe to use public transport. There are also good route planners available. Due to high subsidization (subsidies typically cover more than 50% of the costs), the price of the tickets is also competitive. Especially in Vienna, the annual ticket costs only 365€.

All the three countries have a limited number of city areas that are at the core of the transport development. These cities have a good PT with several transportation modes available. The cities also put emphasis on different last-mile solutions, including emission-free city bikes and scooters. However, even if the development typically starts from the largest cities, due to the spillover effect and high visibility in media, development picks up rapidly in smaller cities as well.

In Switzerland, all the cities are active in developing and improving new services, including transport services – to lure new companies to their city and canton. Therefore, all the five major city areas have sophisticated regional transport systems. On top of that, two significant national level players, the Swiss Railways and PostBus, have linked together the whole country. Public transport is therefore excellent in all major cities and also good in the rural areas.

Table 2 Largest city areas in case countries at the core of the transport development

Austria	Population within area	Finland	Population within area	Switzerland	Population within area
Vienna	2 500 000	Helsinki	1 425 000	Zurich	1 830 000
Graz	613 000	Tampere	375 000	Geneva	1 250 000
Linz	271 000	Turku	325 000	Basel	830 000
				Bern	600 000
				Lausanne	420 000

Last-miles solutions available in the largest cities

All the largest cities in Finland and Switzerland are heavily investing in different last-mile solutions and also enable commercial operators to provide their services within the city limits. Most of the city center areas in Switzerland and Finland will have a city-bike system running in summer 2018. Also, all the city areas in Finland and Switzerland will have shared on-demand ride services operational next year. These services have been able to enter the markets even without subsidies. However, it remains to be seen how these solutions will be integrated to the public transport (as is already the case in Vienna and Turku). The district of Korneuburg and many of the neighborhood regions of Graz already has this kind of well-connected service, ISTmobil/GUSTmobil, due to public-private partnership approach in the development of the service.

All the cities have good traditional car sharing services operational. All the Swiss cities and capital areas of Helsinki and Vienna have pay-per-minute floating car services (Catch a Car, car2go, Drivenow, Gonow). Another new last-mile solution that has been gaining success is a peer-to-peer car sharing services where people can borrow and lend each other's cars (Sharoo, Caruso, Drivy, Shareit Bloxcars). The advantage of this peer-to-peer concept is that it may also work in the rural areas.

Rural area public transport

In Switzerland, also the rural area has a sufficiently good public transport. Basically every municipality is connected to the national PT network while some exceptions in truly remote areas still exist. Usually buses connect villages to each other and to the train network. In future, the purpose is to use more on-demand solutions for the public transport of the areas with lowest population density.

The situation with public traffic is different in the rural areas of Finland and Austria. Outside the major city areas, public transport has declined during the last decade. In Austria, this is mostly due to the good highway network and people used to own and drive private cars when commuting. Therefore, the demand for public transport has decreased. In Finland, this change is mainly due to the population density changes in the rural areas and austerity measures in municipalities after 2008 financial crisis.

The pace of population density change between different areas is significant. In Finland, between 1990 and 2015, the population in low population density rural areas decreased by 30% and 15% in other rural areas. At the same, the population grew by 23% in the cities – mostly in the capital area and in other larger university cities[20]. The same phenomenon does not happen that much in Austria anymore as urbanization has already progressed throughout the history. Also, most of the countryside is still quite close to some city in Austria and due to higher birth rate and migration, also the countryside population remains on sufficient level. However, urban sprawl remains an issue in Austria: the on-going population growth is strongest in the capital area and around other cities. Thus, even in Austria new solutions for public transport are needed.

Even the main transportation corridors in Finland have currently many areas with very little, if any, public transport. Due to the consolidation of municipalities and austerity measures public transport services has diminished and for example, there is no access with public transportation anymore to or from the former municipality centers on some weekdays. Therefore, families in these areas have often two cars in the household. Furthermore, part of the vicious cycle is that once these private cars have been bought, people use them, and there are even fewer passengers using the public transport, reducing the service level even further.

[20] https://www.slideshare.net/TimoAro/suomen-vest-miss-ja-minklaista (Timo Aro, VTT)

Rural areas of Austria have suffered from the same phenomenon. The public transport is very limited in the rural areas, so people have to drive at least to the nearest train station for further transport. However, there are new solutions developed for sparsely populated areas. One example of this kind of new service is ISTmobil/GUSTmobil, an innovative solution conceptually situated between a shared on-demand taxi and public transport (see: for further details[21]). LeibnitzMOBIL is another example of so-called micro-public-transport-solution, based on the concept of the eMORAIL-shuttle-service, which was implemented in a research and pilot project funded by the Federal Ministry for Transport, Innovation and Technology in October 2015. This service is still operational and fulfills the function of a shuttle from and to the railway station in Leibnitz (Styria). There are plans to include additional municipalities within the region to this mobility solution to improve mobility options for inhabitants. Even though the funding from the Ministry has not been continued after the pilot project, the service with affordable pricing is offered by the municipality to the inhabitants.[22] Similarly to services in Switzerland, the Rail & Drive service from ÖBB, the Federal Austrian Railway operator, provides shared cars for railway customers at railway stations for the first/last mile from and to the railway station.[23] The start of this service is timed with the ÖBB-timetable-change in December 2017.

Services like ISTmobil/GUSTmobil or LeibnitzMOBIL could be a viable option for Finland. While it may not solve the problems in the most rural areas, it could help the public transport at the outskirts of transportation corridors. In these scenarios, on-demand shared traffic would supplement public traffic and connect people to the transport hubs in the corridors, and eventually to the national bus and train network.

Further reading:

UbiGo (2017). Website describing numerous mobility services in rural areas in Austria, and also internationally. Available at http://bedarfsverkehr.at/

[21] www.istmobil.at
[22] http://www.leibnitz.at/buergerservice/leibnitzmobil/ (German)
[23] https://www.railanddrive.at/de (German)

4 Technology

Technology is the most significant driver behind the fast development of new ways of transport and commuting. As technology is practically the same anywhere, it means that the development of commuting has certain recognizable patterns everywhere. For example, as the technology has evolved, more people and goods have started to move. However, due to socio-technical differences, the development in commuting has been different in countries and regions have had different kinds of transition pathways. Some countries have traditionally invested more in infrastructure supporting private cars while others have supported high- quality public transport and sustainability.

There are several technology trends related to mobility and vehicle development. In the following, we highlight a few sources describing these trends:

1. Electrification, connectivity, autonomous driving, diverse mobility[24]
2. Shared, electric, autonomous mobility [25]
3. Electrification, automation, connectivity, MaaS transport, demassification, delivery[26]
4. Electrification, automation, shared mobility[27]
5. Connected, electrified, shared[28]

According to these and other sources, electric shared autonomous vehicles and mobility services for people and goods will happen in future. Technologies that are often mentioned together are digitization/digitalization, 5G networks and connectivity, artificial intelligence, cloud technologies, services, Internet of Things (IoT), teleworking and Mobility-as-a-Service (MaaS). Most of these technologies are directly related to the possibilities of increased mobility of workers with the applications of these technologies. On the other hand, some of the changes are rather new ways of utilizing current technology and revolutionizing traffic by new business models, social innovations, ownership and sharing concepts.

When some aspects of life change, this change in technology also changes the commuting and mobility behavior. Digitalization has many impacts on *assets* (infrastructure, connected machines, data, and data platforms), *operations* (processes, payments and business models, and customer and supply chain interactions) and *workforce* (use of digital tools, digitally skilled workers, and new digital jobs and roles). Furthermore, there is also a different path how the technology affects commuting: by changing the jobs of people. Approximately one-third of existing jobs in western countries could be impacted by automation by early 2030s, yet this should be offset by job gains elsewhere in economy[29].

4.1 Autonomous vehicles and related technology

Autonomous vehicles are a hot potato. Gradually cars will do more and more of the driving on behalf of the human driver under optimal conditions. Later on, the situations in which a human driver needs to control the vehicle become less frequent. However, it is difficult to predict the time horizon of this change.

[24] https://peec.stanford.edu/sites/default/files/160401_automotive_2030_-_peec_vp.pdf McKinsey 2016 Automotive Revolution – perspective towards 2030
[25] https://www.morganstanley.com/ideas/car-of-future-is-autonomous-electric-shared-mobility
[26] http://www.blurb.com/b/8222797-the-end-of-traffic-and-the-future-of-access
[27] Fulton L., Mason J. & Meroux D. (2017). Three Revolutions in Urban Transportation. Institute for Transportation & Development Policy. Available at: https://www.itdp.org/wp-content/uploads/2017/04/ITDP-3R-Report-FINAL.pdf
[28] https://www.ibm.com/blogs/internet-of-things/automotive-future-iot/
[29] https://www.pwc.co.uk/economic-services/ukeo/pwcukeo-section-4-automation-march-2017-v2.pdf

The levels of automatization have been described by different authors (e.g. SAE (J3016), NHTSA, VDA and BASt). The levels have been defined from 0 (no automation) to 4 or 5 (full automation, driverless). SAE level 3 means conditional automation, where the system takes care of monitoring and driving in some pre-defined situations, but the driver must be ready to take care of driving when needed. Level 4 means that the vehicle is self-driving under all normal conditions and the human driver is only needed under some special cases. Level 5 means fully autonomous driving under all conditions.

There are two different ways to achieve level 4 qualities. Conventional car manufacturers go forward in a step-by-step approach, while the industry new-comers (Tesla, Google) try to go straight to the level 4 and 5 (Jääskeläinen, 2016). However, the expert opinions (varying, of course) are on average that it will still take around 15 years until we have high quality level 4 automation, and after that, several decades before the fully functional level 5.

There are several reasons the fast development of autonomous vehicles:

- **Computational power** increases significantly. It is required to analyze the enormous amount data available from all the different sensors. The latest version of Tesla's autopilot runs on Nvidia's hardware (Drive PX2) and it has more than a 40 times higher computational capacity in comparison with the previous version from 2015. On the other hand, the next generation to be launched in 2018 will still have approximately 13-fold improvement over the current generation[30].
- **Improved sensors** are another significant area of improvement including cameras, radars, lidars[31], ultrasound, IR, etc. They become more accurate and less expensive all the time, and the prices are expected to become even lower when mass manufactured in scales required by the car industry.
- **New software and algorithms improve fast**. Fast developing hardware is matched together with advanced high-tech software that is based on neural networks and deep learning in recognizing the surroundings. However, one significant task is to combine all the data from different sensors under one reliable driving model. This is technically the most probable reason why it may take longer than expected even before the automation level 4 will be reached.
- **Connected vehicles.** Vehicle-to-vehicle cars can send and receive messages between themselves and the surrounding infrastructure on a short-range according to the standardized protocols. The forthcoming DSRC (dedicated short-range communication) works in 5,9 GHz and has a range of 300 meters. Cars using it communicate about braking, turning, traffic lights, and alarm other vehicles. The standard allows also adding new messages into the communication. Later on, cars will inform others about different objects that are around the corner or difficult to recognize, if approaching from certain directions.

However, there are many different opinions why the development of autonomous driving is more likely to take longer than expected. The not harmonized legislation and conditions in different markets may prevent the development and deployment of autonomous vehicles. None of the manufacturers has a forcing need to roll out their fleet of autonomous vehicles. Also, most parts of the technology (algorithms, computational units, software, and hardware (e.g., Nvidia, Bosch, Here) are bought from external sources, and therefore it is very unlikely that any conventional manufacturer could beat others in this race when everyone is using mostly the same technology and sub-contractors.

[30] https://www.nvidia.com/en-us/self-driving-cars/drive-px/
[31] "laser illuminated detection and ranging"

Public transport in EU will probably embrace automatization later than the conventional car manufacturers. None of the public transportation authorities is willing to take a risk that the whole transport system would stop because of some exceptional occurrence, e.g., because of the severe weather conditions (snow storms, floods), or to have an additional fleet and drivers available for these exceptional cases.

After a few pilot projects, the first autonomous bus line started regular operation in Switzerland in 2017[32]. Running fully autonomously, the buses still need to be accompanied by a supervisor in Switzerland, which should perform an emergency stop if required. In Finland, the first fully automated lines will most likely start in 2021. At that time, the fully automated vehicle or the fleet of vehicles will probably be monitored by human operators in some centralized control room. However, this transition may take more time than wanted by some of the authors.

In Finland, harsh winter conditions may cause troubles because of the coldness, snow and slippery roads. The automated vehicle manufacturers do not yet provide winter readiness in their solutions. The new legislation in Finland is actually very open and permissive for different pilots and use of automatized vehicles, but none of the major manufacturers are actively trying to push their technology for these environmental circumstances. Some of these manufacturers have even stated that Finland is a too small market for them to customize their vehicles according to our needs.

This future trend may not be all good news for the mass public transport. When vehicles become more and more automatized, the driver can utilize the commuting time, thus making a private or shared autonomous vehicle more convenient way to commute. Also, with the electrification of vehicles, the variable use costs reduce significantly, thus making people more likely to use the shared or private autonomous vehicle than public transport.

4.2 Electrification of traffic

There is no doubt about whether the electrification of traffic happens during the next two decades. According to most estimations, the total life-cycle costs of battery-driven vehicles (BEV) will be lower than those of traditional internal combustion engine cars, the tipping point being somewhere between 2024 – 2030 (see, e.g. Bloomberg 2017[33]) without any subsidizations. The two drivers lowering the BEV prices are lower battery pack prices and economies of scale in mass-production of electric cars. This average estimation does not tell the whole story: depending on the taxation, gasoline price, electricity price and the number of kilometers driven a year by average commuter, electric cars may become a less expensive option already before that. In case of the local buses, the total cost of ownership of BEV is already nearly on par in city lines with conventional buses. However, the largest benefits come from reduced local particle emissions and noise reduction.

Before that, most manufacturers will use different hybridization solutions. Volvo, for example, will use at least micro-hybridization in all its new vehicle models after 2019[34]. Also, if the car has any kind of hybridization, it also allows a different kind of engine design for the combustion engine. For example, Mazda's new concept engine, combining properties of gasoline and diesel engine, has better fuel efficiency when less power from the engine is needed[35]. Hybridization with this engine could be used for accelerations and other situations where more power is needed sporadically.

[32] https://www.swissinfo.ch/eng/first-autonomous-transport-service-in-switzerland-inaugurated/43541214
[33] http://docketpublic.energy.ca.gov/PublicDocuments/17-IEPR-07/TN217132_20170417T164544_Global_EV_trends_and_forecast.pdf
[34] https://www.ft.com/content/471cd6e2-60bc-11e7-91a7-502f7ee26895
[35] http://www.express.co.uk/life-style/cars/870841/Mazda-petrol-cars-engine-breakthrough-SKYACTIV-X

Many of the European countries and different stakeholders have set ambitious targets for the EV market share or the share of EVs of the sold vehicles. So far these targets have been reached – at a high cost for society - only in Norway, where the share of electric car and hybrid car sales are already 42% of new car sales, and the purpose is that all cars sold after 2025 would be electric in Norway[36]. If other countries try to achieve the same share of the sold vehicles, they do not have to subsidize BEVs as much as in Norway, since BEV prices have already lowered during the last years. However, the current targets in EU are lower, and the majority believes that the tipping point for electric cars actually happens in 2030's.

There are many organizational, country, and European level initiatives to support the transition towards electric vehicles. For example, different new concepts and investments are made to support the development of charging network. The networks for charging (21 KW) and fast charging (40 – 100 kW) are already quite dense in most Western European countries, and the interoperability between chargers has improved significantly. The latest generation of ultra-fast chargers has power up to 350 kW, and the IONITY, a joint venture by BMW, Daimler, Ford, and Volkswagen, will provide 400 of these ultra-fast chargers in Europe by 2020[37].

Electric light vehicles are another area with significant growth potential. E-bikes, Segways, and other solutions are popular and widely used in Asia, and the same phenomenon will happen in Europe. In Switzerland, for example, sales of E-bikes have massively increased during the last years. In 2016, 23.3% of all sold bicycles were E-bikes[38]. These light solutions offer a viable way to solve the last-mile problem.

4.3 5G networks for teleworking and autonomous connected vehicles

Telework means using information technology and telecommunications to replace work-related travel and to perform everyday work duties from any remote location. Teleworking (telecommuting) has become so popular that it is not even considered a new phenomenon. The equipment offered to employees - laptops, mobile phones, tablets - has become more common. Also, cloud-based services and investments in better security (use of VPN, cloud services, screen blockers etc.) have made teleworking easier. Currently, many companies are changing their traveling and commuting policies to encourage more teleworking.

With the increasing computing power and faster network connections, more tasks and monitoring can be done remotely. Faster speed and lower latency in connections make the feeling of being physically in a meeting more natural. Teleworking may reduce the need to commute during the rush hours – starting work at home and coming later to the office or to the customer may also be more efficient as there is a natural break in working. Also, the time used for commuting is perceived differently when the travel time can be used effectively for working. Not only equipment but also office spaces are designed more towards new ways of working with flexible spaces without assigned places. Therefore, teleworking and related technological development will continue to further change the way we work and commute. In the near future, virtual reality and augmented reality are the prospects for next game changers in remote collaboration.

Forthcoming 5G networks will significantly increase network speeds from the already impressing transfer rates of 4G network. Maximum speeds will be around 10 - 20 Gbps (ten-fold in comparison with the fastest 4G connections). Faster internet speed has been the main agenda for telecom operators all over the world, since virtual reality and augmented reality mediums are creating a high-

[36] https://electrek.co/2017/07/04/electric-car-norway-tesla-model-x/
[37] https://electrek.co/2017/11/03/ultra-fast-electric-car-charging-network-unveiled-by-bmw-mercedes-ford-volkswagen/
[38] http://www.velosuisse.ch/files/Velo%20Statistik%20Schweizer%20Markt%202016.pdf

demand for such hyper-fast network speeds (IBTimes, 31. Aug. 2016). However, from the perspective of commuters and mobile workers, the reduction of latency may be the more important change. Video-conferencing and other face-to-face communication methods feel more natural with a lower delay in response time to the other participants. Another improvement is that the 5G solutions work better when a person is in a moving vehicle. Finland has already 5G test networks running, and the network will start operating commercially in 2019.

Frequencies in 700 MHz band will also open. This lower frequency enables longer distances for the signal and it also goes better through the walls and many other physical obstacles. This improves network speed in rural areas, where the current lower frequencies (800 – 900 MHz) are already heavily used. Together the lower latency and better connectivity in rural areas enable the possibility to use real-time traffic information updates and real-time recognition of the customer. This allows more flexible payment alternatives and makes it easier to combine different alternatives for MaaS operators.

Faster low-latency 5G networks are also considered to be prerequisite for autonomous vehicles in public transport. For specific cases, there has to be a fast low-latency connection to the vehicle so that human driver can take control of the car from some external monitoring and steering center. Some experts say that the first generation 5G network standards do not yet guarantee this functionality, and it will still take close to ten years before the needed level in latency and quality of service will be only fully achieved.

4.4 Digitalization and open data in mobility

Digitization changes many aspects of everyday life - including mobility. An important factor affecting the interoperability of different services is the capability to use open (real-time) data of different transport operators to provide multi-modal integration. In Finland, the second stage of the Act on Transport Services will continue making the data on the use of mobility services open for different actors. For example, the Finnish Transport Agency will be obligated to collect and share through open interfaces data on the use of mobility services in a form where data items cannot be linked to individual users, service providers or services. This way trip chains and Mobility-as-a-Service will be enabled by making it possible for operator to act on customer's behalf: the MaaS operator, for example, will have better opportunities to incorporate tickets for all modes of transport, car hire service, various serial and seasonal products as well as discounts into a combined mobility service by acting on the customer's wishes or on the customer's behalf in different services.

Another benefit of digitalization is related to making data available in one place, as about ten current registers relating to transport are consolidated to form one integrated register of transport affairs containing data on operator permits, transport vehicles and personal licenses such as professional qualifications. On the whole, more and more data is collected by different stakeholders, and this data is offered openly, but partly in anonymized form, to firms and authorities.
The public authorities also take care of several significant systems relevant for intelligent transport systems. For example, Finnish Transport Agency maintains two important open data systems: *Digitraffic*, a system offering real-time and historical information and data about the traffic on the Finnish main roads, and *Digiroad,* a national database which contains precise and accurate data on the location of all roads and streets in Finland (covering a total of 483,000 km) as well as their most important physical features.

4.5 Mobile payments

The Payment Services Directive (2007) has regulated payment services providers throughout the EU. It has increased pan-European competition by enabling market entry of new financial

organizations and harmonized consumer protection and the rights and obligations of payment providers and users in EU. The revised version of the directive will come into force in 2018, and it will have an even more significant impact on payments. For example, with the authorization of a customer, any service provider may get direct access to the customer's bank account and charge it without having to pay the bank for this access. These new rules aim to protect consumers when they pay online, promote the development and use of innovative online and mobile payments, and make cross-border European payment services safer. As a result, global players like Apple Pay can provide payment mechanisms independent of the country or the bank that the customer is using.

Mobile payments will change the way we use services and make micro-payments. It allows secure, simple, transparent and real-time payments between people and companies. Mobile payments are already common in many parts of the world, with certain African countries and China leading the way. For example, M-Pesa service in Kenya is considered faster, easier and safer than traditional cash and bank offices in payments between people and companies, and it is widely used.

4.6 Inside navigation

Navigation inside buildings has not yet been commonly available. Once inside navigation becomes available and common technology, it will help people in doing transport mode changes inside buildings and transport hubs, such as airports, railway stations, bus stations, and metro stops. Often, it is not easy to know how to get to the right terminal or bus stop. This reduces the feeling of safety and easiness of using public transport to get from one place to another.

There are many inside navigation technologies. GPS, Galileo, WLAN signal echoing paths and standardized positioning beacons together with the accelerometers, gyroscopes and visual recognition capabilities of the smartphones already make the technology feasible. Inside navigation will also integrate with building management systems and guide visitors inside the buildings into the right meeting rooms while also preventing them from going to the wrong places. Other applications related to security and emergency situations will also benefit from this technology.

5 Policies and legislation affecting commuting and transport

Austria, Finland, and Switzerland all have different kinds of public sector and governance structures. These determine partly what kinds of legislation, policies and solutions are applied at different levels in each country. Firstly, it is essential to describe the different systems, and then by going through each country, to describe what kind of impact this has had on the transport policies. The different tiers of decision-making and legislation in the three countries are:

- Austria: federal council, states (Bundesland), district commissions incl. statutory cities and municipalities
- Finland: state, municipality
- Switzerland: confederation, canton (province), city and municipal level

5.1 Austria

5.1.1 Political situation/levels and strategic mobility planning

Austria has three levels of legislation and policies: federal government level, Bundesland (state) level, and municipality level. While Austria is officially a federal republic by the constitution, in terms of legislation, this federalism is more theoretical than actual practice. Many legislative powers have been subsequently taken away from Bundesland level, and only a few remain, such as policies related to planning and zoning codes, nature protection, hunting, fishing, farming, youth protection, certain issues of public health and welfare and the right to levy certain taxes. Therefore, the legislative power is strongly in the hands of the government.

However, while the legislation is the same in Austria, different states have different means to fulfill the requirement of the law in acquiring and providing different public services. States differ from each other by culture, geography, population and political tradition, and therefore Austrian parties have varying power in different states. The four largest parties are *Social Democratic Party*, Austrian People's Party (Christian democratic conservatives), Freedom Party of Austria (right-wing national conservative party), and The Greens. The election on 15 October 2017 caused some changes in the government. The mobility landscape will most likely be also affected because the Minister for Transport, Innovation, and Technology is not a member of the Social Democratic Party for the first time since 2007.

The capital area has been politically more in favor of Social democrats and the Greens than the rest of the country. Therefore, the City of Vienna has supported strongly public transportation. Since the significant price reduction for Annual Pass to 365 €/year in 2011, the number of Annual Pass users has doubled[39]. Also, the digitalization of public transport has increased significantly –the Viennese public transport provider, Wiener Linien, offers MaaS by incorporating e.g. car sharing or taxi services in their digital services such as WienMobil[40]. The modal share of private cars has decreased from 34% to 27%[41] in ten years. The model split in daily mobility is considerably different from the Austrian average, which is 18% public transport and 55% private cars[42]. The aim of Wiener Linien is to find

[39] https://www.wienerlinien.at/media/files/2017/facts_and_figures_2016_213708.pdf
[40] https://www.wienerlinien.at/eportal3/ep/channelView.do/pageTypeId/66533/channelId/-3600061 (English)
[41] https://www.fahrradwien.at/wp-content/uploads/2016/01/modal-split-2014-2015.png
[42] https://www.bmlfuw.gv.at/.imaging/mte/bmlfuw/mashup/dam/bmlfuw/schwerpunkte/Unternehmen-Energiewende/klimaaktiv_mobil_foerderprogramm/Mashup-Bilder/Modal_split_UBA_2014.png/jcr:content/Modal_split_UBA_2014.png

even new ways to improve the situation and increase the share of public transport (39%) – which seems to be a challenge for already popular services such as the metro, which is often crowded during rush hours.

However, within the last years, especially the Freedom Party (right-wing national conservative party) has increased their number of seats in the city council of Vienna (2015: 34%). The Christian Democrats and Freedom Party, who have more power outside the capital area, do not favor so much public transportation over the use of a private car. This development and a shift to a free competitive market in public transportation in 2008 increased pressure on closing non-profitable routes and led to a situation where the public transport does not run anymore in rural areas. This is a significant change for the households without cars or with one car and elderly people living in these areas as this change influences the participation in everyday life and the access to the labor market. Therefore, local districts in rural areas are now seeking for more efficient and sustainable ways of organizing public transport and supplementing services for public transportation.

5.1.2 Public transport – lacking an Austrian-wide vision on future transport?

Austrian public transport is known for its good quality. It is clean, safe and ticket prices are sufficiently low due to high subsidization. Intra- and inter-regional associations like e.g. VOR are responsible for the planning, financing, and coordination of all public transport services.

VOR designs and co-ordinates the tariff system in the eastern region, but also acts as the contracting authority for most transport companies in Lower Austria and the Burgenland as well as a clearing-house for the distribution of revenue between the transport companies.[43] In Vienna, multimodal services based on the smile-project like WienMobil (further developed by Upstream) and wegfinder (further developed by iMobility) provide simple information, routing, and ticketing service for travelers.

The main mode of public transport all over Austria is railways, supported by buses. Austrian federal railways (ÖBB) and the Austrian railroad network, owned by the state, are of high quality and offer both dense railway network and frequent trains between the cities and towns. In addition to the trains, the company also operates 2200 busses (ÖBB-Postbus). For families, ÖBB offers an annual pass for a price of 5,30 €/day (1935 € per year) that includes all the tickets for two parents and all the children under the age of 15. Also, young people, students, and senior citizens have their own special price tickets. However, ÖBB has been criticized for the lack of transparency. This lack of transparency has led to questioning whether the operations are efficient enough and truly support the development of the whole Austrian traffic system the best possible way.

The liberalization of the railway operation (2008) led to some pressure on ÖBB to provide service on less frequented tracks, and it offered the possibility for new operators to enter the market. WESTbahn[44] started its operation in 2011. ÖBB-Infrastruktur AG still owns the tracks, and all operators like WESTbahn pay for using the tracks. This liberalization has resulted in additional services for customers on more popular railway connections but also decreased services in those areas with less demand.

Given the quality of Austrian public transport in the majority of cities and regions, the number of annual passengers is low in comparison with, for example, Switzerland. This may be due to the tradition of using own cars, combined with the high quality of the highway network and parking houses in the city centers. Overall, the transportation infrastructure is of high quality in Austria, and there are innovative new companies in the field to solve the last-mile problem. However, there does not seem

[43] https://www.vor.at/
[44] https://westbahn.at/en/

to be a countrywide shared vision of how the whole public transport system should be developed. Developing such vision is difficult due to varying framework between urban and rural areas but also due to the Federal system in Austria. Still, Austria has good potential[45] to develop and utilize new mobility and commuting concepts as there are a lot of (national) funded initiatives to pilot new concepts, to integrate services and to assess their rollout and transferability.

5.2 Switzerland

5.2.1 Confederation, cantons, municipalities and direct democracy

Switzerland differs from most other western countries by its true three-tier legal structure and direct democracy. The country is a confederation with a federal government. The next legislative level consists of 26 cantons with their own parliaments. The third tier is the city and municipality level with their decision-making authorities.

Confederation

The Confederation has the authority in all areas in which it is specifically empowered by the Federal Constitution - for example, foreign and security policy, customs and monetary policy, legislation that is valid throughout the country, and in other areas that are in the common interest of all Swiss citizens. Tasks, which do not expressly fall within the enumerated areas of competence of the Confederation, are handled at the next level, i.e., by the Cantons.

The Swiss Federal Government consists of seven members of the Federal Council (Federal Councilors) who are elected by the Federal Assembly for a four-year term, and each of these Federal Councilors (Secretary) heads a Department[46]. One of these departments is a Federal Department of Environment Transport, Energy and Communications (DETEC), that aims to… ”assure the sustainable provision of primary (transport) services in Switzerland… to meet present requirements for infrastructures and at the same time to secure for future generations the chances of an intact environment.” While Cantons are considered to have significant legal power, DETEC, through its influence on the Swiss railways and Postbus, has a decisive role in the development of the Swiss public transport.

The cantonal level

Each canton has its own constitution, parliament, government, and courts. The cantonal parliaments have between 58 and 200 seats, and the cantonal governments have 5, 7 or 9 members. In all of the cantons, voters make their decisions at the ballot box. The cantons exercise all the sovereign rights, which the Federal Constitution has not explicitly assigned to the Confederation or does not forbid them to exercise by a specific rule.

The municipal level

All the cantons are divided into municipalities or communes, of which there are at present 2760. The number of municipalities is diminishing as they merge. Around one-fifth of these municipalities have their own parliament, and in the others, decisions are made by process of direct democracy in the local assembly. In addition to the tasks entrusted to municipalities by the Confederation and the canton – such as organizing population register and civil defense - the local authorities also have own specific tasks for education and social welfare, energy supply, road building, local planning,

[45] Referring to the table under point 3 in comparison of the three countries Austria shows the longest railway, but also longest highway network

[46] http://www.nyulawglobal.org/globalex/Switzerland1.html

taxation, etc. To a large extent, these specific powers are self-regulated. The scope of municipal autonomy is determined by cantons, and therefore it varies from canton to canton.

Direct democracy

Switzerland – on all of these legislative tiers – also has several systems for direct democracy instead of representative democracy. The voting on different issues is arranged simultaneously for different levels (confederation, canton, municipal). On the confederation level, if someone gets 100 000 signatures from people with Swiss citizenship, a new suggestion can be made to change something in the constitution that then needs to be submitted to a public vote. For example, between 1995 and 2005 Swiss peopled voted 31 times of 103 different confederation level questions directly. These issues are often related to healthcare, taxes, welfare, drug policy, public transport, immigration, asylum, and education. On the municipal level, direct democracy decisions are usually made by open-hand voting. What makes this direct democracy interesting is the ability to make changes directly influencing the legislation in mobility. For example, Swiss citizens could ask to revise certain parts of legislation to make some new transport service available (or legal) in the country. However, this has not happened yet.

However, Canton parliaments and city councils have one by one disallowed Uber service in their area of authority. For example, the Zurich cantonal government has confirmed Uber is operating illegally in the canton. The drivers must have a taxi license in the canton, and the cars should have tachographs to show the current speed and how long the driver has been working.

5.2.2 Swiss system from the entrepreneurs' perspective

Many cantons make it simple for companies to do different short-term pilots. The cantons may have money and intention to develop and try different new services. The downside is that with a countrywide solution in Switzerland companies have to analyze all the rules in different cantons. This is especially burdensome for small start-ups who cannot afford to negotiate with 26 different parties. In addition, if the service is supposed to be a countrywide solution for the customers, changes in legislation in one single canton can destroy this purpose. Also, as Switzerland is not part of the EU, it does not have same rules regarding public competition. However, the legislation is gradually harmonizing with EU regarding both public competition and transport.

The single most significant challenge for the companies to establish themselves in Switzerland is the subsidized, already existing high-quality public transport, and strong stakeholders. As a result, only viable way to establish a new transport service in Switzerland is to a) sell the concept to some of the large cities (for city-wide services) or b) to cooperate with either Swiss Federal Railways of Postbus, and hope that they will buy and launch your service countrywide as part of their own service portfolio.

5.2.3 High-quality public transport for a reasonable price

The travel costs with public transportation in Switzerland are subject to extensive public debates[47]. Regarding the high financial amounts involved, this is not surprising - In 2014, the overall system

[47] Aargauer Zeitung, 2017. Hoher Preis für Mobilität: Verkehr kostet den Steuerzahler 13 Milliarden Franken pro Jahr [WWW Document]. Az Aargauer Ztg. URL https://www.aargauerzeitung.ch/schweiz/hoher-preis-fuer-mobilitaet-verkehr-kostet-den-steuerzahler-13-milliarden-franken-pro-jahr-131751385 (accessed 10.16.17).
Brupbacher, M., 2014. Sind die ÖV-Preise in der Schweiz wirklich überteuert? Tagesanzeiger Datenblog.
Schlittler, T., 2012. Ein GA kostet heute 45 Prozent mehr als noch vor 20 Jahren [WWW Document]. Az Aargauer Ztg. URL https://www.aargauerzeitung.ch/wirtschaft/ein-ga-kostet-heute-45-prozent-mehr-als-noch-vor-20-jahren-125559797 (accessed 10.16.17).
SRF, 2016. Schweizer ÖV-Preise überdurchschnittlich gestiegen [WWW Document]. Schweiz. Radio Fernseh. SRF. URL https://www.srf.ch/news/schweiz/schweizer-oev-preise-ueberdurschnittlich-gestiegen (accessed 10.16.17).

costs for public railway transportation in Switzerland accounted for 8.6 billion Swiss francs (around 10.3 billion euros[48]). This is an increase of 13% from 2010 to 2014[49].

In Switzerland, around 55% of the costs for the railway system are covered by contributions of the public hand (ibid). The remaining share needs to be paid by the railway customer. Therefore an augmentation of general system costs (e.g., due to extensions of the infrastructure) results in an increase of ticket prices. Since 1990, the individual ticket prices have increased by 45%-75%, depending on the type of ticket. During the same period, the costs for private car usage increased by only 20%[50]. This increase in ticket prices often leads to incomprehension among public transport users and therefore drives the aforementioned public debate[51].

Despite this trend in ticket prices, Swiss public transport does is not expensive compared to other countries. According to the research of Sträuli and Killer (2016), which compared six European countries (Great Britain, Italy, Austria, France, Germany and the Netherlands), Swiss PT prices, adjusted to purchasing power parity, lie within the midfield. Especially the “General Abonnement” GA -travel card offers a very good price-value ratio. As an all-in-one ticket, it offers unlimited travel on all trains, buses and local public transport systems in Switzerland. Only some mountain railways and cable cars are excluded. In addition, students, children, families and senior citizens purchase the GA -travelcard at a reduced price. In 2017, one-year GA -travel card costs 3860 Swiss francs (around 3.350 euros[52]) for adults. Adjusted to purchasing power parity, this cost level represents half the price an adult would need to pay for the same mobility in the Netherlands and Germany. The value is even higher considering the high service quality of the Swiss public transport systems: compared to the above-mentioned six countries, Swiss public transport offers by far the best price-performance ratio.[53]

5.3 Finland

Finland has only a two-level administration: governmental level and city/municipality level. The law is the same everywhere in Finland without exceptions. Another typical feature of Finland is the strong public sector that employs around every fourth employee in Finland[54]. With the government changing every four years after the public election, new topics become topical and get funding according to the interests of the parties in the government. On the other hand, many topics and decisions become topical as a consequence of common EU directives and during the preparation of these directives to be fully transposed into national legislation.

The major players at the governmental level are the Ministry of Transports and Communications, Finnish Transport Agency and Finnish Transport and Safety Agency. The Ministry of Transport and Communications is in charge of implementing the intelligent transport strategy and is responsible for allocating sufficient resources to it within the transport administration sector. Under the guidance of the Ministry, the Finnish Transport Safety Agency, TraFi, and the Finnish Transport Agency are responsible for implementing the strategy in their respective sectors and for guiding the Centres for Economic Development, Transport and the Environment (ELY Centres) in implementing the strategy. The Finnish Transport Agency is also in charge of ensuring the availability of services in major urban

[48] Exchange rate 31 of October 2014, see http://de.exchange-rates.org/Rate/EUR/CHF/31.10.2014
[49] BFS, 2017. Kosten und Finanzierung des Verkehrs. Strasse und Schiene 2014. Bundesamt für Statistik BFS, Neuchâtel.
[50] WBF, 2013. Entwicklung der Fahrkosten im Strassen- und Schienenverkehr. Eidgenössisches Departement für Wirtschaft, Bildung und Forschung WBF, Bern.
[51] Brupbacher, M., 2014. Sind die ÖV-Preise in der Schweiz wirklich überteuert? Tagesanzeiger Datenblog.
[52] Exchange rate 16 of October 2017, see http://de.exchange-rates.org/converter/CHF/EUR/3860
[53] Sträuli, C., Killer, M., 2016. Angebot und Preise des ÖV Schweiz im internationalen Vergleich. LITRA Informationsdienst für den öffentlichen Verkehr, Bern.
[54] http://tilastokeskus.fi/til/tyti/2014/02/tyti_2014_02_2014-03-25_tau_009_fi.html

areas and the continuity of mobility services across administrative boundaries and is responsible for the overall intelligent transport architecture.

There are several overlapping policies and legislation changes that guide the changes in Finnish mobility patterns. Currently, the three most topical policies are:

1. Climate policy: how to reduce CO_2 levels by 38% (from 2005 level) by the end of 2030.
2. New transport code (the first stage in act 1.1.2018 and the second stage in 1.7.2018)
3. Legislation reform for Finnish road transport act

These main legislation changes are such that regardless of the government, they are expected to dictate the development of the transportation sector in the forthcoming years.

5.3.1 Finnish climate policy targets

European Union expects Finland to reduce CO_2 emissions by as much as 38% by the end of 2030. The transportation sector should halve the CO_2 emissions before 2030, which means 5,5 Megatons less CO_2 emissions. This is a major guideline that already steers Finnish policies related to transport of people and goods.

Three major ways to reduce the emissions in the transportation sector are:

1. Use of biofuels (target level is 30% of transportation fuels by the end of 2030)
2. Use of more electric cars (target level is 250 000 EVs by the end of 2030)
3. Changing consumer behavior and supporting MaaS

Biofuels in Finland are expected to be domestic and made primarily from the wood residues of mechanical wood, pulp, and paper industry. The number of large-scale biorefineries required in Finland to reach the biofuel target would be between 5 to 10, with capacities of approximately 200 000 tons of annual biofuel production in each of the refineries. This is the highest sustainable level that can be achieved regarding the supply of wood residue. There has not yet been an open discussion about the price of these biorefinery investments and how much the government or EU could subsidize the investment costs.

Another target is to have 250 000 electric cars and 50 000 other low-emission vehicles on the roads by 2030. The government has stated that they will support the construction of the charging infrastructure. Tax policies will also favor low emission vehicles, but direct subsidies for buying the vehicles are not expected to be significant – if any. This policy is based on the assumption that by 2030 the electric cars will have lower total cost of ownership than conventional internal combustion engine cars, and therefore the transition could happen without unnecessary subsidies.

The current CO_2 emissions in Finland for produced energy are 183 kg CO_2/MWh. By 2030, Finland will have at least one new large 1600 MW nuclear power plant. The share of wind electricity produced is also expected to increase with modest subsidies. A third high voltage electric transfer line will be built between Sweden and Finland, further reducing the average CO_2 emissions of electricity consumed in Finland. Therefore, with more emission-free production, the electrification of vehicles will reduce CO_2 emissions.

A third important target is to change the current mobility patterns of Finnish people. The purpose is to get from the use of private car use towards sharing economy, MaaS, increased use of public transport, and increasing the share of active modes in transportation. Increasing the use of active modes in transportation is also considered to be important from the viewpoint of national health. The

government is changing legislation and giving funding to support this transition. The cities and their transport operators are also actively supporting this behavioral change.

5.3.2 New Transport Code

New Transport Code reform aims to support new service models and better response to the needs of transport users. The Transport Code will make market access easier and promote the interoperability of the different parts of the transport system through digitalization of these services.

The new transport code promotes the introduction of interoperable digital ticket and payment systems by ensuring open information and payment interfaces for the whole ecosystem. In practice, this means that the payments will be based on recognition of the passenger, and the actual monetary transfer happens in the background. When the identification and monetary transaction are separate processes, it becomes easier to support smart travel chains with added services. Also, this separation allows several different alternative ways (bus card, mobile phone, other cards) and different technologies (NFC, RFID) to be used for identification.

Forthcoming transport code does not significantly ease the introduction of new disruptive transport concepts in Finland. Uber, for example, will still be illegal according to the new law, unless the company and its drivers' have similar permissions and licenses that are required from the ordinary taxi companies In Finland. On the other hand, after the reform, for example, on-demand mobility services may combine the delivery of both people and goods better.

In parallel with this reform, the Ministry of Transport and Communications of Finland has released a plan for promoting intelligent automation. This plan covers all transport modes: road, rail, air and maritime transport. The aim of this published plan is to create an environment in Finland that is attractive for the development of automation in transportation and easy in terms of getting permits for automation experiments and short-term projects.

5.3.3 Legislation reform for Finnish road transport act

The new Finnish road transport act will collect and update different regulations under the same act. This reform aims at taking into account changes in technology and new international (EU) policies. The purpose is to support deregulation, have less bureaucracy and update many outdated laws. At the same time, this new legislation is aimed to improve road transport safety, support sustainability in transportation and encourage walking and cycling. However, the most significant part of the legislation will be related to taking into account new technologies and automatization in road transportation, of which the two most significant changes are related to 1) autonomous vehicles and 2) new light classes of personal vehicles.

The current legislation actually allows autonomous vehicles to drive on open roads in Finland. However, there has to be a legally responsible driver dedicated to the vehicle while it drives. This driver does not need to be inside or close to the vehicle: it is enough that some legal entity - not necessarily even a human – is able to take control and responsibility of the vehicle in case of an emergency. Therefore, this legislation makes it possible for car manufacturers to sell their autonomous cars in Finland and take the responsibility of possible accidents involving their cars instead of the owner of the car. Volvo Car, among other companies, has already stated that they would like to take the responsibility away from the traditional driver because it is their product and background services that will "drive" the vehicle.

Another significant change in road legislation takes into account the new types of light personal vehicles. A legislative reform in act from 1.1.2016 allows the use of e.g. kickboards with electric

engines and Segway-type devices in road traffic. Typical for these vehicles, their use or ownership does not require a driver's license, registration, roadworthiness tests or specific insurance. Lightweight devices that travel at a maximum speed of 15 km/h are comparable to kickboards and roller skates. Therefore, ordinary pedestrian traffic regulations apply to the use of these devices. The traffic regulations that apply to cyclists also apply to larger personal vehicles that travel at a maximum speed of 25 km/h and have a maximum output power of 1 KWh and a maximum width of 80 cm. Self-balancing devices such as Segways may also be used on pedestrian walkways if they are driven at a walking (running) pace.

6 Socio-technical regime in the chosen regions

The three chosen case areas in the countries represented in the ENSCC Smart Commuting project are large commuting areas with a need for new services and concepts developed by the project partners. Figure 3 represents the different characteristics of these areas in net graph format, and the following chapters describe the socio-technical regimes in these areas in more detail. Despite the differences in the characteristics of these areas, the development of intelligent transportation systems is at the same stage in these countries. These similarities make it possible to implement new mobility services, get experiences about the needs of users and discover some common ground for governance and city planning policies.

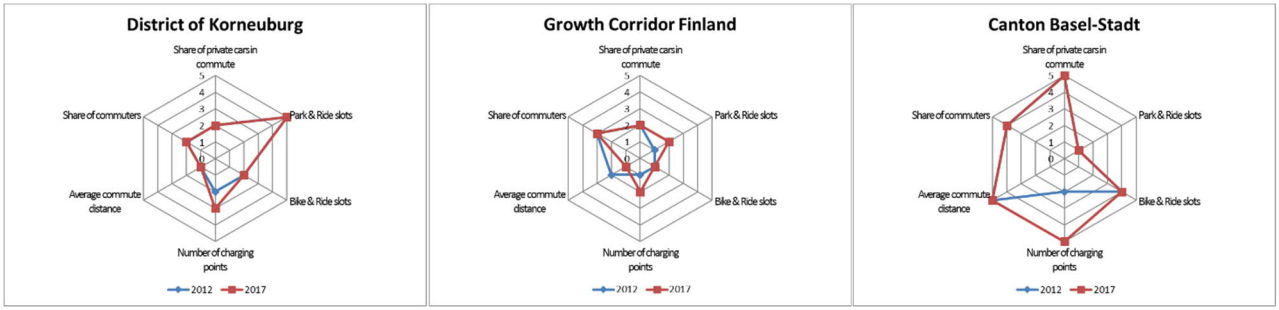

Figure 3 Net graphs of the areas from left to right: District of Korneuburg in Austria, Growth Corridor Finland, and Canton of Basel-Stadt in Switzerland.

We are using the data collected for these net graphs for descriptive purposes only, as the quality of the data is not representative for deeper analysis. Neither do the selected indicators represent our opinion of the most important performance indicators for the case areas. The scale in the graphs illustrates the differences in the chosen areas and does not compare the state of the development in these areas to other countries. Number zero in the scale represents the least sustainable situation and five (usually) the most desirable situation: for example, with the share of private cars in commute smaller percentage is preferred and with park and ride slots, larger amounts are preferred. The graphs have been made by using the following data:

<u>Share of private cars in commute, Average commute distance and Share of commuters</u>

- For the "2012 situation" in Korneuburg, we have used the study made by Planungsgemeinschaft Ost[55] that reports the modal split in the Stockerau corridor (includes trips made for multiple reasons and also trips from other districts in the same direction) and the commuting study made by AKNÖ in 2014[56]. For the year 2017, we used the travel behavior survey conducted in our project (sample from the whole Austria)
- For the "2012 situation" in Finland, we have used the national travel survey conducted in year 2011 (using only the responses from people living in GCF municipalities) and official statistics (http://www.stat.fi/index_en.html) of that year. For the year 2017, we used the GCF travel behavior survey conducted in our project
- For the "2012 situation" in Basel-Stadt, we have used the official statistics of the Canton (http://www.statistik.bs.ch/zahlen/tabellen/11-verkehr-mobilitaet/pendler.html) and for the year 2017 we used the Basel travel behavior survey conducted in our project

[55] Rittler C. (2011). Kordonerhebung Wien in den Jahren 2008-2010. Planungsgemeinschaft Ost. Available at: http://www.planungsgemeinschaft-ost.at/no_cache/studien/ansicht/detail/studie/kordonerhebung-wien-in-den-jahren-2008-2010/

[56] Kronister T. (2015). Pendleranalyse 2014. AK Niederösterreich. Available at: https://noe.arbeiterkammer.at/service/zeitschriftenundstudien/verkehr/Pendleranalyse_2014.html

Park & Ride and Bike & Ride -slots

- For the district of Korneuburg, the number of official Park & Ride and Bike & Ride -slots have been calculated using the railway station information of ÖBB-Personenverkehr AG (http://fahrplan.oebb.at/bin/stboard.exe/en?) and the number of slots has been then divided by the number of commuters using them. The number of commuters is from the commuting study made by AKNÖ[57] in 2014, and since there is no more recent information, the numbers are the same for 2012 and 2017
- For the 2012 situation in Finland, we have used a study of the Park & Ride systems in the Tampere–Helsinki public transport corridor [58] and official statistics (http://www.stat.fi/index_en.html) of that year. For the more recent situation, we have used the Park & Ride and Bike & Ride information from the web pages of Helsinki Regional Transport Authority (https://www.hsl.fi/en/information/park-and-ride) and the most recent number of commuters of the region from the Statistics Finland
- For Basel-Stadt, we have used the estimation given by Canton's office of mobility (http://www.mobilitaet.bs.ch/motorfahrzeuge/parkieren-in-basel/park-and-ride.html) and divided that number by the number of commuters using them in 2012 and 2017 (http://www.statistik.bs.ch/zahlen/tabellen/11-verkehr-mobilitaet/pendler.html)

Number of charging points

- For all the areas, we have calculated all the public standard and fast charging stations using chargemap.com web service when we made the funding proposal (12/2015) and when reaching the mid-point of our project (3/2017). In order to take the demand for these charging points in consideration, we have divided the number of charging points with the best available information about the number of commuters possibly using them at each point of time

[57] Kronister T. (2015). Pendleranalyse 2014. AK Niederösterreich. Available at: https://noe.arbeiterkammer.at/service/zeitschriftenundstudien/verkehr/Pendleranalyse_2014.html

[58] Haukka A. (2012). Park and ride in the Tampere-Helsinki public transport corridor. Master of Science thesis (In Finnish), Tampere University of Technology. Available at: https://dspace.cc.tut.fi/dpub/bitstream/handle/123456789/21059/haukka.pdf

6.1 Austria: Korneuburg district

ISTmobil GmbH currently operates in the district of Korneuburg, just North of Vienna, and also in the neighborhood municipalities of Graz. Despite the high number of Park and Ride facilities in the district of Korneuburg and frequent train connections to Vienna from the most densely population areas (Figure 4), the modal split in commuting from Korneuburg to Vienna between car and public transportation is 71 to 29%[59] (Rittler, 2011). This is partly a result of many historical choices in spatial and transportation planning affecting the urban fabric of the region (Knoflacher, 2007). ISTmobil's service in the district is a last-mile solution supporting public transportation. Further information on ISTmobil is available online: http://www.istmobil.at/.

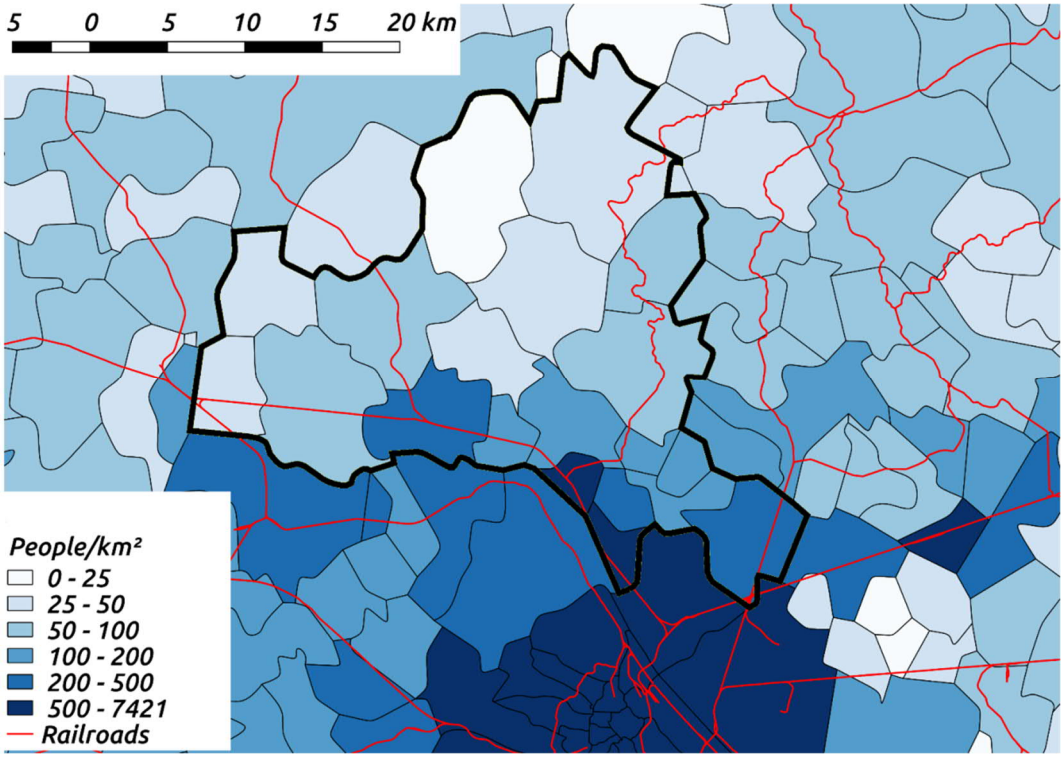

Figure 4 The population density and railroad lines in the district of Korneuburg.

[59] Rittler C. (2011). Kordonerhebung Wien in den Jahren 2008-2010. Planungsgemeinschaft Ost. Available at: http://www.planungsgemeinschaft-ost.at/no_cache/studien/ansicht/detail/studie/kordonerhebung-wien-in-den-jahren-2008-2010/

6.2 Finland: Growth Corridor Finland

The Growth Corridor Finland[60] (GCF) is a cooperation network and an innovation platform consisting of 20 municipalities and cities, 3 Regional Councils, 4 Chambers of Commerce and 4 Ministries: Ministry of Employment and the Economy, Ministry of Transport and Communications, Ministry of the Environment and Ministry of Education and Culture. As a geographical area (Figure 5) GCF stretches from Helsinki to Tampere as a string of cities (Figure 6), but also the city of Seinäjoki (connected by railroad to the GCF) is represented in this collaboration network. It forms the forefront basis of national competitiveness; more than 50 % of Finland's GDP is produced in this area. In addition, GCF is the biggest pool of workforce in Finland with more than 340 000 daily commuters.

Figure 6 GCF as a string of cities

The role of Growth Corridor Finland network is to support different actors in the development of the transportation corridor according to GCF vision, which includes becoming the leading experimental platform on intelligent traffic services and systems in Europe.

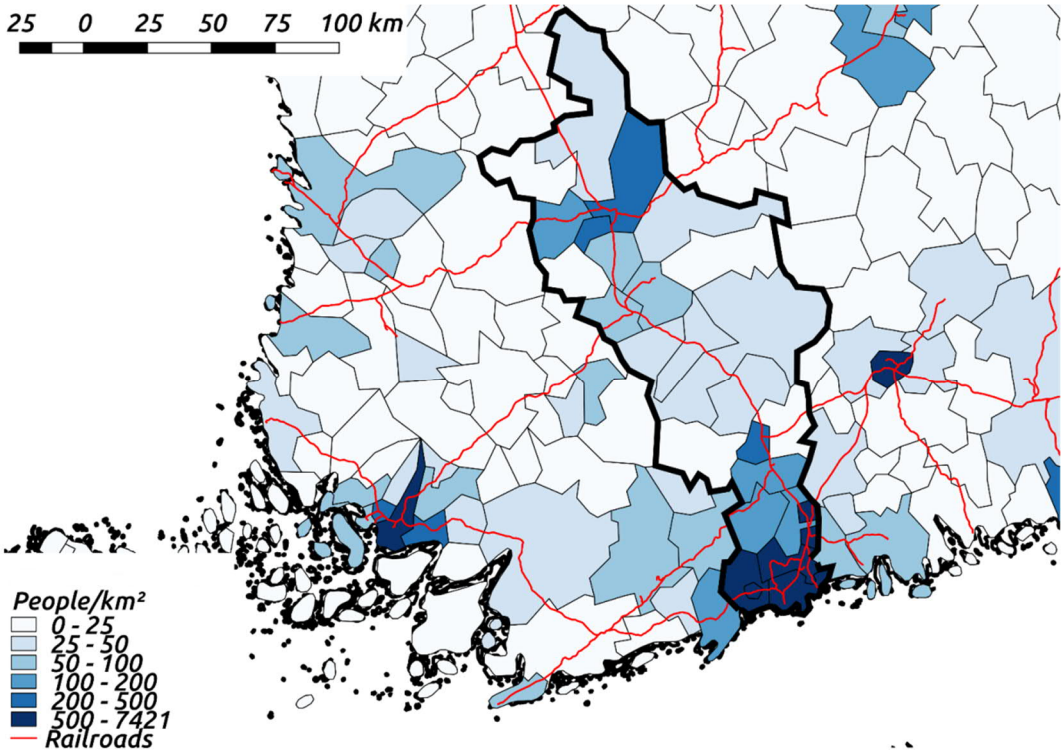

Figure 5 The population density and railroad lines in the main geographical area of Growth Corridor Finland.

The Transport Policy Report in Finland (approved in April 2012), promotes the creation of a transport system centered on the level of organizing the needed mobility services. In this approach, a public sector client defines the level of service required, and service providers are given greater freedom to meet these requirements through the technological means of their choosing. In the future, all levels of the transport administration in Finland will reflect this change in thinking.

[60] Growth Corridor Finland. (2015). Growth Corridor vision 2020. Available at: http://suomenkasvukaytava.fi/briefly-in-english/

6.3 Switzerland: Basel region

Basel area is one of the five largest urban areas in Switzerland. What makes this region unique is the fact that the larger metropolitan area of Basel spans to three different countries: Switzerland, France, and Germany. The metropolitan area has approximately 830,000 inhabitants, with 60% in Switzerland, 30% in Germany and 10% in France. It is estimated that around 100 000 commuters come from surrounding areas to work in Basel city and of those commuters, 36 000 are cross-border commuters[61].

Basel region is considered to be a testament of the ability of the multinational actors to overcome the inherent complexity of cross-border cooperation, which in the case of Basel includes three countries and four Swiss cantons, with significant legal and regulatory differences, and even an EU border[62]. One part of the success is a good cooperation on a higher political level, but also concrete activities in developing joint public services for the whole area. One example of these activities is a trinational cross-border public transport running since 1997.

One of the collaboration networks in Basel-travel-to-work area is TEB or the Trinational Eurodistrict Basel, which is an organization consisting of municipalities and cities in the metropolitan area of Basel (Figure 7). TEB carries out common spatial and transportation system planning and it is currently responsible for the development of different new sustainable mobility concepts in the region. One of the tools used in the planning of transportation system for Basel metropolitan area is Pendlerfonds. The money for this fund comes from the gross income from commuter and visitor parking tickets of the Basel city. The aim of the fund is to promote projects that help to reduce the parking pressure on the city center and facilitate public transport by, for example, constructing park-and-ride and bike-and-ride facilities in the neighborhood (Figure 8).

[61] Statistical Office of the Canton of Basel-Stadt (2017): http://www.statistik.bs.ch/zahlen/tabellen/11-verkehr-mobilitaet/pendler.html, table T11.5.01
[62] Sohn C., Reitel B., & Walther O., 2009.

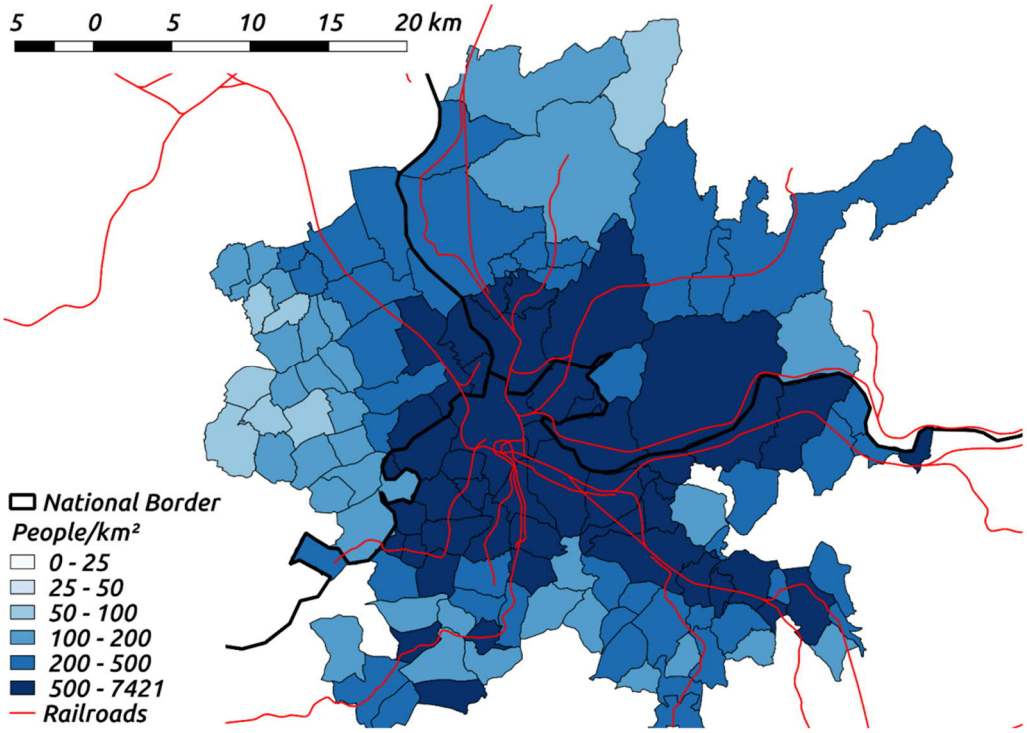

Figure 7 The population density and railroad lines in Basel and surrounding areas.

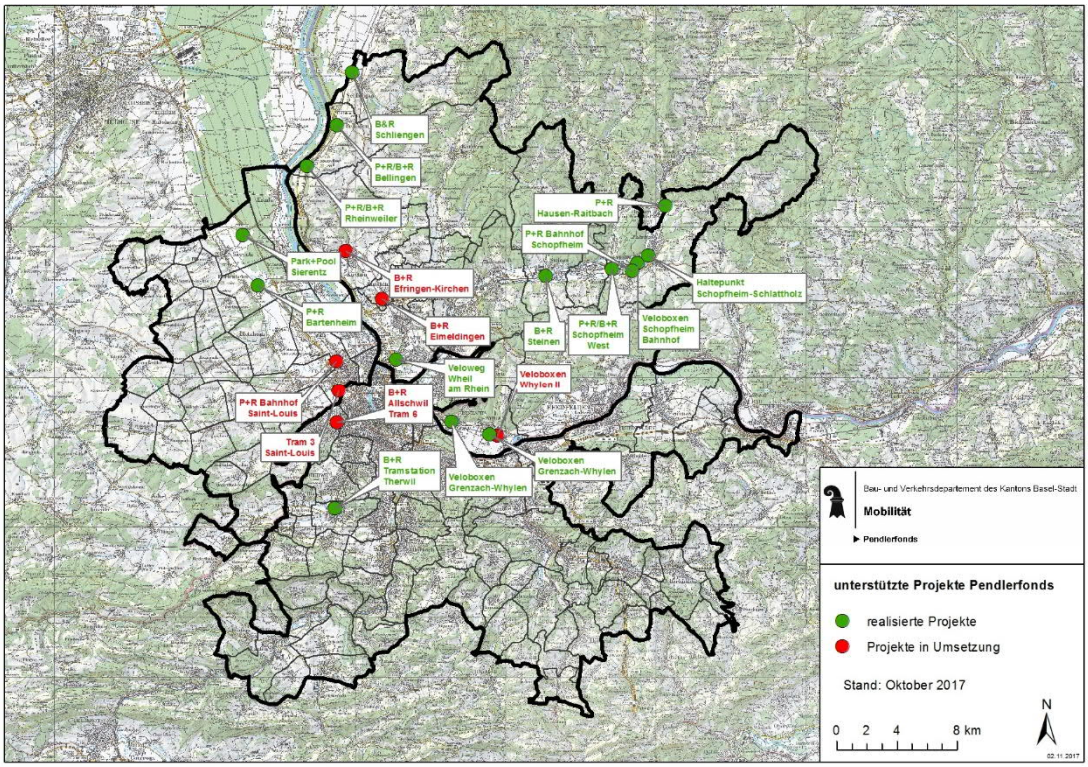

Figure 8 Pendlerfonds supported projects. Picture copyright: the Department of Mobility in the Canton Basel-Stadt, used with permission.

7 Results

There are numerous relevant institutional aspects, which we can a priori highlight regardless of the region in question. First, rules and regulations are bound to specific governmental entities. Introducing transportation offering in a metropolitan area with a strong governmental entity covering that area is very different from doing that in a metropolitan area where that governmental layer is with limited powers. Multi-level governance problems stem from the way in which jurisdictions are institutionalized. For example, there may be differences in how the data extraction from induction loops, cameras, and other sensors and the external use of that data is regulated. Similarly, the operational and strategic management of the transport network capacity as a whole varies from region to region.

Second, public transport services, bus, rail, taxi, are generally heavily regulated in Europe. The regulatory framework sets the scene for the relation between the transportation provider and the transportation authorities in the region. A key institutional factor is how public mobility services are regulated, more specifically, how the role of government is set up in defining the services. For example, instead of market-based transportation, a country, regional or metropolitan government might define the service level, regulate prices and the quality of traveler information. If in addition services are tendered out in longer concessions, requirements of more sustainable and intelligent transportation might be more difficult to take into account. Ensuring the sustainability of services might be a challenge of the near future when looking at the current development and landscape of global transportation stakeholders: **Uber, Ofo, oBike**, etc. pursue other objectives than offering mobility to every individual.

Third, data ownership, availability, and privacy are aspects that are generally institutionalized in national or EU legal systems. Legislation on these issues dictates the way in which the data flows through the transportation ecosystem. For example, for those data streams that are developed with public money, national governments can demand that data to be open for everyone. Legal systems can also allocate tasks or roles to stakeholders. As far as they are not, roles may also be defined in transactions - i.e., contracts - among solely private actors.

Yet another example is the sustainability of transportation, where European Commission has a long history of supporting research, technological development, and demonstration for alternative fuels and propulsion systems (including biofuels, electromobility, and hydrogen) through its Research Framework Programs and by setting sustainability targets for its member states. On 24 January 2013, the European Commission launched a clean fuel strategy for Europe, with the main aim of ensuring common standards in the EU member states and overcome barriers to the use of clean vehicles and alternative fuels. The “Directive on the deployment of alternative fuels infrastructure” aims at ensuring the build-up of alternative fuel infrastructure and the implementation of common technical specifications for this infrastructure in the European Union. Its objective is to facilitate the work of market participants and contribute with this initiative to economic growth in Europe.

However, the situation for electric charging points varies greatly across the EU. The leading countries are Germany, France, the Netherlands, Spain and the UK. Under the directive, a minimum number of recharging points will be required to be established each Member State by 2020, 10% of which should be publicly accessible. This required number is based on the number of electric vehicles planned to be in operation in each of the Member States by that year. The aim is to put in place a critical mass of charging points so that car companies will mass produce the needed vehicles at reasonable prices and thus help to reach the goal in each country. A common EU wide plug is also an essential element for the rollout of electric vehicles. The EC proposes to have common standards

for electric charging points across Europe to ensure that electric cars can be sold and driven easily across the EU. To end uncertainty in the market, the Commission has announced the use of the "Type 2" plug as the common standard for the whole of Europe.

7.1 Examples of the resulted mobility services in Austria

7.1.1 MaaS Service: information, booking, ticketing

The pilot project SMILE was carried out in Vienna in 2014-2015, providing an integrated mobility platform with a personal mobility assistant allowing end-users to get real-time information for their multimodal travel chain, book all transport modes needed and receive the necessary tickets and access codes.

As the Austrian Federal Railways was one of the partners in the SMILE consortium, the project aimed to provide a nationwide mobility solution allowing end-users to travel seamlessly across the country. Routing information, including real-time data for all public transport services in Austria and a complete road information system, to this initiative, was provided by “Verkehrsauskunft Österreich” (Austrian traffic information). SMILE was funded by the Austrian Climate fund, making the Ministry of Transport a major stakeholder – a setting which allows discussing necessary regulatory issues and which may help to disseminate multimodal solutions through a standardized, open interface. Vienna has recently decided to not only provide timetable information but also real-time data for all public transport as open data. And although SMILE hasn’t been rolled out as nationwide solution, based on its results BeamBeta has been initiated in Vienna as a laboratory project by the **Wiener Stadtwerke** and its subsidiary **Neue Urbane Mobilität Wien GmbH** and is now operational as WienMobil app[63], developed by **Upstream – next level mobility** and provided by the Viennese public transport operator Wiener Linien. A parallel development was done by **iMobility** (a subsidiary of the **Austrian Federal Railways** and **Speedinvest**) with its service https://wegfinder.at/.

7.1.2 MaaS in urban areas: multimodal mobility

MaaS is not only about providing digital services but also mobility that usually takes place in urban fabric. In Austria, some development projects aim at providing services in public space or in residential buildings in the form of “mobility-points”, where different modes of transport are combined. These mobility points usually link public transport with car-sharing, bike-sharing and other local last-mile solutions through a mobile app. The main objective of these different solutions is to offer alternative mobility solutions to private car (the following list is not exhaustive):

- Smarter together / mobility points: http://smarter-together.eu/cities/vienna/
- TIM Graz: https://www.tim-graz.at/
- MO.Point: http://www.mopoint.at/
- Bike-sharing:
  - Citybike: https://www.citybikewien.at/en/, http://www.citybikesalzburg.at/
  - Ofo: http://www.ofo.so/
  - oBike: https://www.o.bike/
- Scooter-sharing:
  - Scooter Sharing in Vienna: https://sco2t.com/
  - Vespa Sharing: https://www.mo2drive.com/
  - Go-Urban: https://gourban.at/en/
- Car-sharing:
  - car2go: https://www.car2go.com/AT/en/wien/
  - DriveNow: https://www.drive-now.com/at/en/vienna

[63] https://www.wienerlinien.at/eportal3/ep/channelView.do/pageTypeId/66533/channelId/-3600061

- Numerous local/regional initiatives

7.1.3 MaaS in rural areas: first/last mile

In the pilot project eMORAIL, commuters used electric cars for the first and last mile from and to the railway station while the e-cars were used by local companies during the day for their business. There are many local and regional initiatives all over Austria, of which some can be found online (at http://bedarfsverkehr.at/). The following list includes some of these last mile solutions:

- ISTmobil: http://www.istmobil.at/
- eMORAIL / LeibnitzMOBIL: http://www.leibnitz.at/buergerservice/leibnitzmobil/
- eMORAIL / Rail & Drive: http://railanddrive.at/
- Bike-sharing: Nextbike
- Car-sharing: Caruso, Ibiola/24/7.

7.2 Examples of the resulted mobility services in Finland

This section describes the current situation in Finland related to smart commuting. Special attention is given on the new concepts and services, and especially to MaaS and innovative last mile solutions. While most of these companies and their services are still new, they might already have an impact on the private car ownership: the number of new car registrations has declined in Uusimaa (the county around the Helsinki capital region) by 2.5 % from the previous year in the first half of 2017 despite the good economic situation. The information manager of Finnish Transport Safety Agency, Juha Kenraali, has stated that new phenomena in traffic, e.g. shared cars and other new alternative ways of mobility, may be a reason for that[64].

7.2.1 MaaS Services

MaaS, short for Mobility as a Service, combines different transport providers and modes of transport into a single mobile service. It usually combines public transport, car share, bike share and other last -mile concepts under one service in a mobile app. It is considered to be a viable and hassle-free alternative to owning a car. In addition, other types of services , e.g, transportation of goods, related to personal mobility can be combined with the concept. These services are of value for individuals, families and corporations of different sizes. The ideas related to MaaS have been presented for a long time, but the term 'MaaS' dates back to 2006 and Mr. Sampo Hietanen, the current CEO of **MaaS Global**. However, it took until 2016 before two different Finnish MaaS companies, **Tuup Ltd.** and MaaS Global, first launched their services in Finland.

While MaaS companies have launched their services in several places in Finland, they have not yet been able to extend their service into an inter-regional solution. This is because the national railway company or the long-route bus companies have not yet opened their APIs for other service providers. Both of the companies mentioned above have launched their services also outside Finland.

Tuup (Kyyti Ride)[65]

Tuup is one of the largest Finnish MaaS players. It operates currently in the regions of Oulu, Turku, Tampere and in the Capital area. The service is currently expanding both in Finland and internationally. The value proposition of the service is targeted to end users, cities, and companies. The current version integrates route planner, travel plan optimizer, and payment. The customer can choose from different modal alternatives. The service also includes reminders of forth-coming trips

[64] http://www.tuulilasi.fi/uutiset/henkiloautojen-ensirekisteroinnit-laskussa-trafin-tietojohtaja-pohtii-vaikuttavatko
[65] http://www.kyyti.com/

and real-time information about the current traffic situation. Users may also set their own preferences for mobility options to the application.

While Tuup is a MaaS operator, it also develops mobility services that are part of typical MaaS offering. One example of these is **Kyyti**, a shared on-demand taxi service (see more on next page). Tuup has also developed several company-specific solutions that combine current public transport services with flexible last-mile solutions. Also, the company has been involved in autonomous on-demand bus service development.

MaaS Global (Whim)[66]

MaaS Global has branded its product **Whim**. In Finland, their offering covers local public transport, taxi services and different mobility services through their partners, such as Sixt car rental. Typically, the service is offered as a monthly package that includes unlimited public transport and some amount of these additional services depending on the level of the package. Customer may easily upgrade the package. The app can also synchronize with user's calendar and learn about user preferences, and this way suggest customer most likely suitable connections.

The amount of possible additional services in the package depends on the points included in the package. Currently, there is no possibility to earn points by any method (or none of the service providers in the service yet utilizes this functionality). However, this point system allows different gamification opportunities in the future.

Whim also operates in Birmingham (UK) and Amsterdam (The Netherlands), Antwerpen (Belgium), and Vienna (Austria) are very likely to follow in 2018. Many other cities (e.g., Singapore, Chicago, Toronto and Seattle) have also expressed their interest, and some pilots or even large-scale implementations are expected to start in these cities in 2018.

7.2.2 Other MaaS related service pilots.

There have been different MaaS experiments in Finland that have been limited by the number of pilot customers, geographical area and/or time. In the following, the most significant and promising ones (expected to continue later on) are described briefly.

Fölix[67]

Fölix is a last-mile solution that combines shared taxis to the local public transport in the city of Raisio. Each Fölix taxi ride starts or ends in transportation hub where the buses from nearby focal city Turku (and other local buses) stop. The service operates between Mo–Fri 16-22 and Sat-Sun 8–20, which are the times, when there is not sufficient public transport service to people in the city of Raisio.

Each trip costs 5 € in one direction. The customers must book a ride at least one hour before the trip so that the taxis have enough time to combine different passengers into a shared vehicle. Because taxis (and customers) know when the buses leave and arrive at the transportation hub, the trips are scheduled to support these connections.

Originally, the pilot was supposed to end at the end of 2016. However, the service is still operational. The use of the service has not been as wide as expected. However, those customers using the service have been very pleased with it, and from the city's viewpoint, there is no need now to run nearly empty public transport buses in Raisio outside the rush hours. Therefore, also other cities and

[66] http://maas.global/
[67] http://www.folix.fi/

municipals in the region have expressed their interest to extend the service to their geographical area.

Kätevä[68]

Kätevä Seinäjoki was a new mobility concept targeted to the citizens of Seinäjoki. The purpose was to investigate how to improve the quality of local transport services. The demonstration was active between 14.11.2016 - 30.4.2017 with 20 people in the pilot. Organizing participants in the demonstration were the City of Seinäjoki, its local transport authority, public transport services and taxi companies and **Sito**, a Finnish consulting company.

Kätevä offered three different monthly packages that included unlimited use of the local public transport in combination with different amounts of on-demand shared minibus rides and taxi services. The prices of the packages were 29 €, 39 €, and 49 €. The most common of the packages was Sopiva, priced at 39 €/month. On top of the mobile routing application and unlimited public transport, it offered unlimited use of on-demand minibus transportation for a fixed price of 4 € per ride and also 20 shared taxi rides for a fixed price of 7 € per ride. The most expensive package, Menevä, offered on top of the previous package also 8 normal taxi rides for a fixed price of 10 €/ride.

The pilot demonstrated that the concept and the application work fine. However, the sample size was very small (20) and it is not yet known whether this pilot will continue or not. Currently Kätevä's project group is analyzing the results and will publish the results and their future plans later. However, lessons learnt will be used in other forthcoming MaaS pilots by Sito.

Kyyti smart shared taxi

Kyyti is a Finnish taxi-pooling service that was launched in March 2017. It operates currently in three large cities in Finland, but the aim of the company is to cover all the large and medium-sized Finnish cities by the end of 2018. The service will also expand to foreign markets soon with test pilots already on-going.

Kyyti service is offered by a private start-up company Tuup. The service is dynamically priced, but the customer knows in advance the price of the trip. The service is operated with different size taxis and professional drivers. Unlike many other similar services, Kyyti is not subsidized by the cities.

Shared Kyyti rides have a minimum cost of 2 euros. The price of the ride depends on the distance, how many other passengers share the ride and also how flexible the customer can be with the start and end time of the ride. The service has currently three different levels: Express, Flex and Smart. The first one is the most taxi-like service, while Flex and Smart are more cost-effective with slightly longer waiting and driving times. On the other hand, they are also more eco-friendly as more rides can be done with fewer vehicles and lower emissions.

Kutsuplus

Kutsuplus was a shared taxi system owned and operated by the regional transport authority, aimed at complementing public transport in the center area of the capital region. The pilot started in 2012 and closed at the end of 2015 due to cost reasons.

Kutsuplus was offered to customers with varying prices. In the end, a typical price for short trips was around 7 € – significantly less than with a taxi. However, even at the end of the pilot period, the actual operating cost for a single Kutsuplus ride was nearly 40 euros. In comparison, most expensive bus rides for certain lines in the same region cost around 11,60 euros per customer. The pricing and

[68] http://katevaseinajoki.fi/

capacity of the service were not dynamic nor optimal. The whole pilot was too much technology oriented even though there were significant potential to become a viable complementary service for mass public transport.

From the viewpoint of research, technology, and development, the pilot was a success. During the project, mobile apps, back-end solutions, route optimization for ride sharing and many other technologies were demonstrated to work. However, being a pilot of the regional transport authority, Kutsuplus never had a good business plan, nor the concept was never developed further to truly test its potential. For example, these dedicated Kutsuplus vehicles were used in the city of Helsinki while it would have been more efficient to use these smaller (and less diesel consuming) vehicles in the outskirts of the operational region to replace nearly empty full-sized buses there. In addition, the service could have been promoted more. It has also been questioned why there had to be a fixed number of own mini-vans always in operation, instead of also making contracts with certain taxi companies to make the capacity more dynamic. This would have reduced capital and costs. Also, according to the simulations, if there had been more vehicles in operation, it would have been possible to combine different people into same vehicles. With only nine Kutsuplus vehicles, this hardly ever happened.

7.2.3 Car sharing

Ordinary car sharing

There are several car sharing companies active in the capital region. Examples of such companies are **EkoRent**[69] and **City Car Club**[70]. They both offer service packages with different features for customers according to their mobility needs. City Car Club has several different types of vehicles from small city cars to plug-in hybrid family cars and diesel minivans in their service while EkoRent provides customers electric cars. Depending on the type of the monthly package and car type, typical price for one-hour rental starts from 10 euros.

The car sharing companies usually require users to return cars to the same place where they have been taken. Also, the number of these car sharing stations is still limited. None of the companies have operations outside of the capital area yet. However, some conventional car rental companies have started to rent some of their cars for shorter time periods for a reasonable price in other cities. Therefore, the situation in Finland is improving.

Floating pay-per-minute car sharing services

There are two different pay-per-minute services in the capital area: **Gonow!**[71] and **DriveNow**[72]. They both use mobile application where customers can find and make reservations to the car and also control the car doors. Both services are targeted for short one-way trips in the city. Both services are all-inclusive, including price of the fuel, parking fees, maintenance and insurances. The operational area of both these services covers approximately 30 square kilometers in the city center.

The customers only need to pay for the time they use the car for driving. As of autumn 2017, Gonow has a price of 47 c/min for driving and 10 c/min for short parking. Gonow! is part of the Finnish **24Rent**[73] car rental service.

[69] www.ekorent.fi
[70] http://citycarclub.fi/
[71] https://www.gonow.fi/en/
[72] https://www.drive-now.com/fi/fi/helsinki/
[73] https://www.24rent.fi/

DriveNow is an international service provider that operates in several countries. In Finland, DriveNow offers 150 different BMW and Mini vehicles for the customers, including also electric cars (BMW i3). The regular DriveNow price for customers is 57 c/min, but the service has also dynamic pricing model, and if the car has not moved recently, its price will reduce to 40c/min. It is also possible to rent a car for one hour (around 25 €), three hours (59 € including 150 km) or six hours (99 € including 200 km). Drivenow service is part of OP Kulku services provided together by **BMW** and **Sixt** car rental.

Peer-to-peer car sharing

Shareit Bloxcar[74] is a company that enables people to share their cars to other users. As a result, there are lots of different kinds of vehicles (e.g. cars, pickups, vans, motorbikes, motor homes) available for different transportation needs. The prices usually start from 5 €/h including 20 km of driving for older cars. The advantages of the service are scalability and that there are cars outside the capital area. Peer-to-peer car sharing is not yet very common in Finland, but it is continuously increasing popularity[75] and is part of the larger sharing economy trend.

Anyone can join and register to the service and start using these cars for a pre-defined price according to the time and kilometers driven. It is also easy to put own car to be part of the service. All the cars are insured by a new specific product developed by **IF** (insurance company) for peer-to-peer car sharing. The cars need to be in good shape and officially inspected according to the Finnish law. The service platform creates the needed trust and reliability, with both the owners and users giving reviews about their experience and the service immediately after the usage.

Shared cars for housing companies

There have been several pilots on car sharing in housing companies. The most common concept is such that the housing company makes a deal with some car rental/sharing company who provides the cars. One example of such collaboration is 24Rent car rental company offering shared cars for residents of rented apartments made by **VVO** construction company. Also, abovementioned car sharing company EkoRent has made several contracts with housing companies in large cities. Such concepts are beneficial also for the housing companies. On average, car sharing reduces the need to buy and use private cars, thus reducing the need for the parking lots at least by 30 – 40 %.

Shared company cars

Another pilot of OP Kulku is a model in which shared electric cars are available for all the city's employees in the city of Imatra. This model enables the city to use the cars more efficiently and provide its employees with a new emission-free opportunity to move around. The City of Imatra has acquired four electric cars for this purpose, and OP Kulku provides the service, including a car sharing application and the charging technology. The pilot started in autumn 2017, and the purpose is that the service continues and expands after the pilot stage.

The cars are primarily intended for work-related driving by the City employees. Employees can also rent the cars out for private use via a mobile application whenever the cars are not in use. In the future, the City of Imatra plans to offer these shared cars to its citizens and tourists as well. The price for using the car is 8 €/hour. The pilot between **OP** (a Finnish financial services company) and the City of Imatra is the first experiment of its kind, enabling the principal holder of electric cars to rent them onwards to selected target groups, via an easy-to-use application[76].

[74] https://www.shareitbloxcar.fi/
[75] http://m.iltalehti.fi/autouutiset/201707252200285195_oa.shtml
[76] https://www.op.fi/op/op-financial-group/op-financial-group/pohjola-in-brief?cid=161898535&srcpl=4

One reason why this concept is not yet more widespread is related to the Finnish car taxation. If the company car is also used outside the work-related duties, the company has to pay a higher car tax. However, the Finnish car taxation is currently based on car emissions. Therefore, if some company or city uses this car sharing scheme, it will probably choose electric vehicles, similarly to the pilot in the City of Imatra. Also, to promote electric mobility in Finland, it has been suggested that electric cars that are registered as company cars or car sharing cars, should be free from the car tax and be eligible for value-added tax deduction.

7.2.4 Car rental and importer companies

Car rental companies have also been active in the field. They have developed themselves or together with new MaaS companies new solutions to the mobility. Some of these solutions are international concepts that already exist elsewhere and some are specifically tailored to Finnish markets.

VaaS – Veho as s Service

Vaas is a name of **Veho's** (a Finnish company importing and selling cars) new mobility services. They have three packages for their customers to choose from depending on how often the customer expects to use the car: Ready, Flex and Flow. The first package is targeted to those customers who use a car only a few days in a month (for example, a small car for one weekend). Flex is tailored for those customers needing a car for about 7 days a month, and Flow is meant for those customers needing a car continuously. The prices range from 78 euros/month for Ready to 599 euros/month for Flow. These same packages are also offered to companies, but there is also a special package for companies who mostly need a van but also a small car occasionally. The VaaS service is provided together with the international car rental company **Sixt**, which allows customers to use any of the Sixt car rental shops for their needs..

Seasonal car rent

OP (a Finnish financial services company) launched together with **Europcar** a new service called Kausiauto (seasonal car) for customers who need a car only for a month or two. For these customers, it may be more reasonable to rent a car for a specified time period instead of buying one as the customer doesn't have to worry about any costs related to owning and maintaining a car. Kausiauto service offers different kinds of vehicles for customers. The whole service is web-based, and the vehicles are delivered to the customer's home door or working place usually within 24 hours. The cars offered in this service are mostly quite new, and the pricing starts from 570 €/month.

Shared cars for companies

There are many companies offering car sharing solutions to companies. Among these are **ALD automotive** and **Arval**. Their services are similar to the solutions they offer to private customers, but for company customers, there are also additional digital services related to car bookings, reporting and driver/driving management. Both solutions of these companies are based on - and used - with sophisticated mobile applications and keyless car door control. The pricing starts from below 15 €/day for a small car and 25 €/day for an electric car. Currently, the cars in these sharing services are used only for work-related trips.

7.2.5 Company- and stakeholder-specific pilots and solutions

There are also different company-specific solutions being developed currently in Finland in the field of MaaS and smart sustainable mobility. Mostly these solutions are related to cases where certain groups of employees need to go regularly to the same place, and there is currently no feasible public transport alternative available for them. Typically, the new MaaS related concepts developed for these purposes combine some last-mile solution to the existing public transportation offering. The purpose is to develop the concept together with the customer in a way that benefits customer but at

the same gives service provider experience on how to develop their offering for other companies and stakeholders.

One example of a successfully tailored solution is a passenger collection service for employees of **Valmet Automotive**. The car assembly line of Valmet Automotive is located in the small economic region of Uusikaupunki, and the company requires skilled workforce from a further distance. To improve the mobility of the workforce, the Centre for Economic Development, Transport and the Environment (**ELY Centre**) in the region procured a service that collects employees from the larger economic region of Turku by combining public transport and on-demand services to certain predefined transportation hubs in Turku. Then a bus from these transportation hubs brings employees to Uusikaupunki in a timely manner.

7.2.6 Promoting bicycle use

City bikes

City bikes have become very popular in many European cities. The city bikes in Helsinki region started to operate in the summer of 2016 with 500 bicycles and the feedback was positive. Therefore, for the summer of 2017, the number of bicycles was increased to 1400 units with 140 stations in Helsinki and 100 bicycles in Espoo with 10 stations. The system is provided by a French company **Moventa Smoove**.

The use of the city bike in Helsinki region costs 5 €/day, 1 €/week, or 25 €/season. With this pricing the service is targeted mainly to the local citizens – not for tourists. There were 33 000 registered users for the season of 2017[77]. The number of individual rides from May to early August was more than a million, with the average number of rides per bicycle being 9.7 during a day[78]. These numbers are much higher than expected in the beginning of the service (the estimation was 3.5 rides a day with 20 000 registered users)[79]. Also, none of the bikes disappeared in 2016, which is a significant change in comparison with the earlier two experiences in the region. The costs of the system are covered with customer payments, sponsor payments (advertisement stickers on the bikes) and the subsidies (around 50 %) of the local transport agency HSL. Currently, other cities in Finland have set their targets to launch a city bike system as part of their public transport: Espoo (700), Turku (300) and Tampere (400) with differing operating models. The HSL city bike model is based on fixed docking stations, but other cities are also considering free-floating systems.

Electric bicycle test drive possibilities

Recently, the city of Hämeenlinna had a pilot on using electric bikes. It provided citizens opportunity to test an electric bicycle for commuting and other daily trips. The purpose was to promote bicycle use as well as to ask cyclists opinions on how to improve cycling opportunities in Hämeenlinna. Similar activities have also been done in the nearby city of Riihimäki in cooperation with Hämeenlinna School of Applied Sciences.

Joensuu bicycle road[80]

In August 2017, the first official bicycle road in Finland was opened in the city of Joensuu. It is a three-block-long road for cyclists in the middle of the city center, where the rules and the pace of traffic is set to favor cycling. The pavement in the middle of the road is red and meant for the cyclists,

[77] http://www.tekniikkatalous.fi/talous_uutiset/liikenne/kaupunkipyorilla-sompailu-rikkoo-ennatyksia-viikottain-kansainvalisesti-huimaava-luku-6669187
[78] http://www.tekniikkatalous.fi/talous_uutiset/liikenne/kaupunkipyorilla-sompailu-rikkoo-ennatyksia-viikottain-kansainvalisesti-huimaava-luku-6669187
[79] Helsingin kaupunkipyöräjärjestelmä – päivitetty hankesuunnitelma 27.3.2014.
[80] http://www.joensuu.fi/pyorakatu

and the sides of the bicycle road are meant mainly for the pedestrians. Joensuu has the highest rate (47%) of all trips made by bicycles and pedestrians in Finland, and the city wants to further improve the infrastructure for light traffic. The bicycle road is a natural extension to the existing network of 225 kilometers of bicycle lanes in the city.

Although the name is bicycle road, also motorized vehicles are allowed to drive on the bicycle lane, but it is strictly forbidden to bypass a bicycle in this road. In addition, cars need to give way to all other traffic. There is no previous experience of bicycle roads in Finland, and there is no legislation supporting the use of these roads yet. However, these solutions are common in many other European countries (e.g., in Netherlands and Denmark where cycling is very popular), and therefore there is sufficiently experience of these solutions for developing Finnish city planning and related road traffic legislation.

The bicycle roads are a good solution to expand existing light traffic infrastructure when there is no room to construct dedicated bicycle lanes in the cities. In addition, usually it is not possible to close the roads as certain real estates would not be accessible, and thus bicycle roads fit into these situations perfectly.

Baana & other activities to support cycling[81].

Baana network is a concept to construct and maintain high-quality cycle lanes in the capital area. The goal of the city is to make cycling more attractive option for longer commutes and trips to school by providing high-quality cycle paths. On this network, special attention is given to the lightning, cycle lane surface quality, smoothness of ride by removing all the unnecessary kerbs and highest possible winter maintenance. Also, bridges and underpasses are used, and the lanes are made so that faster cyclists can pass slower ones safely.

Baana cycling routes enable smooth transport around the city, also during the morning and afternoon rush hours. The routes connect the largest residential areas of the capital region with the city center and other employment concentration areas with fast and direct cycle paths. The total length of the planned network is 130 kilometers. The Baana network comprises totally new sections as well as current cycle paths, which will be improved.

Parallel to this network, also other types of bicycle lanes are constructed and improved. Special attention is given to access to metro stations and train stations. The bicycle parking will also be improved in these transportation hubs: most of the new parking lots allow locking the bike by its frame. They also provide some shelter or at least a cover for the bikes. Supporting cycling instead of park-and-ride facilities is a rational choice for the city: ten bicycles take the same space as a single parking lot for a car. Solutions and activities similar to Baana are under construction on a smaller scale in other Finnish cities.

Helsingin pyöräkeskus (Bike maintenance Centre)

Regarding cycling, Helsinki has also established a new service, The Bike Centre, located in the city center of Helsinki and at one of the busiest underground stations. The Bike Centre provides free practical advice for maintaining a bike and the opportunity for independent bike maintenance, with a mechanic on hand to provide advice and guidance for free. However, it is also possible to leave a bike to be maintained by professionals (paid service). The Bike Centre is operated by Helsinki City Transport company HKL and is operational from the beginning of May to the end of October each year.

[81] https://www.hel.fi/helsinki/fi/kartat-ja-liikenne/pyoraily-ja-kavely/pyorareitit/

Kick scooter: Samocat[82]

Another last-mile solution suitable for urban areas is a kick scooter. A Russian startup Samocat offers a sharing system for high-quality, light, and foldable kick scooters. The service is used with a smartphone app. The idea is that after the trip to the nearest public transport hub (first-mile) the user can take a scooter inside the public transport vehicle and then continue the trip with the scooter in the destination (last-mile).

Compared to city bikes, the advantage of the system is that the stations require very little space. In additions, the stations and vehicles cost only a fraction of a typical city-bike system. The advantage of kick scooters is that they are legally compared to pedestrians, so it is legal to use them on pavements. Later on, it may be possible that some of the scooters in the system are powered by electric motor.

7.2.7 Services for the last mile of goods

Another approach for solving the last mile problem is the use new mobility services that bring goods and groceries home. This is a part of a larger trend, where first, people bought known goods from local domestic shops with home delivery and some electrical devices by mail order. Gradually, people got used to buying a larger variety of goods also from companies previously unknown to them. Internet has provided people easy access to different webstores and a way to find information about all products, marketplaces and sellers, including their reputation, quality and reliability. This has significantly increased the e-shopping and different logistics services.

Now there are several services also for delivering daily groceries and meals with internet/mobile interface for ordering, choosing a grocery pick-up or a delivery. Some of these solutions are additional services of traditional chain stores, others have specialized their operations and logistics to act solely as e-groceries (e.g., kauppahalli24h). In the USA, Wal-Mart is already running a pilot where cold products are put to the customer's freezer and fridge at home, and therefore the customer does not even need to be at home during the delivery.

Another typical category is a ready-meal delivery service. Some companies deliver food from different partnering restaurants to the customer (e.g., Wolt, Pizza-online, Delivery Hero (Foodora), others make the meals themselves and take care of the delivery. These latter services work like traditional "pizza taxis" but offer usually higher quality food, including both lunches and dinners (e.g. epic.fi). One important customer group are elderly people who cannot do the shopping themselves anymore and some of these services provide both hot meals and some groceries to these customers.

The contemporary postal service companies have less physical post offices. Instead, they use automated self-service "smartpost" box offices where customers can themselves send and receive the parcels. These smartpost boxes consume very little floor space, and thus they can be placed anywhere indoors. As a result, post companies place these smartposts to shopping centers and such transportation hubs that are easily available to people.

New concepts include "ride-sharing" services for goods. One example of such company is Finnish **Piggy Baggy**[83]. The idea is that anyone can request a delivery for a parcel and set the conditions. Then, anyone who is registered as a transporter can accept the terms and deliver the parcel. These services are applicable for both people-to-people and company-to-people purposes. The service have been used also for voluntary work and with public services. For example, people can voluntarily carry public library books to elderly people.

[82] http://www.samocat.net/
[83] http://piggybaggy.com/

All these trends and changes also have an impact on how people commute. Very common reason to use a private car in commute used to be the need to combine grocery shopping with trip to home. However, if groceries and goods are delivered to home, shift to the public transport would be easier for many private car users.

7.3 Examples of the resulted mobility solutions in Switzerland

Switzerland is not only specific as the only confederation in Europe, but it also has a unique history in arranging public transport and railway connections. Despite the mainly mountain terrain, the connections between different parts of the country are of high quality. This is due extensive use of railways and other collective public transportation.

7.3.1 Swiss Federal Railways

Switzerland has an extensive railway network compared to its size, and its railway network density is the highest in the world. There are 5323 km of ordinary rails in the country and a few hundred kilometers of narrow width rails. This infrastructure is used extensively as there are fast trains between the major cities every half an hour. Therefore, also the number of kilometers traveled per inhabitant in a year – around 2500 km – is highest in the world.

Swiss rail network functions as the core of the public transport system: other public transport connections and their timetables are scheduled according to the trains. The railway has a so-called *clock face timetable* to make this easier. In 1982, the clock face timetables were introduced, meaning that certain trains leave every 60 minutes (or on some other fixed time interval). This makes remembering the timetables adjusting other connections to this schedule easy. In addition, different trains are scheduled to meet at the same time at stations so that there is no need to wait for a connecting train.

In 2004, Swiss railways finalized the task of reducing the travel times between the large cities. Especially, the travel times between the triangle Zurich-Bern-Basel were all reduced to under one hour. This has further helped to improve the clockface timetable system. This task required many stations to be changed and renovated. Also, the number of trains had to be increased by 12 %. Now, the primary target of Swiss railways is reducing connection times through the nodal system. At the same, Swiss railways has stated that their focus is on new digital services and to further improved passenger transportation and freight logistics. In passenger traffic, this means even better integration of other modes of transport to the clock face system. Basically, this means aligning the schedules of the other large operators and their offering, e.g. with PostBus, the biggest national bus company, with trains and cooperation with local regional transport authorities.

Total costs of Swiss railways were CHF 9 billion in 2016. Half of the money comes from the passenger payments and another half from the federal, canton and municipal subsidies. The share of commuters using rails is 30 %.

7.3.2 Postbus

PostBus is a subsidiary of the Swiss Post. It operates bus routes in the regional and rural areas of Switzerland. It has 869 different routes and 2193 buses. Some routes are operated in collaboration with local bus companies. Currently, PostBus carries more than 150 million passengers a year.

PostBus offers extensive services in public, public-private, and private transit, including:

- PostAuto: Bus lines (municipal, regional, long-distance, and vacation transportation)

- PubliCar: Dial-a-bus service for lightly traveled routes
- ScolaCar: Small buses for student transportation
- PostCar: Tourist travel (chartered)

The company is also actively developing or acquiring new types of services into its portfolio. This is part of the company's active digitalization and service development. In July, the company launched a new smartphone app that combines the offering of practically every public transport operator in Switzerland to the same service. Within the application, customers can purchase electronic tickets for almost all public Swiss transport networks, including also mountain railways and cable cars.

Later this year, the application will get even more features. It will become a country-wide full-featured multi-modal route planner. Customers will then receive a variety of suggestions for travel with different modes of transport for the desired route. In addition to public transport, these modes will also include taxi services, bicycle and walking routes, private transport and shared mobility services. In practice, once all the different service providers are included in the system, Switzerland will become the first country in the world to have a nation-wide MaaS available.

Postbus is also active in lowering their overall emissions. The company has launched an electric bus line, and it also operates its own fuel cell bus and the hydrogen filling station needed for the technology. Because there are many types of routes, the company tests actively new technologies and drive systems.

7.3.3 Local public transportation companies

While Swiss railways and Postbus take mostly covers the long-distance travel and rural areas, the cities in Switzerland have their own high-quality transport systems. Many of these local transport systems include a balanced mixture of buses, trams, underground and local trains. The local transport is also scheduled according to the nation-wide clock face train system.

7.3.4 Last mile solutions

Shared cars

Switzerland has a large car sharing company called **Mobility**. It offers 3000 cars in 1500 different transportation hubs in large and middle-sized cities in Switzerland. The company has more than 130 000 customers. The pricing is based on a vehicle class, travel time and actual kilometers driven. The customers can have reduced rates if they are also subscribers to partner transportation companies or other cooperation partners, e.g., universities. More than 40 percent of the Mobility cars are situated at railway stations of the Swiss Federal Railways. The aim is to offer the last-mile solution complementing the public transportation. While the basic operational mode is based on fixed stations, the company also has a service for one-way trips between certain large cities.

Mobility also offers two different business solutions. "Business Car Sharing" allows companies to make use of Mobility cars, either on a one-off basis or using vehicles exclusively reserved for the company's employees. "Mobility Pool Car Sharing" involves equipping existing corporate fleets with car sharing technology, thereby allowing the company customer to operate a car sharing system of their own.

Pay-per-minute car sharing

Mobility also has a pay-per-minute car sharing service Catch a Car in Basel and Geneve. The prices start at 0.41 CHF for a minute. There are no competing services in Switzerland as of autumn, 2017.

Peer-to-peer car sharing

Sharoo is a company that allows peer-to-peer car sharing. Everyone can offer their cars to the users of the service and rent a car according to the rules and prices defined by the car's owner. The service has a mobile app that is used to find and book a car and to unlock the car doors. This operationality requires that the cars are equipped with a company-specific technology. The service takes care of the payments between the user and the car owner. The prices for a decent car start from 7 CHF/hour, which includes 50 km of driving.

Uber and similar new concepts

Uber and some of its services were generally available in Geneva, Lausanne, Zurich, and Basel. However, on 16.6.2017, the Zurich cantonal government declared that Uber is operating there illegally, as legal drivers need to have a taxi license, the cars used in the service should have different kinds of insurances, and the vehicles should also have tachographs recording speed and how long the driver has been working. In Geneva, Uber service is compared to the public transportation in legislation. However, it does not fulfill the requirements set for public transportation, and therefore it is not legal there, either. Overall, the situation with Uber and similar services is unclear, but canton after canton, these services have been discontinued because of the legal issues.

PubliBike: city-bikes in different cities

PubliBike is a bike sharing scheme with bicycles and e-bikes that operate via self-service stations. Customers can hire a bike from one station and return it to a different station, 24 hours a day, 7 days a week. The annual cost of the service is 60 CHF for the whole country or 25 to 35 CHF for a single city region. Currently, the company operates in many cities, but the cities of Geneva and Zürich are not (yet) included. The slogan of the company describes its purpose best: Travelling by public transportation while making the last part of your journey with a traditional or electric bike.

Excellent cycling possibilities with bike-and-ride support

Switzerland has excellent facilities for bike-and-ride. There are lots of parking places for bicycles next to the stations or at the station. Some of these are under the railway stations, secure and guarded, and some of these facilities even include bicycle maintenance shops. The cities also have extensive bicycle roads and dedicated lanes for bicycles on the public roads.

7.3.5 Challenges in mobility service development and acceptance of new innovations

Switzerland's mobility market has traditionally been subject to intense public debates and discussions. Accessibility plays a crucial role in Switzerland's every-day live. This fact is also reflected by the above average mobility demand in Switzerland[84]. In addition, Switzerland has a tradition of extensive democratic participation, which often leads to lively public discussions about transportation topics. These discussions often reveal contradictory mindsets when regarding implementation of new mobility services. According to the World Intellectual Property Organization (WIPO), Switzerland is one of the most innovative countries in the world[85]. When it comes to the implementation of mobility innovations, however, this ranking cannot necessarily be confirmed. This issue is outlined with an example of the slow take-up of bike sharing systems in Switzerland next.

In the last years, several big cities around the world have successfully implemented bike sharing services, for instance, Paris and London[86]. In Switzerland, bike sharing is still a niche. **PubliBike**,

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[85] Fahy, J., 2016. Five reasons why Switzerland is top in innovation [WWW Document]. SWI Swissinfoch. URL https://www.swissinfo.ch/eng/business/global-ranking_five-reasons-why-switzerland-s-top-in-innovation/42375380 (accessed 11.1.17).

[86] Hickman, L., 2010. London and Paris: a tale of two bike-hire schemes. The Guardian.

Switzerland's biggest bike sharing provider launched its services in a few cities in Switzerland in 2011. PubliBike's original offer was technically complex and inflexible: The station-based system involved heavy bikes and the construction of the stations was expensive, which limited the number of stations available per city. The system relied heavily on subsidies, which lead some cities to cease operation of the service in their area[87]. The biggest city in Switzerland, Zurich, has never even got a bike sharing service. Since 2007, the city council of Zurich has been planning an extensive bike sharing system in Zurich. After a long period of planning and a complex tender procedure, PubliBike was awarded in 2015 a contract, which comprised the implementation and operation of 1'500 bikes and 100 stations in the city. Although the system was expected to be less complex than the previous one, it still remained station-based[88]. After a long legal dispute with unsuccessful parties in the procurement, the Zurich bike sharing system is finally expected to commence in 2018.

In the summer of 2017, an unexpected player from Hong Kong entered the Swiss bike sharing market: Without any announcement, the company **O-Bike** distributed 900 of their yellow free-floating bicycles in Zurich and created a public debate[89]. Thus, after years of difficult discussions and slow planning for an official bike sharing system in Zurich, a relatively unknown company achieved the planned objective within a few days. However, the bikes were not well received. Although some observers supported this new offer for Zurich[90], many citizens claimed that the bikes are cheaply made and that they occupy existing bicycle stands[91]. Even the media picked up the subject extensively, and other municipalities in the canton of Zurich banned O-Bike from their territory[92]. In the end, this new competition leads to an adaption of the planned official bike sharing service, as PubliBike is currently considering to deploy their bikes also within a flexible free-floating system[93].

This example shows a few of the challenges when implementing new mobility services in Switzerland. Mobility topics are subjects of intense public interest and discussion in the media. In addition, city and cantonal authorities want to have a say, how and when new services are implemented. Finally, based on the abovementioned example it can be said, that the Swiss mindsets are not always favorable to innovations. "Trial and error" does not seem to be very established operation mode in the Swiss culture, which sometimes leads to perfectionism or lack of courage[94], and hence the long planning time for the official bike sharing service in Zurich. Nevertheless, advocates for changes and innovations can be found, and they may become more numerous as more people realize that innovations and competition can lead to a better transport system and push existing players (like PubliBike) to question the attractiveness of their offers.

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[89] Schüepp, W., 2017. O-Bike setzt zum Grossangriff an. Tages-Anz.

[90] Zweifel, P., 2017. Ich mag O-Bikes. Tages-Anz.

[91] Eggli, M., 2017. Zürich nervt sich über neuen Veloverleih. Tages-Anz.

[92] Petrò, L., 2017. Erste Zürcher Stadt beschlagnahmt umstrittene O-Bikes. Tages-Anz.

[93] Bernet, C., 2017. oBikes fluten Zürich – jetzt setzt auch der städtische Veloverleih aufs freie Parkieren [WWW Document]. watson.ch. URL https://www.watson.ch/!220240735 (accessed 11.1.17).

[94] Merkel, K., 2017. «Schweizer Firmen müssen scheitern lernen» [WWW Document]. Handelszeitung.ch. URL http://www.handelszeitung.ch/blogs/digital-switzerland/schweizer-firmen-muessen-scheitern-lernen-1366543 (accessed 11.1.17)
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8 Conclusions

The countries are different by many aspects of sociotechnical analysis: geography, population density, government structure, history, policy and different stakeholders. Therefore, their development paths in mobility and commuting have also been different. However, new viable *technologies and ideas related to mobility and commuting spread quickly between different geographic areas*. There are lots of pilots and concepts tried by companies and municipalities. While a majority of these pilots are not successful, some of them turn out to be sustainable and can be developed further for new mobility services. Then, other transportation actors can learn from the past and adjust the already qualified and tried services to their own sociotechnical context and portfolio of different mobility solutions.

As a result, *despite different backgrounds, the trends in the mobility service development are quite similar in the different regions, and most interviewed stakeholders have very similar views about what will happen in future*. A consensus of opinion about the future of mobility within the following decades is that the efficient mass transport on rails will be accompanied by smartly synchronized local electrified transport, and the last miles of the trips are made by shared electric – later autonomous - vehicles or by other new last mile solutions, e.g. light electric vehicles or by bikes. There is also strong trust in on-demand based mobility especially in rural areas and during off-peak hours.

However, there are differences in the viewpoints of how these changes are expected to happen. This depends on the individual views of the respondent and the organization type he or she represents. A distinctive viewpoint is the role of the government and municipalities in this development: is their role an enabler or a service provider? And, what the public authorities should provide as an enabler? For example, what kinds of digital platforms, databases and their APIs should the public side provide to enable functional MaaS ecosystem and at what price? On the other hand, should these enabling platforms be developed in each country separately or should everyone wait for joint EU-level standards? These questions and our suggestions will be discussed in further detail in the forthcoming deliverable of WP9.

In all countries, the largest city areas are the frontrunners in development. They have developed (or supported companies to develop) multi-modal solutions and new services that enable smart mobility. Governments have also had a supportive role in this. In Finland, this has happened by providing development funding and legislation changes. In Switzerland, the role of Federal Government has been even stronger via Swiss Railways and Postbus.

Another significant development in mobility is the MaaS sector. Switzerland will most likely be the first country in the world that has a first full-scale, country-wide MaaS in operation by the end of 2017. However, the hierarchy-driven governance style, market dominance of the two large publicly owned firms, and dispersed canton based governance model have not encouraged local companies to develop new mobility-related services and concepts. The more liberal approach in Austria and Finland have resulted in several pilot projects and seems to have supported the development of new innovative mobility services more.

The increasing number of different last-mile-solutions in the (city) regions during the last few years include traditional and floating city bike services, shared scooters, different car sharing services (traditional, peer-to-peer, pay-per-minute) and different on-demand ride-sharing services (e.g., ISTmobil, Kyyti, Föli). Currently, also different new service concepts and business models have been developed for delivering parcels, consumables, and food. The portfolio of different MaaS-related services is increasing. However, even if the new services and MaaS concepts are gaining popularity

in cities, there is still *much to be improved in rural areas*. Even on the outskirts of the cities, public transport is mostly on a mediocre level. There is no truly smart MaaS solution(s) for both people and goods either.

Despite good development in mobility services, the use of the private car in commuting and everyday mobility has not yet decreased as hoped. Partly this is because people are used to their way of commuting, but there is still some development to be done in MaaS solutions until they are on such a level that they match or outdo the convenience of private cars. Also, there is still need for further cooperation between the public and private sector to achieve the sustainability goals in mobility.