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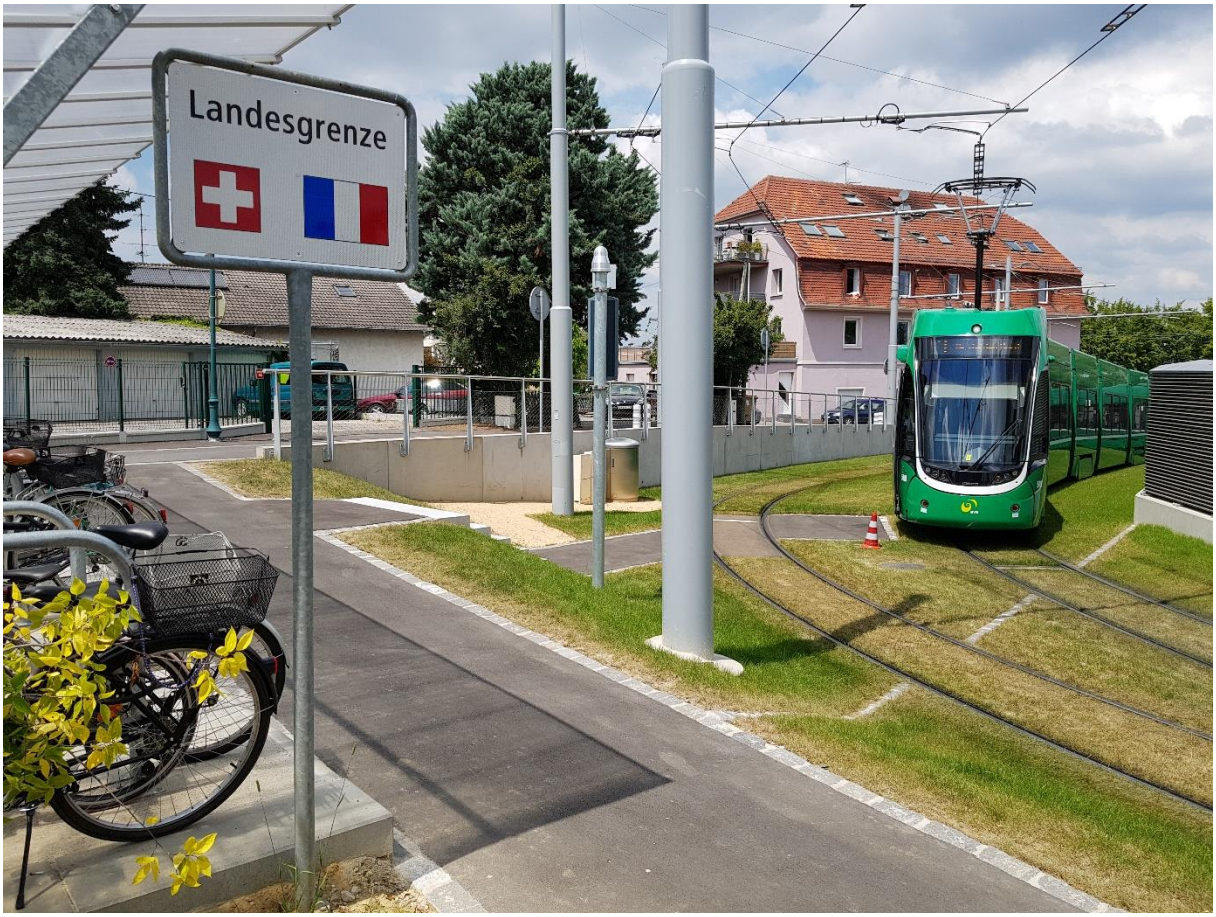
Final report

ENSCC Smart and Mobile Work in Growth Regions

Smart Commuting



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Summary

The aim of the two-year international project “Smart Commuting” was to understand the needs and characteristics of commuters as well as the opinions of various transport-related stakeholders concerning smart and sustainable commuting. Attention was also given to the understanding of current trends affecting the mobility sector and its implications for sustainable commuting with a special focus of new mobility concepts like car-/ridesharing or mobility as a service. Finally, guidelines for an effective transformation of the current car-based commuter paradigm to more sustainable ways of travelling were derived.

The study comprised an extensive literature research about trends in the commuter environment, an online-based commuter and stakeholder survey as well as interviews and workshops with experts and aimed at deriving findings with a high potential for practical and effective implementation. The commuter and stakeholder questionnaires were conducted in Austria, Finland and Switzerland enabling to capture relevant European trends and commuter characteristics. The following report encompasses mainly the findings of the Institute for Sustainable Development of the Zurich University of Applied Sciences (ZHAW) with focus on Switzerland and refers to the deliverables of the Smart Commuting project partners.

The study revealed that the commuter society can be grouped into four different groups with specific characteristics. This classification allows to specifically design measures with higher adoption potential, thus accelerating the transition to a sustainable commuter environment. Overall, public transport is still seen as less comfortable and enjoyable than the private car for the majority of commuters. Moreover, the proportion of survey respondents open to the use of new and more sustainable mobility systems such as car- or ridesharing is low (less than 20% in average). Furthermore, a gap between the expectations of commuters and stakeholders with respect to the openness towards these new systems exists as the stakeholders stated to actively promote new and sustainable mobility. The study therefore provides starting points on how to close this gap and foster sustainability in commuting. Finally, the findings from two expert workshops highlight the need for company specific mobility management, since there was overall agreement that this measure leads to a high benefit for both, the employee and employer.

Zusammenfassung

Ziel dieses zweijährigen internationalen Projekts war es, die Bedürfnisse und Eigenschaften von Arbeitspendler sowie die Meinungen verschiedener verkehrsbezogener Akteure zum Thema intelligentes und nachhaltiges Pendeln zu verstehen. Weitere Aufmerksamkeit wird dem Verständnis aktueller Trends im Mobilitätssektor und deren Auswirkungen auf das nachhaltige Pendeln gewidmet, wobei ein besonderer Schwerpunkt auf neuen Mobilitätskonzepten wie Car-/Ridesharing oder Mobility as a Service liegt. Schließlich werden Leitlinien für eine effektive Transformation des derzeitigen autobasierten Pendlerparadigmas zu nachhaltigeren Reisemöglichkeiten abgeleitet.

Durch eine umfangreiche Literaturrecherche zu Trends im Pendlerumfeld, eine onlinebasierte Pendler- und Stakeholderbefragung sowie Interviews und Workshops mit Experten wurde eine hohe Praktikabilität der Ergebnisse angestrebt. Die Pendler- und Stakeholderbefragungen wurden in drei Fallstudien in Österreich, Finnland und der Schweiz durchgeführt, um relevante europäische Trends und Pendlermerkmale zu erfassen. Der folgende Bericht umfasst die Ergebnisse des Instituts für Nachhaltige Entwicklung der Zürcher Hochschule für Angewandte Wissenschaften (ZHAW) und bezieht sich auf die Berichte der Smart Commuting Projektpartner.

Die Studie ergab, dass sich die Pendlergesellschaft in vier verschiedene Gruppen mit spezifischen Merkmalen einteilen lässt, die es ermöglichen, Maßnahmen mit einem höheren Wirkungspotenzial zu gestalten und so den Übergang zu einer nachhaltigen Pendlerumgebung zu beschleunigen. Öffentliche Verkehrsmittel gelten nach wie vor als weniger komfortabel und angenehm als das private Auto. Des Weiteren ist der Anteil der Befragten, die neue und nachhaltigere Mobilitätssysteme wie Car- oder Ridesharing nutzen würden gering (im Durchschnitt weniger als 20%). Darüber hinaus besteht eine Lücke zwischen den Arbeitsreisenden und den Stakeholdern hinsichtlich ihrer Offenheit gegenüber

diesen neuen Systemen da die Stakeholder sehr positiv zu neuen und nachhaltigeren Mobilitätssystem stehen. Die Studie liefert daher Ansatzpunkte, wie diese Lücke geschlossen und die Nachhaltigkeit im Pendeln angeregt werden kann. Schließlich wird aus den Ergebnissen zweier Expertenworkshops die Notwendigkeit eines unternehmensspezifischen Mobilitätsmanagements hervorgehoben, das sowohl für den Arbeitnehmer als auch für den Arbeitgeber einen hohen Nutzen bringt.

Résumé

L'objectif de ce projet international de deux ans était de comprendre les besoins et les caractéristiques des voyageurs d'affaires ainsi que les opinions des différents acteurs du transport en ce qui concerne les déplacements intelligents et durables. Une attention particulière est accordée à la compréhension des tendances actuelles affectant le secteur de la mobilité et de ses implications pour la mobilité durable, avec un accent particulier sur les nouveaux concepts de mobilité tels que le covoiturage ou la mobilité en tant que service. Enfin, des lignes directrices pour une transformation efficace du paradigme actuel de la voiture de banlieue vers des modes de déplacement plus durables sont dérivées.

En menant une recherche documentaire approfondie sur les tendances de l'environnement des navetteurs, un sondage en ligne auprès des navetteurs et des intervenants, ainsi que des entrevues et des ateliers avec des experts, l'étude visait à assurer la pertinence et la praticabilité des résultats. Les questionnaires sur les navetteurs et les parties prenantes ont été réalisés dans les trois études de cas en Autriche, en Finlande et en Suisse, ce qui a permis de saisir les tendances européennes pertinentes et les caractéristiques des navetteurs. Le rapport qui suit englobe les conclusions de l'Institut du développement durable et fait référence aux produits livrables des partenaires du projet Smart Commuting.

L'étude a révélé que la société de banlieue peut être regroupée en quatre groupes différents avec des caractéristiques spécifiques, ce qui permet de concevoir spécifiquement des mesures ayant un potentiel d'adoption plus élevé, accélérant ainsi la transition vers un environnement de banlieue durable. Les transports publics sont encore considérés comme moins confortables et moins agréables que la voiture particulière et la proportion des personnes interrogées qui sont ouvertes à l'utilisation de nouveaux systèmes de mobilité tels que le covoiturage est faible (moins de 20 % en moyenne). En outre, il existe un fossé entre les voyageurs et les parties prenantes quant à leur ouverture d’esprit à ces nouveaux systèmes, car les parties prenantes sont très favorables à de nouveaux systèmes de mobilité plus durables. L'étude fournit donc des points de départ sur la façon de combler cet écart et d'invoquer la durabilité dans les déplacements domicile-travail. Enfin, deux ateliers d'experts soulignent la nécessité d'une gestion de la mobilité spécifique à l'entreprise, dont il est convenu qu'elle présente un grand avantage tant pour l'employé que pour l'employeur.

Contents

List of abbreviations

AIT	Austrian Institute of Technology
ARE	Federal Office for Spatial Development
DV	Dependent variable
GDP	Gross Domestic Product
ICT	Information and Communication Technology
IV	Independent variable
JPI	Joint Programming Initiative
MaaS	Mobility as a Service
MLR	Multinomial logistic regression
OLR	Ordinal logistic regression
PT	Public transport
RoI	Return on Investment
SNA	Social Network Analysis

1 Introduction

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. Mobility needs in Switzerland, continue to increase with economic development and settlement growth. Rising incomes, an active lifestyle and the increase in population due to migration contribute further to these developments. This trend has consequences for society and the economy: long or cumbersome commuting can reduce labour productivity and restrict time for other activities such as leisure, recreation or family. The increasing number of commuters and ever-increasing commuting distances are also pushing existing transport systems to their capacity limits, increasing energy consumption and emissions that are harmful to health and the environment. As a result, labour mobility is increasingly generating negative impacts on social, economic and ecological areas. The relevance of this topic is steadily increasing, especially in heavily congested metropolitan areas. Cities with a high proportion of commuters such as Basel have to adapt their mobility strategies to these changed conditions. Opportunities coming along with new technologies can be exploited to improve the sustainability of mobility systems. Smart Commuting aims to shed light on the potential to support sustainable mobility of such technological innovations. In particular, the applicability of intermodal planning and booking systems such as "Mobility-as-a-Service (MaaS)" will be examined in this project.

The overall objective of "Smart Commuting" is 1. to identify the potential for reduction of energy consumption and CO_2 emissions in commuter mobility, 2. to identify starting points for a change towards sustainable mobility and 3. to develop strategies for sustainable mobility for individual mobility behaviour as well as for companies and urban transport and mobility planning. The project follows an integrative approach to developing commuter mobility solutions. Developments in society, the economy and the working world are taken into account as a reason for the demand for mobility and as a starting point for measures. The aim is also to support decision-makers from politics and planning in order to shape the change of the mobility system towards sustainability.

The research work related to the key questions is covering the tasks of

- providing an overview about the context for Mobility as a Service related to commuting (chapter 2)
- identifying mobile workers needs based on an online survey among commuters (chapter 3)
- analysing mobility behaviour, needs and attitudes based on the data of the survey (chapter 4)
- grouping commuters with similar and specific characteristics by classification (chapter 4.2.1)
- understanding trends influencing demand and supply in mobility with their trends and related opportunities and risks by a trend analysis (chapter 5)
- gaining an overview of the network of decision makers by workshops and a stakeholder survey (chapter 6)
- understanding the context of decision making by characterizing the socio-technical regime (chapter 7)
- identifying design principles of and developing strategies for sustainable mobility in commuting (chapter 8)
- revealing how to realize mobility management in companies by recommendations (chapter 9)
- applying findings to the case of Basel (chapter 10).

Surveys took place and data were collected and comparatively analysed for case studies in Finland, Austria and Switzerland. Although, in detail the work, interpretation and development of recommendations differed between the three countries, focusing on the special situation of the respective case study. In this report, results of comparative and joint work with relevance for and focus on Switzerland is presented as well as specific analysis for Basel city. This project is a part of the ERA-NET Cofund Smart Cities and Communities (ENSCC), established by the Joint Programming Initiative (JPI) Urban Europe and the Smart Cities Member States Initiative (SC MSI).

2 Context

2.1 Background / State oft the art

This project deals with the new ways of combining work and life with the help of intelligent transport system services and new concepts for supporting sustainable commuting. Globalization, technology development and environmental issues have increased the use of new types of work arrangements (such as dispersed and flexible mobile work) increasing the number of locations from which knowledge-intensive work can be performed (Andriessen and Vartiainen, 2006; Eurofound, 2015). A big portion of work takes place in mobile settings; i.e., it is often not restricted to any one location (Vartiainen et al., 2007). Multi-locality 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 (Huning et al., 2012). In addition, the mobility of workers brings along the increase in CO_2 emissions, if low emission transport services are not available.

The mobility of the workforce is continually increasing. Commuting is no longer just considered as a trip from place of living to place of work. Options for digital work support working on the run in turn leading to new requirements towards mobility services, higher tolerance in terms of commuting distance and time etc.. This changing nature of mobility and work is relevant when it comes to designing and implementing new mobility services, such as MaaS. Eurofound study (2012) shows a quarter of the European workers are e-nomads. By e-nomads we mean 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 e-nomads 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. Similarly, the International DATA Corporation is projecting in their Worldwide Mobile Worker Population 2011-2015 forecast (IDC, 2011) that area consisting Europe, the Middle East, and Africa will have 244.6 million mobile workers in 2015. This has several consequences. Studies have found that prolonged commuting times decrease the productivity of work (e.g. Ommeren and Gutierrez Puigarnau, 2011). The duration of commute is influenced by a large number of other factors, such as the income of the residents of the central city (Shen, 2000) and the quality and the cost of living. However, the journey to work plays only a limited role in residential location choices (Giuliano and Small, 1993). In addition to commuting, the nature of work may require extensive traveling. One study (Koroma et al., 2014) shows that the change of physical locations results in continuous searching for a place to work and remaining socially as an outsider in all communities, including the main office. Limited connections in the locations used for work seem to be the main challenges of increased mobility despite the recent developments in technology.

The quality of travel time, especially in commuting, is changing, however, and might do more so in the near future. Telecommunications technologies and services provide options to work on the go, which leads to different perception and acceptance of commuting times. This increases the demand for equipment and also the importance of qualitative aspects of transport services. In return, a greater supply of supporting (and entertaining) equipment during travel will have an impact on behavior. This project explores this increased mobility and its relationship with sustainable and intelligent transportation system services. Due to the above-described trends, the value and the use of travel time will change, which in turn will affect mobility, travel, and working behavior. These trends need to be taken into account when designing new solutions and services for mobile workers. Recent projects and prototypes, such as "smile" (http://smile-einfachmobil.at/index_en.html) in Austria, will inform the value propositions of these new solutions and services.

There are new operators and companies in the participating countries offering Mobility as a Service (MaaS), and some of them were participating in this project as a Co-applicant or Co-operation partner. Although these companies with networked business models have already established themselves and similar concepts have been developed around EU, the appropriateness and applicability of these new services and business models in enhancing mobile work still needs to be evaluated. Thus in addition to helping design new solutions, the objective of this project is to identify the needs of mobile workers, how

they are changing due to abovementioned trends, and envision evaluation methods for matching the changing needs of mobile workers with the value propositions of different mobility concepts.

Another objective is to increase the sustainability of mobility by enhancing the implementation of sustainable and intelligent transportation system services, such as electric car sharing. Thus, examining how these new types of transportation services could support the workers, their organizations and urban areas as a whole were topics of the project. We are also interested in how these services challenge urban planning and design, as well as governance structures – and which new possibilities come along with them. For example, in addition to the land consumption, it is estimated that the provision of parking space increases the living costs by 20% in the city. Thus, the reduction of parking space requirements creates new innovative possibilities and reduces some of the difficult trade-offs in land use. We identified starting points for a transition of the socio-technical regimes towards more sustainable commuting - using the multi-level perspective to socio-technical transition (Geels, 2002). In Switzerland, this development is related to the decisions on “energy transition”, which is addressed in the research initiative of the Swiss Competence Center for Energy Research (SCCER). One main topic of the SCCER initiative is mobility, where technologies, strategies and measures for systemic transition are developed (http://www.sccer-mobility.ch/). Likewise Austria recently updated measures included in the national ITS action plan (http://www.bmvit.gv.at/bmvit/verkehr/gesamtverkehr/telematik_ivs/index.html). Insights on transition pathways of these initiatives, were used to gain insights from the representatives of different interest groups about the changes needed in the urban design and governance structures.

In addition, urban and regional policies need to support sustainable commuting. These kinds of strategic level concepts and policies have been developed for example in the city of Basel, which is co-operation partner in this project. The city of Basel provides funding for projects that decrease parking and car commuting into the city by providing alternatives for the use of a car. They have a strong need for this, as the city of 174 000 residents needs to cope with 97 000 commuters – out of which 34 000 from neighboring countries (Statistisches Amt des Kantons Basel-Stadt, 2017). The funds, coming mainly from parking fees, are used to fund for example Park-and-Ride- and Bike-and-Ride facilities or public services related to these facilities. The project arranged workshops in different countries to discuss how cities can improve their mobility policy with new concepts and integrated strategies for commuting.

Based on this situation, case studies of the three participating countries were analysed concerning commuting behaviour, openness for new mobility services, stakeholder attitude, starting points for action and recommendations for supporting MaaS in terms of sustainable mobility were elaborated. Depending on the different starting bases of the three countries focus of the work differed. For example in Finland, the transport corridor from Tampere to Helsinki (Growth Corridor Finland) was considered as an implementation case, where services span the whole transport corridor, with mobile workers passing through several city borders, which is one of the unique aspects in this case. For Austria, ISTmobil provided empirical data, such as traffic data and commuter statistics from the district of Korneuburg, North of Vienna, and a simulation-based decision support for choosing the right solutions was developed. In Switzerland, experience from the city of Basel on strategies for commuting were considered to provide recommendations on the best practice of how to develop integrated concepts.

2.2 Motivation oft the project

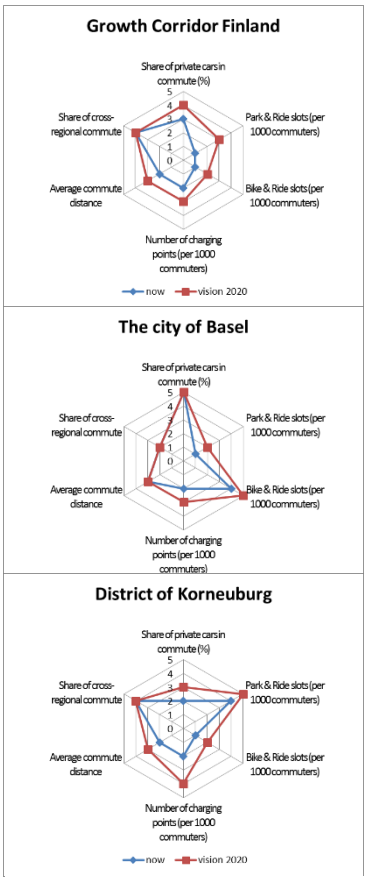
The emphasis of this project was on how new mobility solutions such as smart tools, services and concepts for integrated urban energy and transport systems could fit into todays’ context of commuting respectively how the transformation of the transport system related to this innovations could work. One of our main motives is the promotion of sustainable transportation. We explored potential acceptance of new services, challenges coming along with them for the given system and stakeholders. Based on the analytical work recommendations on how to support sustainable commuting and mobility by integrating new solutions in the city and regional policies were derived.

The consortium used surveys, interviews, simulations and workshops in different countries were used to analyse how new services could meet the evolving needs of mobile workers. Mobile workers are considered in this project as lead users of new services, but the results are intended to benefit all the

users of these networks. The combination of the methods provided a basis for recommendations for strategies supporting new policies and investments on workers' mobility.

The partners of the consortium have previous experiences in this field. Ac2sg Software Oy has implemented smart electricity grid solutions in different markets and Liikennevirta Oy, has already gained extensive experience on how to operate them in these markets using network organization business models. This gave the project a good starting point in thinking how energy networks should be integrated into the urban fabric, how their design and management should be updated to support these new service models and how this knowledge can be used for improving the functionality of mobility services and energy grids. In addition, implementations and insights on running measures in collaboration with communal actors in this project (Growth Corridor Finland, City of Basel in Switzerland, and Korneuburg region in Austria) provided material to identify potential and challenges for sustainable commuting and implementation of new mobility solutions.

One case case study area per country was chosen, (Figure 1: from left to right: Growth Corridor Finland, City of Basel in Switzerland, and district of Korneuburg in Austria) representing large commuting areas with a need for new services and concepts to be developed.



The Growth Corridor Finland is a commuting area characterized by long commuting distances. Growth Corridor Finland is becoming the leading experimental platform on intelligent traffic services and systems in Europe. With over 300 000 daily cross-region commuters there is a great potential in implementing more sustainable and integrated travel chains in the corridor – especially in concepts that feeds commuters into train stations and takes also care of the last mile to the destination. Netgraphs are based on estimates and proxies.

The commuting strategy developed in Switzerland in the city of Basel addresses similar problems as in Finland. Commuting to/from the city of Basel is characterized by short distances, but also over 34 000 commuters crossing country borders daily to work in the city. The consistent work in supporting non-motorized transportation and cross-border collaboration has resulted in a low share of private cars (16% in 2013, Das Statistische Amt Basel-Stadt, 2014) and new concepts in inter-modal transport.

ISTmobil GmbH operates in the district of Korneuburg, North of Vienna. Despite a high number of Park and Ride facilities in the area, the modal split in commuting traffic from Korneuburg to Vienna between car and public transportation is 79-21% (Statistik Austria, 2012). This is partly a result of many historical choices in the region affecting urban fabric (Knoflacher, 2007). ISTmobil is currently testing solutions for this in the district and aims to scale up their operational area to new commuting regions.

Figure 1: Study sites in Finland (growth corridor), Switzerland (Basel) and Austria (Korneuburg) with their respective characteristics depicted in spider charts.

Despite these differences in the characteristics, the mobility concepts in the interest of this project are at the same stage in these countries. These similarities allow to benefit from a comparative study to draw general conclusions, identify national and regional specific characteristics as well as to derive recommendations beyond recent transport strategies within the case study areas.

2.3 Goals

The focal point of the overall project is the implementation of existing solutions for more sustainable mobility of workers and also the demonstration of feasible technologies and services that are not yet ready to be scaled up. The design of the project is shown in Figure 2. The applied research supporting these implementations are divided into two parts: First, supporting the implementations by contrasting current user needs and individual behaviour with the possibilities of new services and changes in the socio-technical regime (WPs 1-4). In the first part, we have two broad themes that underline the trans-national co-operation in this project: 1) current and future user needs and behavioural changes needed, and 2) changes in the socio-technical regimes and required decision support.

The second part is supporting the implementations by assessing the impact of these new services on individual behaviour and identifying commonalities in the mobile workers' future needs (WPs 8-9). Thus, the second part was meant to help scaling up these implementations to other regions in EU by offering proven results and approaches that work in the European context. Although, the focus of the three countries differed related to their stage of implementation the cooperation and comparison allowed synergies and critical reflection of the respective regional situations, strategies and out of the box thinking for recommendations. Interdependencies are reflected in the collaboration between different work packages.

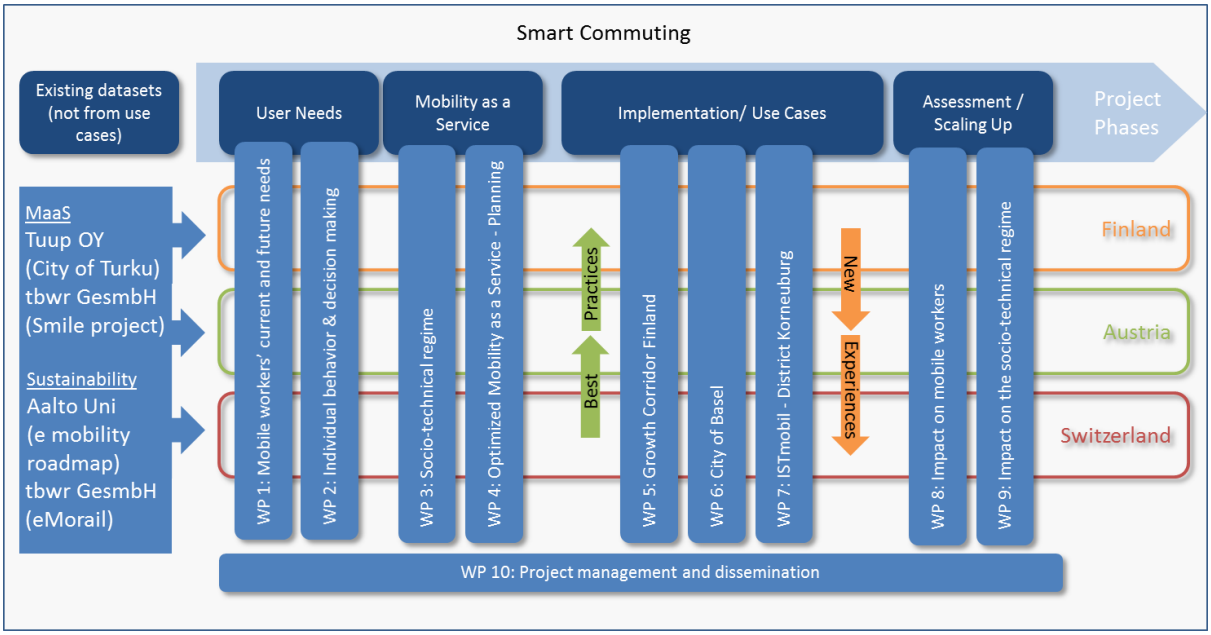


Figure 2: Work package overview of the Smart Commuting project.

Related to this context of a changing mobile world and the leading questions, the project combined different research steps and fields of analysis to develop a deep understanding about the commuting situation of the three case study areas, to identify the potential of new mobility solutions such as MaaS and to elaborate recommendations. Main results of the work are presented in this report. In order to identify mobile workers current needs an extensive comparative survey was carried out in the three case study areas; the method and characteristics of the sample comparing the Finnish, Austrian and Swiss situation is described in chapter 0. Results of the survey concerning mobility behaviour, needs and attitudes are analysed in detail and presented for the case study of Basel in chapter 4. Based on the survey data a classification of commuter types was computed, allowing to separate groups with similar and specific characteristics (chapter 4.2.2.), which should allow for successfully addressing commuter

needs and increasing attractiveness as well as competitiveness of (new) mobility services. Mobility behaviour in commuting – and elsewhere – can only be understood within the context of factors influencing demand and supply in mobility. In turn, changes within this context might provide opportunities for the acceptance and success of new mobility solutions as well as risks. Thus, a trend analysis was done with results are described in chapter 5. The trend analysis is related to the mentioned commuter survey and to a stakeholder survey analysing the network, attitudes and potential roles of them in implementation of new mobility solution, described in chapter 6. Part of the context analysis is to understand the socio-technical regime, which is crucial for understanding decision making as enabler for implementing new mobility solutions; a description of the Swiss socio-technical regime is included in chapter 7. Results of all the mentioned analytical steps provide the basis for developing strategies for sustainable mobility in commuting, which are shown in chapter 8 focussing on the specific situation of Basel. As commuting is closely linked to the economy and the working world the potential of mobility management in companies is explained and recommendations are given in chapter 9.

3 Identifying Mobile workers' current and future needs[1]

According to the goal of the Smart Commuting project to explore new ways of combining work and life with new intelligent transport system services and new concepts for supporting sustainable commuting there is a need to gain a deeper understanding of how mobility and work are interlinked. 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.

Related to one main objective of this project to identify the changing needs of mobile workers data for the three case studies was collected to characterize commuters behaviour, needs of mobile workers and estimate implications for the future (for definition of terms see Table 1).

Table 1: Definitions.

Name	Definition
Commuter	Commuting is a periodically recurring travel between one's place of residence and place **of work, or study**, and in doing so **exceeds the boundary of their residential community**. A distinction is often made between commuters who commute daily or weekly between their residence and workplace, and are therefore considered respectively local or long-distance commuters. Commuting therefore **does not include trips conducted as a part of work activities** such as a bus driver's workday or an executive's business trip to attend a meeting.
Mobile worker	An employee who accomplish a part of his work outside of his regular place of work – either as a part of his/her commute or as a part of work activities.

[1] Haahtela, T., Viitamo, E., Hackl, R., Härri, F., Asamer, J., Surakka, T., 2017. Smart and Mobile Work in the Growth Regions. Deliverable 1.2: Survey results of the mobile workers' needs.

Viitamo, E., Haahtela, T., Hackl, R., Härri, F., Asamer, J., Surakka, T., 2017. Smart and Mobile Work in the Growth Regions. Deliverable 1.3: The current and future needs of mobile workers

3.1 Methodology

The online survey was based on an extensive questionnaire (see APPENDIX 15.1) with questions related to the following themes (no. of questions): respondents' background (18), commuting environment (5), present modes of commuting (13), satisfaction and motivations (5), future modes of commuting (3). The questionnaire was issued in Oct. 2016 – Feb. 2017 and the data was collected in Dec. 2016 – May 2017. The geographic focus of the survey differs in each country, which in part reflects the policy priorities and needs in developing sustainable commuting. Hence, there were three identical (region-adjusted) commuting surveys in Austria (N = 531), focusing the whole country, Finland (N = 523) focusing on the Finnish Growth Corridor and Switzerland (N = 550) focusing on Basel Region. Owing to the large sample size the data enables to compare the descriptive statistics across the three regions/countries and - based on the statistical clustering methods - identify commuting profiles within each country/region and across the three countries/regions.

The **Finnish** data (forced n=521) collected from the Growth Corridor Finland, uses the internet panel of Taloustutkimus. Using a representative sampling method half of the Finnish responses are collected from municipalities and small towns, the other half coming from the four large cities (Helsinki, Espoo, Vantaa, Tampere) located in the Helsinki-Tampere growth corridor. Along with place of living, representative sampling was applied to other central background variables; age and gender. Using a random sample out of the official business register ZHAW contacted 2504 companies in the canton of **Basel-Stadt** by e-mail. Companies were asked to forward the link to the online questionnaire to their employees. The survey was available both in German and French. Of the total number of responses 1186 (including completed questionnaires and all types of drop-outs), 550 were completed giving the completion rate of 46 %. Of the respondents with completed responses 463 live in Switzerland, 65 in Germany and 22 in France. In **Austria**, the survey was conducted by ZHAW in unipark (online survey tool). Being available both in German and in English, the questionnaire was distributed to the registered users of a market research institute (Marktforschungs GmbH). The method was iterative and selective to collect a representative sample. Of the total number of responses 724 (completed questionnaires and all types of drop-outs), 531 answers were completed yielding completion rate of 73 %. The Austrian sample also includes retired persons, which are excluded from the Finnish and the Swiss samples.

In summary, the three focus regions are characteristically different as the purpose of the survey is to examine and compare different national policies in commuting, mobility and the related services. Hence, with the exception of Austria, the descriptive statistics presented in the following examines the differences and similarities between the regions, and therefore the results are not directly applicable to the respective countries[2].

3.1.1 Sample definition for Basel

The target population is defined as the **entity of working commuters** (people, who are periodically travelling between their homes and their place of work) commuting to the city of Basel. Therefore, the **targeted maximum age is set to 65**, the highest retirement age in Switzerland.

One of the main goals of the Smart and Mobile Work in Growth Regions Project is the assessment of new mobility services regarding their potential in the future. Therefore, **commuting students**, representing the potential working users of tomorrow, are also included in the survey. The **targeted minimum age of the subjects is set to 15** as younger students are usually attending primary or secondary school and therefore are (due to the higher density of these school types) unlikely to commute. This data collection is also valuable regarding the fact, that younger people show an increased use of internet-services than older people and that many new mobility services rely on ICT.

Concerning spatial movements, the main focus of attention is concentrated on the movements **towards Basel** and not on outside directions. This is justified by the fact, that the main traffic problems in

[2] In order to draw conclusions that are more general for the countries, the results should be weighted and extrapolated according to the respective national distributions.

commuting areas like Basel are mainly existent in load direction of traffic. Exemplary this is the inbound traffic to the city in the morning and the outbound traffic in the evening. Therefore, we look at places of attraction (work/studying) **inside the commuting area Basel.** It needs to be stressed that all kind of commuters independently of their mode of transport, occupational sectors or social stratum need to be questioned. The only constraints are the above mentioned conditions.

3.1.2 Sampling and Data collection

In the Smart Commuting project proposal, the sample size is defined to **n=500** per research region. As one of the common properties of all subjects is the fact that they are working at a company or studying at a school. This offers a way how to approach survey particpants. As the “Amt für Mobilität des Kantons Basel-Stadt” and the “Handelskammer beider Basel” offered their support conducting the survey, different companies and schools were approached through them. Also the “Bundesamt für Statisik” of Switzerland maintains a Database of companies registered in the city of Basel. Schools teaching commuting students aged 15+ are mainly high schools, vocational schools and universities. These are relatively easy to identify. We thus, approached companies and scholar institutions with the request to hand over the survey to their employees/students. The preferred way of filling out the survey was online, alternatively the survey could have been filled out by paper/pen and sent back to ZHAW (sampling procedure see Figure 3)

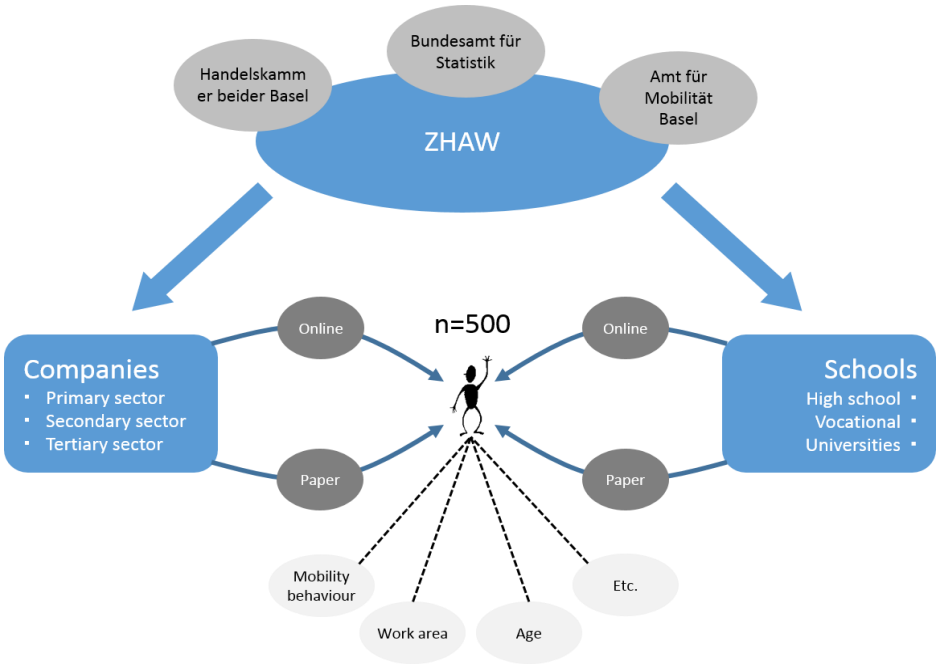


Figure 3: Sample definition.

3.2 Comparative analysis of the three case studies

Despite the different geographic and cultural contexts and geographic foci of the three surveys, the samples show high similarity across the regions and the distributions with respect to some background factors. In general, the 1600 respondents and their regions/countries share the following main features. Full-time employment is the dominant employment status in all regions/countries. The predominant age group is 46-55 (30 % in Finland and Switzerland). On aggregate, the educational levels of the 1600 respondents are high. The dominant group in household size is two persons (typically couples) accounting on average for 40 % of the respondents. In a similar vein, for “the number of working or studying persons in the household”, the dominant group is two persons consisting on average 50 % of the respondents. Also, “for how many children living at home,” the dominant group is “zero” consisting on average of 70 % of all the respondents.

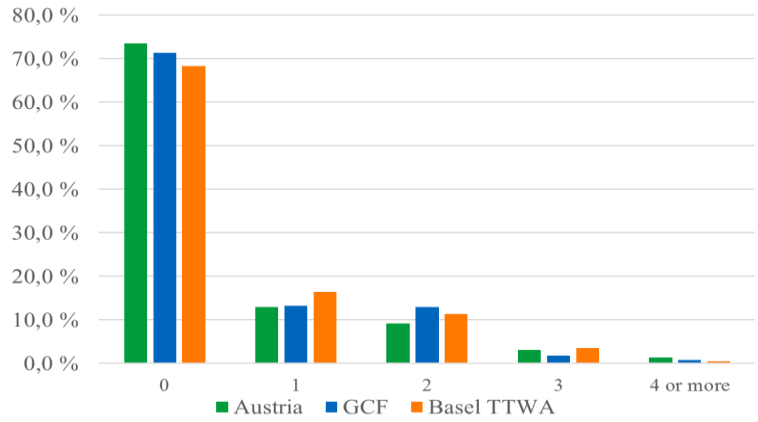


Figure 4: Number of children living at home.

A typical number of cars in a household is one car in each region/country with the average of 45 % of the respondents. The overall accessibility to a car is, however, much higher as 91 % of the households in Austria, 80 % in GCF and 70 % in Basel Region own at least one car. As to the household monthly net income, the Swiss respondents outperform the Finns and Austrians. The monthly net income among the Swiss/Basel commuters is about double higher than in the other regions/countries. However, this difference is partly diminished by the high price level of Switzerland. Finally, while almost all the respondents in each region/country have a driving license, e-bikes are virtually non-existent.

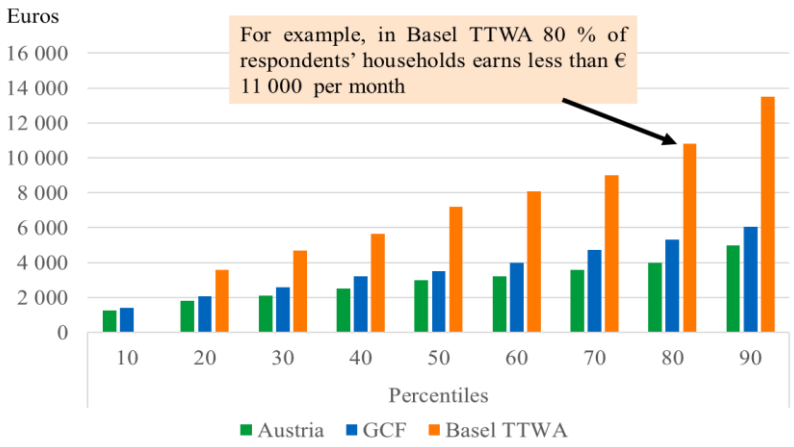


Figure 5: Household monthly net income.

3.2.1 Commuting environment in the regions – the highlights

As with the background factors, the regions show *high similarity* and the distributions of the given categories featuring the commuting environments. However, some systematic differences can be identified as well. Whereas the dominant type of living environment in each region/country is *urban* accounting for 40 % of the aggregate sample, Austria shows the highest share of respondents living in rural areas (over 20 %). The type of environment can be contrasted with the present population densities, which gives a more objective view of what rural and sparsely populated areas mean in different regions. This characteristic is illustrated in Figure 6.

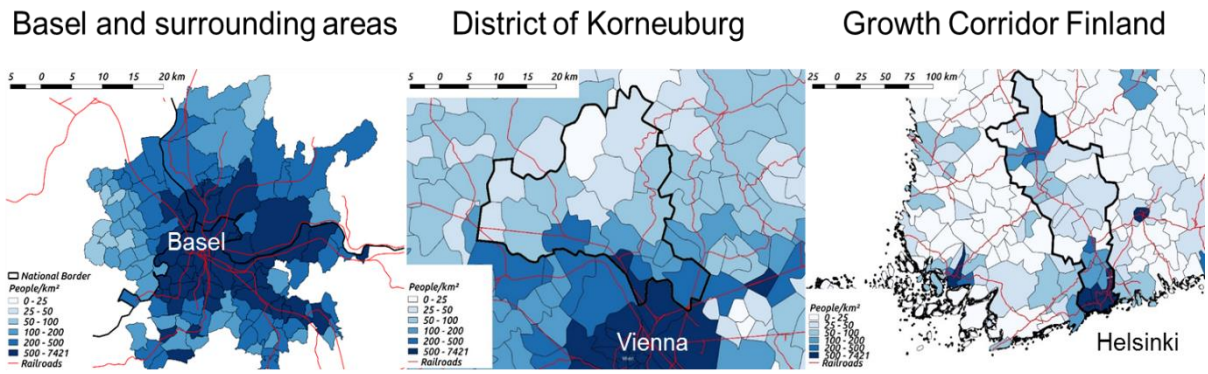


Figure 6: Population densities in the focus areas 2016 (source: National bureaus of statistics).

Regarding the “access to basic necessities within walking distance” the highest share (over 90 %) is shown by public transport access point. Distinctively, the Austrian commuters have the lowest accessibility in each category of the basic necessities. Of the different types of public transport stations, Bus stop dominates in the walking distance to the closest transport point in all regions/countries (90 % of the respondents on average). Distinctively, the share of bike- or car sharing stations is highest in Basel Region (over 30 %). The dominant place of work among the respondents in all regions/countries is the primary workplace varying between 78 % (Austria) and 89 % (Basel Region). For the GCF and Austrian commuters, the dominant workplace location type is urban (47 % of the respondents) whereas in Basel Region the predominant location is city center with 52 % of the respondents.

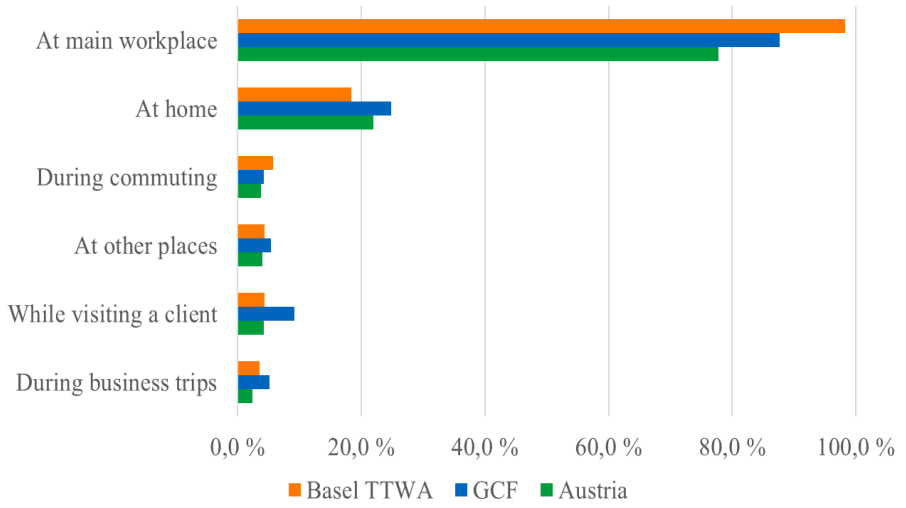


Figure 7: Commuting environment - Places of work.

3.2.2 Characteristics and modes of present commuting – the highlights

On aggregate, the three regions show relatively high similarity with respect to the main characteristics and modes of present commuting. There are some specific differences, however, which may be explained by distinct “cultural” and “locational” (city vs. larger areas) factors. As expected, the dominant category for the “number of times commuted to the main workplace in a week” is 4.5 to 5.5 times. This accounts for 58 % of the respondents on average. Surprisingly, given the marked differences in the geographic sizes of the countries, the regions are relatively similar in the commuting distances and the distribution of lengths in each percentile. A half of the respondents have a commuting distance less than 10 km. Whereas GCF and Basel Region are relatively similar with respect to the daily commuting time and the distribution of commuting time in each percentile, Austria shows the lowest commuting time in each percentile. A half of all commuters have a daily commuting time less than 50 minutes on average.

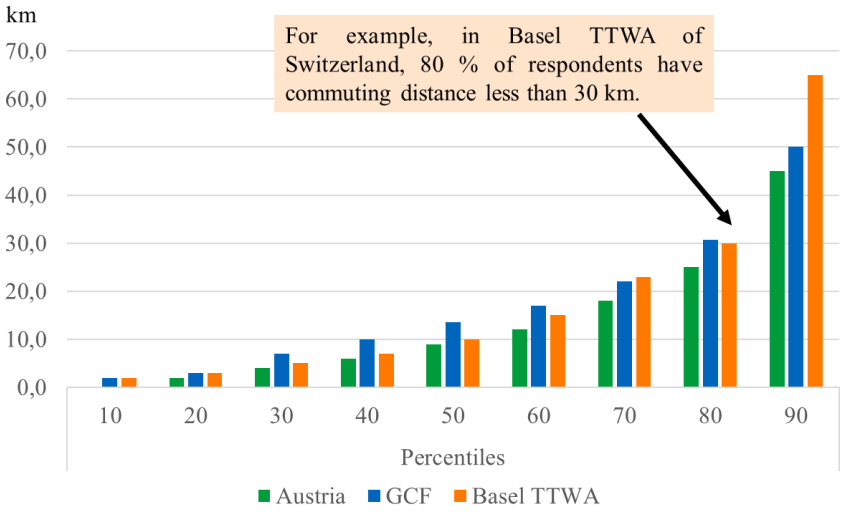


Figure 8: Present commuting - Distance between home and workplace.

On average, 60 % of the respondents has an “access to private car” while less than 10 % of the respondents has an access to a company car[3]. For the most important means of transport used for commuting GCF and Austria show similar patterns. In Austria and GCF, car-driver is the dominant mode (over 50%) whereas “walking” is next important with around 20 %. In Basel Region instead, bike, train, and tram are equally important with 30 % among the respondents. Of the public transport ticket types used commonly in commuting, year-ticket is the most common (around one-third of the respondents) In Basel Region and Austria, whereas in GCF the most common modes are value ticket, flat rate month pass and single/return ticket in the respective order. The regions/countries show similar patterns in the relative importance of “combining other activities with commuting” of which the most important are shopping, social activities and sport and leisure in the respective order.

The utilization of digital services related to commuting is characterized by specific patterns across the regions. Basel Region is the most advanced in the “use of Internet for commuting info seeking” whereas in GCF and Austria show similar patterns (the relative shares of high use/moderate/low use). The use of Internet for booking in commuting is relatively rare in each region. Basel Region is showing the highest and GCF the lowest ranking. The same holds for the “use of Internet for paying in commuting”. The lead position of Basel Region in digital services is influenced by its higher share of public transport in commuting.

[3] In this question, accessibility means the “possibility to use”.

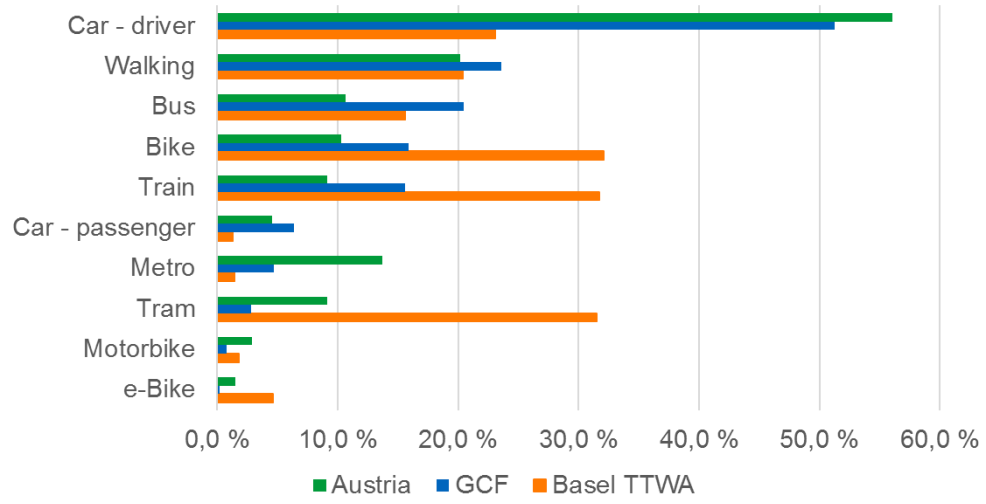


Figure 9: Present commuting - the most important means of transport used for commuting.

The high share of public transport in commuting in Basel Region also shows up in scope and intensity of the various “activities during commuting” in which Basel Region ranks the first. In particular, reading is relatively uncommon among the GCF commuters. Moreover, it seems that the GFC commuters do a narrower scope of activities than the commuters in Austria and Basel region. As the expected requirement of the job is the dominant reason to commute during peak hours in all regions, GFC ranking the first.

3.2.3 Satisfaction and motivations – the highlights

Regarding satisfaction and motivations related to the present modes of commuting, i.e., what is appreciated by and what is not, there are distinct commonalities across the regions but also region-specific differences. These commonalities may provide guidance of how and in which focus areas to develop mobility services, For instance, Figure 10 shows the order of importance of specific dimensions of satisfaction associated with present commuting independent of its mode. In general, the rankings of the dimensions of satisfaction are highly consistent across the three regions. Over these dimensions, GFC commuters are the most satisfied and the Austrian commuters the least satisfied with their present modes of commuting. The highest-ranking dimensions are easy to use, the reliability of the service and comfort of traveling. Service frequency shows intermediate satisfaction whereas the lowest ranking dimensions are prices, travel time and enjoyment of travel. This implies that there is potential for improving travel enjoyment and making travel time more valuable.

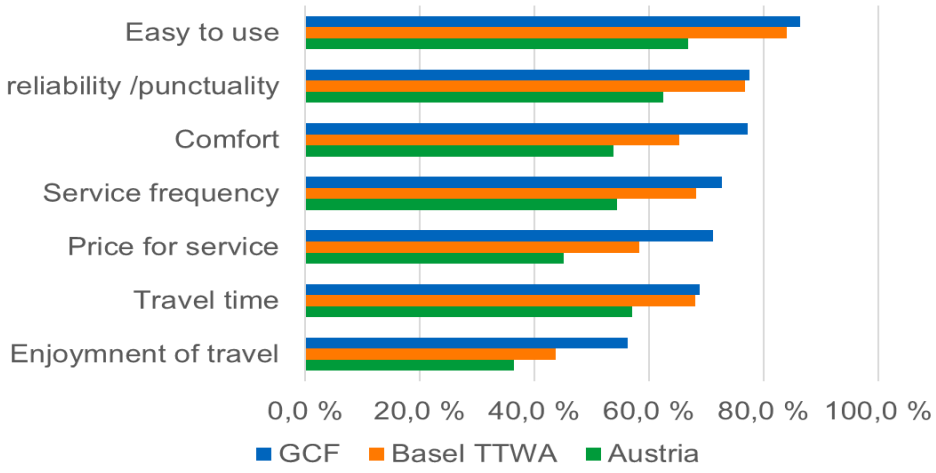


Figure 10: Satisfaction with the most common modes of commuting.

Of the two most prominent reasons for using a private car, the commuters have a shared view across the three regions. The highest valued advantages of using a private vehicle are flexibility and speed of traveling. On the other hand, the lowest ranking reasons are environmental concern, transportation of other people, and avoidance of traffic jams. Other non-influential motivations are safety, price, weather, and privacy. Of the regional differences, no other alternative is ranked distinctively high by the Austrian commuters, which may be an indication of limited public transport services in specific rural/sparsely populated regions or the lack of information regarding the existing public transport services. In a similar vein, free parking space at work ranks relatively low among the GCF commuters indicating regional differences in the company and public policies on private cars. Finns also appreciate more the reliability of traveling, which may say something about the perceived quality problems in public transportation and privacy, which may reflect the influence of cultural differences (ethos).

As expected, the rationales for using public transportation are very different from those of using private cars. Moreover, the rankings for the most important rationales show higher variance across the regions. In this respect, Austria and Basel Region are more alike. In general, environmental concern is the most often mentioned motivation among the commuters to use public transportation. For the second most important rationale price implying low costs of commuting, there are regional variances, which may indicate impacts of different tariff policies and efficiencies in the public transportation more generally. On aggregate, there two motivational aspects that makes GCF commuters different from those of Austrians and Basel Region. First, Finns do not commute by train or bus primarily to avoid traffic jams but they do so because there is no other alternative. While the rationales to motivate present mode of commuting may be objective and real, they may also involve subjectivity and ideological aspects. The potential influence of ideological/subjective motivation is manifested by the fact that reliability and no other alternative rank high for both car users, and public transport users. Similar to the car users there is higher consensus on the less influential motivations across the three regions. Distinctively, the possibility to work while commuting is not influential motivation to use public transport.

Table 2: Motivations to use public transportation in commuting; rank order.

	Austria	Switzerland	Finland
Environmental concerns	2	1	2
Price	1	5	3
To avoid traffic jams	3	2	7
Reliability	4	3	5
No other alternative	5	8	1
Speed	6	6	4
Weather	6	4	8
Safety	8	9	6
Possibility to work while commuting	9	7	10
Flexibility	10	10	9
Transportation of goods	11	11	12
Medical reasons	12	12	11
Privacy	13	13	13

The motivations of using a bicycle in commuting represent a hybrid of the rationales for using the car and public transportation. Cycling enables flexibility and speed, and at the same time, it is considered cheap and environmentally friendly. By the GCF commuters health and to do sports is considered particularly important indicating some cultural differences relative to Austria and Switzerland. Hence, or the Austrian and Swiss commuters bicycle seems to be more of practical alternative among the other modes of mobility. The rankings of motivations for walking are similar to those of using a bicycle with the exception that speed is non-influential in the former. Here also the GCF commuters value to do sports and health distinctively high meaning that a more substantial proportion of GFC commuters are motivated to walk for its health effects compared to the commuters in Austria and Basel Region.

3.2.4 Future commuting – highlights

From the perspective of future commuting modes and the policies to support the desired change, two issues are of specific interest; a) the *enablers* that would encourage commuters to shift to, and increase the use of public transport services, and b) the propensity of the commuters to use the *new or emerging mobility services*. The survey results indicate that *the most important enablers to increase public transport* are more or less the same across the three regions. Ticket prices, better connecting services, decreased waiting time and more frequent service, are all pragmatic enablers related to higher efficiency and service intensity of the public transport and the travel chains.

Table 3: The required improvements encouraging more public transport use: rank order.

	Austria	Switzerland	Finland
Cheaper tickets	2	1	3
Better connecting services (decreased waiting time)	1	2	4
Decreased travel time	3	4	2
Tickets provided by the employer	4	3	5
More frequent service	6	6	1
Improved reliability	5	8	6
More comfort in public transport vehicles	7	5	8
Better bicycle-transport opportunities	10	7	9
Park & ride offers	8	10	11
Opportunities to work during the trip	12	9	12
Better transport possibilities for luggage/goods	11	12	10
Better safety-feeling	9	14	13
Better walking accessibility	14	15	7
Better bicycle parking opportunities	15	11	14
Street tolls for private cars in city centers	13	13	15

Since the elasticity of increased use for the commuters that already use public transport as their principal mode is – logically - lower than in other groups the rankings in Table 3 can also be interpreted to approximate the propensity of the shift among the non-public transport users. Hence, e.g., cheaper tickets would be influential for the car users to change their commuting behavior towards public transport. Distinctively, the GCF commuters consider that public transport services are too infrequent to mobilize its increased use, i.e., there is a higher potential compared to Austria and Basel Region. A similar observation holds for better walking accessibility. More generally, there seems to be a higher potential for increased use in Finland related to specific characteristics of the public transport infrastructure. Moreover, in Finland, the propensity to increase public transport is higher among the car users than in other commuting groups. In contrast, to the recently raised arguments for the public transport services, neither the opportunities to work during trips nor the street tolls for private cars in city centers are considered unimportant enablers.

The market potential for the new modes of commuting was estimated by respondents' answers to the question: "could you imagine using one or more of the following transport modes for your commuting trips?" The alternative commuting modes and the answers thereof are highlighted in Figure 11. Except for the GCF commuters on ride sharing, the commuters in each region seem to be highly conservative indicating low propensity to change from the present commuting behavior. This result is consistent with commuters' relatively high satisfaction (Figure 10) with their current modes. Another potential explanation is that many commuters - or people more generally – are not fully aware of the emerging commuting modes and therefore they cannot yet consider them as viable alternatives.

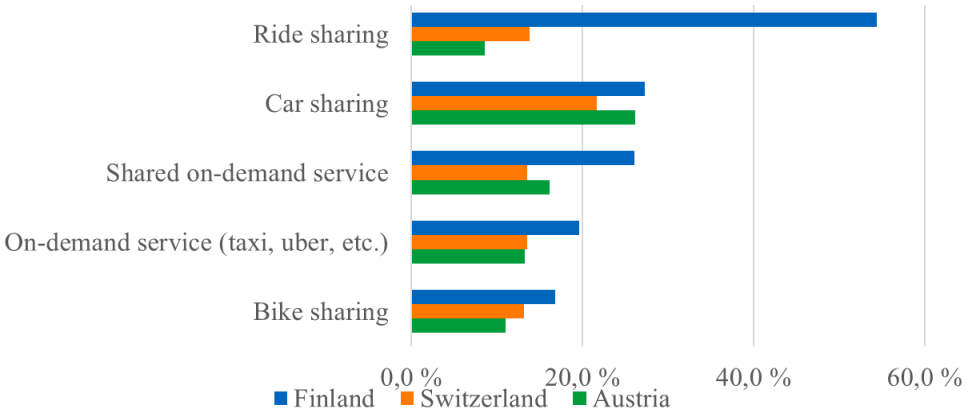


Figure 11: Future commuting – The market potential for new modes of commuting.

Considering how new mobility services should be designed and be offered to the users it is helpful to get back to questions about how commuters today spent the time during their trip. Concerning use of the internet during the trip, especially commuters in Basel appeared as internet-affine with around three of four persons seeking information during the trip, but also for booking and paying – although the latter two activities take place on a lower level. Thus, providing internet access could increase comfort and maybe also the enjoyment of travel, which was rated lower for PT compared to the car. Demand for such services is likely to gain importance in the future as use of this technology will further spread within (commuter) society.

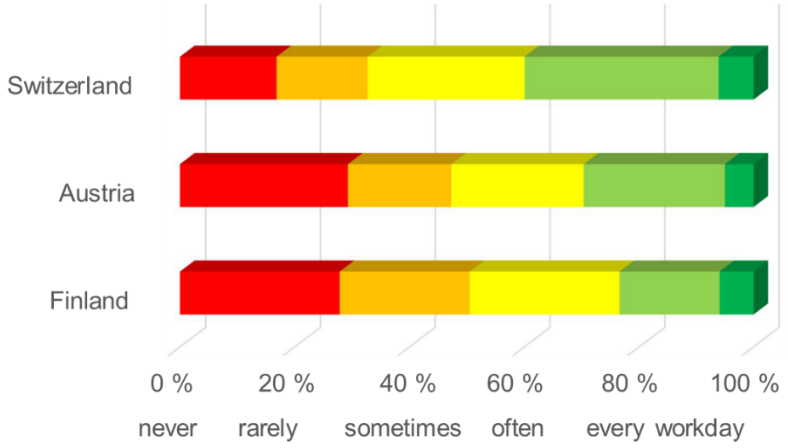


Figure 12: Present commuting - Use of Internet for info seeking during commuting.

Besides this, in general the use of electronic devices is a common activity, with cultural differences between the three case studies. While in Finland it is on the first position of the ranking, a majority of the commuter in Basel prefer reading, followed by use of electronic devices. Thus, time during the commute seems to be used more for leisure, entertainment and information activities then for working (with electronic devices), which ranks on place four of the list in Finland and in Switzerland – and place six for Austria. Working on the run does not (yet) seem to be the preferred way to work and activity to fill time during the trip. Taking these findings into account would mean to consider and design public transport out of a perspective of leisure facilities.

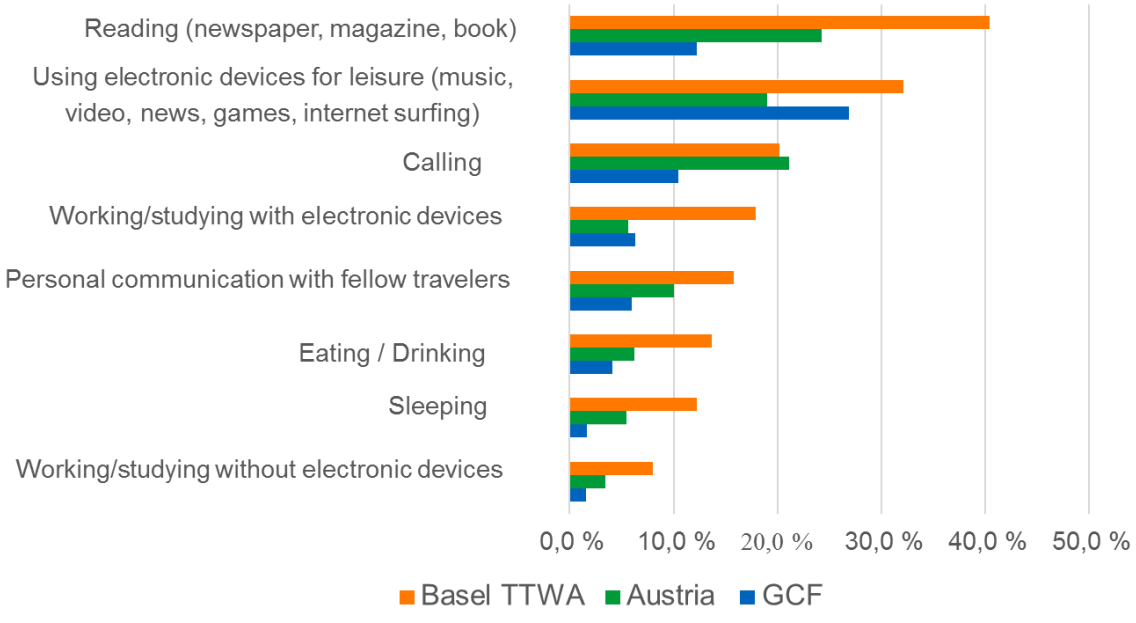


Figure 13: Commuter characteristics – Present commuting - Activities during commuting.

To summarize the findings with regard to future commuter need there will be more demand for internet connectivity and electricity, a need for more space for electronic devices as well as for free seats in public transport.

Concerning work on the trip both, quiet working space as well as quiet space for calling would be a benefit. In order to enable working during the trips there is also a need of cultural change at the side of employers, who would need to give appropriate tools to work during commute and to accept work during commuting as full working time. There are signs that leisure activity during commute might remain an important activity, which could be enabled by good internet connectivity and a better, more leisure oriented design and appearance of public transport facilities and vehicles.

The comparative analysis of the three case studies allows to identify national respectively regional specific characteristics of commuters as well as aspects of general importance allowing to derive such with importance for the future of commuting. As regions appeared to be specific a more detailed analysis of commuter behaviour was done for each region. In the following chapter detailed results for Basel are described, which also includes a classification of commuters within the region into groups with similar characteristics.

4 Commuters' mobility behaviour with related recommendations fostering sustainable commuting[4] with a focus on Basel

In order to support the systemic change towards sustainable mobility on the levels of individuals, transportation systems and society, knowledge about individual and group behaviour and decision-making is crucial – which has been analysed for the three case cities based on an extensive survey among commuters.

4.1 Methodology

4.1.1 Approach and research questions

The goal of present assessment is to assess the foundations on which new mobility services and strategies for commuting should be built on, starting from the end-users needs and commuting behaviour presented in this report. Based on this assessment, together with the stakeholder-analysis (chapter 6) and the trend analysis (chapter 5), recommendations and design principles for new mobility services and commuting strategies were elaborated (see Figure 14). While in chapter 3 an overview for and a comparison of the three case studies is given, analysis as presented in this chapter are focused on and specified for Basel.

As the analysis are based on a survey, which was designed to provide data for the whole Smart Commuting project and not specifically for the work presented in this chapter, the analysis was performed related to the following research questions:

- Starting from the **needs** and **commuting behaviour** of **end users**, which **criteria** need to be considered when creating new mobility solutions and strategies for commuting applicable in Basel and upscalable to an European level.
- How can end user be **reached** in order to support a change towards sustainable commuting behaviour? Are there specific user groups?

[4] Hörler, R., Härri, F., Hoppe, M. and Hackl, R., 2017. Smart and Mobile Work in Growth Regions. Deliverable 2.1.1: Commuters' mobility behaviour with related recommendations fostering sustainable commuting.

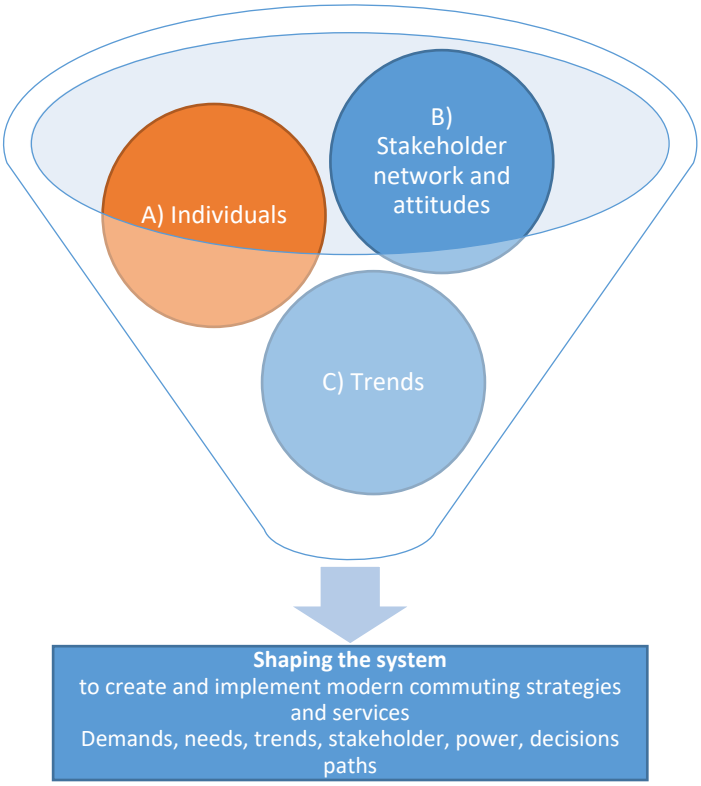


Figure 14: Research framework for creating commuting design principles. The part "A) Individuals" is presented within this report.

Commuting behaviour is influenced by many factors. In regard of sustainability principles, the modal split, the travelled distances and time use of said modality are of special interest. Ultimately, the Smart Commuting project aims at changing commuting patterns both by providing better opportunities and services for sustainable transportation and by positively impacting people's decision-making and behavioural patterns. Therefore, different drivers and barriers are addressed. Accordingly, it is essential to explore and understand the mechanisms forming individual commuting patterns. To establish new commuting services and concepts it is key to have a comprehensive understanding of individual commuting behaviour and the respective starting points aiming towards the above-mentioned change. Various studies regarding mobility behaviour have been conducted in the past, but were not specifically focused on commuting. Lanzendorf (2003) for example assessed how specific events in a person's life course can influence travel decisions.[5] Such insights can also be applied to change commuting-behaviour. The present study approaches the issue from different perspectives identifying ways and means to foster sustainability in commuting by changing mobility behaviour.

According to Jensen (1999), mobility behaviour studies mostly showed the quantitative picture of transport behaviour: "*It has summed up the person km, examined how many people use the various means of transport, incl. the number of cars and how transport behaviour can be broken down based on gender, age, income etc.*"(Jensen, 1999, p. 20). However, with this focal point the reasons leading to a corresponding transport use are not assessed. Based on the assumption, that a person would show a very different commuting behaviour when put in different personal, environmental, socio-economic or demographic contexts, these factors are therefore very relevant for the present study.

[5] Lanzendorf (2003) assumes, that when change in life is bound to happen (e.g. moving the place of living), people are more open for change regarding their mobility behaviour.

4.1.2 Statistical analysis based on empirical data

The “Smart Commuting” project aims at changing commuting patterns by providing better opportunities and services for sustainable transportation and by affecting people’s decision making towards sustainable mobility. Therefore, statistical analysis of the country survey (Haahtela et al., 2017; Viitamo et al., 2017) provides insights regarding changing needs of mobile workers and reveals starting points how commuters need to be approached in order to successfully create, and implement new mobility systems.

At a glance the survey questions/items can be roughly grouped into the below categories. These categories are closely tied to the above research approach aiming at understanding current individual commuting behaviour in its respective contexts as well as identifying starting points for future potential behavioural change. Chapter 4.2.1 describes these demographic, spatial and socio-economic characteristics in detail.

(1) Individual/ household-specific demographics and socio –economic attributes (such as sex, age, education, income, domestic situation/household structure)

(2) Employment and work arrangements (employment status, workplace location, frequency of working trips, etc.)

(3) Individual/household-specific amenities (amenities related to mobility such as vehicle ownership/access, driving licence, public transport ticket, ICT devices, etc.)

(4) Spatial and locational attributes (such as basic type of settlement structure/land-use pattern both for place of residence and workplace, accessibility to basic necessities and PT stops)

(5) Current commuting/mobility behaviour (though modal choice in working trips is a key variable in this context, other factors include: work trip distance, duration and combination with other activities (shopping, pick-up, etc.))

(6) Satisfaction with current commuting situation and options/conditions for behavioural changes (a set of conditional questions on attitudes towards modal choice and changes in behaviour)

Furthermore, an in-depth analysis of the survey data aiming to group the commuters into clearly separable segments was conducted. This also serves as starting points on how these user groups need to be approached in order to successfully create and implement new mobility systems. To this end, statistical classification methods like cluster analysis described in chapter 4.2.2 were applied.

The commuter survey was designed together with the academic partners AIT und Aalto University as well as with tbw research. The survey setup is based on a profound research approach, also created in extensive international exchange. The survey was completed with an online survey tool.

4.2 Commuting behaviour of individuals and groups

The target population for the survey is defined as the entity of working commuters (people, who are periodically travelling between their homes and their place of work) commuting to or within the city of Basel. It was aimed to interview all kind of commuters independent of their mode of transport, occupation or social class. As most subjects work in a company this offered an opportunity to approach our test candidates. In addition, the Federal Statistical Office maintains a database of companies registered in the city of Basel. Thus, the survey was distributed via the chamber of commerce in Basel to their address list of local companies requesting to make it available to their employees, mainly online. Alternatively, a paper and pencil version was available to include less digital affine commuters. However, none of the contacted companies made use of the latter possibility. To force participation based on list of the chamber of commerce push mails were send to companies as a reminder to motivate their employees to participating in the survey. Finally, 550 finished datasets were obtained. For the subsequent evaluation of the questionnaire, only finished entries were used (N_{total} = 550) in order to perform the

analysis based on a consistent and coherent dataset. The main share of the 550 participants are Swiss, with only 65 located in Germany and 22 in France.

A descriptive comparison of the survey data was already performed previously (see Haahtela et al., 2017; Viitamo et al., 2017). Therefore the outline of present paper will focus on an evaluation for the Basel case study, with chapter 4.2.1 presenting the descriptive and chapter 4.2.2 the explorative analysis results. In chapter 4.2.3 the obtained explorative results will be compared additionally to the other two Smart Commuting case studies in order to scale the results up to an European level.

4.2.1 Basel commuter characteristics

Hereby, a general overview of the results of the survey will be presented for Basel: First, the individual/ household-specific demographic and socio-economic attributes and the general mobility behaviour will be outlined (chapters 4.2.1.1 to 4.2.1.5). Then, the evaluation will focus on the unsatisfied needs and the openness of the surveyed commuters regarding new mobility solutions (chapters 4.2.1.5 and 4.2.1.6) in order to provide the basis for the creation of design principles and recommended actions analysed in the upcoming tasks. This comprises an overview of the current quantitative transport demand (commuting times and distances) and the individual's / household's current options and decisions on how to satisfy this transport demand and how these commuting journeys look like in terms of trip combination and activities during the trip. Furthermore, a specific user group evaluation will be undertaken (chapter 4.2.1.8) and starting points with the aim to implement new strategies and mobility offers identified.

4.2.1.1. Individual / household demographics and socio-economic attributes

A lot of value is given to variables that capture the current mobility behaviour of commuters. However, it is important to understand that these variables would be of little or no use if their respective demographic, socio-economic and locational conditions were unknown. Demographic and socio-economic variables of the respondents and their households have an influence on the actual commuting or mobility needs. Furthermore, they can be used to describe their abilities to adjust to changes in transport options like the availability of transport modes, price structure, and access to tickets and driving permits.

One of the most important items in the socio-economic domain is the disposable income since it is the key variable of the household's price elasticity of demand and its ability to pay. Ability to pay and price elasticity will largely determine whether new additional transport options will be accepted or not, simple because some households are not capable to afford a corresponding offer. Figure 15 shows the total household income stated by the Basel respondents.

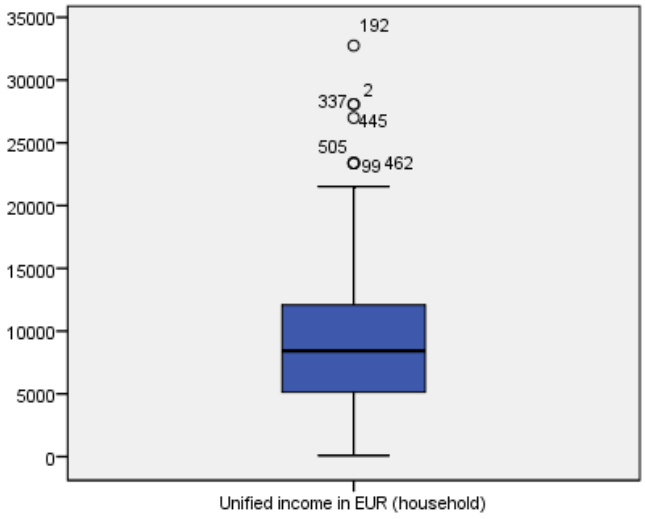


Figure 15: Monthly net Household-Income of respondents in EUR, N=468. Extreme outliers are omitted, data: ZHAW.

When comparing the median (8'420 Euros) to the mean value (16'264 Euros) it becomes apparent, that a big discrepancy persists.[6] This is due to a high amount of extreme outliers. While this can also be an effect of the above-average representation of academic commuters with higher salaries (see Figure 16 below), the results are plausible, as around three quarters of all respondents have completed at least a higher professional education and around 50% are in possession of a Bachelor, Master or Doctorate degree. According to the Swiss Federal Office of Statistics (BFS), the average monthly income of Swiss households was around 8'000 Francs in 2016, or 7'484.8 Euros (BFS, 2016a). Considering that structurally weak regions are also taken into account in the BFS study and that the survey participants in Basel tend to be well educated (Figure 16), the income data appears probable.

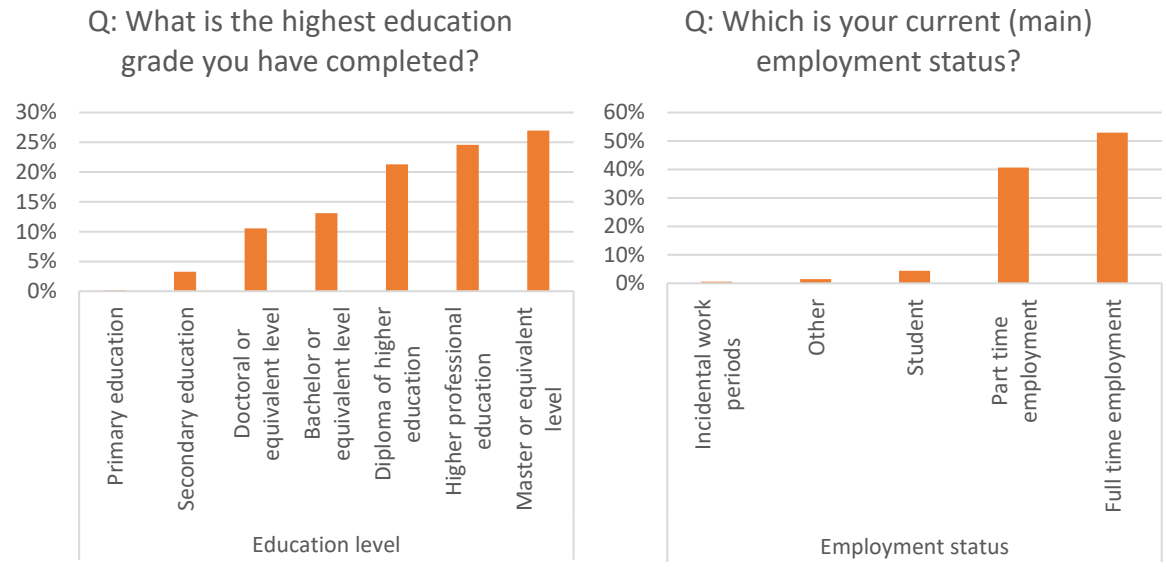


Figure 16: (left): Education grade, N=549. (right): Current main employment status of the respondents, N=548, data: ZHAW.

Employment and work arrangements are relevant for commuting by their very nature: they strongly influence the need for commuting trips in terms of distance and frequency. It is key to collect these variables in order to be able to control for the respective effects when looking at commuting behaviour and any potential starting points of changing it. Few years ago full-time work was the general rule (Bundesamt für Statistik, 2017a). Today, part time employment with additional sideline tasks (family, education) is getting more and more important and therefore increases the need for more dynamic and individual mobility solutions. The trend to a more dynamic and individual work-life balance can be underlined by our data (Figure 16), where the current main employment status of the respondents is represented. It becomes apparent that only a little more than half of all respondents do have a full time job, whereas 40.7% state that they are doing a part-time job. The rest are students and "other".

4.2.1.2. Commuting itinerary characteristics

It was assessed how often respondents visit their main workplace per week and where they conduct their work. The predominant answer to this question was: "At main workplace" (98.7% of the respondents see Figure 17), 18.5% stated that they also perform teleworking from home, and 5.9% stated that they work during their commuting trip. Around 4% stated, that they work during business trips or while visiting a client. These numbers again suggest that the classical work-stile (working at main workplace) is still dominant. However, around one fifth of the respondents stated that they are

[6] The conversion Swiss Francs to Euros is undertaken by the following rate: 1 CHF= 0,9356 EUR (finanzen.net as of 2017/03/30).

performing teleworking. This is the same number, which the Federal Office of Statistics BFS found in their own study (NZZ, 2016), the numbers of the commuter survey in Basel are therefore plausible.

Matching the work location figures, most respondents, in accordance to the dominant work arrangement ("full time", see chapter 4.2.1.1), visit their main workplace on five days per week. Around 25% do this four times a week, 20% three times or less (Figure 17).

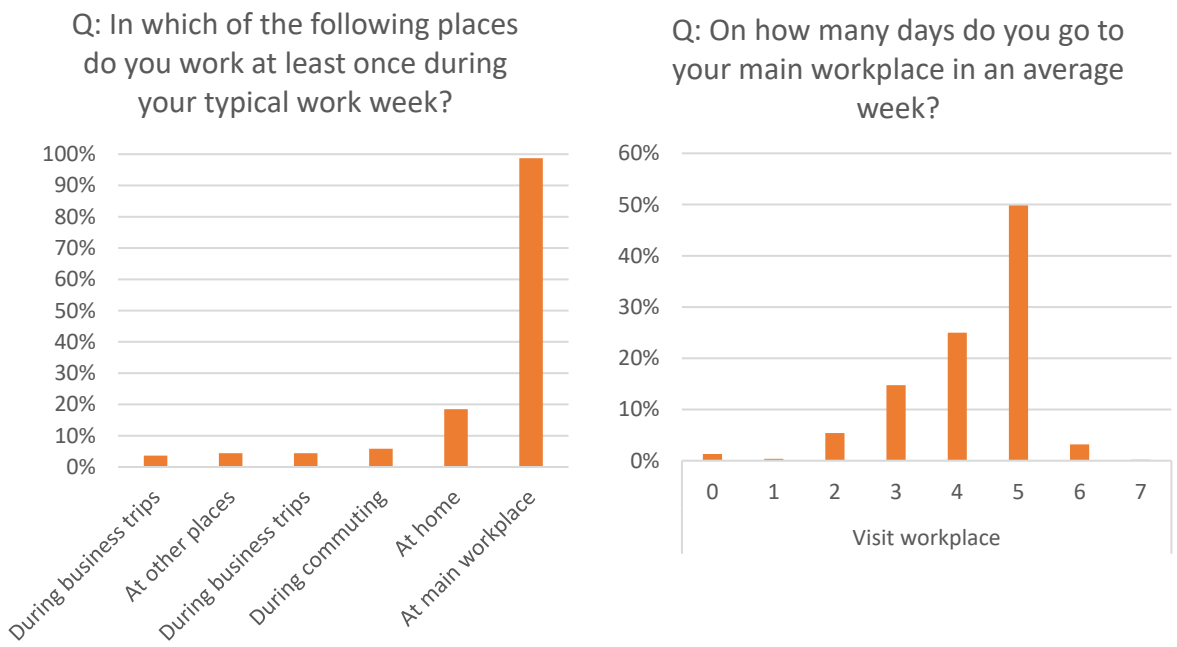


Figure 17: (left): Working places of respondents, N=741. (right): On how many days respondents visit their main workplace, N=536. Percent of the cases (checkboxes), data: ZHAW.

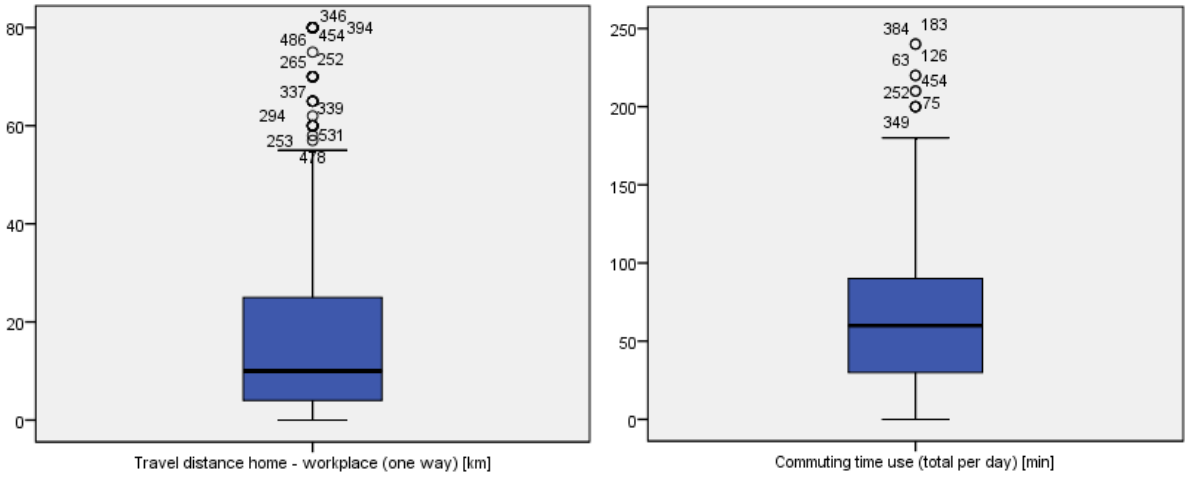


Figure 18: Commuting distance (one way) and time per day of the respondents, N=550. Extreme outliers are omitted, data: ZHAW.

The mean commuting distance between home and workplace was found to be 24 km. The distribution is strongly positively skewed, as the median is only 10 km (Figure 18), which seems quite plausible as most participants live in an urban area and work in the city-centre (Figure 19).

Regarding the commuting time, the data spread is far less extreme. On average the participants use 67 minutes for their daily commute, the median value is 60 minutes. This shows that the variance especially persists in terms of distance. This supports the assumption that people mostly think in time investments when planning their commuting trips. Distance issues do not play a major role. Therefore, faster commuting modes tend to increase the commuting distance.

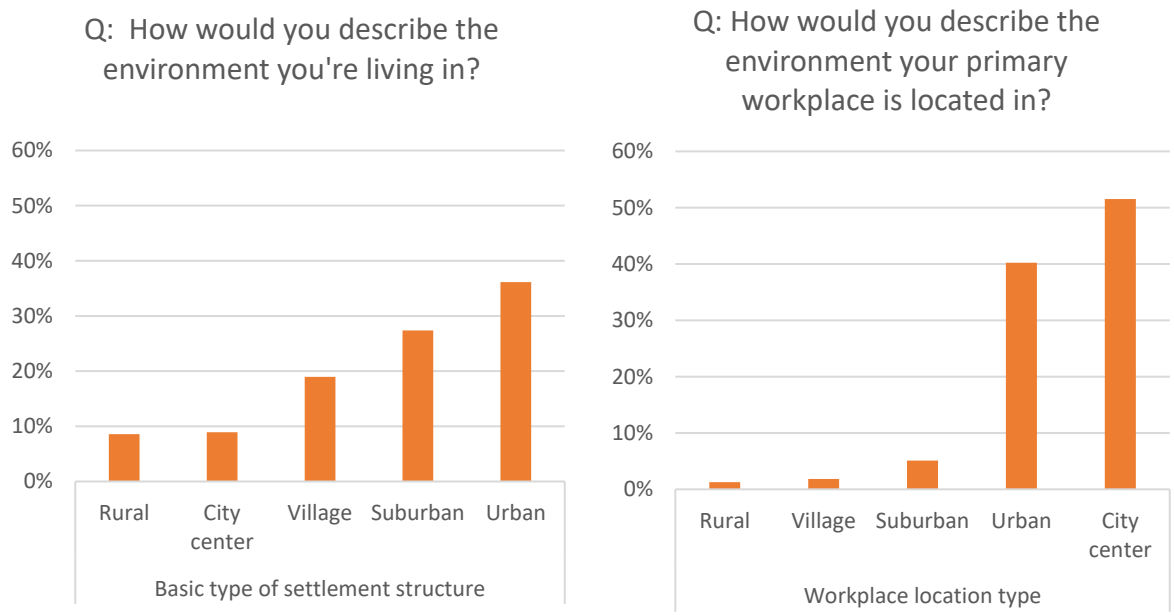


Figure 19: (left): location of residence, N=548. (right): Workplace location of participants, N=547, data: ZHAW.

Most respondents live in suburban (27.4%) or urban areas (36.1%) and work in the city centre (Figure 19). This is not surprising, as the canton of Basel Stadt (in which the contacted companies were located) is mostly represented by the city of Basel and can therefore be considered as a so-called “city-canton”.

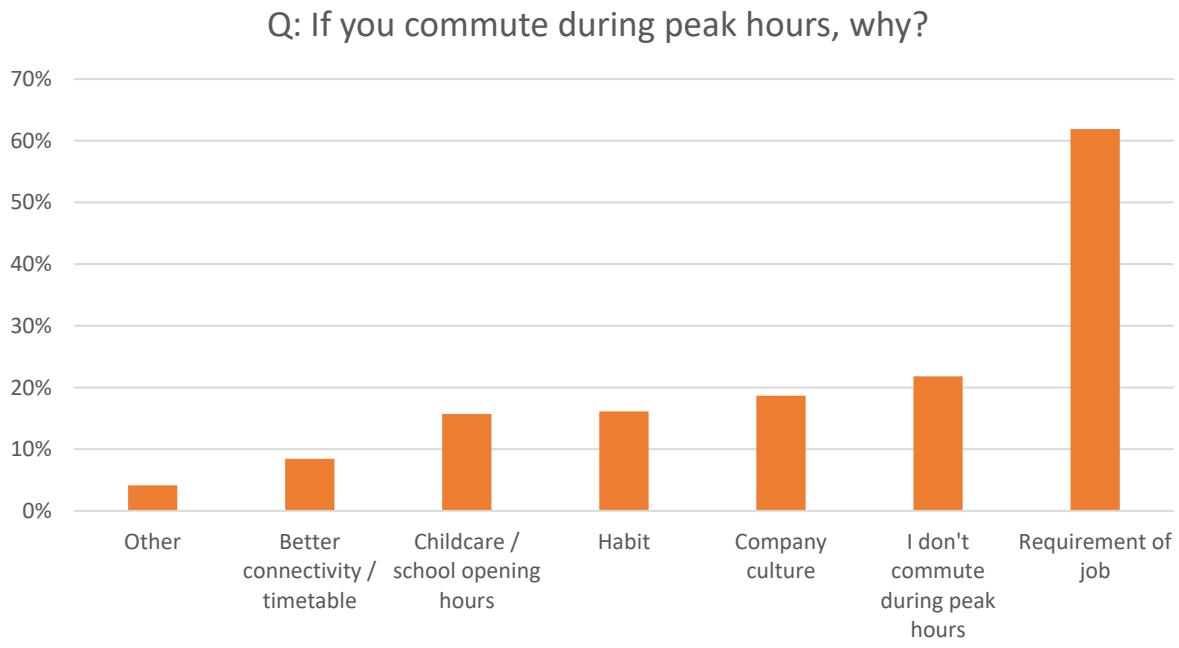


Figure 20: Reasons why respondents need to commute during peak hours, N=747. Percent of the cases (checkboxes), data: ZHAW.

One of the main sustainability issues within the current commuting regimes are the peak-hours. Therefore, it is necessary to identify the reasons, why people actually need to commute during peak hours and according to that, a multiple answer question was included in the survey (Figure 20). By far the most chosen answer was “requirement of job” with 61.9% of all respondents selecting this option. This is an important result suggesting where policy measures towards a more sustainable commuting regime could have a high effect. Also important factors are childcare (15.7%), company culture (18.7%) and habit reasons (16.1%). Only one fifth of all respondents do not commute during peak hours.

4.2.1.3. Transport modes and access to vehicles

The availability and use of transport/vehicle/mobility resources (vehicles, driving license, season tickets, membership cards, etc.) and associated means and devices like ICT (smartphone, internet) have a relevant impact on commuting possibilities and transport demand. This also influences the question regarding potential multi-modality ambitions in commuting behaviour. This is especially interesting, as many new forms of mobility offers rely on multi-modality. The analysis of these mentioned variables allows assessing whether commuter’s mobility behaviour is the result of true free choice or a consequence of practical restrictions (e.g. missing access to public-transport (PT), no driving licence etc.).

Figure 21 shows the frequency of different transport modes respondents’ use for their commute. The high share of PT users in Basel (Basel shows the highest PT modal share among Switerzland biggest cities, see Basel-Stadt, Mobilität et al., 2012) can also be observed in the survey data: Around 40% of all respondents stated that they use the train or the tram “every workday” or “often”. The values for the modality “bus” are slightly lower: Around 20% claimed that they use this mode on such a regular basis. In addition, only 20% of respondents stated that they “never” use the tram for commuting. This shows that the share of general PT-denier is rather low in Basel.

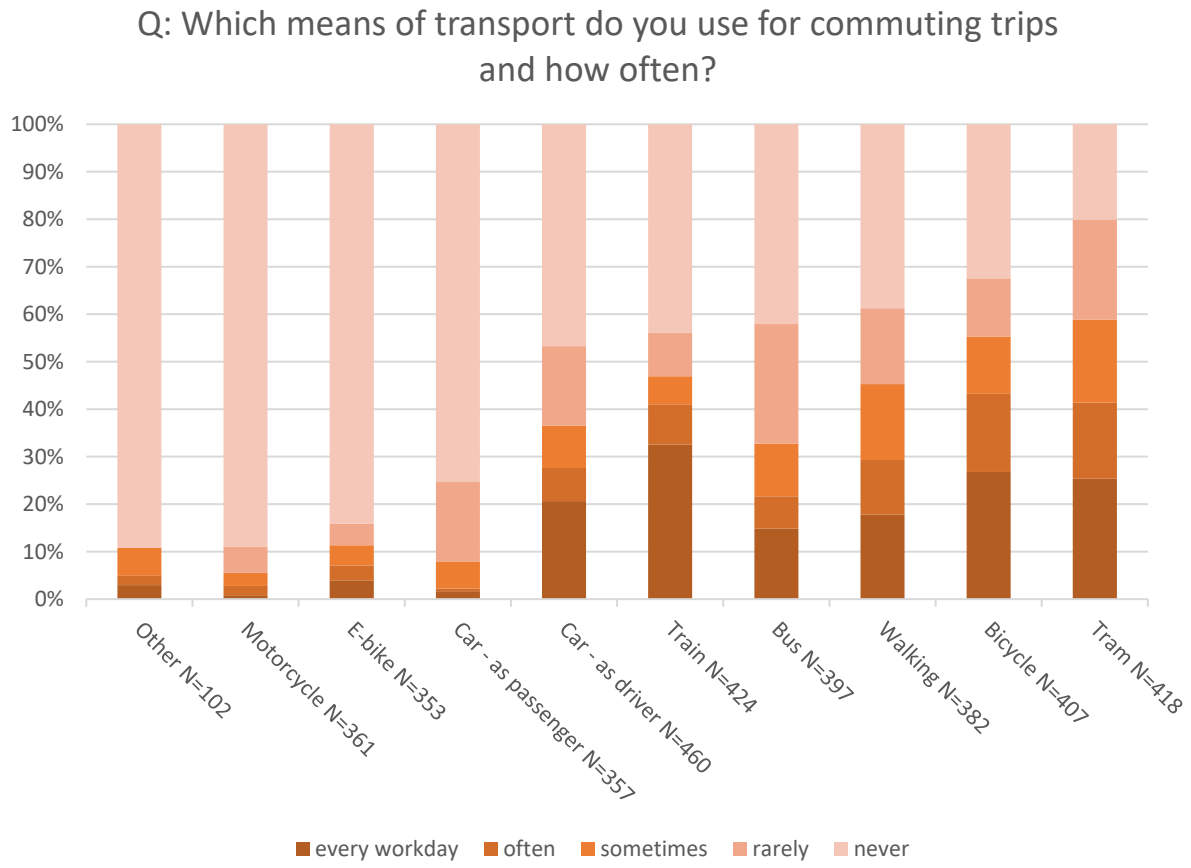


Figure 21: Respondents frequency of use of different transport modes, data: ZHAW.

Around 30% of respondents use the car “as a driver” “every workday” or “often”. Around 25% claim to use the car “sometimes” or “rarely” and 45% never use the car. As a non-driving passenger, the car usage is significantly lower. Only 2.6% of the respondents drive to work as a car-passenger “every workday” or “often”. A bit more than 20% do this “sometimes” or “rarely” and 75% do not use this way of commuting at all. There seems to exists potential to promote ride share possibilities, especially when considering that there were specific investments in ride-sharing infrastructure in the Basel area during the last years (Amt für Mobilität des Kantons Basel-Stadt, 2017).

Especially pleasant from an environmental viewpoint is that more than 40% of surveyed commuters use the bicycle “every workday” or at least “often”. Only 30% respondents “never” use the bicycle for commuting. This also corresponds to findings from another study: In comparison to other city areas in Switzerland, Basel shows an above-average use of bicycles (Basel-Stadt, Mobilität et al., 2012). Comparably low is the usage of E-Bikes. Only 7% of the respondents use this mode of transport on a regular basis (“often”, “every workday”), another 9% use it “sometimes” or “rarely”. Considering, that in 2015 8% of all households in Switzerland possessed an E-Bike (BFS and ARE, 2017) this may however be a high value, as all of those people need to have access to such a vehicle. This factor can be seen in Figure 22 and underlines the following interpretation: Around 18% of households possess one or more E-Bikes. An interesting assumption can be made when comparing the same numbers within the modality “motorcycles”. Even though around 25% of all respondent’s household have one or more motorcycles, only around 5% of all surveyed persons use this mode of transport “every workday”, “often” or “sometimes”. This means that E-Bikes are, if available, used a lot more often for commuting than motorcycles. This may indicate that E-Bikes are specifically bought for commuting activities.

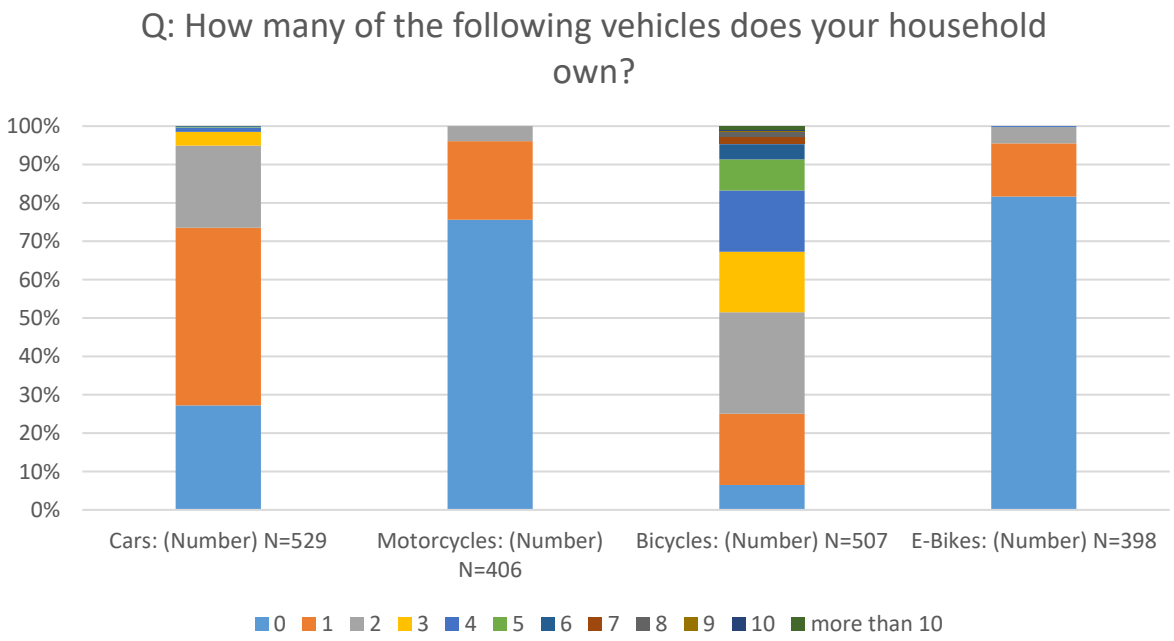


Figure 22: Vehicle possession of participant's households. Percent of the cases (checkboxes), data: ZHAW.

Considering the availability of other vehicle types, it can be seen that the availability of cars is very high: More than 50% of all participant’s households possess one car, around 20% two and around 5% more than two. Only around 25% of all households do not possess a car. Bicycles are also very widespread. Around 20% of all households have one bicycle, 25% two, 15% three or four (each), another 15% more than four. Only 5% of households do not have a bicycle. Therefore, there is still potential for cycling and reasons for not using bicycles for commuting are not due to missing vehicle access, but for other factors.

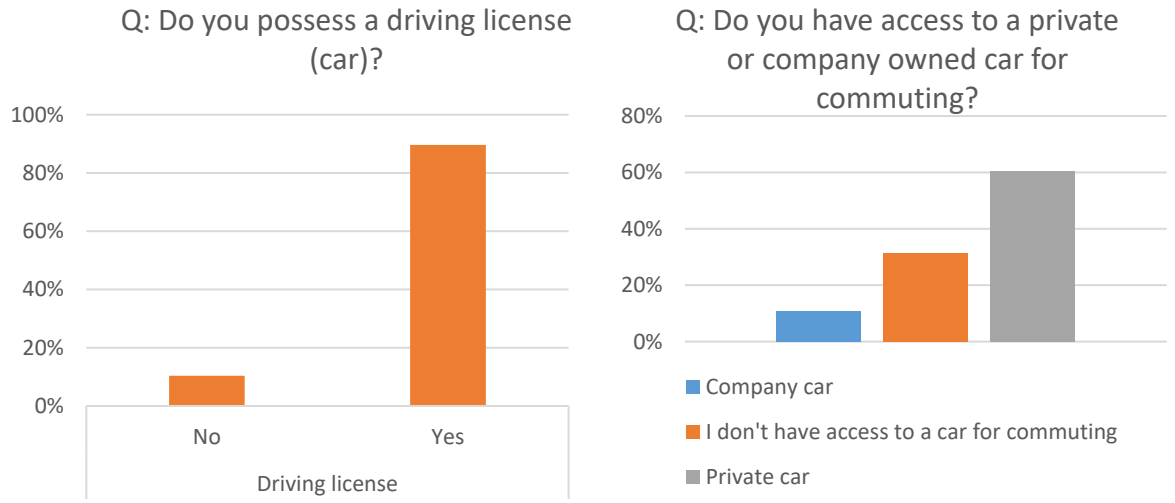


Figure 23: Driving licence possession (N=548) and car access (N=499) of respondents. Percent of the cases (checkboxes), data: ZHAW.

Another aspect, which can strongly influence the use of car (or associated modes like car sharing) is the access to car sharing and the car itself. Around 90% of the survey commuter possess a driving licence. As such, an analysis according to age groups should be of special interest and has been described in chapter 4.2.1.8.

According to the high household's car possession, it is not surprising, that 60% of respondents state to have access to a private car for commuting (Figure 23). Around 10% state to have access to a company car for their commuting activities. This may very well influence the modal choice for commuting and the specific reasons why people use the car will be addressed in the upcoming chapter 4.2.1.4.

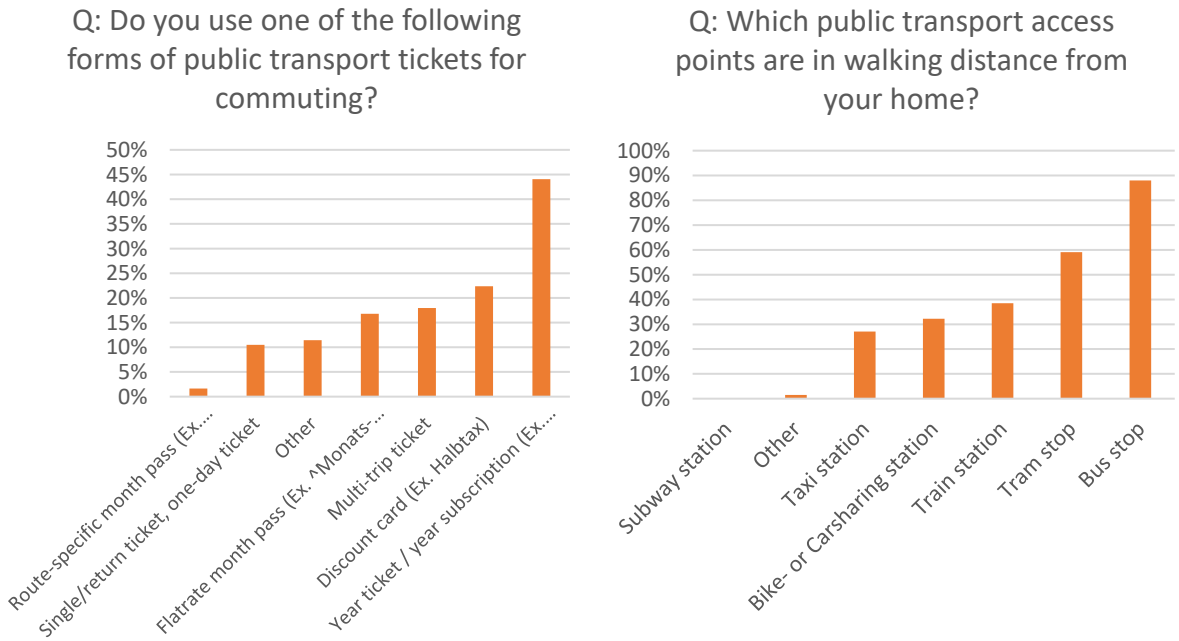


Figure 24: (left): Type of tickets PT-commuters use for their rides, N=429. (right): Accessibility of PT-access points within walking distance of participant's homes, N=540. Percent of the cases (checkboxes), data: ZHAW.

Similar access factors were investigated for public transport users[7]. The most used public transport tickets for commuting were the year tickets / year pass (Figure 24). Around 45% of all participants use this type of ticket for commuting. Less popular for commuting are discount cards (e.g. Swiss Halbtax, around 22%) and single/return tickets (around 10%). This might be due to the high-cumulated costs of these tickets when used on a regular basis.

Another important factor for implementing new public transport (related) offerings is the access to the respective stopping points (train/bus station, but also car sharing stations). The results of these surveyed aspects are displayed in Figure 24. Almost 90% of respondents have access to Bus stops. The very popular tramway in Basel is accessible for around 60% of the respondents and a train station can be reached by foot by roughly 40% of respondents. Bike- and car sharing stations can be accessed by 30% of surveyed commuters.

This confirms the impression that basic access to PT-services are quite good within the Basel area. However, Figure 24 does not indicate how good the overall happiness or e.g. how dense the timetables with the services are. Factors, which would motivate commuters to increase their use for PT, are presented in chapter 4.2.1.7.

4.2.1.4. Reasons and opinions regarding the own commuting behaviour

Another goal of the survey was to assess personal reasons why a certain commuting behaviour persists. Therefore participants, who stated that they occasionally use a specific modality where asked due to what reason they do so. This gives insights to factors that need to be specifically taken into account when creating more sustainable alternatives.

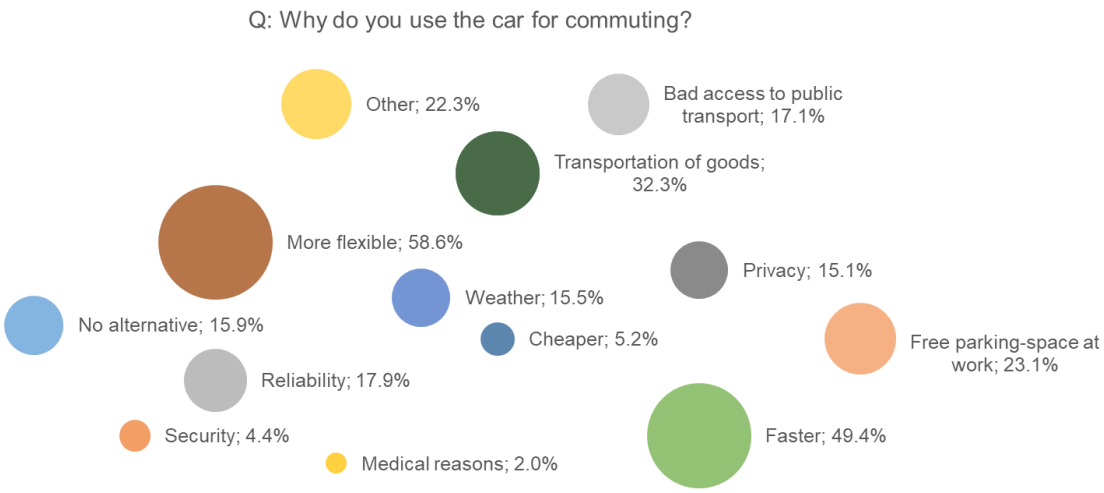


Figure 25: Reasons why respondents use the car for commuting, N=739. Percent of the cases (checkboxes), data: ZHAW.

In Figure 25 these reasons concerning car use for commuting are displayed by filled circles, where the diameter width corresponds to the frequency of mentioning the specific reason. The car users appreciate the high flexibility (58%) and the short travel times(49%) by car. 32.3% of the respondents also stated that they needed the car to transport goods, which is an aspect that new mobility systems like MaaS can easily offer by combining different and more sustainable modes of transport. Another important, often mentioned aspect is the factor “free parking-space at work” (23%). Considering, that surely not all respondents have access to such commodities, this is a quite high value and should therefore be taken into account when performing e.g. mobility management in companies. The price factor “cheaper” is

[7] In our context, PT-users are participants who explicitly stated that they use PT for their commute at least “rarely”.

almost not mentioned (5.2%), therefore car commuters in Basel don't seem to consider their mean of transport as a cheaper alternative, even if PT-ticket prices increased significantly more during the last years compared to car-usage prices (WBF, 2013).

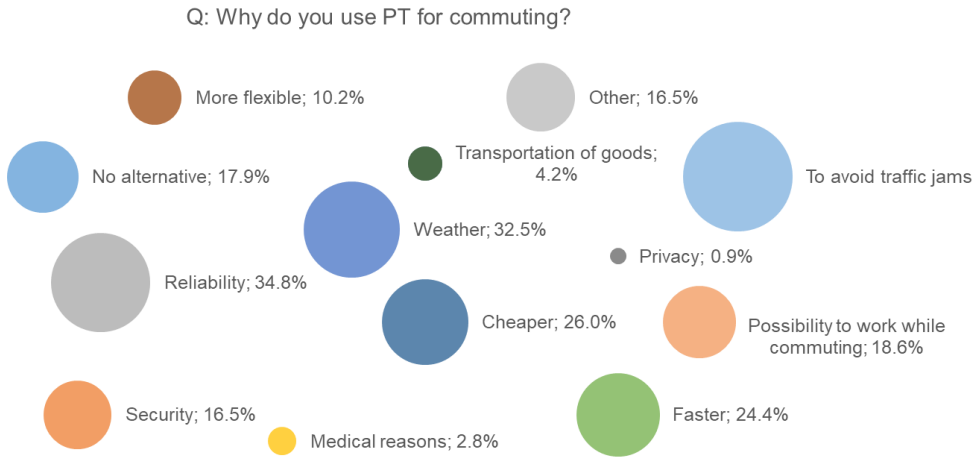


Figure 26: Reasons why respondents use public transport (PT) for commuting, N=1249. Percent of the cases (checkboxes), data: ZHAW.

Interestingly regarding the pricing-context, PT-users consider their mode of transport more often (26%, Figure 26) as a cheaper alternative as other mode of commuting, even if the rise of PT-ticket fares were often publicly debated during the last years, especially within the media (e.g. Schlittler, 2012; SRF, 2016). In addition, some other less expected factors were frequently mentioned. Respondents like the "reliability" (34.8%) and the possibility "to avoid traffic jams" thanks to public transport. The factor "weather" (32.5%) is also quite popular among the respondents, which may be linked to the use of other transport modalities like bicycle, which is less convenient during bad weather. In addition, the factor "faster" (24.4%) seems to have a positive impact on the attractiveness of PT. The factor "possibility to work during commuting" (18.6%) is still a relevant reason for some users, however not for the majority of PT-commuters.

New commuting systems and strategies should therefore build upon these revealed aspects of public-transport. High reliability, fast connections and the possibility to avoid traffic jams can be essential to foster the use of public transport in the first place. In addition, it seems that PT is not considered as being that expensive as suggested by the Swiss media. This finding therefore also shows that PT-users are aware of the real PT pricing. This raises also the hypothesis that price increases for PT (even "hidden ones" like omitting commuting-tax-reductions) would be realized by commuters and may have a mode-switch effect towards less sustainable transport modes.

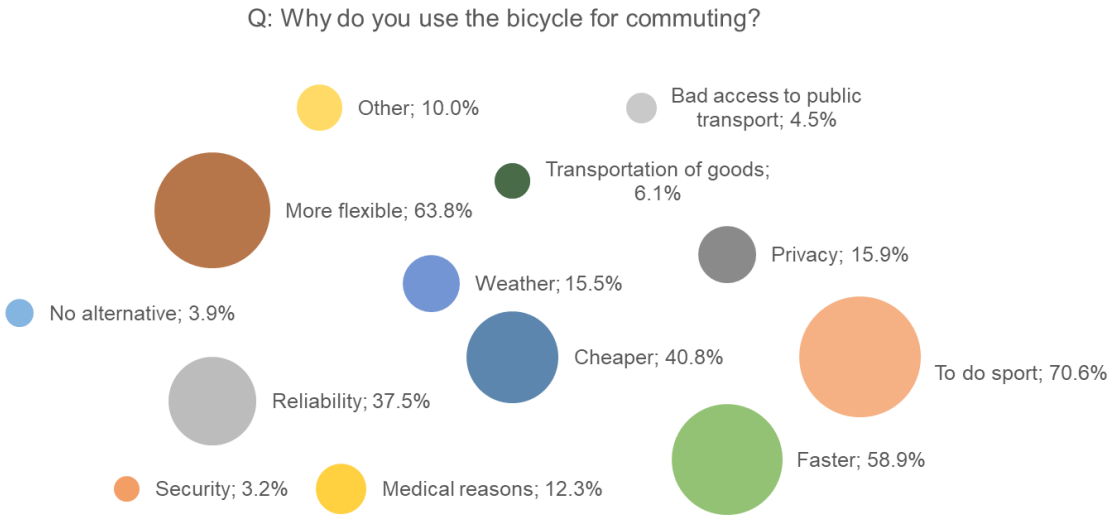


Figure 27: Reasons why respondents use bicycle for commuting, N=1334. Percent of the cases (checkboxes), data: ZHAW.

Considering reasons of why respondents use the bicycle for commuting (Figure 27) it becomes clear that the factor “sport” is on top of the list with 70.6% of all participants mentioning this aspect. Nonetheless, the reason “faster” is also a very strong incentive for using bicycles (58.9%), as are the “flexibility” aspect (63.8%) and because it’s “cheaper” (40.8%).

The price seems therefore to play an important role for PT and bicycle commuters. This needs to be taken into account when designing new mobility systems and offers for commuting, as well as the aspects “flexibility” and travel time. The aspect of “sport” which seem to be a strong incentive for the use of active mobility modes like bicycles can be used in communication and health awareness programs.

4.2.1.5. Combined activities with and within commuting travels

When creating new commuting strategies and offers it is key to create need and user oriented services that address the commuters demands and harmonise with their daily activities. Therefore, these issues were specifically surveyed in the questionnaire. First, participants were asked if they combine workplace commuting with other activities and how often they do so. The results of this inquiry can be seen in Figure 28.

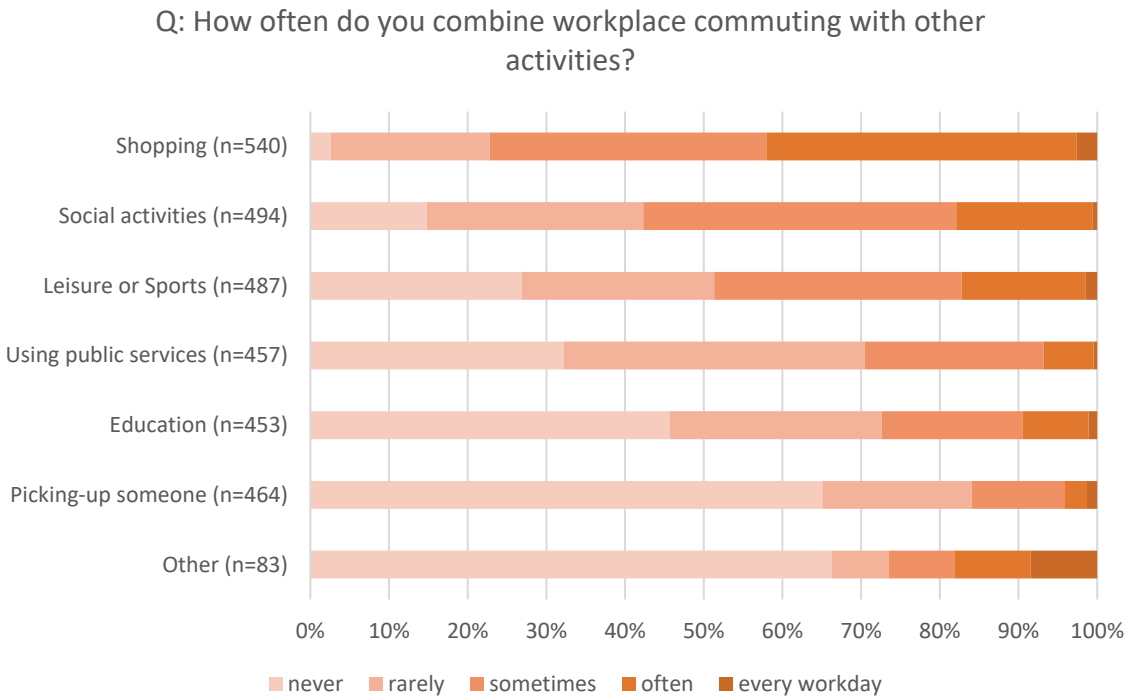


Figure 28: Frequency how often respondents combine other activities with their commuting-travel, data: ZHAW.

As the results show, ways of working are often combined with other activities. 40% of respondents stated that they often combine their ways of working with purchasing activities (Figure 28). Only less than a quarter do this rarely or never. In addition, “social activities” or “leisure” or “sport” are very often combined with commuting travels. The activity of “picking someone” up is rarely combined with commuting.

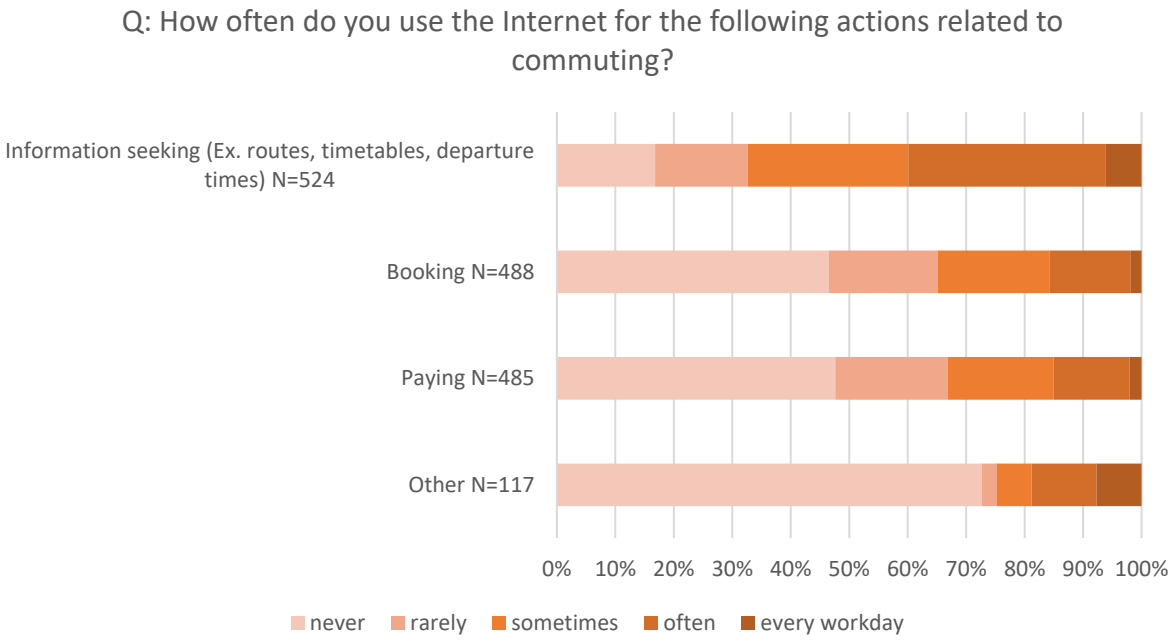


Figure 29: Frequency on how often respondents use the internet for their daily commute, N=524, data: ZHAW.

However, the possible use of new mobility systems (e.g. MaaS) often requires that users are digitally networked and willing to be informed regularly about the ideal design of their commuting paths. A large number of commuters stated that they already frequently (33.2%) or every working day (6.3%) consulted the internet for information searches (timetables or route information) (Figure 29). Using the internet for booking and paying of the travel is done rarely. One of the reasons could be that Basel has a generally high proportion of public transport subscriptions, which often only have to be paid once a year (chapter 4.2.1.3).

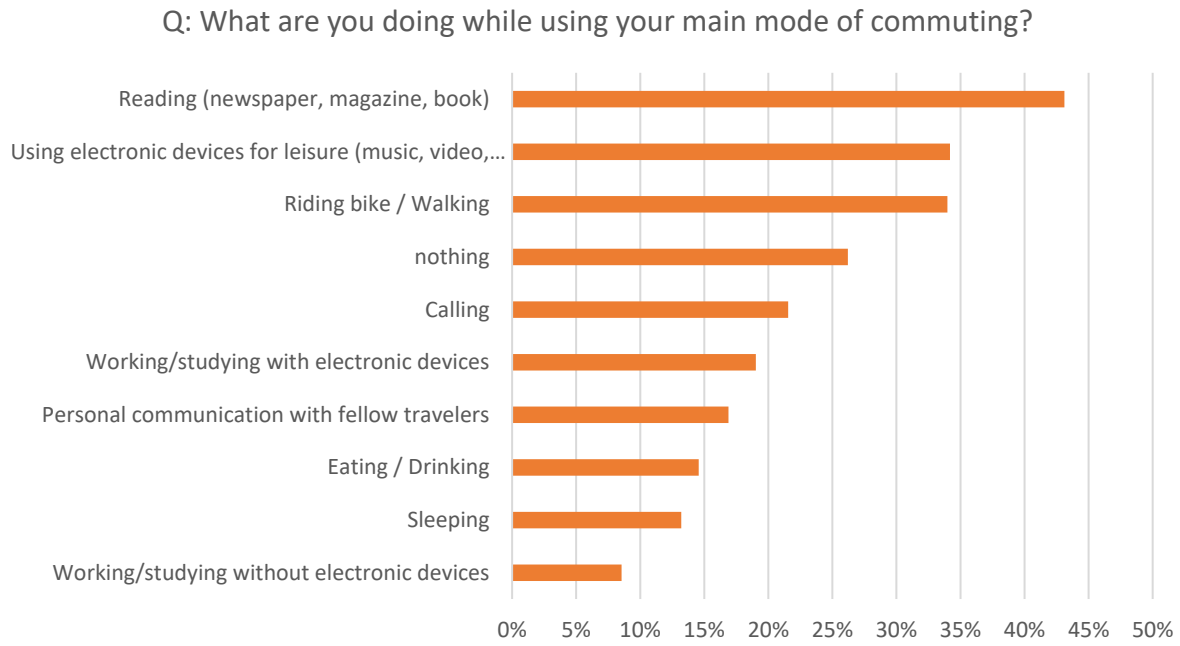


Figure 30: Activities respondents perform during their commute, N=1191. Percent of the cases (checkboxes), data: ZHAW.

The activities during commuting can be relevant when designing new commuting systems. Therefore, this aspect was surveyed within the questionnaire (Figure 30). People primarily (43.1%) stated that they were reading classical print media like newspapers or books. Furthermore, the use of electronic devices was at the forefront of the mentioned activities during commuting travels (34.2%). The activities indispensable for the use of active modes, using a bicycle or walking were mentioned third mostly.

The activity “working/studying” was not mentioned often and even ranked behind “calling someone” (21.6%). However, the answer possibilities were split into “working with electronic devices” (19%) and “working/studying without electronic devices” (8.5%). Therefore, it seems that the working activities are quite limited during commuting. They are however performed dominantly with electronic devices. The question, however, if this is due to missing prerequisites of the current mobility systems has been elaborated in chapter 4.2.1.7.

4.2.1.6. Satisfaction with current commuting situation

Further parts of the survey addressed satisfaction with the current commuting situation and options to change it for the better. They included items that were based on conditional questions (e.g. willingness to consider change). The results of those items are presented in Figure 31.

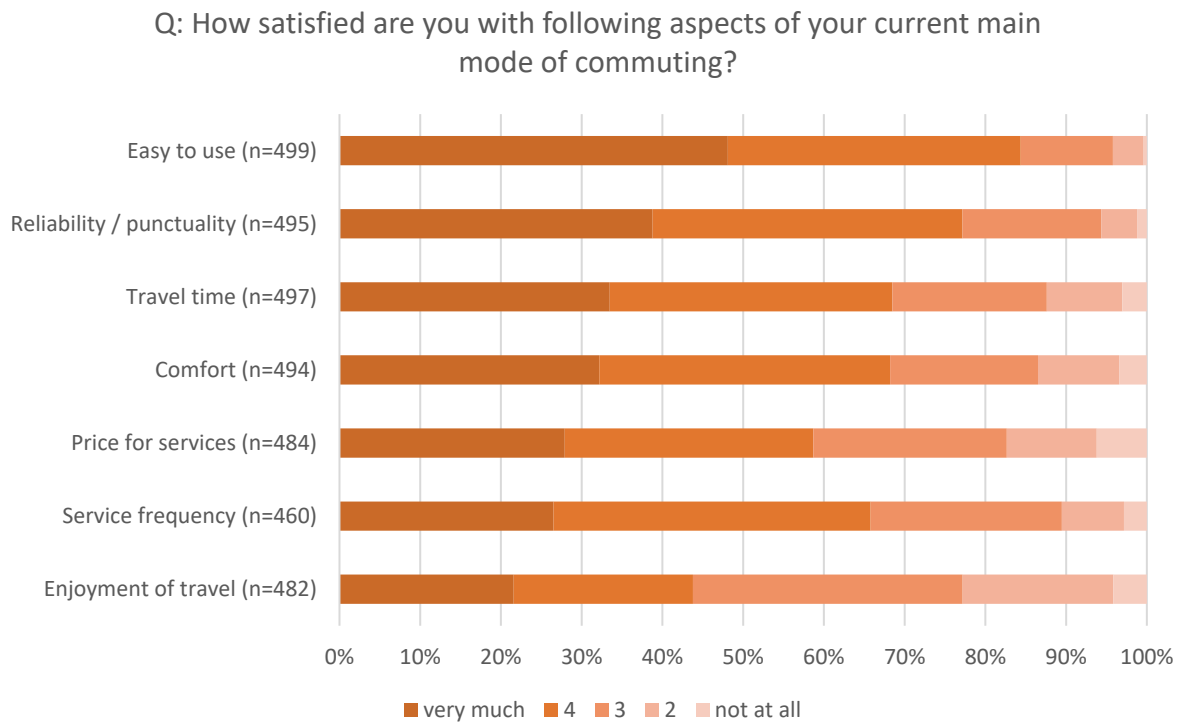


Figure 31: Satisfaction with the current commuting situation, data: ZHAW.

What becomes apparent is the fact that of all aspects despite “enjoyment of travel”, the “very good” to “neutral” categories are dominant. This reveals a big potential for new mobility systems in terms of unsatisfied happiness of the commuters. Only around 42% of commuters are “very much” or “rather” satisfied with their enjoyment of travel.

4.2.1.7. Openness for change

Although more sustainable forms of mobility have the potential to meet the needs of commuters (see previous chapters), this does not necessarily mean that these possibilities are actually accepted. As such, the lack of openness of commuters to new forms of mobility poses a challenge (Figure 32).

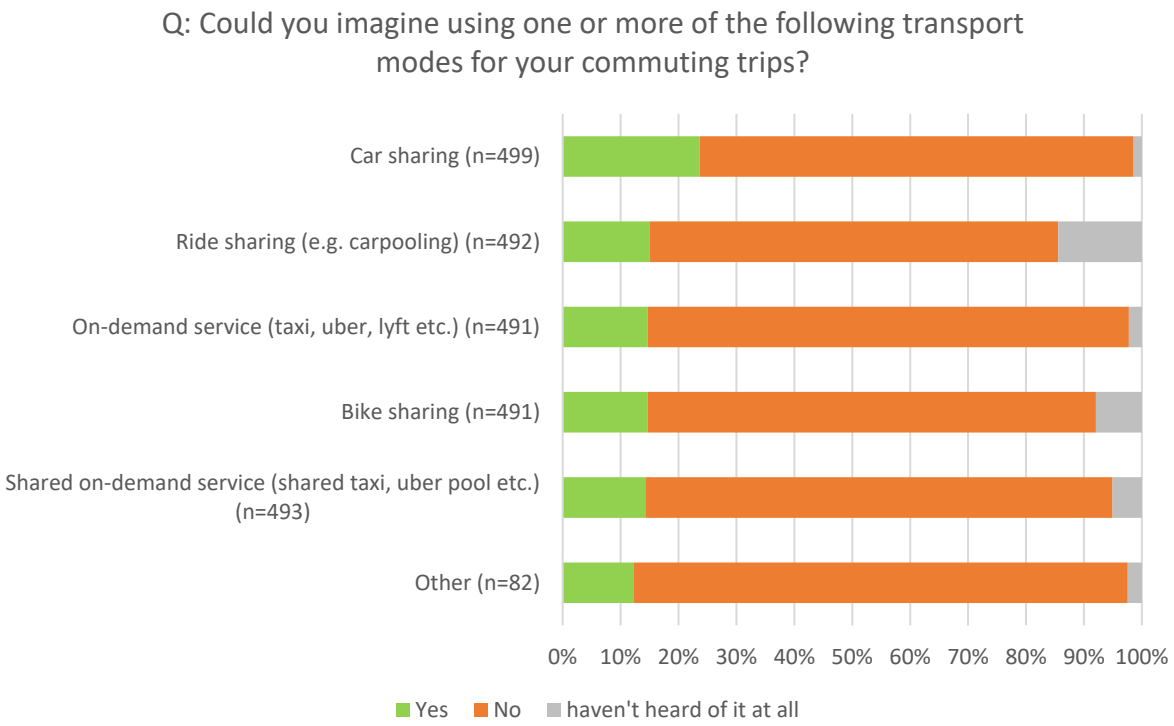


Figure 32: Openness of commuters for using another mode of transport for their commuting trips, N=499, data: ZHAW.

Just under a quarter of the surveyed commuters could imagine driving to their workplace by “car sharing”. For other modes of transport, the openness is even lower. Only about 15% of the surveyed commuters are open to “(shared) on-demand services”, “bike sharing” and “ridesharing”. Participants were also able to mention other transport modes in an open-format question if they ticked the “Other” answer option (12,2%). Additional transport modes mentioned were E-Bike sharing, Inline Skates and sharing possibility with an ordering option (vehicles are brought to the desired location).

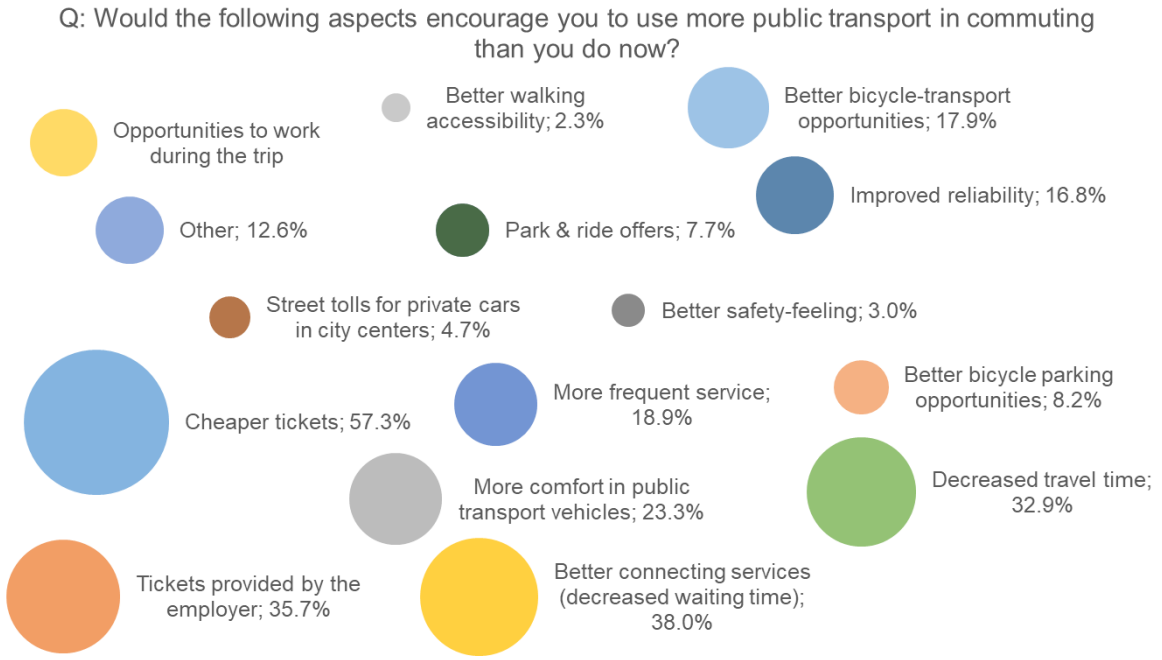


Figure 33: Aspects, which could encourage the use of PT, N=1308. Percent of the cases (checkboxes), data: ZHAW.

Public transport is generally considered as a more sustainable alternative to automotive individual mobility. Therefore, the survey also comprised a question about factors that would motivate participants to use more public transport. These results are shown in Figure 33. On top of the list is the item “cheaper tickets”. This supports the hypothesis that commuters are indeed price-aware travellers. The results show other starting points for new mobility services. The complete integration of various transport services, e.g. as public transport access roads, can reduce waiting times (38%) or overall travel time (32.9%) and therefore increase attractiveness of public transport.

These results also support the interpretation regarding the current reasons why people use public transport (chapter 4.2.1.4). Issues addressing ticket prices and travel times seem to have a strong influence regarding the use of public transport.

4.2.1.8. Commuting behaviour and characteristics of specific user groups

To further gain insights to characteristics of specific user groups, numerous cross table analysis were performed. The most significant are presented in the present chapter.

First, a spatial based analysis regarding the mean satisfaction with the current commuting mode was performed. As such, a “satisfaction index” was created by calculating the mean values of all satisfaction items queried in the survey and taking the overall mean of these means. This overall satisfaction index was then calculated for every municipality in the Basel area and visually presented (Figure 34).

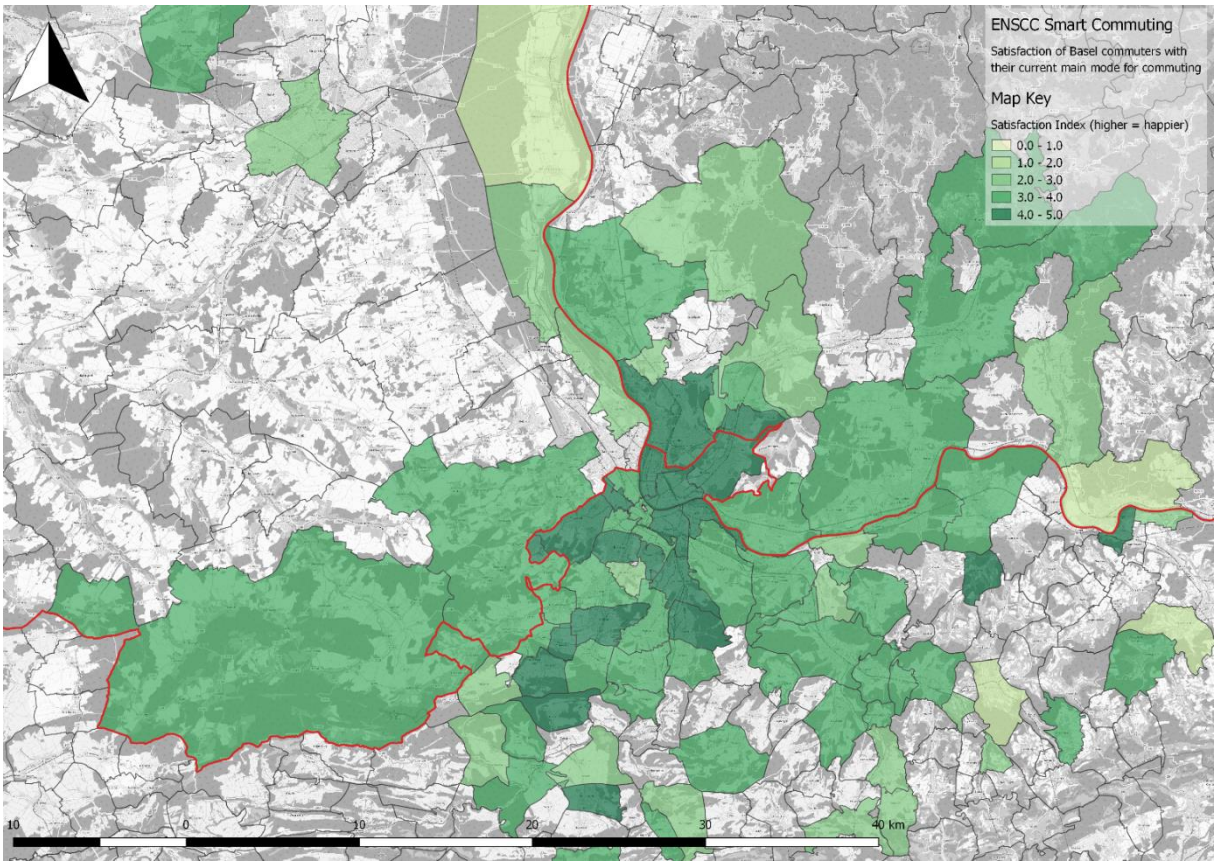


Figure 34: Mean satisfaction index for every municipality in the Basel-area, data: ZHAW. Geodata: © OpenStreetMap contributors.

It became apparent that the satisfaction is definitely higher within the larger municipalities, generally fitted with better mobility services. While this insight for itself is not surprising, it highlights a big issue that during the next years, the biggest growth in terms of jobs and citizens will occur in the surroundings of the larger areas (see Haerri et al., 2018a). The issue of low satisfaction with the commuting situation is therefore likely to get even worse if no countermeasures are taken.

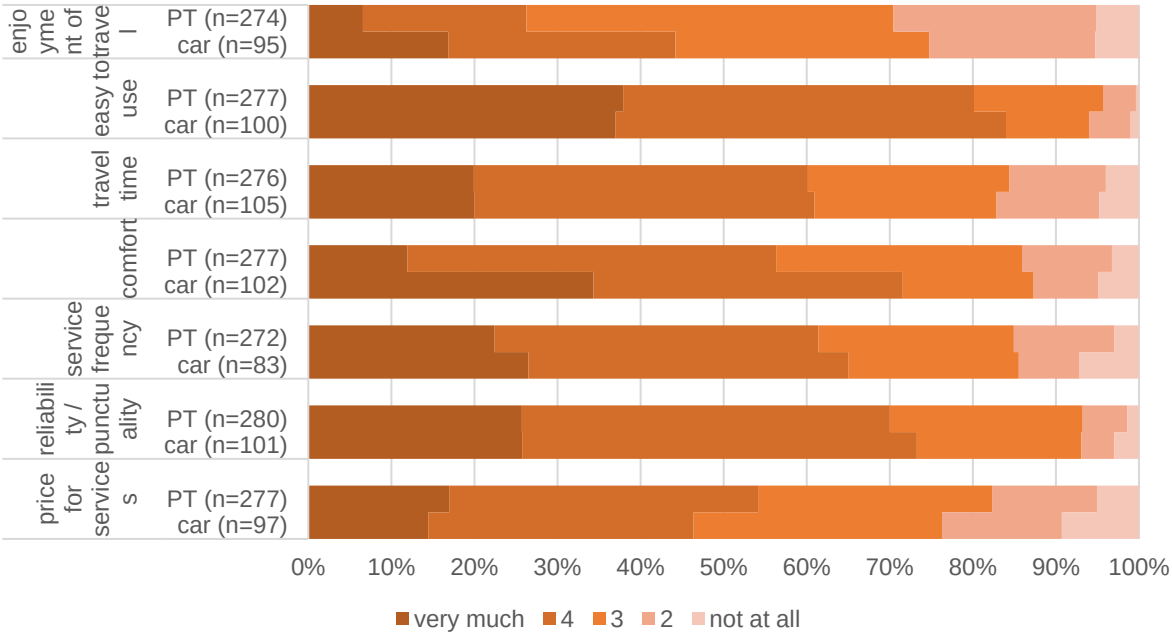


Figure 35: Satisfaction of car-users and PT-users, data: ZHAW.

Another interesting cross-variable comparison regarding satisfaction has been conducted between PT-users and car-users (Figure 35). The analysis revealed a difference in satisfaction, especially concerning “enjoyment of travel”. While 40% of the car-users belong to the very much or rather satisfied category, PT-users share this same view by only 25%. Similar differences can be observed within the category “comfort“ (car: 71%, PT: 56%). The only factor, where PT users are more satisfied than car users, is the item “price for service”. This corresponds with the commuter’s stated reasons and opinions of why they use their respective modality.

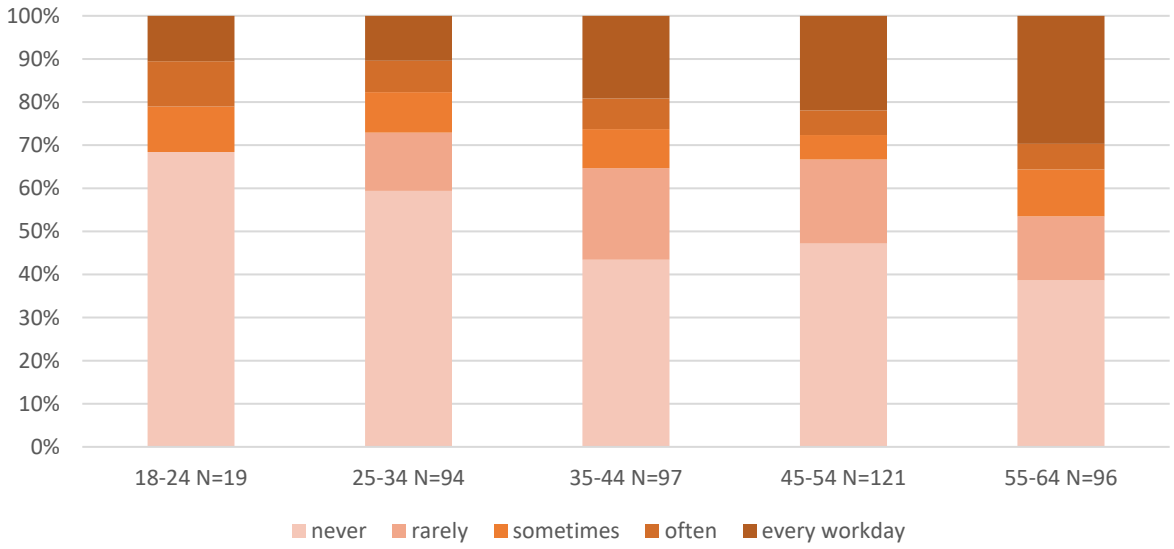


Figure 36: Frequency of car use of different age classes, data: ZHAW.

Figure 36 shows the frequency of car use (as a driver) in commuting for different age groups. What becomes apparent is the trend that the older someone is, the more often she/he uses the car. 68% of young people (age category 18-24) “never” use the car for their commuting travels. For the next older

category (25-34 y.o.) this value sinks to 59%. However, respondents of this age category use the car less often “every workday” or “often” than the younger category. The next older age category (35-44 and 45-54) uses the car clearly more often, only 43% resp. 47% never use the car for commuting and the “often” and “every day” values are clearly higher. Within the oldest age category (55-64 y.o.), only 39% of the respondents “never” use the car for their commute.

By default, this corresponds to a trend, which can also be observed within other studies (e.g. Swiss microcensus). Young people showed a decreasing interest in automotive mobility, which showed itself e.g. within lower driving licence possession. However, it may seem that a peak in this development is reached. Within the last Swiss microcensus (2015) it became apparent that the reduction of driving licences among young people stopped. In the Basel commuter survey, similar effects can be seen: While young people (18-24) show the highest percentage of never using the car for commuting among respondents, they us it more often “every workday” or “often” than the next older category (25-34).

4.2.2 **Classification of commuter groups**

Cluster analysis is a tool applied in various disciplines, but especially for marketing research (Sarstedt and Mooi, 2014). The goal of clustering is to identify homogenous groups of objects (also referred to as observations or cases) from a collection of records (Gelbard et al., 2007). As such in marketing research, markets can be clustered into segments of customers with similar needs, which are then easier to target by firms (Sarstedt and Mooi, 2014). Cluster analysis can also help policy makers by grouping the population into segments with different characteristics (such as household income, residence location, gender, etc.) which can then be targeted by specific policy strategies. Many different researchers already applied cluster analysis in transportation research (see e.g. Semanjski and Gautama, 2016; von Berg and Graff, 2016). Still, a typification of commuter groups has not yet been undertaken in Switzerland. Due to its complexity, the clustering method was a niche application used by specialists. However, many different statistical packages that can easily perform various clustering methods exist today (Filho et al., 2014). One of the newer clustering method is the so-called two-step approach. It combines the advantages of methods like the popular hierarchical method and k-means procedure. Additionally, the two-step approach allows the use of continuous as well as categorical variables in the same model, which does not apply to the other two methods. Another advantage of the two-step clustering is that the algorithm determines the optimal number of clusters automatically and therefore mitigates perception bias. The algorithm also processes big datasets very fast (Sarstedt and Mooi, 2014). Gelbard et al. (2007) conclude that the two-step clustering algorithm outperforms other clustering methods. Considering the fact, that both continuous and categorical variables are present in our study and we do not know the optimal cluster beforehand, the two-step clustering method was used to analyse the survey.

Four different procedures ensured high quality of the cluster solutions and the further analysis. First, all variables were checked for correlation to ensure that no variables had higher correlations than 0.8, preventing overrepresentation of specific aspects of a variable in the cluster analysis (Sarstedt and Mooi, 2014). Second, the sample size should be reasonable for the number of variables used in the cluster analysis. Formann (1984) suggests a minimum sample size of 2^m with m depicting the number of variables. With a sample size of at least 300 and a maximum number of variables used of seven, we stay in the proposed minimum. Further, the data was screened for unreasonable combination of answers and outliers. Lastly, ordinal logistic regression (OLR) and multinomial logistic regression (MLR) were conducted to find relevant, influential variables.

As a starting point, three variables of interest, namely *enjoyment of travel, openness to car-/ridesharing* (see Table 4 for the definition of this variable) and *mode choice* were set as anchoring points, also referred to as dependent variables (DV), in the cluster analysis. It was hypothesised that these variables are key to sustainable commuting and that groups with specific characteristics of these parameters enable more targeted policy strategies. Then, all variables described in Table 4 were included in the two-way cluster analysis and the SPSS statistics software output was analysed according to several criteria. We checked the goodness-of-fit measure called “silhouette measure of cohesion and separation”, equal cluster size distribution and high cluster building influence of the variables of interest according to which we finally evaluated the usefulness of the cluster structure for policy implementation.

Variables were changed using heuristics and checked for improvement of these cluster quality criteria. At the same time, OLR and MLR with the three variables of interest (*enjoyment of travel*, *openness to car-/ridesharing* and *mode choice*) and the independent variables (IV) were conducted to complement the cluster building process. As such, all IVs and their 2-way interactions were included in the regression. This allowed us to have a better understanding of the correlation between variables. No 3-way interactions were explored, as the model would get too big and complicated for the scope of this study. In a step-wise procedure, all non-significant interaction terms were eliminated from the model until only significant interaction terms remained present. Next, each separate variable was eliminated, if it did not improve the model significantly (i.e. improving the model fit or pseudo R^2). Thus, only variables with significant effect on the dependent variables were explored more closely in the cluster analysis.

Table 4: Overview of dependent (DV) and independent (IV) variables used in the regression and cluster analysis.

Variable	Definition
Dependent variable (DV)	
Enjoyment of travel	1, Very low; 2, Low; 3, Medium; 4 High; 5, Very high
Openness for car-/ridesharing	Indicates if a respondent is willing to use car-/ridesharing in the future: 0, Never; 1, Either willing to use car- or ridesharing; 2, Willing to use both car- and ridesharing
Dominant mode choice	1, Multimodal; 2, Private motorized (acts as reference in the MLR); 3, Public Transport; 4, Active modes (bicycle, walking)
Independent variable (IV)	
Dominant mode choice	1, Multimodal; 2, Private motorized; 3, Public Transport; 4, Active modes (bicycle, walking)
Household size	1, Single person; 2, Small (2-3p); 3, Large (gt3p)
Residence location	1, Rural; 2, Semi-urban; 3, Urban or centre
Driving licence	1, Yes; 2, No
Gender	1, Female; 2, Male
Combination with other activities*	How many times a participant indicated to combine commuting with other activities at least often, from 0 to 6 activities
Commuting time*	Total daily time used for commuting in minutes
Income per active person	Income of household members considered active (working or studying) in CHF (EUR for AT,FIN)
Age	Age of the respondent in years

* Marks variables only used in the cluster analysis.

4.2.2.1. Influential parameters for sustainable commuting

This chapter describes the usefulness of the OLR and MLR and the effect of the IVs on the DVs starting with the DV *enjoyment of travel,* following *openness to car-/ridesharing* and *mode choice.*

Parameter's influence on *enjoyment of travel*

The Omnibus test of model coefficients was statistically significant, χ^2 (*df* = 12, *N* = 330) = 94.218, *p* = < 0.001, indicating that the IVs improved the model compared to the baseline model without any variables and can therefore significantly predict the DV *enjoyment of travel*. The Cox & Snell and the Nagelkerke R squared estimates showed that the model explained between 25% and 26% of the variance from the DV, which is considered high enough for further analysis. The Wald chi-square statistic (Wald χ^2) was used to test the statistical significance of individual regression parameters (B). The variables mode choice ($p < 0.001$) and commuting distance ($p < 0.05$) have a significant effect on enjoyment of travel. Yet, the Wald statistic suggest that the effect of mode choice is much stronger than the effect of commuting distance. For a more intuitive comparison of this effect, the odds ratio for mode choice on the enjoyment of travel can be calculated using the exponent of the parameter estimates B of the respective ratio of interest. The odds ratio gives the effect difference between categories of an IV on a DV. As such, it is 5 times more likely to have a higher enjoyment of travel when using active modes as compared to using private motorized transport. The difference is even higher between active modes

and public transport (factor 9), indicating that active modes are generally associated with a much higher enjoyment of travel compared to other modes. If the IV is continuous (e.g. age), the odds ratio states the effect on the DV from a one unit increase of the IV. The odds ratio of commuting distance is 0.992. Thus, a one-unit increase in commuting distance leads to a 0.8% decrease in the likelihood to be in a higher level of enjoyment of travel. As commuting distance is a continuous variable, the effect can be multiplied by the respective value of interest. For example, a 10km increase in travel distance leads to an 8% decrease in likelihood to be in a higher level of enjoyment of travel.

Parameter's influence on *openness to car-/ridesharing*

The Omnibus test of model coefficients was statistically significant as well, χ^2 (*df* = 15, *N* = 333) = 38.962, *p* = < 0.001, indicating that the IVs improved the model compared to the baseline model without any variables, and can significantly predict the DV *openness for car-/ridesharing*. The Cox & Snell and the Nagelkerke R squared estimates showed that the model explained between 11% and 14% of the variance from the DV, which is rather low but still usable for an explorative analysis. Despite the low R^2, the Hosmer & Lemeshow test of the goodness of fit suggested the model is a good fit to the data as the chi-square statistic was non-significant *p* = 0.585 (> 0.05). It compares the existing estimated model (H0: Estimated model) to a more complex one (HA: Complex/Saturated model) and hence a non-significant result means that there is no lack of fit in the estimated model. Again, the Wald chi-square statistic (Wald χ^2) was used to test the statistical significance of individual regression parameters (B) (see Appendix 15.2).

The variables *gender, age* and the interaction between *mode choice* and *gender* were found to be significant on the *p* = 0,05 level. The Wald chi-square statistic suggests that age is the strongest predictor of *openness to car-/ridesharing*, followed by *gender* and the interaction. The odds ratio of age is 0.965. Thus, a one-unit increase in age leads to a 3% decrease in likelihood to be in a higher level of *openness for car-/ridesharing*. Again, age is a continuous variable; the effect can be multiplied by the number of years. As an example, a 10-year increase in age leads to a 36% decrease in likelihood to be in a higher level of *openness to car-/ridesharing*. Gender interacts with mode choice and as such, cannot be interpreted alone. The calculation of the odds ratio reveal that male commuters using multimodal modes are 4.5 times more likely to be in in a higher level of *openness to car-/ridesharing* than their female counterparts. Likewise for public transport (by the factor 2.9) and active modes (by the factor 4.9). Yet for private motorized transport, the odds ratio of male/female is 0.5, defining the interaction. Figure 37 depicts this phenomenon in a line graph with the y-axis representing the overall openness score (the higher the more open). This interaction could be explained by men still seeing the car as a means of status symbol and thus are less willing to share their car or even restrain from owing a personal car. On the other hand, woman see less need to car- or ridesharing if they mainly not use private motorized transport for commuting.

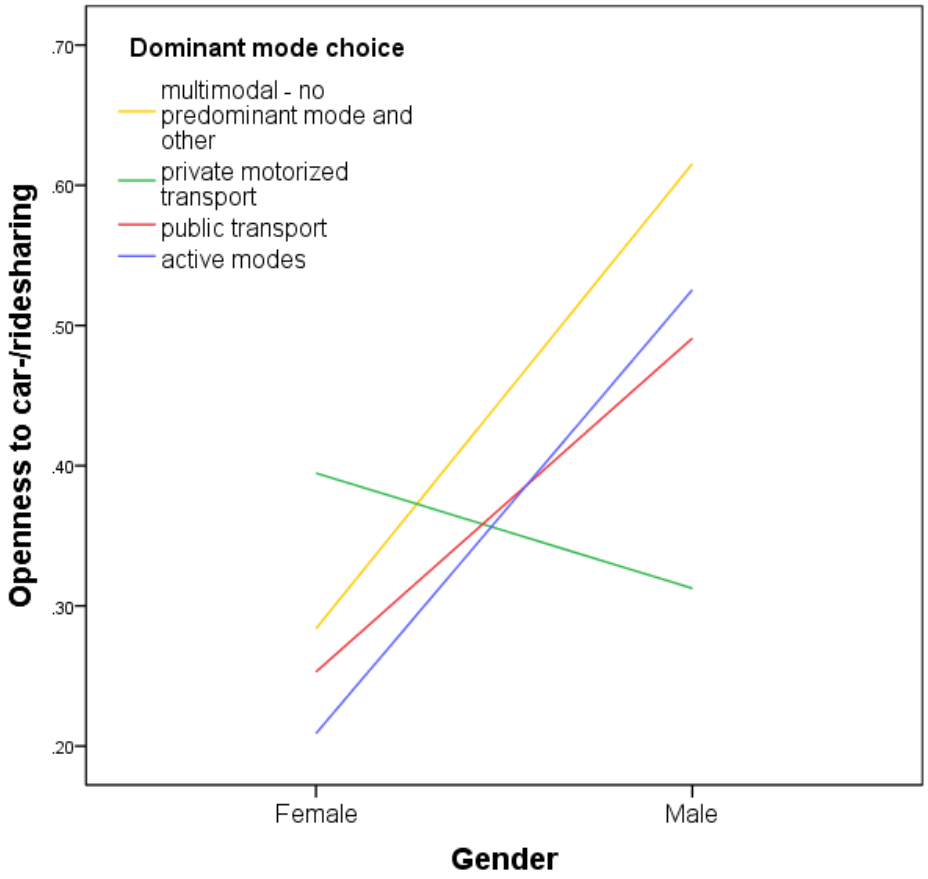


Figure 37: Difference in the openness to car-/ridesharing between female and male commuters, data: ZHAW.

Parameter's influence on *mode choice*

In the third logistic regression analysis, the variables listed in Table 27 (see appendix) were tested for significant effects on the mode choice for commuting. As the variable mode choice is a categorical variable with no meaningful distance between categories, multinomial logistic regression was used.

The Omnibus test of model coefficients was statistically significant, χ^2 (*df* = 27, *N* = 370) = 169.375, *p* = < 0.001, indicating that the IVs significantly improved the model compared to the baseline model without any variables, and can significantly predict the DV *mode choice*. The Cox & Snell and the Nagelkerke R squared estimates showed that the model explained between 37% and 39% of the variance from the DV. The Wald chi-square statistic values in Table 27 were used to test the statistical significance of individual regression parameters (B).

By investigating whether multimodal or private motorized transport (which is the reference category in Table 27) is preferred for commuting, the variables *residence location*, *gender* and *commuting distance* were found to be significant on the *p* = 0.01, *p* = 0.05 and *p* = 0.05 level. The first two variables also significantly influenced the likelihood to prefer public transport over private motorized transport. Commuting distance does not seem to have an effect on the preference of public transport over private motorized transport. Commuters are significantly less likely to prefer active modes over private motorized transport when residing in rural or semi-urban areas as compared to residing in the city. Further, female commuters seem to be slightly more likely to use active modes instead of private motorized transport compared to men and a higher commuting distance strongly increased the likelihood to choose private motorized transport for commuting instead of active modes.

In sum, commuters are more likely to choose private motorized transport over multimodal (by factor 3), public transport (by factor 5) or active modes (by factor 13) for their commuting travel when living in a rural environment, compared to commuters living in the city. The second conclusion is that women show

a higher likelihood to choose multimodal (by factor 3), public transport (by factor 2) or active modes (by factor 2) over private motorized transport compared to men. A 10km increase in commuting distance would lead to a higher likelihood to choose multimodal modes (17% increase) and public transport (9% increase) over private motorized transport for commuting, respectively. Lastly, the same increase in distance would lead to a 73% decrease in likelihood to use active modes over private motorized transport.

4.2.2.2. Results – classification of commuters

In this section, a summary of the cluster quality and an in-depth descriptive analysis of the different clusters is conducted. Further, the clusters are analysed on their specific commuter groups and properties, which defines how these different user groups should be approached for a sustainable change in commuting. Two different cluster solutions were found. The first includes the variables of interest *enjoyment of travel* and *mode choice*, hereby referred to as the **socio-economic cluster**. The second includes the variables of interest *openness to car-/ridesharing* and *mode choice*, hereby referred to as the **openness to car-/ridesharing cluster**.

Classification based on socio-economic characteristics

The socio-economic cluster consists of seven variables building four clusters. The Goodness-of-fit measure lies just in the fair range; as such, the interpretation of the clusters should be taken with care (see Figure 38). Despite the fair cluster quality, the cluster size is very similar across all four clusters with the smallest consisting of 68 cases and 99 cases for the largest, respectively. The variables have different influences on the formation of the clusters, which is shown in Figure 39. Our variable of interest is *enjoyment of travel*, having a considerable influence on the cluster formation. The most influential variable is *household size*, following *mode choice* and *residence location*. *Commuting time*, *combination of commuting with other activities* and *income per active person* play a less important role in the cluster formation.

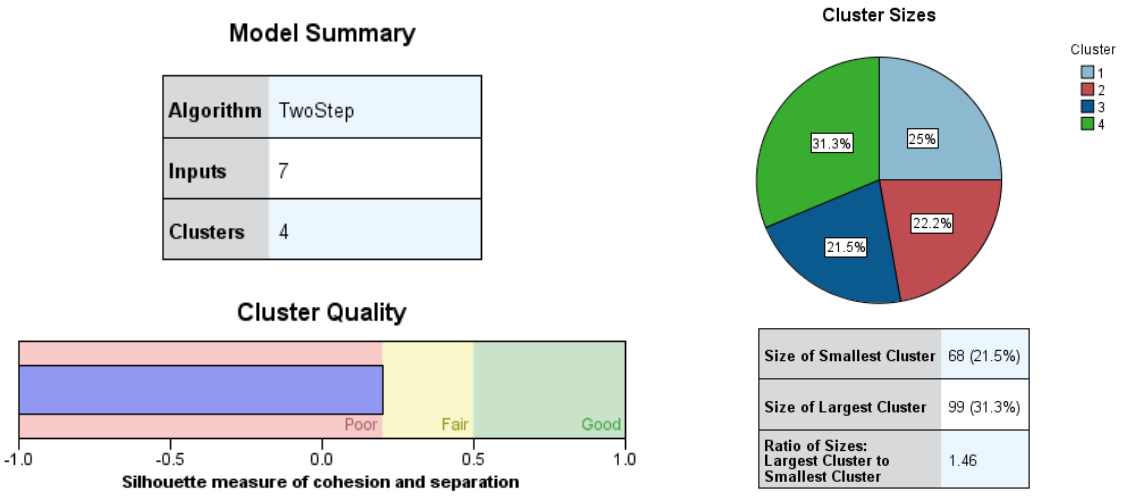


Figure 38: Model summary and cluster size output from the socio-economic cluster analysis, data: ZHAW.

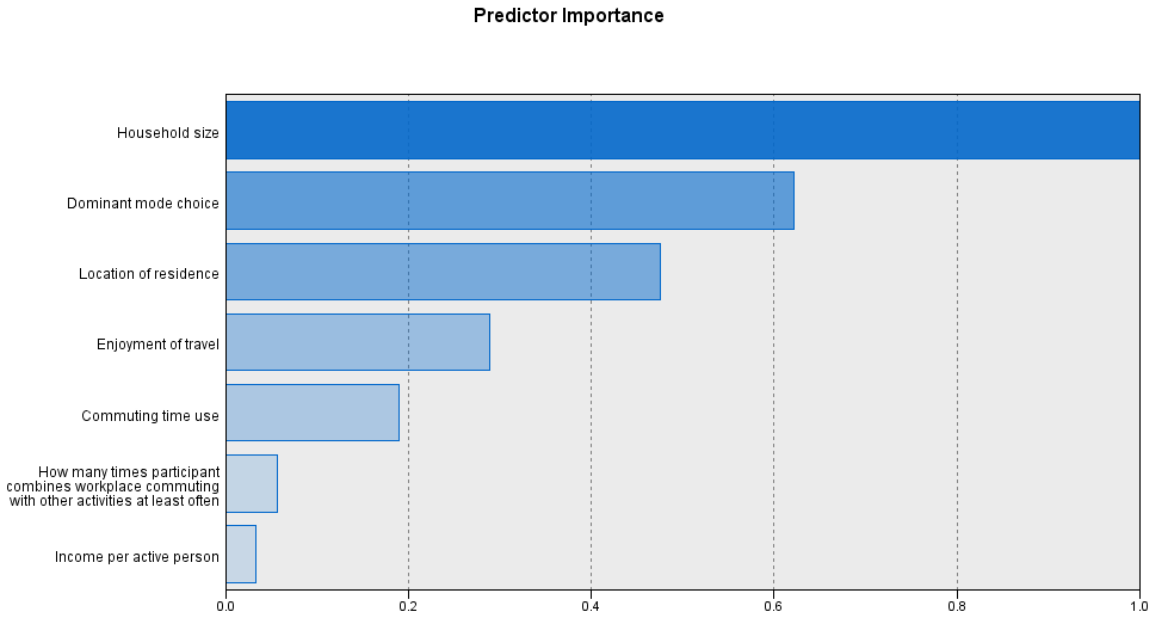


Figure 39: Predictor importance output from the socio-economic cluster analysis. The closer the variable is to 1, the higher is its importance in cluster formation, data: ZHAW.

The four clusters differ in their values for all seven variables defining the groups. As such, Figure 40 to Figure 45 visualize these differences starting with the most influential variable *household size*. While cluster 1 and 4 have approximately the same distribution for said variable, cluster 2 and 3 are quite different.

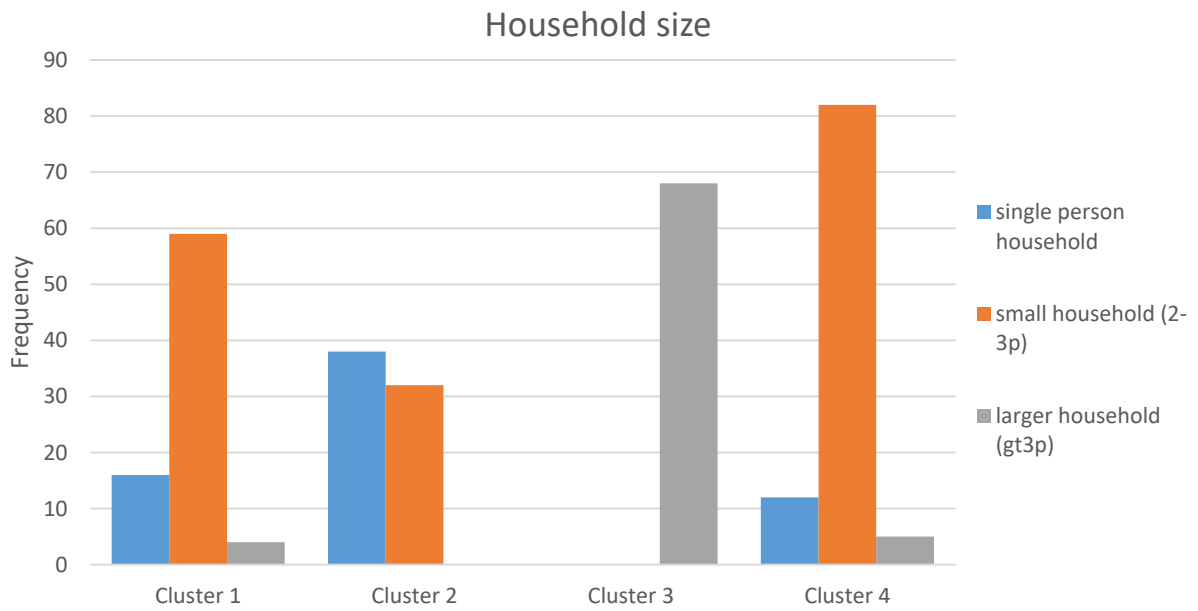


Figure 40: Distribution of household size in each socio-economic cluster, data: ZHAW.

Even though cluster 1 and 4 are similar in household size distribution, they strongly differ in their dominant mode choice. Cluster 2 and 3 are easily distinguishable as they represent the public transport commuters and multimodal commuters, respectively (Figure 41).

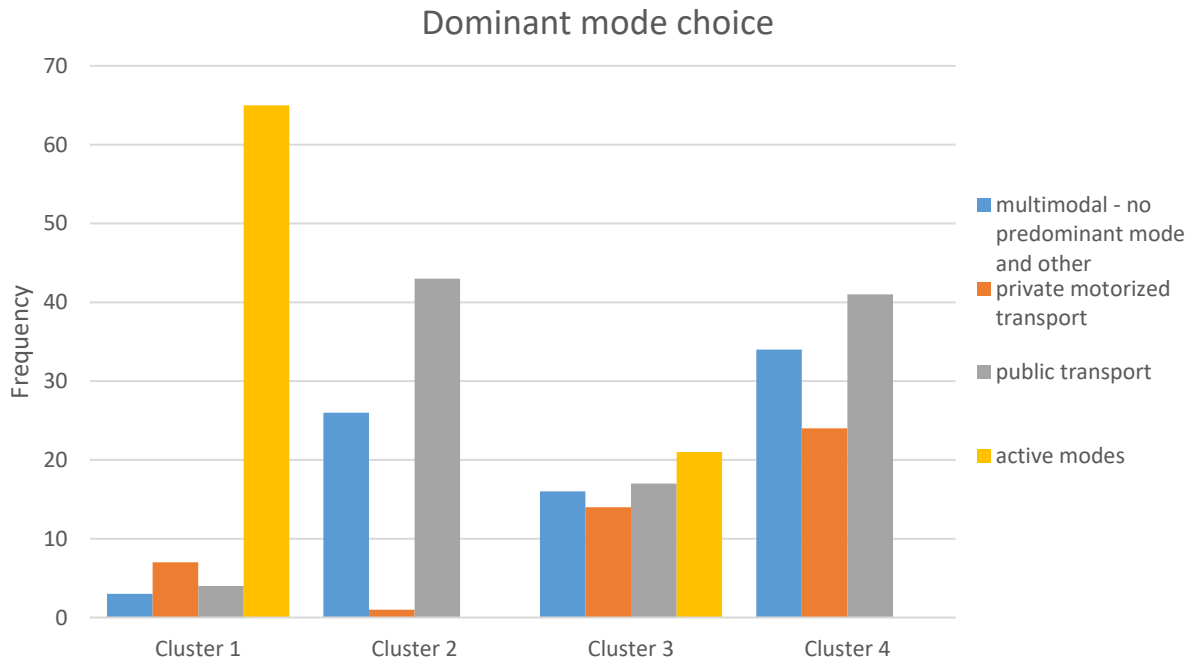


Figure 41: Distribution dominant mode choice in each socio-economic cluster, data: ZHAW.

A slight similarity can be found between cluster 1 and 2 in respect to residence location distribution as they both dominantly contain residents from an urban environment (Figure 42). Cluster 3 has an even distribution across residence location and cluster 4 is dominated by rural residents.

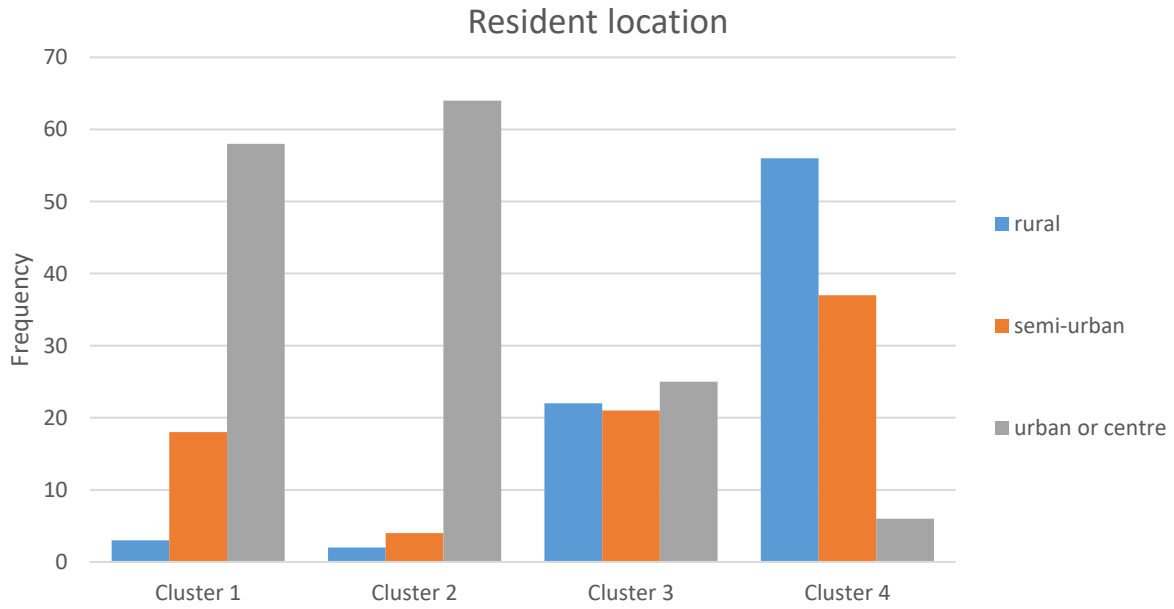


Figure 42: Distribution of residence location in each socio-economic cluster, data: ZHAW.

Regarding the variable *enjoyment of travel*, cluster 1 stands out among the four clusters as it shows a much higher enjoyment. Cluster 2 and 4 stay in the medium range while cluster 3 is slightly above average in enjoyment of travel (Figure 43).

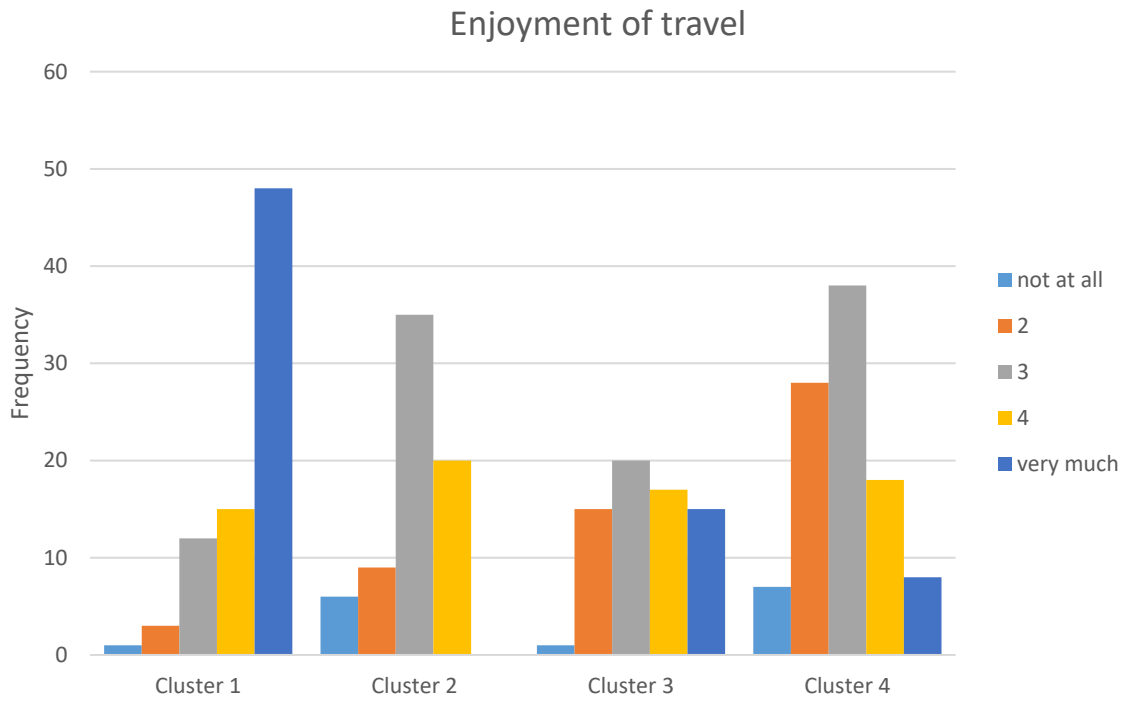


Figure 43: Distribution of enjoyment of travel in each socio-economic cluster, data: ZHAW.

As the variables get less important in the cluster forming, it gets more complicated to distinguish the clusters from each other (refer to Figure 39). This is the case for the variable “combination of commuting with other activities”. While cluster 3 clearly has a lower average value than the other three clusters, cluster 1, 2 and 4 are quite similar and the difference is negligible.

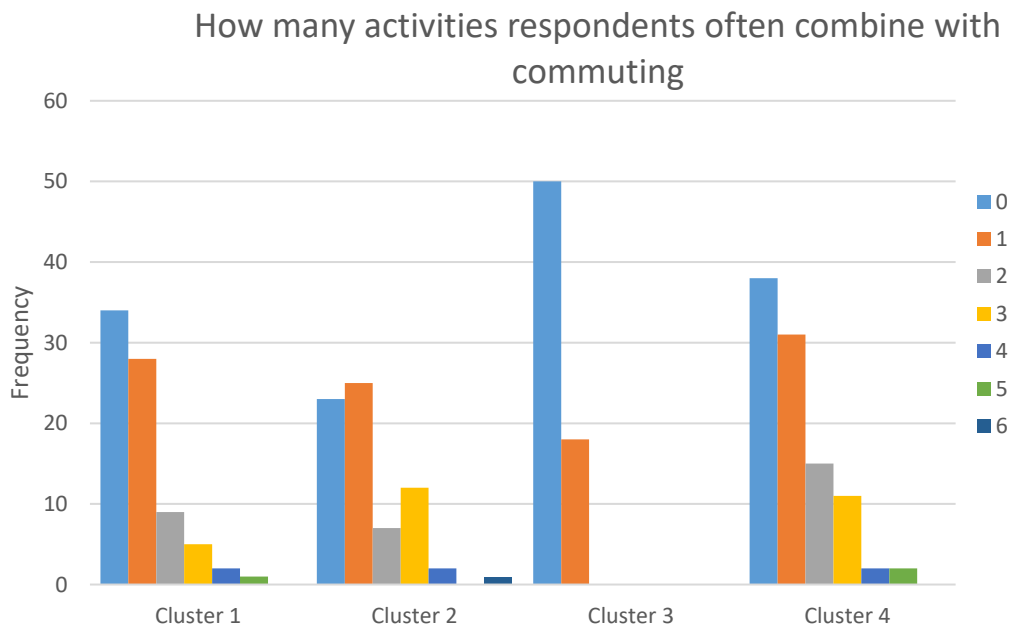


Figure 44: Combination of commuting with other activities in each socio-economic cluster, data: ZHAW.

Lastly, the clusters differ by the *daily commuting time use* and *income per active person*. Time use for commuting has a considerable influence and as such, the clusters can be separated accordingly. Cluster 1 has a very low commuting time compared to the remaining clusters, while cluster 2 clearly shows the highest time use and cluster 3 and 4 stay in a medium range. Income per active person has the lowest cluster building influence and does not strongly differ across cluster 1 to 3, yet cluster 4 has a considerable higher income per active person than the rest.

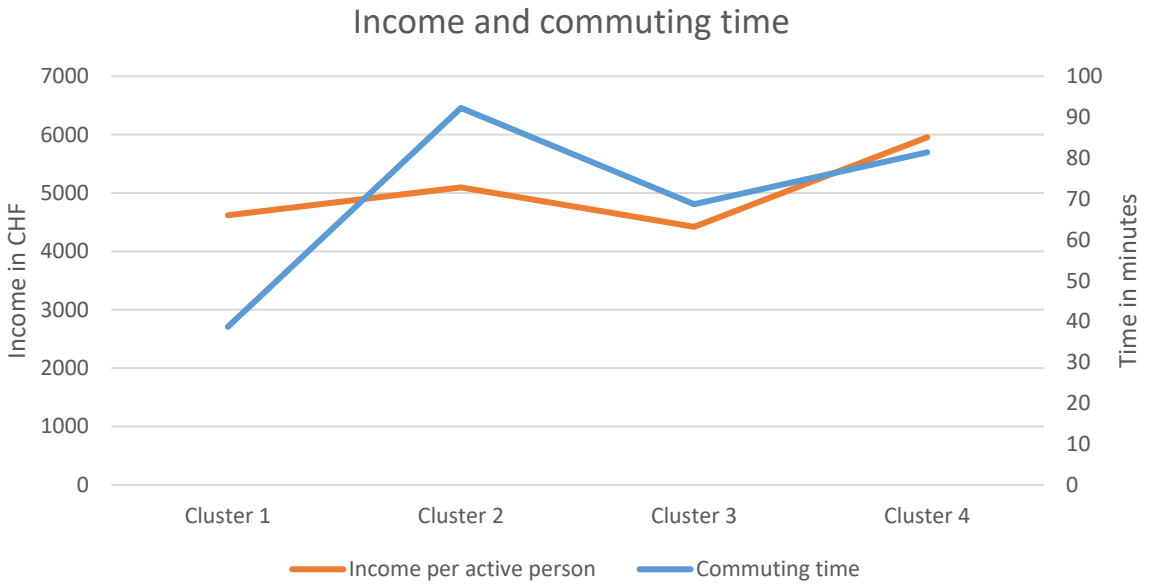


Figure 45: Mean income per active person and commuting time in each socio-economic cluster, data: ZHAW.

Consolidation of the cluster characteristics

Figure 46 summarizes all groups in a spider chart, visualizing the specific characteristics of each group. The percentage for the degree of urbanisation, enjoyment of travel, commuting time, combination of commuting and income are relative to the highest value among the four groups. The mode choice values are relative to the most used mode within the same group.

Cluster 1 is characterized by a small household size (2-3 persons). Commuters belonging to this cluster almost exclusively use active modes for commuting and live in urban areas or in the centre. They very much enjoy commuting and often combine commuting with approximately 0.9 other activities in average. Generally, they have a low commuting time and average income per active person. We therefore call this cluster the *active urban couple*.

Cluster 2 is dominated by single households (1 person) and mostly use public transport for commuting. They tend to live in urban areas or in the city centre, moderately enjoy commuting and show a high openness to combine commuting with other activities (1.3 activities in average). Further, a high commuting time and average income characterizes this group. It can be summarizes as the *single urban public transport opportunist*.

To cluster 3 mostly belong larger households (more than 3 persons). They use all the different modes for commuting and evenly live in rural, semi-urban and urban areas. The group has an above average enjoyment of commuting and yet does not combine commuting with other activities often (0.3 times in average). Their commuting time and income lies in the medium range. We therefore call this group the *semi-urban multimodal family*.

Cluster 4 is dominated by households of 2-3 person, no preference for active modes and a rural place of residence. They moderately enjoy commuting, combine commuting with approximately 1.1 other activities in average and have a high commuting time. A standout characteristic is their above average income. They are thus referred to as the *well-off rural couple*.

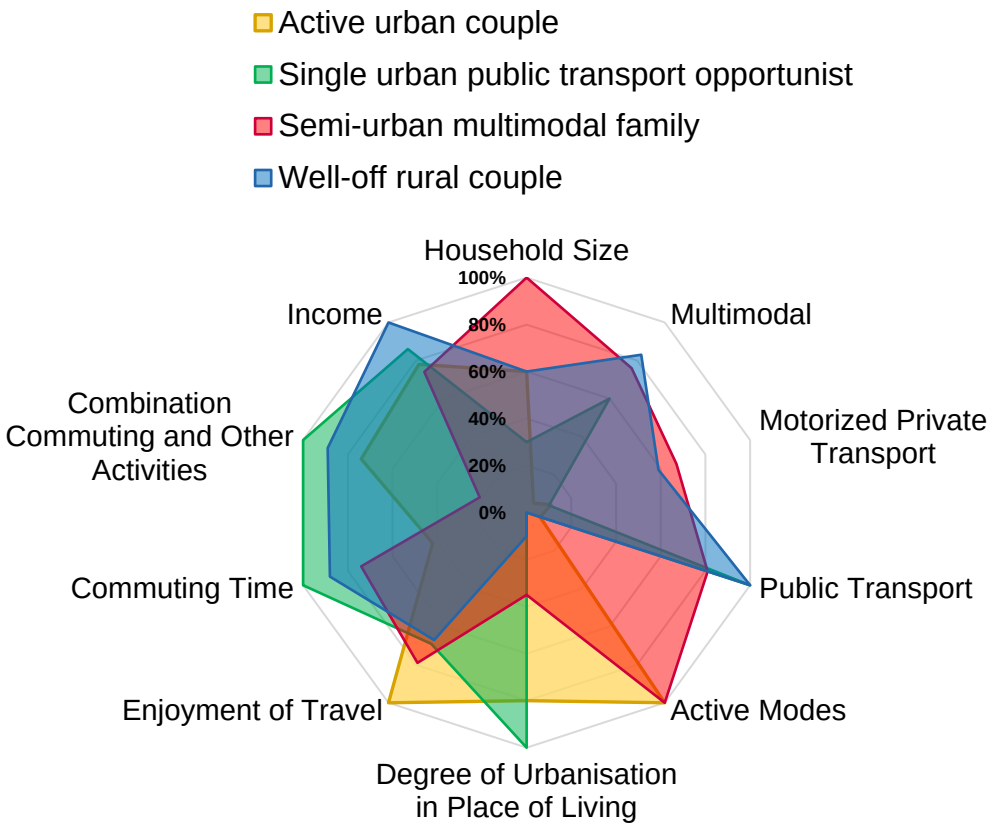


Figure 46: Spider chart describing the socio-economic clusters.

Relevance of the socio-economic cluster for policy interventions

Chapter 4.2.2.2 gave a holistic overview of the performed cluster analysis and the distribution of cases on the variables within each cluster. This section highlights the relevance of the findings for policy interventions.

One of the main goals of the Swiss energy strategy 2050[8] is the reduction of greenhouse gases, primarily CO_2. As such, cluster 1 from the socio-economic cluster analysis already acts as an optimal case. It is characterized by active commuters using their bicycle for travel or simply walking to their workplace. Therefore, their commute travel does not emit any greenhouse gases. Furthermore, it could be shown with the regression analysis that these commuters very much enjoy their travel. It can be used to gain insights on what factors promote commuting by active modes and how this influences personal sensitivities and feelings. At this point, the picture changes with the other cluster groups. Persons in cluster 2 of the socio-economic analysis do less enjoy commuting while they dominantly use public transport. They also display a very long commuting time further associated with lower enjoyment of travel. However, this group likes to combine commuting with other activities. Special offers that link commuting with the combined activities may decrease additional travel demand otherwise satisfied

[8] The "Energy Strategy 2050" was adopted by the Swiss population on 21 May 2017 with the aim of reducing energy consumption, increasing energy efficiency, promoting renewable energies in Switzerland, reducing dependence on imported fossil fuels and strengthening domestic renewable energies. In addition, the construction of new nuclear power plants will be banned (UVEK, 2018).

separately. This could include for instance bike-sharing systems (including cargo bikes) designed to cover the miles from the train station to the sports centre, shopping centre or meeting points in the city. The third cluster is characterized by no predominant travel mode but can be easily distinguished from the other groups due to their big household size (at least four persons in the household). Here, special offers for families could enhance the low openness to combine commuting with other activities and targeted information campaigns on the advantages of a GA subscription may foster a shift from private motorized transport to public transport. The fourth cluster is standing out with a high average income per active person and dominantly rural location of residence. As such, information campaigns incentivizing electric vehicles may be effective as they are still generally more expensive than a fossil fuel car and therefore more affordable for commuters belonging to this cluster.

Classification based on the openness to car-/ridesharing

The openness to car-/ridesharing cluster contains four clusters built by five variables. The Goodness-of-fit measure indicates a fair cluster quality, yet slightly higher than in the socio-economic cluster. The cluster size is very similar across clusters with the smallest consisting of 84 cases and 132 cases for the largest, respectively (see Figure 47). In Figure 48, it is clear that the variable *mode choice* has the strongest influence on cluster formation, while *openness to car-/ridesharing*, and comes second. *Gender* and *commuting time* still show a considerable effect on cluster formation, while *age* is less important in defining the cluster.

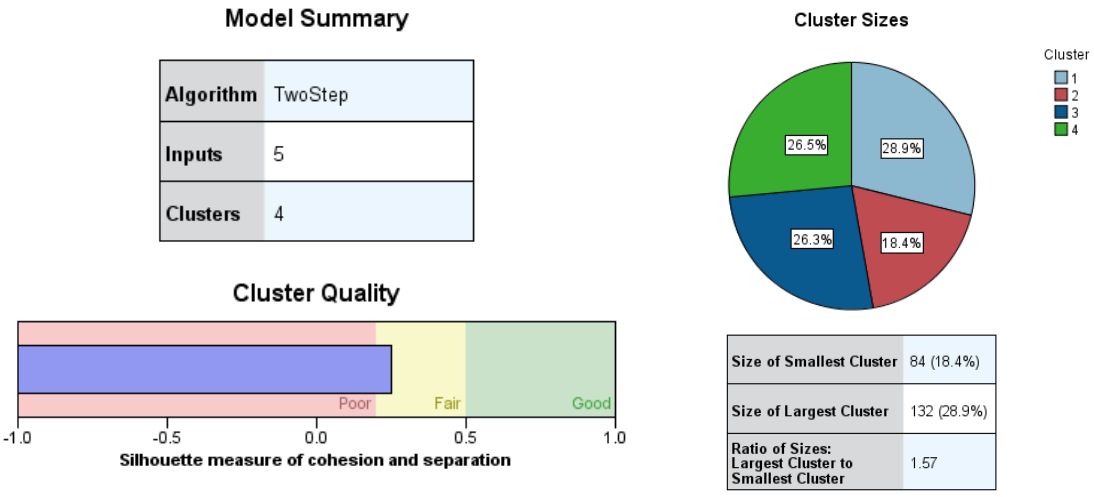


Figure 47: Model summary and cluster size output from the openness to car-/ridesharing cluster analysis, data: ZHAW.

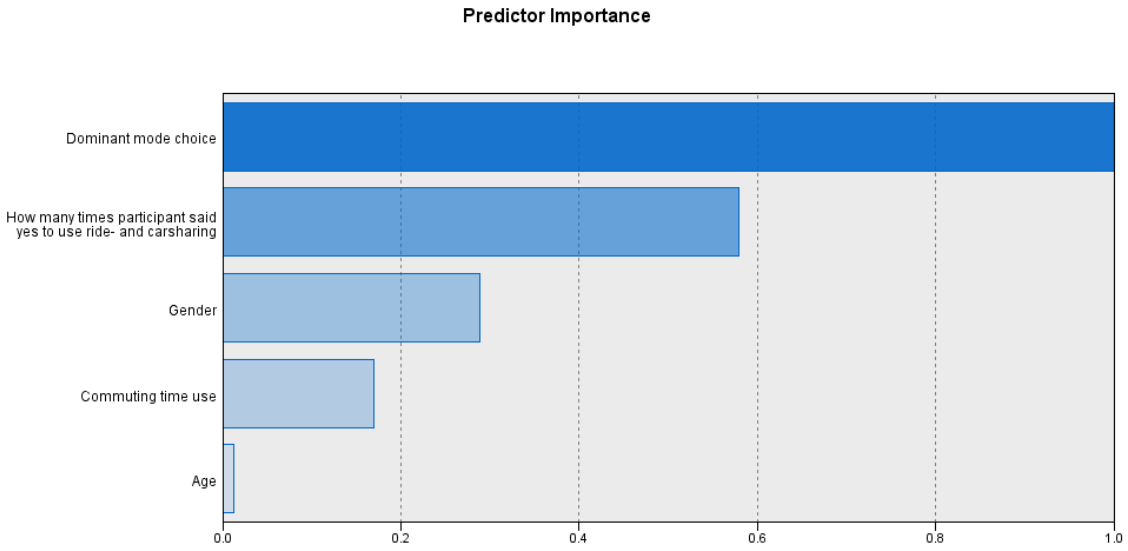


Figure 48: Predictor importance output from the openness to car-/ridesharing cluster in SPSS.

The four clusters differ in their value for all five variables defining the groups. As such, Figure 49 to Figure 52 visualize these differences starting with the most influential variable, *mode choice*. All four clusters can be easily distinguished by their dominant mode choice. Cluster 4 accommodates all respondents using active modes, while cluster 1 is dominated by public transport users, cluster 2 has an approximate equal distribution between multimodal, private motorized and public transport modes, and cluster 3 is dominated by private motorized transport.

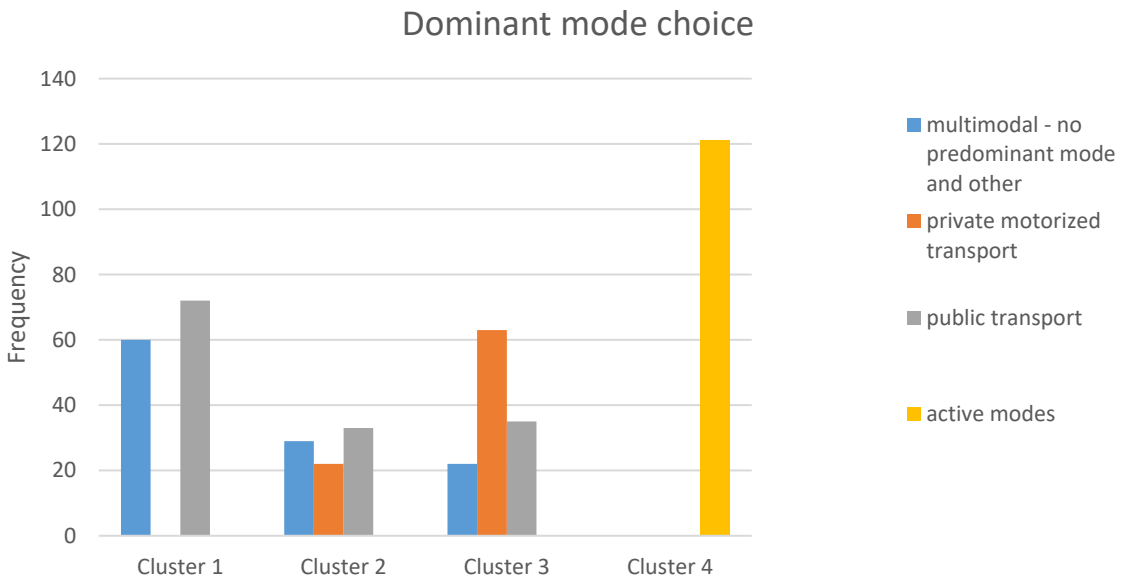


Figure 49: Distribution of dominant mode choice in each openness to car-/ridesharing cluster.

Our variable of interest, *openness to car-/ridesharing*, separates the four clusters in two groups. Namely, cluster 1 and 2, which are not open to car-/ridesharing and cluster 2 and 4, which are very open and slightly open, respectively (Figure 50).

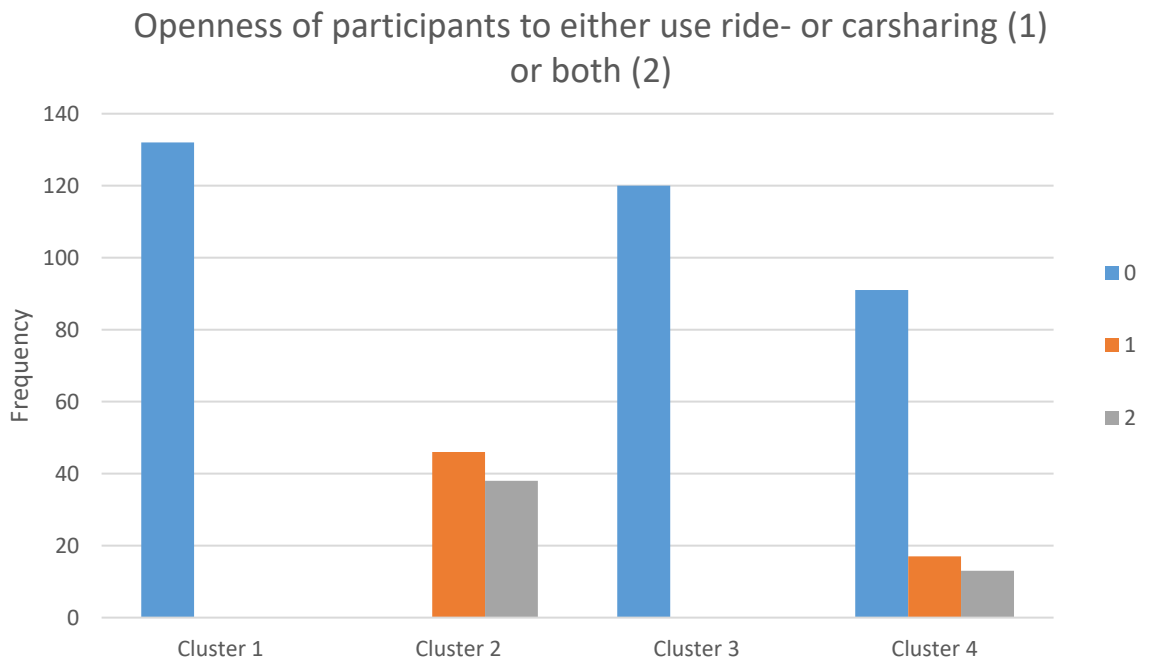


Figure 50: Openness of participants to either use ride- or car sharing (1) or both (2) for each cluster.

Cluster 2 and 4 are approximately equal in gender distribution, while cluster 1 is solely female and cluster 3 is dominated by male respondents (Figure 51)

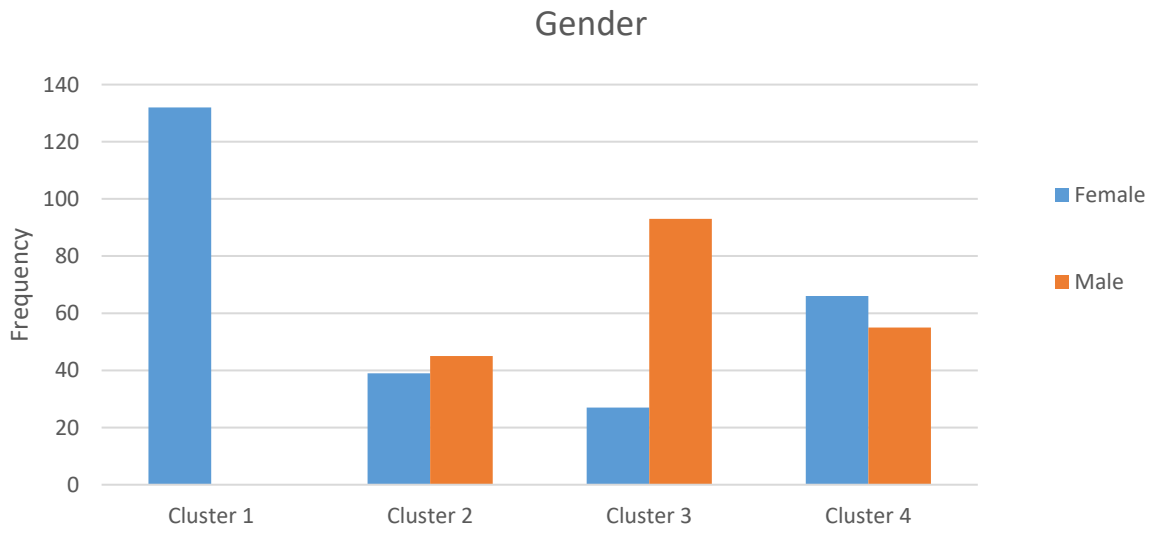


Figure 51: Distribution of gender in each openness to car-/ridesharing cluster.

Lastly, cluster 4 shows a very low daily commuting time compared to the other three clusters (Figure 52). Cluster 1 and 2 are almost equal in commuting time but differ in age. Cluster 3 has an average commuting time and above average age. Yet, we need to keep in mind that this difference in age is small (between 41 and 46) and therefore less applicable in policy strategies.

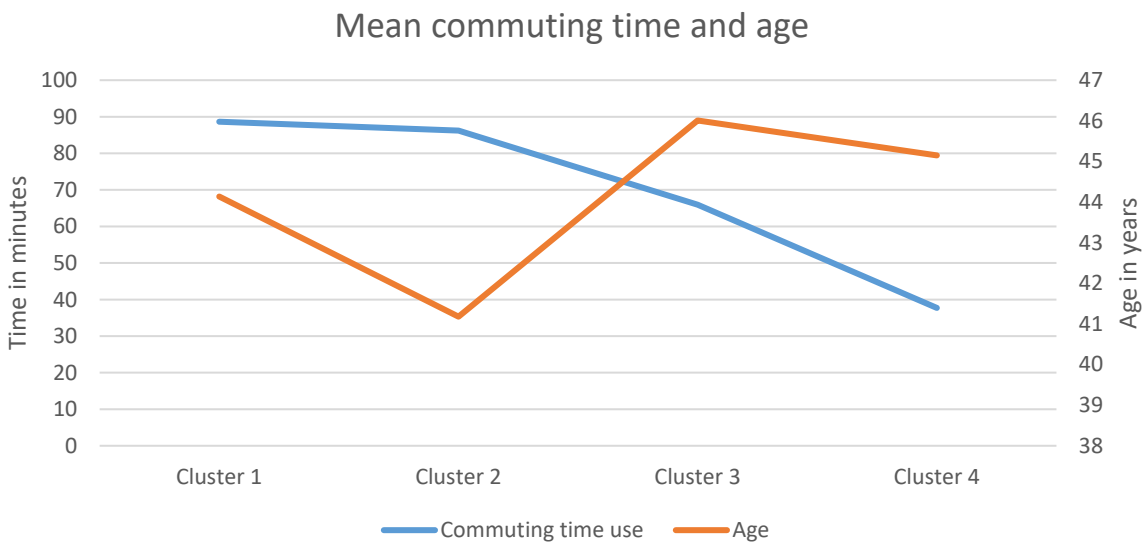


Figure 52: Mean commuting time and age for each openness to car-/ridesharing cluster.

Consolidation of the cluster characteristics:

Figure 53 summarizes all cluster in a spider chart, visualizing the specific characteristics of each group. The percentage for openness to car-/ridesharing, female, commuting time, and age are relative to the highest value among the four groups, while the mode choice values are relative to the most used mode within the same group.

Cluster 1 is characterized by public transport and multimodal commuters that are not open for sharing modes. They are exclusively female and display a high commuting time and an average age. We call this group the *long distance female public transport user.*

Cluster 2 evenly uses multimodal, private motorized transport and public modes for commuting, are very open for sharing modes and balanced between genders. Further, this group has a high commuting time and below average age. This group is summarized as *the young and open long distance commuter.*

Cluster 3 dominantly uses private motorized transport for commuting and is not open for sharing modes. The cluster is dominantly male and further characterized by an average commuting time and high age leading to: *the old male car enthusiast.*

Cluster 4 only uses active modes for commuting and are slightly open for sharing modes, have an even distribution between gender and a low commuting time. Their age is close to the mean among groups. They are referred to as *the active and open traveller.*

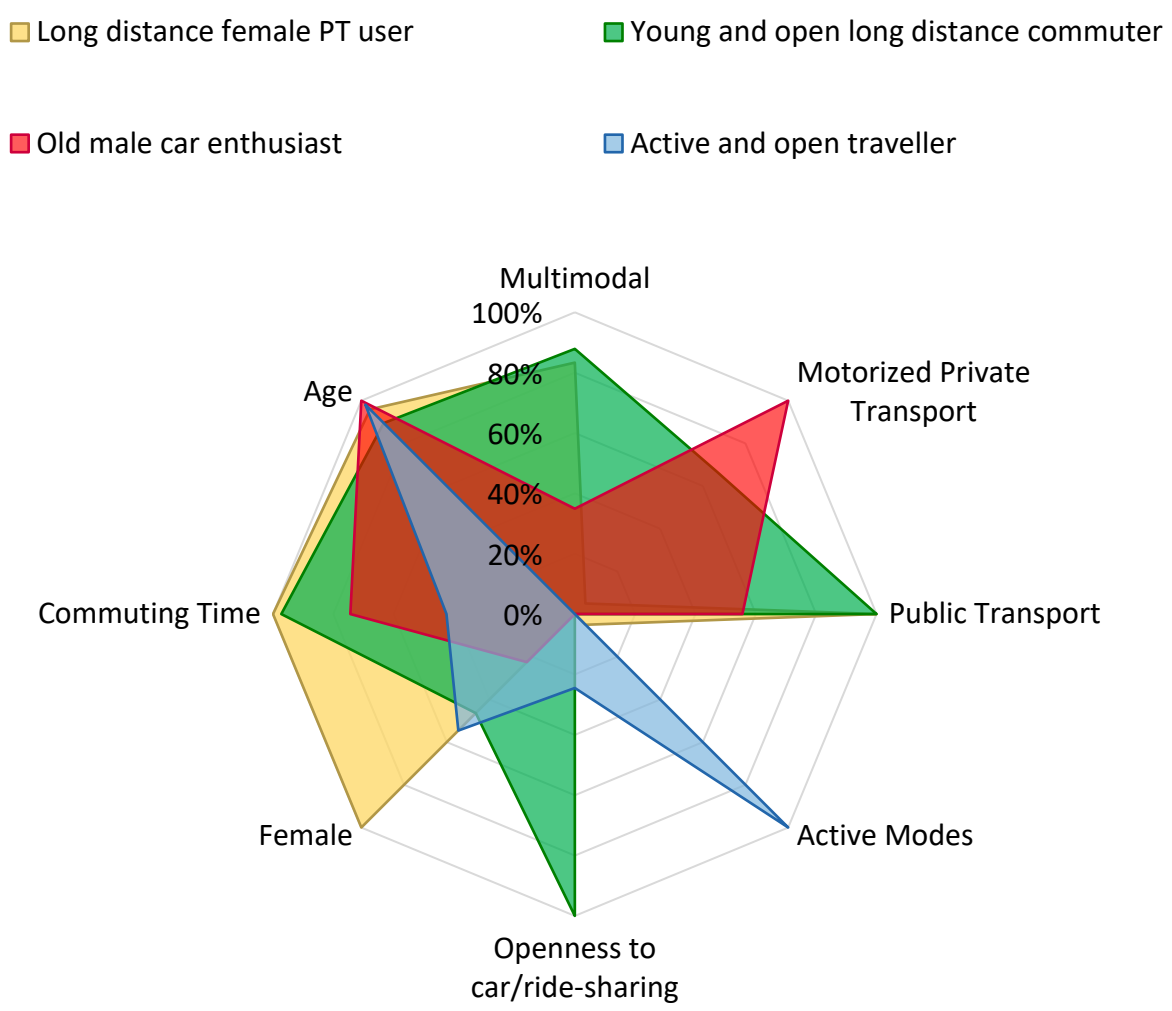


Figure 53: Spider chart describing the openness to car-/ridesharing clusters.

Relevance of the openness to car-/ridesharing cluster for policy interventions

This chapter focuses on policy interventions in connection to the above-identified openness to car-/ridesharing cluster.

The use of car-/ridesharing is said to effectively decrease the CO_2 footprint and therefore, a higher openness to car-/ridesharing is favourable (MOMO, 2010). Cluster 1 is dominated by female public transport users not open for sharing modes. Similarly, cluster 3 is characterized by dominantly male private motorized transport users not open for sharing-modes. Figure 37 depicts the interaction between gender and mode choice on the openness to car-/ridesharing. Findings indicate that measures promoting sharing options will be most effective when targeting female private motorized transport users and male commuters not using private motorized transport on a regular base. The overall goal of such measures should be part of a strategy increasing attractiveness first of active modes, second of public transport and third not only making use of private car, but car ownership useless. These measures are not only meant to push a shift towards more sustainable commuting modes, but also to prevent the opposite. The analysis revealed a hidden potential for car commuting with around one fourth of public transport users stating to have no alternative as a reason for their mode choice. Further, policies

targeting younger commuters are advised as lower age showed a significant positive effect on the openness to car-/ridesharing (see Table 26 in the appendix). Cluster 2 shows a considerable lower average age than the other clusters and high openness to sharing modes independent of gender and therefore most suitable for the above-mentioned policies. Commuters belonging to cluster 4 are slightly more open for sharing modes despite relatively high age. Additionally, Table 26 (in the appendix) underlines a trend for higher openness to car-/ridesharing among commuters with lower income. As commuters belonging to cluster 4 show the lowest income, they also reveal an above-average willingness to consider sharing options. As such, low-income groups may be more willing to try out different sharing options.

4.2.3 Upscaling the results to a European level - Comparison to Austria and Finland

While we specifically performed an in-depth analysis of commuting patterns in the case of Basel (CH), a comparison of the results to data from Austria (AT) and Finland (FIN) will gain insights into the range of these commuting patterns and relevance for policy planning. The same cluster algorithm and regression procedure used in the Basel case (see chapter 4.2.2) was performed with the AT and FIN data and described below.

4.2.3.1. Comparison of influential variables between Switzerland and Austria

The ordinal logistic regression was used to test the effect of several variables on *enjoyment of travel*. This revealed slightly different results for the Austrian data when compared to the Swiss case study (see Table 5). When compared to active modes, all other modes of travel showed a strong negative association with *enjoyment of travel* in the Swiss case study. In Austria, only multimodal traveller displayed a strong negative association with enjoyment of travel when compared to active modes. Further, commuting distance does not significantly influence enjoyment of travel in Austria. Also in contrast to the Swiss data, the Austrian data reveals a trend that older commuters are less likely to enjoy commuting than their younger counterparts. Both countries display the same trend that higher income per active person increases the likelihood to enjoy the travel.

The ordinal logistic regression with the dependent variable *openness to car-/ridesharing* revealed similar results for the variable *age*. In both datasets, age had a significant effect on the $p = 0.01$ (CH) and $p = 0.1$ (AT) level, respectively. The location of residence further interacts with income per active person in the Austrian dataset. The Cox & Snell and the Nagelkerke R squared estimates are slightly higher (14-18%, respectively) than of the Swiss estimates (11%-14%, respectively) but still explain fairly little of the causes for openness to car-/ridesharing.

Results from the multinomial logistic regression with the DV *mode choice* vary slightly between the Swiss and the Austrian data. The most prominent difference being *gender* having no effect in the Austrian analysis, whereas in the Swiss case, women have a higher likelihood to choose multimodal or public transport over private motorized transport. A one-unit increase in commuting distance significantly ($p < 0.05$) decreased the likelihood to choose multimodal modes over private motorized transport in both datasets. Similarly, longer commuting distance is associated with preferring private motorized transport over active modes in both countries, yet more significant in the Swiss case study. The Cox & Snell and the Nagelkerke R squared estimates are in a medium range (31-34%, respectively) and thus are considered useful in explaining the cause for mode choice.

4.2.3.2. Comparison of influential variables between Switzerland and Finland

The Finnish data revealed very similar results to the Swiss data for the dependent variable *enjoyment of travel*. Mode choice as well as commuting distance were significant on the $p = 0.05$ level. Again, the gap of enjoyment of travel between private motorized transport and active modes was smaller than multimodal/active modes and public transport/active modes. The Cox & Snell and the Nagelkerke R squared estimates are in a low range (17-18%, respectively) and thus are considered less useful in explaining the cause of enjoyment of travel.

Comparing the results of the ordinal logistic regression with the dependent variable *openness to car-/ridesharing* between the Swiss and the Finnish data, only the variable income per active person shows

a similar effect on openness for sharing modes. The higher the income, the less likely it is that commuters are open towards sharing modes. Further, a significant interaction ($p < 0.05$) was found between mode choice and household size for Finland, not present in the Swiss data. The Cox & Snell and the Nagelkerke R squared estimates are in a low range (9-10%, respectively) and thus considered less useful in explaining the cause of openness to car-/ridesharing.

The multinomial logistic regression results for Finland differ more from the Swiss data compared to the Austrian data. Especially, commuters living in a small household (2-3 people) are significantly more likely to choose multimodal travel over private motorized transport than commuters living in a larger household (more than 4 people). No such effect could be found in the Swiss regression analysis. Higher income per active person is associated with higher likelihood to choose private motorized transport over public transport in the Finnish case, whereas no such effect is present in the Swiss dataset. However, higher income per active person shows a trend for a higher likelihood to choose private motorize transport over active modes in the Swiss case, an effect not found in the Finnish dataset. Additionally, high commuting distance is related to a higher likelihood to choose private motorized transport over public transport modes in the Finnish data, not observable in the Swiss dataset. In contrast, both countries display the same significant effect that high commuting distance raises the likelihood to prefer private motorized transport to active travel modes. Lastly, Swiss commuters residing in rural areas are much more likely ($p < 0.01$) to choose private motorized transport over active modes as compared to living in the city, not significant in the Finnish case. The Cox & Snell and the Nagelkerke R squared estimates are in a medium to high range (45-49%, respectively) and thus are considered quite useful in explaining the cause of mode choice.

To sum it up, the main findings from the Swiss case study can be relocated in the Austrian as well as Finnish datasets. Especially the finding, that commuters using active modes (walking, bicycle) are significantly more likely to be in a higher enjoyment of travel level than commuters using multimodal transport, public transport and private motorized transport. Further, private motorized transport commuters are more likely to be in a higher level of enjoyment of travel compared to multimodal and public transport users. Higher likelihood of travel enjoyment with lower commuting distance also shows the same polarity across countries and is significant on the $p = 0.05$ level for Switzerland and Finland. Age is considered important in the Swiss and Austrian case as lower age is associated with a higher likelihood to be in a higher openness to car-/ridesharing level, yet not significant in the Finnish data. *Gender* showed a significant interaction with mode choice in the Swiss case – women see less need for car-/ridesharing when not using the private car for commuting as compared to men who in contrast are less open towards car-/ridesharing when dominantly using a private car for commuting. Residence location in the Austrian case also has an influence: Male commuters residing in a semi-urban environment are much more likely to be in a higher openness to car-/ridesharing level than their female counterparts, yet no difference for rural and urban environments could be observed. Lastly, a significant interaction between mode choice and household size on the openness to car-/ridesharing is present in the Finnish dataset: The larger the household, the more likely it is for private motorized commuters to be in a higher openness to car-/ridesharing level than commuters using active modes. These findings suggest that, when it comes to the enjoyment of travel, commuters behave similarly across countries. However, the factors behind openness to car-/ridesharing are less known and vary strongly between the three countries. Furthermore, the data is too small to explain all interactions affecting openness to car-/ridesharing. Thus, more research is necessary to better target the specific factors influencing the openness to sharing modes. The MLR with the reference category private motorized transport yields comparable results for all countries and gets the highest Nagelkerke R squared estimates with a range of 34% to 49%. Still, an interesting contrast could be found for the variable commuting distance (see Table 5). These different characteristics may be explained that the public transport network of Finland is not as connected and developed as the Austrian public transport service.

Table 5: Summary of OLR and MLR results for all three countries and each independent variable.

DV	Enjoyment			Openness			Mode choice (Multimodal vs. PMT)			Mode choice (PT vs. PMT)			Mode choice (Active vs. PMT)		
IV \ Country	CH	AT	FIN	CH	AT	FIN	CH	AT	FIN	CH	AT	FIN	CH	AT	FIN
Multimodal (active)							NA	NA	NA	NA	NA	NA	NA	NA	NA
Private (active)							NA	NA	NA	NA	NA	NA	NA	NA	NA
Public (active)							NA	NA	NA	NA	NA	NA	NA	NA	NA
Household size: 1p (gt3p)															
Household size: 2-3p (gt3p)															
Rural (urban or centre)															
Semi-urban (urban or centre)															
Driving licence: Yes															
Female (Male)															
Commuting distance															
Income per active person															
Age															

Green and light green = significant positive effect on the $p = 0.01$ and $p = 0.05$ level, respectively, very light green = positive trend ($p < 0.1$), red and light red = significant negative effect on the $p = 0.01$ and $p = 0.05$ level, respectively, very light red = negative trend ($p < 0.1$), blue and light blue = significant interaction on the $p = 0.01$ and $p = 0.05$ level, respectively (could be positive or negative), very light blue = interaction trend ($p < 0.1$), grey = no effect, NA = not applicable, words in parentheses = reference category.

4.2.3.3. Comparison of cluster solutions between Switzerland and Austria

In the previous chapters, we could identify similarities and differences between the Swiss, Austrian and Finnish regression results. Now, we want to see whether the cluster analysis with the same input variables as in the Swiss case (chapter 4.2.2.2) produces similar types of commuter groups in Austria. Both model summaries for the *socio-economic* and *openness to car-/ridesharing* cluster display very similar cluster qualities (see Figure 54). Yet, the cluster quality of both clusters is slightly lower than the quality of the Swiss clusters. Further, instead of four clusters in the Swiss case, the clustering algorithm determined three clusters with the Austrian data. Despite these quite similar outputs, the usability of these clusters differ. When checked for predictor importance value, the variable of interest “enjoyment of travel” ranks lowest (see Figure 55). Further, with only three clusters, interesting combinations of answers are missing. Due to these issues, the clusters are not further investigated. Nonetheless, the patterns are very similar and may reflect the close proximity and mind-set of these two countries.

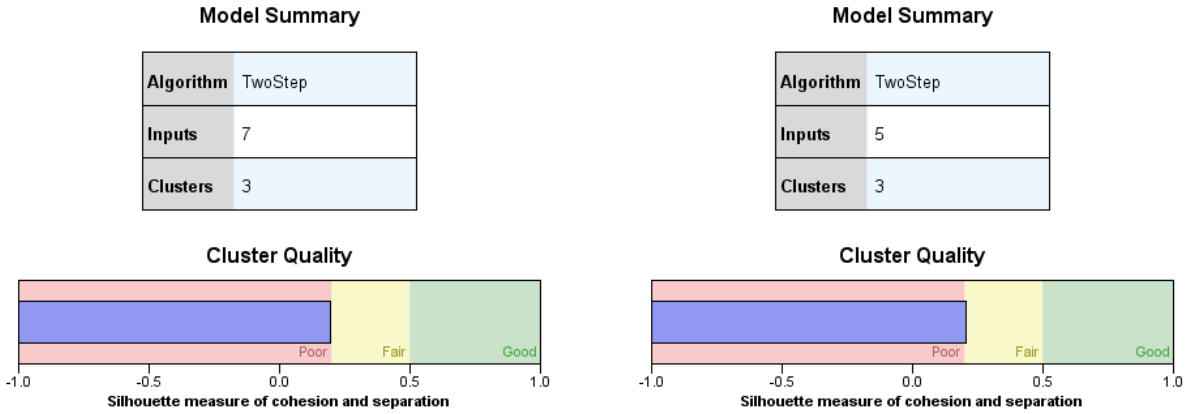


Figure 54: Model summary of the socio-economic cluster quality (left) and the openness to car-/ridesharing cluster quality (right) with the Austrian dataset.

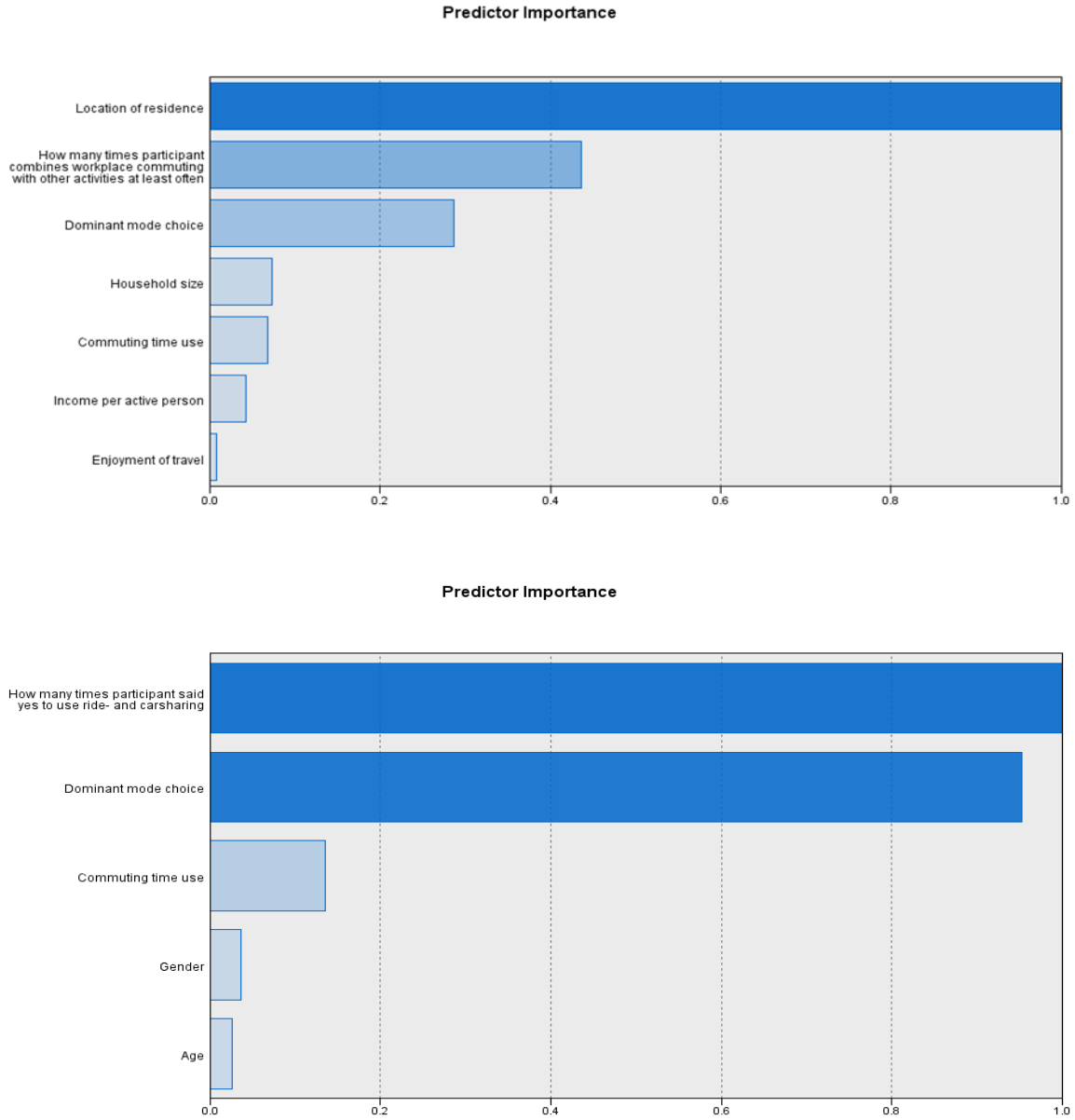


Figure 55: Predictor importance metrics for the socio-economic (top) and openness to car-/ridesharing cluster (bottom), respectively, with the Austrian dataset.

4.2.3.4. Comparison of cluster solutions between Switzerland and Finland

The Finnish cluster quality output for the socio-economic cluster shows a comparable pattern to the Swiss data, which is not surprising as the regression analysis produced similar results (see Figure 56) as well. However, the quality is poor and the cluster forming process is dominated by the variable *mode choice* and little influence is given to the variable of interest, *enjoyment of travel* (Figure 57). The socio-economic cluster is therefore not appropriate for the Finnish case. The *openness to car-/ridesharing* cluster solution is very different to the Swiss cluster, consisting of eleven clusters compared to four in the Swiss case. As the number of cases per cluster gets very small with a rising numbers of clusters, the cluster quality cannot be guaranteed and as such, renders this cluster unsuitable for further analysis. It is clear from this analysis, that the Finnish data cannot be clustered in the same way as we did with the Swiss and Austrian data, which might be due to its cultural difference inducing divergent commuting behaviours or data quality.

In sum, the regression analysis suggests that on a European level, commuters have a similar mind-set regarding the enjoyment of travel with different travel modes and travel distances. In addition, younger commuters might be more open to new mobility concepts like sharing modes. However, finding specific groups of commuters suitable for policy interventions is difficult on a European level but well possible with countries culturally similar.

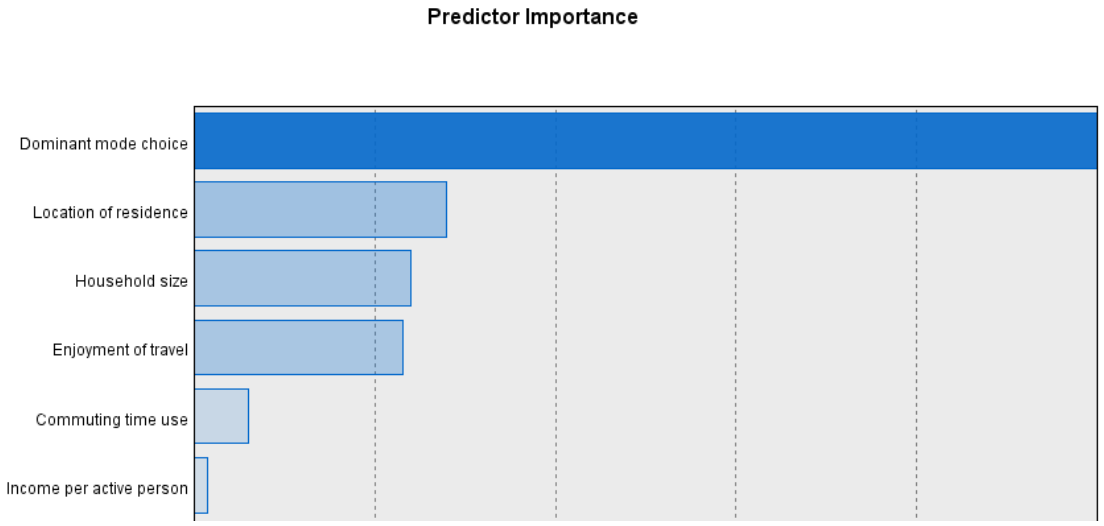


Figure 56: Model summary of the socio-economic cluster quality (left) and the openness to car-/ridesharing cluster quality (right) with the Finnish dataset.

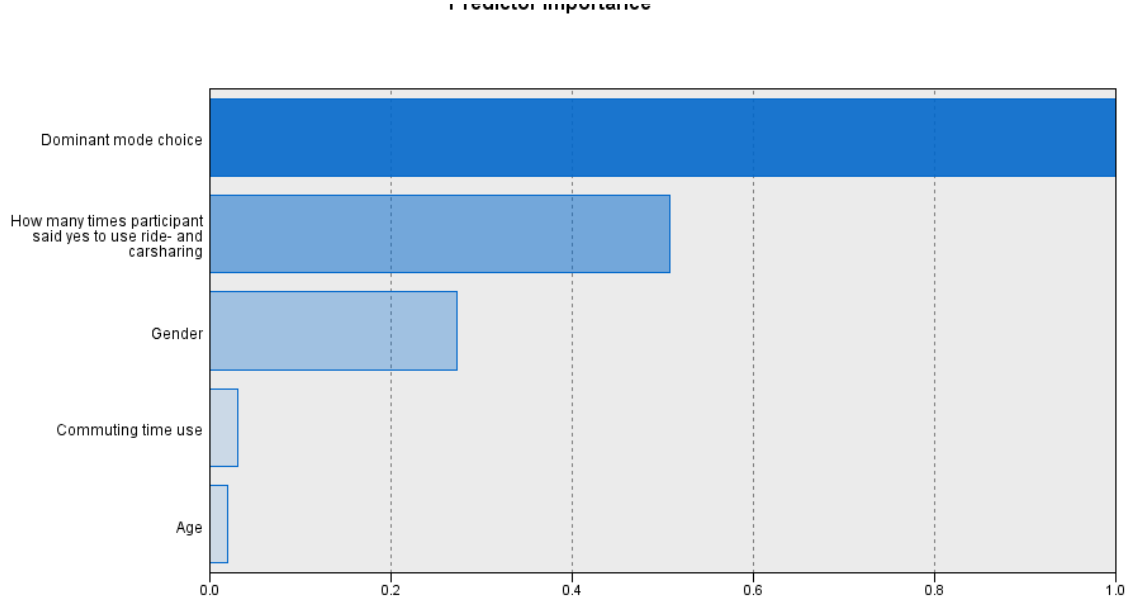


Figure 57: Predictor importance metrics for the socio-economic (top) and openness to car-/ridesharing cluster (bottom), respectively, with the Finnish dataset.

4.3 Conclusion and a baseline for recommendations

The survey analysis revealed some aspects behind the mechanics and reasons that influences ones' commuting. The persisting challenges and problems in commuting became apparent within the data. For example, the mean satisfaction with their current commuting situation of people living in urban centres is higher than of people living in the surrounding areas (see chapter 4.2.1.8). Taking into account the trend, that especially in these areas population growth is expected to occur within the next years,

this shows which areas should be considered with priority when developing new commuting strategies. Another issue, which could be identified within the data, is the satisfaction gap between public transport users and car users. In almost all queried items, PT users are less satisfied especially when it comes to enjoyment of travel and comfort. This shows potential when it comes to improve PT for the daily commute or at least reveals where issues regarding PT riding experience are located, in particular by improving enjoyment of travel and comfort. The only aspect where the situation is opposite is the price, where PT users are somewhat more satisfied than car users. This is surprising as the price of PT significantly increased during the last years in contrary to prices for car usage. One hypothesis is that PT users are more price sensitive and compare the price and service quite accurate and realized, that for the given service the Swiss PT-prices are not that overpriced. Still, lower PT-ticket prices motivate the respondents (car users included) to use more public transport (see chapter 4.2.1.7). In addition, more frequent and faster services would clearly improve the attractiveness of PT according to the respondents. This may be due to the fact that commuters think in “time budgets” (see chapter 4.2.1.2) which can clearly be observed in the variance of the daily commuting time and daily commuting distance. Faster services would therefore increase the possible commuter range within these “time budgets”, which, by implication, increases total distances travelled by public transport, which by default is not necessarily sustainable. Another identified expansion potential is car sharing, which is currently used rarely for commuting in the Basel area. Even if the openness to consider this mode of commuting (see chapter 4.2.1.7) is low, it is the highest among the surveyed alternative commuting modes.

Another interesting conclusion of the survey analysis appeared in the use of E-Bikes. The numbers between the possession of this type of vehicle and the use for commuting add up. This reveals that this mode is attractive for commuting, especially when comparing to motorcycles. Another potential in commuting could be identified, as only 5% of all households do not have a bicycle. The reasons why this sustainable mode of transport is not used broadly for commuting therefore needs to be searched elsewhere. Missing infrastructure or unsafe bicycle pathways could be the underlining reasons. In addition, people stated that they often use bicycles because it is faster and flexible, but also for doing sports. This mode of transport may therefore not only have potential to increase the travel itinerary but also improve people’s fitness and health.

When it comes to people’s daily activities and the resulting mobility needs, it becomes clear that new solutions like Mobility-as-a-service (MaaS) can help to satisfy these needs and at the same time, increase attractiveness of public transportation. Especially when considering that 90% of all respondents do have access to a public transport station within walking distances, unused potential seems to exist. Especially young people could be targeted in order to increase PT-usage, as they show clearly a below average car affinity than the older age categories. However, as time analysis based on the Swiss microcensus showed (see trend analysis in Haerri et al., 2018a) this trend may not be persistent and therefore needs to be addressed quite quickly.

Another starting point in order to improve sustainability of the current commuting system was identified. Only around 20% of the respondents do not commute during peak hours. The rest state that they do so because it is a requirement of the job or because of their employer (company culture). In addition, childcare was mentioned quite often. This leads to two promising areas were participatory processes in commuting could be located: Within companies (see “mobility management in companies” projects) or by improving childcare.

This paper also provides insides on the behaviour and classification of different commuter groups. It was possible to separate the Basel-commuters into four groups in two different settings. In the first setting, a socio-economic classification differing in household size, mode choice, location of residence, enjoyment of travel, commuting time, combination of commuting with other activities and income per active person was derived. The second classification is characterized by mode choice, openness to car-/ridesharing, gender, commuting time and age. Both yield insights into particular commuting groups, yet differ in their field of application. While the socio-economic classification is designed to differentiate the commuter community into groups for an easy application of targeted policy strategies promoting sustainable change, the second classification identified those groups open for car-/ridesharing.

The results of the socio-economic classification suggest that household size, mode choice and residence location are good factors for differentiating commuters. In general, big families living in a semi-urban environment seem to opt for a multimodal behaviour, while the single urban citizen prefers public transport for commuting. Further, the average couple living within close proximity to the workplace dominantly uses active modes, enjoying the commute very much, while well-off rural couples express very low enjoyment and almost never use active travel modes. As such, each of these groups can be easily distinguished from each other, enabling more specific policy strategies. Policy makers and stakeholders in the transportation sector may use this classification for shaping strategies. It allows to develop specific measures promoting a sustainable way of commuting including, but not limited to, promotion of public transport, regionalized incentives, family discounts, e-bike showcase, etc. Furthermore, enjoyment of travel has been found to be correlated with mode choice and commuting distance. Public transport and a high commuting distance are associated with lower enjoyment of travel compared to private motorized transport, active modes and low commuting distance.

Therefore, there is still room for improvements in the public transport sector, such as improved connection service, better bicycle transport opportunities and attractive ticket price offers revealed in Figure 33.

The second classification of travel attitudes identified mode choice, openness to car-/ridesharing, gender, commuting time and age as those most suitable for grouping the commuter community based on openness to car-/ridesharing. Here, it could be shown that female commuters see less need for car-/ridesharing when compared to men if they dominantly use multimodal, public transport or active modes for commuting, yet contrary results were found for those dominantly using private motorized transport. As such, those not open for car-/ridesharing are characterized by solely female commuters not using private motorized transport and male commuters using dominantly private motorized transport. The remaining two groups show a high and medium openness for car-/ridesharing, respectively but a more or less even distribution of gender. They differ in their average age and mode choice, where the group with the highest openness is the youngest. The analysis suggests that age is significantly attributed to higher openness to car-/ridesharing. These results may serve as a starting point when trying to promote car- or ride-sharing programs. As car or ridesharing is still not widely accepted nor used, there is a need for awareness rising. Policies or information campaigns would gain the most response when targeting those groups already open for sharing systems and can then widen their customer base with increasing awareness of the whole society due to word-of-mouth propaganda.

In addition to the above-described analysis, a comparison of the Basel case with data from Austria and Finland was conducted to investigate commuting patterns on a European level. While it is clear that the samples differ on a regional context (Swiss data based on a city, Austrian data on county level and Finnish data on a growth corridor) and that differences exist in the available infrastructure and cultural context, similarities could be found. One such finding suggests that for all three countries, it is more likely for commuters using active modes to enjoy their travelling than users with no predominant mode of travel (see Table 5). Likewise, active mode commuters are more likely to enjoy their travel than such using dominantly public or private motorized transport in the Swiss and Finnish case study. This finding may be explained by the additional purpose of this travel mode. As commuting by public transport or private car is an instrument to cover the distance between A and B, cycling or walking might also satisfy the physical need of exercising and therefore increases the overall enjoyment of travel. Further, high commuting distance is associated with a lower likelihood to enjoy the commute in the Swiss and Finnish case, yet not significant within the Austrian data. This might suggest that the public transport is well designed for long distances in Austria, giving more opportunities to enjoy the travel. The aforementioned assumption can be supported by the trend that with higher commuting distance, Austrian commuters in the survey prefer public transport to private motorized transport. Some sharing programs have already been implemented in Finland (LVM Finland, 2015). Therefore, the awareness of a sharing economy may be already on a higher level compared to Austria and Switzerland and adopted more widely across age groups. Younger commuters are prone to innovative, new concepts, less likely to be the case for older people sticking to their habits in the latter two countries. Higher income per active person leads to a lower likelihood to be in a high openness to car-/ridesharing level in Finland and similar trends could be found in the other two countries. These findings could imply that generally over Europe, sharing

systems like car- or ridesharing are seen as a way to reduce costs and that with a high income the need to save costs and openness to sharing might be missing.

If these new services are accepted by users will depend on attitudes and openness for reconsidering mobility behaviour as analysed for the samples (chapter 3) and for the identified commuter groups (chapter 4). But individual decisions and behaviour change are embedded in trends of the environment, such as social movements, technological change or changing working world, lifestyles etc. Such trends could force or hinder behaviour change in terms of accepting new mobility services. Thus, an assessment of trends relevant on either demand or supply side of mobility was conducted. Results were considered in the later step of developing recommendations for stakeholders (chapter 8 and 9).

5 Trend assessment for commuting[9]

In order to support the systemic change towards sustainable mobility on the levels of individuals, transportation systems and society, knowledge about individual and group behaviour and decision-making is crucial as well as knowledge about how the context for mobility will develop. To ensure sustainability of new mobility offers and strategies, the ongoing change - e.g. in the field of technology, lifestyle or work – was considered in a foresight study identifying trends as presented in the following.

5.1 Paradigm change in commuting

Commuter flows are steadily increasing in urban regions in Europe. The results are traffic jams at peak times, congested public transport systems, rising costs and environmental effects such as increasing land usage, noise and air pollution. At the same time, political and social developments are accompanying this trend: lifestyles and working ways are becoming more dynamic and versatile. Traditional offices are increasingly being replaced by mobile or private workplaces, flexible working time models and part-time work are in vogue. These developments require a rethinking of current mobility strategies. Based on case studies in Switzerland, Finland and Austria, the European research project ENSCC Smart-Commuting is investigating the extent to which new and networked mobility offers such as Mobility-as-a-Service (MaaS) or targeted measures like mobility management in companies can respond to these changes. The project examines the extent to which these solutions can contribute to a mobility system tailored to the needs of commuters and how negative effects of labour mobility can be reduced.

Transportation and commuting is of great importance when it comes to paradigm shift towards more sustainability: A report from the United Nations elaborated this issue and demonstrated, that transportation has numerous interconnections to social, economic and environmental aspects and therefore has massive impact on society and its environment (UN Secretary-General's High-level Advisory Group on Sustainable Transport, 2016). This can also be confirmed by figures: In 2010 the transportation sector was responsible for approximately 23% of the total global energy-related CO_2 emissions, producing around 7 gigatonnes of CO_2 (Sims et al., 2014, p. 603). In addition, road congestion especially during peak hours is a massive problem for the local economy. The United Nations estimates GDP-losses due to congestion from about 2% in Europe to as high as 10% in developing cities like Lima, Sao Paulo or Beijing. Also for social aspects, transportation plays a vital role. It is a requirement for accessing basic needs like education or health care (UN Secretary-General's High-level Advisory Group on Sustainable Transport, 2016, p. 7). Therefore, according to the United Nations, implementing sustainable transportation is strictly necessary and can even be achieved without additional financial expenses. If the positive effects of sustainable transport are considered (less fuel

[9] Härri, F., Hörler, R. and Hoppe, M., 2018. Smart and Mobile Work in Growth Regions. Deliverable 2.1.2: Trend assessment for commuting.

consumption, decreased losses from congestions), global savings of about 70 trillion USD by 2050 can be achieved (UN Secretary-General's High-level Advisory Group on Sustainable Transport, 2016, p. 7).

In Switzerland, the number of commuters has risen sharply in recent years. In 1990, 2.9 million people used to commute to their place of work. By 2015, the number already reached 3.9 million. At the same time, the average distances between home and work have grown steadily: in 2000, the average distance between home and work amounted to 12.9 km. In 2013, this figure had risen to 14.6 km, which is an increase of 13%. In this context, 54% of commuters opted for motorised private transport for their daily work travel (Bundesamt für Statistik, 2017b, 2016). These growth trends are particularly relevant to economically strong urban centres such as the city of Basel.

But also needs and requirements regarding the journey itself are evolving, as the living and working conditions change: More dynamic lifestyles, the increased digitalization throughout society and in the professional world are questioning the up-to-datedness of our current transportation systems. In Switzerland, the proportion of part-time employees has grown steadily since the early 1990s. 25.4% of all employed persons worked part-time in 1990, 36.5% in 2015 and a departure from this trend is not foreseeable (Bundesamt für Statistik, 2017a). With increasing digitalisation, it is generally assumed that the employees of the future will be increasingly mobile, digitally connected (Zobrist and Grampp, 2016) and will be able to work independently from fixed offices. This also changes the character of the way to work. Commuting trips are already often combined with other activities today. In such cases, new mobility systems can provide a travel chain according to transport requirements, integrating cargo transport possibilities for instance. The ENSCC Smart Commuting project examines the abovementioned developments and wants to find out how new mobility concepts, such as Mobility as a Service (MaaS), can help address these challenges.

5.2 Methodology

5.2.1 Approach and research questions

The goal of the trend analysis is to assess the foundations on which new mobility services and strategies for commuting should be built on, starting from the end-users needs and commuting behaviour presented in this report. In addition, trends that could influence the means of commuting are presented. Based on these two assessments, together with the stakeholder-analysis (chapter 6), recommendations and design principles for new mobility services and commuting strategies were elaborated (see Figure 58).

In order to ensure the sustainability of developed tools, the ongoing change - e.g. in the field of technology, lifestyle or work in the trend analysis. With the mean of a foresight study, trends and developments in commuting were assessed according to eight different areas (see chapters 5.3.1 to 5.3.6). The study was conducted by literature review ("desk research") and by analysing existing data, notably the Swiss Microcensus for Mobility, (see excursus below). In priority, this analysis was conducted for Switzerland, where possible comparable international data were used to upscale the obtained results to an international (EU) level.

Following research questions are addressed within this part of the project:

- Which **trends persist** in the area of mobility and commuting in Switzerland?
- Can these trends **also be observed in Europe**?
- Which **starting points** for policy development can be deducted from these trends?

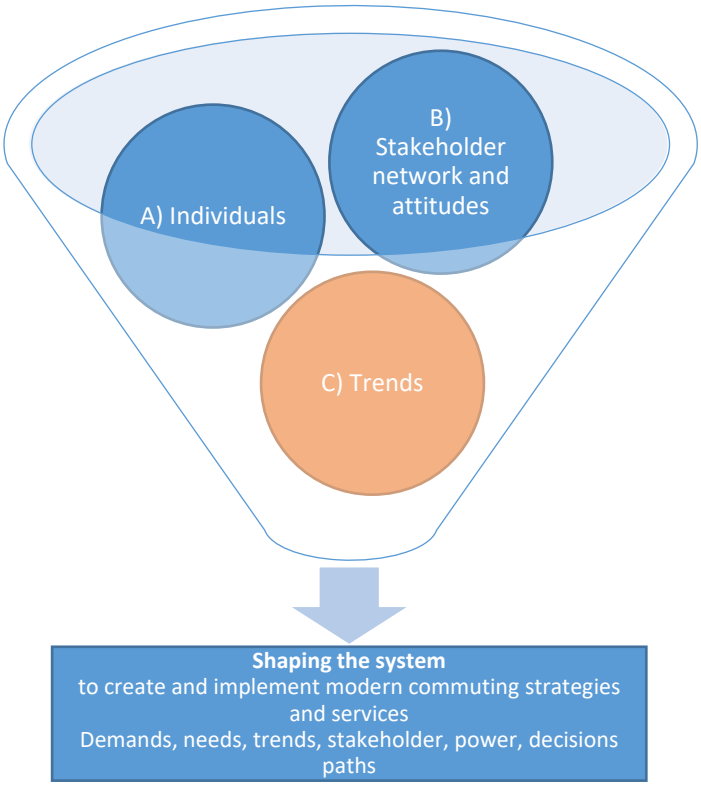


Figure 58: Research framework for creating commuting design principles. The part C) Trends is presented within this report.

5.2.2 Trend analysis and transition study

Initiating sustainable transition in a social system like commuting requires insights of the subject area and its surroundings. To gain this understanding, existing transition models were assessed. Geels and Kemp (2012) are offering a comprehensive approach in transition studies with the multi-level perspective (MLP) on socio-technical transitions, serving as a basis for this report. The MLP is based on the premise, that transitions are resulting from the interplay of the three analytical levels “innovations”, the “socio-technical regime” itself and the surrounding “socio-technical land-scape” (Figure 59, Geels, 2012). We therefore aimed to understand the socio-technical system as a whole based on the empirical analysis of individual commuting behaviour and the stakeholders interactions (see Haerri et al., 2018c). Secondly, we identified trends and innovations to gather insights on potential regime-changing forces and influences. By foreseeing trends and game-changers in mobility, we create strategies and measures supporting behaviour change. As such, future-oriented mobility solutions can be implemented by properly steering and promoting the transformation of the commuting systems towards more user-friendly and sustainable mobility. The process of the trend inquiry is designed in different phases: First, we created our own trend-assembly by desk-research. This allowed us to develop ideas about relevant trends and gain a basis for the upcoming steps.

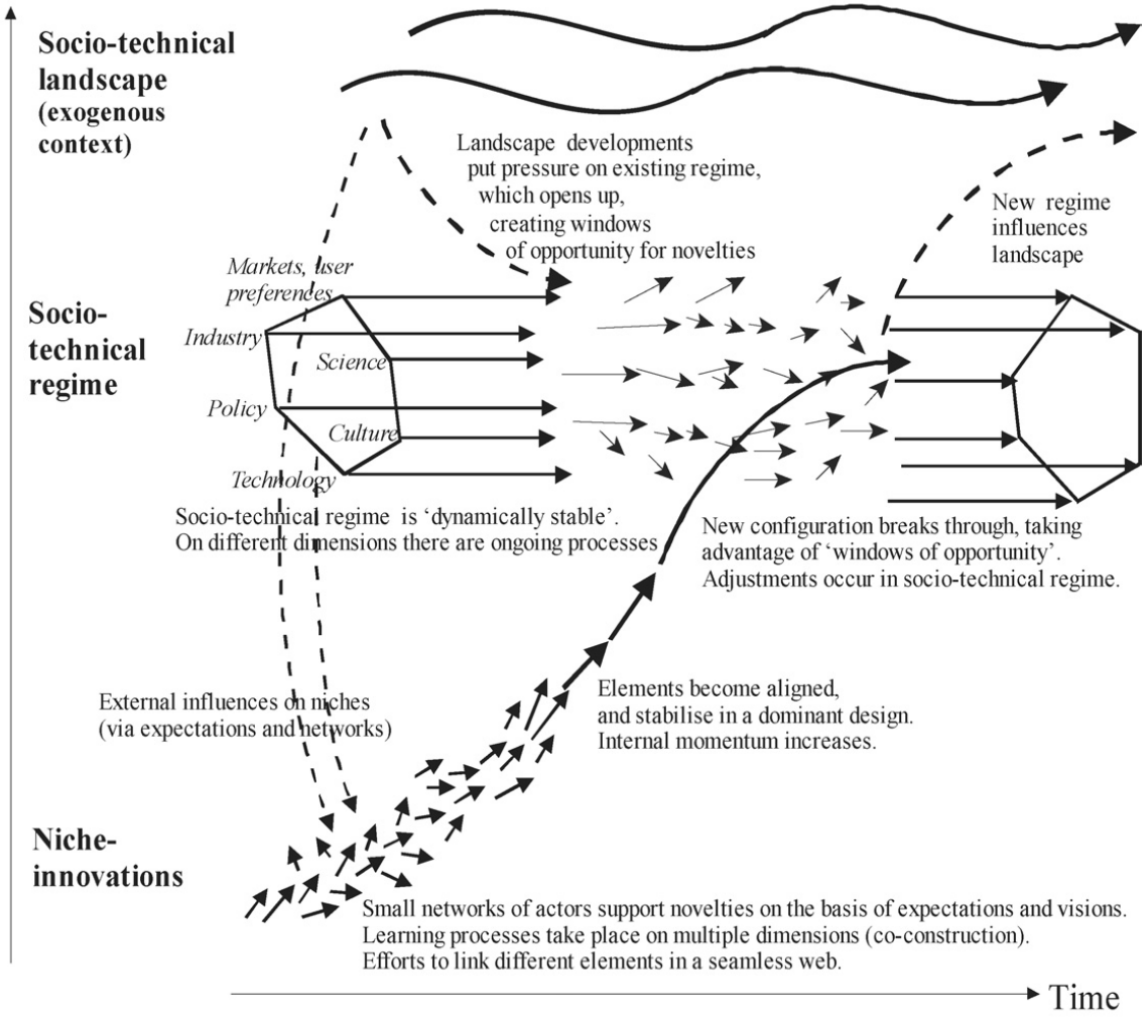


Figure 59: Multi-level perspective on transitions (Geels, 2012, p. 474).

5.3 Trends

The trends identified during the trend research are presented below. The trends were allocated as well as possible to the various development areas, a multiple allocation would certainly be possible, but was not carried out in our case. In addition to the text-based presentation, the trends were transformed into a "mobility trend blend" (Appendix 3: WP 2.1.2).

5.3.1 Trends in mobility

5.3.1.1. Travel time, distance and intermodality

According to the Swiss Microcensus for Mobility, from 1994 to 2005, the average daily travel time increased from 77 to 88 minutes. Since 2005 the total daily travel times are decreasing again. In 2015, the average daily travel time in Switzerland was 82.2 minutes, a decrease of 7.5% since 2005. The share of mobile people stayed constant since 1994. Around 90% of all Swiss people are mobile every day. However, their average distances increased significantly, since 1994, by 17.3% from 31 to 36 kilometre. In the last years, this growth has slowed down. A study published by the Federal Office for Spatial Development ARE (Mathys et al., 2016) awaits a further increase of the daily travel distances by 18.9% by 32.3% till 2040. The same study estimates that the amount of trips undertaken per day will increase between 19.1% and 37.1%, depending on the scenario till 2040. The retrospective evaluation however speaks another language: From 2000 to 2015, the number of trips residents of Switzerland undertook in average decreased from 3.6 to 3.4. Regarding the ways and means of these travels it

becomes apparent, that the number of trip legs (number of change of means of transport per day) increased from 1994 to 2010 from 4.5 to 5.0. In 2015, it was again somewhat lower with 4.9. Therefore, a stagnation may be present regarding the intermodality of journeys. (BFS and ARE, 2017)

Similar trends are expected within the EU, where the growth of passenger transport demand is also expected to increase by 38% till 2050 (measured on level of 2010). Also, a strong increase of other transportation modes like public transport (especially high-speed rail) is expected, which can lead to a higher share of intermodal journeys (European Commission, 2016). The total of passenger transport demand in the EU-28 countries showed a robust growth in the last years: Since 2000, the total transport volumes (in pkm) grew by 10% for cars and by 19% for railway and by 28% for trams and metros (European Environment Agency, 2017). Regarding daily travel time no EU-totals could be obtained by the time of the writing of this report.

5.3.1.2. Mode-share

From 1994 to 2015, the share of car use (of average distance over all means of transport) dropped from 69.7% to 66.1%. However, the total travelled distance increased due to overall increase of travel distance (see 5.3.1.1). For the future a further decrease of car modal share is anticipated. Until 2040 ARE estimates that the share will decrease by up to 4.3% regarding the level of 2010 (BFS and ARE, 2017; Mathys et al., 2016). In the EU the share of car us (per passenger-km, inland transport [car, bus, train]) stayed constant with a slight decrease from 83.2% to 83.1% between 2006 and 2015 (Eurostat, 2017a).

The modal-share of public transport (PT) as measured by the average distance increased from 18% to 24% between 1994 and 2015 in Switzerland (BFS and ARE, 2017). Regarding to the level of 2010 the share of Person-Kilometres (pkm) of PT is expected to further increase by up to 4% till 2040 (Mathys et al., 2016). Within the EU, again, from 2006 to 2015, the share of PT (per passenger-km, inland transport [car, bus, train]) remained constant with 16.8% (EU27, own calculations based on Eurostat, 2017a).

5.3.1.3. Travel purposes

Most travel activities in Switzerland are due to leisure activities. Although from 1994 to 2010 the share of the total average daily travel distance for leisure activities decreased from 50.5% to 40.2%. From 2010 to 2015 it increased again to 44.1%. The share of the second most important travel purpose (but the most relevant one regarding the addressed topic of present report), the work-related travels, increased from 21% (1994) to 24%(2010) and stayed on this level till 2015. (BFS and ARE, 2017)

5.3.1.4. Trends in commuting

During the last years, the distance of travel activities due to commuting increased from 12.9 km in 1994 to 14.6 km in 2015 corresponding to an increase from 20.7% in 1994 to 24.3% in 2010 measured at the total travelled distance per day (see chapter 5.3.1.1). From 2010 to 2015, the share decreased again to 24% (BFS and ARE, 2017; Bundesamt für Statistik, 2017b). According to ARE the total distance of commuting trips is bound to increase by 13.8% to 28.6% compared to 2010 until 2040 (Mathys et al., 2016).

The total time consumption for commuting has steadily increased by 7 minutes to 30 minutes in total from 2000 to 2014. Regarding the used modes specifically for commuting the share of PT increased mainly due the use of train (1990: 11%, 2014: 16%). The share of car use for commuting decreased slightly however. (Bundesamt für Statistik, 2016)

On the EU-level no time series data could be found regarding commuting, making trend evaluation difficult. However, in 2011 the OECD created a comparison of their member states based on various National Data. In average, persons in full-time employment commuted 38 minutes in average every day. Above-Average European countries were Germany (39 minutes), Great-Britain (40 minutes), Spain (45 minutes) and Italy (46 minutes) (OECD, 2011). For Germany, according to the official regional statistics of the Federal and State Statistical Offices, this figure is somewhat higher than in the year 2002 (Schüller and Wingerter, 2016).

5.3.2 Trends in access, infrastructure and vehicle ownership

5.3.2.1. Infrastructure

The overall length as well as the land use of transportation infrastructure in Switzerland increased significantly during the last years. From 1980 to 2014, the total length of the road network increased by 7.5% and the length of the railway network by 2.5% during the same period of time (own calculation based on BFS, 2017a). The total use of land for transportation purpose is also significantly increasing, especially space for parking and for highways (1985 to 2009, +55% resp. +49%). Also significantly increasing is the number of e-charging stations. In Switzerland in the third quarter of 2017 2'558 stations could be counted, while at the beginning of 2016 there were only 1'514 of them (Sigrist, 2017). This is an increase of 69% in only one and a half years.

At the same time the numbers of total congestion hours increased drastically. From 1995 to 2014 they increased from 3'000 to 21'000 hours. This ranks Switzerland on place 14 of the global congestion country ranking (INRIX, 2016). The increase of congestion is an European, as well as a global phenomenon (Cookson, 2017).

5.3.2.2. Vehicle possession

The reasons for the developments described in chapter 5.3.2.1 are inter alia caused to the increasing vehicle ownership. In Switzerland alone the number of matriculated vehicles increased by 30% between 2000 and 2016 with a total number of 5.9 million motorized street vehicles (without motorcycles) (BFS, 2017b). This includes commercially used vehicles as well as privately owned vehicles. The share of private households owning a car increased between 1994 and 2005 from 75% to 81%. In 2015, this figure decreased again slightly to 78%. However increased has the number of households owning an E-Bike. In 2010 only 1% of Swiss households owned one or more e-bikes. Five years later, this figure increased to 6%. (BFS and ARE, 2017)

5.3.2.3. Digitalization

Since the advent of laptops, mobile phones and tablets, mobility and internet use can no longer be separated. Especially among younger age groups, the use of the internet has increased considerably in Switzerland in recent years. 95% of all people between 14 and 39 years regularly used the internet in 2016. In 2005, this figure was just under 75%. For older age groups, 85% of all 50 to 59 year olds used the Internet regularly in 2016. For the 60 to 69 year-olds it is still 70% (BFS, 2016b).

The use of the mobile Internet via smartphone and laptop is also noticeable. Following indicators provide information on mobile Internet on how often the internet is accessed on the move (outside the home or workplace), regardless of whether via WLAN or mobile phone network. In Switzerland 73% of people, aged 16 to 74, accessed the Internet regularly via a phone. This places Switzerland slightly above the European average for 2016 (EU-28: 68%) (BFS, Eurostat, Omnibus IKT, 2017). However, the trend towards digitisation can also be confirmed at a European level.

5.3.3 Environmental trends

Globally, the CO_2 emissions caused by transportation are increasing. In 2010, the transportation sector was responsible for 23% of all global energy-related CO_2 emissions and therefore contributes a substantial share to climate change. When looking closer and analysing emissions according to the respective transportation modes, it is clear, that carbon based road transport is the main culprit. But also aviation and shipping are important contributors (Sims et al., 2014).

In Switzerland, emissions due to transportation activities increased between 1990 and 2008. Since then CO_2 emissions are decreasing slightly (-3.3% between 2008 and 2015). Until 2050, the total energy demand for transportation is expected to decrease by 24% to 42% (BFE, 2016). Between 2000 and 2013, the air pollution (SO_2, NO_x, NMVOC, CO, NH_3, PM10) caused by transportation decreased slightly. Cd (+15%) and Hg (+96%) however increased (BFS, 2017c). The percentage of Swiss population exposed to transport noise decreased slightly between 2002 and 2012 from 32% to 26% (BFS, 2014). Switzerland's new Energy Strategy 2050 aims to significantly reduce its energy

consumption while at the same time satisfying its energy needs in a renewable and sustainable manner. Nuclear energy production is to be discontinued and energy networks expanded (UVEK, 2018). This shows how much the pressure for a profound paradigm shift will increase due to a high demand for sustainability development, especially in the energy and environmental sectors.

5.3.4 Demographic trends

In Switzerland, the number of population is expected to increase between 13% and 33% till 2045, based on 2015 population numbers (own calculations based on BFS, 2015, p. 7). The share of over 65 old people (pensionists) is expected to increase to approximately 26.4% (today 18%) till 2045 (BFS, 2015, p. 13). Another factor heavily influencing access to some mobility modalities is the possession of a driving licence. Here, especially in the younger age categories a decline could be observed: Between 1994 and 2010, the share of 18 to 24 year old possessing a driving license decreased from 70% to approximately 59%. This decrease however stopped between 2010 and 2015. In the working age category (25 to 64 years old), it stayed mostly constant since the year 2000 with around 80%. Massively increased has the share of over 65 old people with driving licence. While 1994 only 45% of people of this age category possessed a driving licence, 2015 this number amounted to 70%. (BFS and ARE, 2017)

In the Europe Union however, a population increase is also expected to increase till 2040. At this point in time however, the development is expected to stagnate. As in Switzerland this will lead to an aging of the population. It is also expected, that this aging will contribute to the stagnating car ownership ratio. (European Commission, 2016)

5.3.5 Economic trends

In Switzerland, as in Europe, the general GDP increased during the last years. Exceptions are the years 2008 (Switzerland and EU) and 2012 (EU) (Eurostat, 2016). Prognoses suggest an ongoing expansion (OECD, 2017). Therefore it can also be expected, that this development will contribute to the expected growth in mobility demand.

At the same time, monthly gross salaries increased by 6.3% (adjusted for inflation) between 2008 and 2014 in Switzerland. This growth, however, declined during the last years and it is uncertain how this development will continue in the next years (Landolt and Stoll, 2017). Same conclusion can be drawn for the Europe Union. Even when an overall economic trend can be expected (European Commission, 2016), net earnings of the population are only increasing slightly (Stuchlik, 2015).

5.3.6 Spatial trends

Spatial development has a significant impact on transport demand and commuting travel paths. Therefore, it is essential to keep in mind these trends when sketching and defining the requirements for future commuting. A study from the Swiss Federal Office for Spatial Development examined the spatial development of workplaces in Switzerland. There it became clear, that the amount of population working in large and middle centres is expected to further increase, however the most intense growth is expected in the surrounding of middle and large centers (Ecoplan, 2016). Similar developments could be observed regarding the living spaces (ARE, 2009). The biggest growth happened mostly in the surroundings of cities. Therefore, the amount of population living and working in the surroundings of middle centres can be expected to increase above average within the next years.

Similar statistics are also collected in the EU and they match the Swiss trends: In 2016, almost three quarters of the EU-population lived in cities. While the increasing urbanisation continues unabatedly, the main development takes place primarily in the suburbs. The reasons for this development are inter alia explained by the increased motorisation rate, the improved road networks and better public transport links. However, big regional differences can be found within the EU. In most European countries, the urban population increased between 2 and 18% between 2004 and 2014. Only in Latvia, Lithuania, Poland and Greece a de-urbanisation can be observed (Eurostat, 2017b)

5.4 Technological Trends

5.4.1.1. Unmanned aerial vehicles (UAV) / Drones

In recent years, drones have increasingly become the focus of attention in the area of mobility. Before that, drones were mainly used in military applications, but nowadays they are increasingly being used for private and commercial applications. According to a study by Allianz Global Corporate & Specialty, 600,000 drones are currently in commercial use in the USA and 1.9 million drones in private areas. These figures are expected to triple by 2020 (Dobie et al., 2016). First concepts based on drones also exist for passenger transport and therefore are relevant for commuting. At the beginning of 2016, the Chinese drone manufacturer Ehang presented its "Ehang 184" concept. The single-seater aircraft should be able to carry its passengers autonomously over a distance of up to 32 kilometres. According to the company, this would be the world's first autonomous aircraft for passenger transport (Cavanagh, 2017).

5.4.1.2. Watertaxis

Water taxis are not a new phenomenon. In cities such as Amsterdam, Venice and New York, they are regarded as common means of passenger transport (NZZ, 2003). In 2016, the French startup SeaBubbles introduced a new water taxi concept, which falls within the scope of technological innovations: small electrically powered hydrofoil boats with space for up to five passengers are to carry passengers on a group taxi principle from special jetties. The jetties are equipped with water turbines that supply the boats with electricity. Particularly in large cities with extensive waterways such as Paris or London, the system is intended to reduce the traffic congestion and could therefore also contribute to new commuting systems. Trial operation was to begin in Paris in mid-2017 (Mawad and Boksenbaum-Granier, 2016; Pluta, 2016a). In June 2017 Seabubbles conducted a demo tour with a first prototype in Paris. However, the vehicle differed markedly from the previously published visualizations. For example, it did not have a roof (Dan, 2017). According to Seabubbles, further demo tours are planned and the industrial production of the water taxis is scheduled to start in 2018. However, comprehensive trial operation is currently not explicitly stated (Seabubbles, 2017).

5.4.1.3. Autonomous street vehicles

Research sees a wide disruptive potential in autonomous driving for the mobility sector which could also strongly influence the means and ways people travel to work every day. MacKenzie (2017, p. 14ff) estimates that the introduction of autonomous vehicles could reduce the individual cost of a taxi ride to a quarter of the current price. On the one hand, this is due to the fact that the driver becomes superfluous and, on the other hand, because autonomous driving could optimize the use of the vehicle. Such cost reductions could also lead to the elimination of incentives to share these vehicles. But it will take years to reach this point. A complete SAE Level 5 integration, in which the technology bears full responsibility for driving, is not expected before 2030 (MacKenzie, 2017, p. 26). Completely autonomous vehicles must be able to cope with any environmental and road situation and this seems utopian at the moment (Graser, 2017). For Switzerland, the Federal Office for Spatial Development (ARE) estimates the possible proportion of autonomous passenger cars on Swiss national roads in 2040 to be between 10 and 20%, depending on the development scenario of the legal framework conditions (Prognos, 2016, p. 31f). For the EU area no realiable estimations could be found by the time of the present research.

5.4.1.4. Autonomous street vehicles (public transport)

The advantages of automatic driving should also be used in public transport: Since the end of 2015, an autonomous bus (operator Postauto AG) has been in pilot operation in Sitten's (Switzerland) Old Town. The vehicle offers space for 15 persons and drives up to 20km/h fast. Other cities and regions are also interested in the system. (Kiwitter, 2017; RTS, 2016). Similar concepts for autonomous minibuses are also being tested in the USA, Holland and Finland. Near Washington, the bus "Olli", a joint product of Local Motors and IBM, was tested. In the Dutch city of Wageningen and Helsinki, buses from Easy Mile (Pluta, 2016b) were tested.

5.4.1.5. Infrastructure-bound transport modes

Infrastructure-bound vehicles are firmly tied to the infrastructure regarding their driving dynamics. A classic example of this is the railway, which especially in Switzerland, has a significant role in commuting. However, only completely new overall concepts will be presented in the following.

The Chinese company TEB Technology Development Company presented the "Trans Elevated Bus 1" in August 2016. The vehicle, which is 7.8 metres wide and 4.8 metres high, drives above the regular road traffic on rails laid next to the road. It is therefore not blocked by a traffic jam, but overpasses it. Currently, a prototype of this bus exists. However, there are doubts about the practicality of this concept, since both the width of the road must be constant and the low height of the bus represents a potential conflict with the road traffic underneath (Pluta, 2016c).

Hyperloop is a transport concept that was presented in August 2013 by the US entrepreneur Ellon Musk. Goods and people are to be transported at high speeds (up to 800 km/h) in transport capsules in an air-evacuated tube. The drive is realized by means of a linear motor (magnetic levitation technology) (Stewart, 2016). Construction is currently underway on a 1.6-kilometer long test track in California on which the technology and design of the capsules are to be tested (Thompson, 2016).

The German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) is currently developing the concept of the "Next Generation Train". This concept is intended to define the long-distance train of tomorrow and combines findings in materials, propulsion, aerodynamics and vehicle research. Thanks to the use of lightweight materials, the train should be significantly lighter and more energy-efficient. Numerous different train constellations and technologies are tested and simulated for optimization. However, the train should adhere to the classic wheel-rail principle of today's railway (DLR, 2013).

5.4.1.6. Sharing-Systems

With the general spread of the economic model “sharing economy” - the sharing of existing resources (Portmann et al., 2017, p. 5) - the sharing of vehicles and mobility services has also increased in Europe (Loose, 2010, p. 15f). Classical car sharing mostly concerns bicycles and cars and can be divided into three categories:

- In peer-to-peer sharing, private individuals provide their personal vehicle via information and communication technologies such as online platforms of the sharing community. In Switzerland, the car sharing provider Sharoo is particularly noteworthy for this category (sharoo, 2017). Other established providers are Tamyca (tamyca.de, 2017) in Germany and Caruso in Vorarlberg (Caruso Carsharing, 2017). These companies only provide the booking platform; vehicles and responsibility for maintenance remain with private individuals.
- In freefloating, the vehicles belong to a central provider who is also responsible for the provision and maintenance. The vehicles are parked on public areas and can be re-parked at any location after use, taking into account certain requirements such as the type of parking space or geofencing. In 2016, car sharing provider Mobility launched such an offer in Basel with Catch a Car (Mobility, 2016). Bikesharing provider Smide operates a freefloating e-bike sharing service in Zurich (Smide.ch, 2017)
- The organisational structure of the station-based sharing is similar to that of free floating: the vehicles belong to a provider. However, they are parked at a defined station and have to be returned at such stations. In some cases, this must even be done at one and the same station.

Another type of sharing system is ridesharing: taxi rides are shared (e.g. Uber pool) or private rides offer individual free seats (BlaBla-Car or Hitchhike).

5.4.1.7. Mobility-as-a-Service (MaaS)

Mobility-as-a-service (MaaS) describes service concepts, which combines planning, booking and paying of journeys in one system. This is done on basis of ICT, usually a smartphone application. MaaS includes all forms of transport, like human powered mobility, public transportation or sharing services. It offers

users personalised service packages, completely tailored according to their needs for mobility, as well as their personal preferences and their way of living. It provides multi-modal travel-chains based on real-time information and user preferences. For the user this means an easy access to various forms of mobility through a single application and, instead of various tickets and payment procedures, one single payment channel. It therefore should provide the user the best value proposition. This means a mobility offer which meets exactly his needs and which makes the cum-bersome planning of individual journeys redundant.

For transport operators MaaS can entail new business models. The new way to organize transport operations can optimize their business activities, open up new market segments or expand the client base, as MaaS as a new way to approach mobility users can provide opportunities to meet unsatisfied mobility needs. Another goal of MaaS, according to MaaS Alliance, is to provide an alternative to the use of the private car. (MaaS-Alliance, 2017).

In Finland in particular, MaaS is a popular topic (LVM Finland, 2015). In Switzerland, there are now isolated attempts in this direction. Nordwest-Mobil (Nordwestmobil, 2017) or the SBB Travel Planner (SBB, 2016) are two examples of this, although these systems do not yet integrate all modes of transport, as should be the case for a complete MaaS system.

5.4.2 Socio-cultural Trends

5.4.2.1. Sharing economy

As mentioned in chapter 5.4.1.6, the general socio-cultural trend towards sharing economy is also influencing commuting. The amount of car-sharing users is expected to increase in Switzerland, as well as in Europe. For Switzerland, no specific figures could be found by time of writing of the current report. In Europe, the amount of car sharing users is expected to increase from 2.1 to 14 million by 2021 (Bert et al., 2016). A good combination with car sharing is public transportation. In Switzerland, the share of people owning a PT-travel card (in Switzerland: GA travel card, Halftax-travel card) is increasing (BFS and ARE, 2017). However, the cost of public transport tickets increased significantly compared to the car. Since 1990, the individual ticket prices increased by 45% to 75%, depending the type of ticket. During the same period the costs for private car usage increased by only 20% (WBF, 2013, p. 10).

5.4.2.2. Driving licence possession

To be able to use car sharing, a driving licence is required. In 2015, 82% of all persons over 18 possessed a driver licence. This is 5% more than in 1994. In the youngest age category (18-24 years), the amount decreased between 1994 and 2010. In 2015 however, this trend seemed to abate (BFS and ARE, 2017). Similar observations could be made within the EU-area: In the United-Kingdom, for example, the driving licence possession decreased since the mid-1990s till 2005. Since then, the figures remained constant. According to Berrington and Mikolai (2014) similar observations could also be made within other industrial countries.

5.4.2.3. Work life and teleworking

Currently, 6 out of 10 employed women and 1.7 out of 10 men work part-time. Part-time work is therefore a lot more common among female workers. On the one hand, part-time employment often means less social security (e.g. lower pension fund) and fewer opportunities for career development. On the other hand, it offers the opportunity to take on other work besides gainful employment, such as childcare, informal help and domestic work. This may be a reason why part-time work has increased since 1991, both among working women and men. In general, the world of work is expected to become increasingly flexible, interconnected and digital (Zobrist and Grampp, 2016). This is partly because of the increasing digitalization of society, but also due to the more flexible ways of working and living. An attractive employer must adapt to these developments. The number of people, whom their main place of work is their home, has quadrupled between 2001 and 2015 to 120’000 (NZZ, 2016). Home office or teleworking is considered environmentally judiciously and family-friendly. It may also help to reduce stress while reducing commuting traffic and improve workers productivity (Hansen, 2018; Hoffmann, 2018).

5.5 Conclusion and a baseline for recommendations

As the trend analysis with future perspective (chapter 5.3 and 5.4) could show, the area of commuting is subject to manifold changes and influences occurring currently or foreseeable in the near future. Regardless of whether in a societal or spatial context, trends and developments will have a lasting influence on future commuter mobility forcing actors in the transport system to adapt their strategies and commuting as such. New technological developments make new product concepts and business models possible. At the same time, mobility behaviour is changing, together with demographic developments within society. The trend assessment showed that the requirements of transport systems for commuting mobility are changing. People are getting older and the travel purposes as well as the vehicle possession are evolving. While the amount of cars has increased during the last years, the trend seems to have stopped. In contrast, the number of relatively new vehicles like E-Bikes are increasing steadily, indicating a change on the demand side. At the same time, technological developments open up the possibility of providing the necessary means and tools to enable such an adaptation.

The following set of developments need to be taken into account when establishing new strategies and solutions for commuting: The above developments can be well integrated into Geel's transformation theory (see chapter 5.2.2). Technological trends can be assigned to so-called niche-innovations (blue elements as examples in Figure 60). These changes in society and economy are potentially disrupting the existing sociotechnical regime, which has developments and changes happening within itself (orange elements in Figure 60), but influenced and guided by niche-innovations. It is likely that the new socio-technical regime will have to consider one or both of the following aspects:

- The changing demand that leads to **more user-oriented offers, asking for new business models**.
- The **digitalization** that is facilitating the **interaction and exchange** between different offerings and transport modes.

It takes place in a **sustainability** context that grants users, companies and administrative stakeholders the right of **codetermination and participations** regarding the appropriate designs. Furthermore, the developments must be incorporated into the design of future-oriented strategies and new mobility offers. Strategies and decisions relevant to the implementation of MaaS are strongly depending on involved stakeholders. Thus, the stakeholder network and schemes of cooperation were analysed as described in the next chapter to be considered in recommendations.

- Continuation of economic growth, job increase and the associated demand for mobility (chapter 5.3.5).
- Increasing requirements regarding the environmental compatibility of mobility (it must be ensured that this increasing demand can be satisfied as sustainable as possible).
- Individual car ownership may become less important in the coming years (chapter 5.4.2.1).
- The younger generation show a less pronounced affinity to driving licences (chapter 5.4.2.2).

These developments must therefore be taken into account and used positively in the **interests of environmental sustainability** (chapter 5.3.3). The **increasing digitalization** (chapter 5.3.2.3) and electronic connectivity of mobility users offer the possibility to use infrastructure and vehicles more efficiently in the sense of "sharing economy" (chapter 5.4.1.6). These mobility services should also respond to the changed mobility behaviour, especially increasing part-time work and patchwork life. They pose new challenges to the **flexibility of work mobility** (chapter 5.4.2.3). Where in the past people used to travel to their place of work by the same mean of transport every day, **their daily travels are often multimodal today** (chapter 5.3.1.1) and hence journeys should be adapted regarding user’s daily needs. This is all the more important if you want to offer commuters an attractive alternative to the car and thus prevent them from making a corresponding vehicle purchase. The private car as an extremely flexible form of transport is a strong competitor for shared or public forms of mobility. Also with regard to the spatial priorities, the trend study indicates where the priorities for mobility strategies are to be set: The strongest job and settlement development is to be expected in **the vicinity of the large and medium-sized centres** (chapter 5.3.6). These are regions where the transport infrastructure is usually

less developed than in bigger cities and thus offer great opportunities for future development in the sense of sustainable commuting mobility.

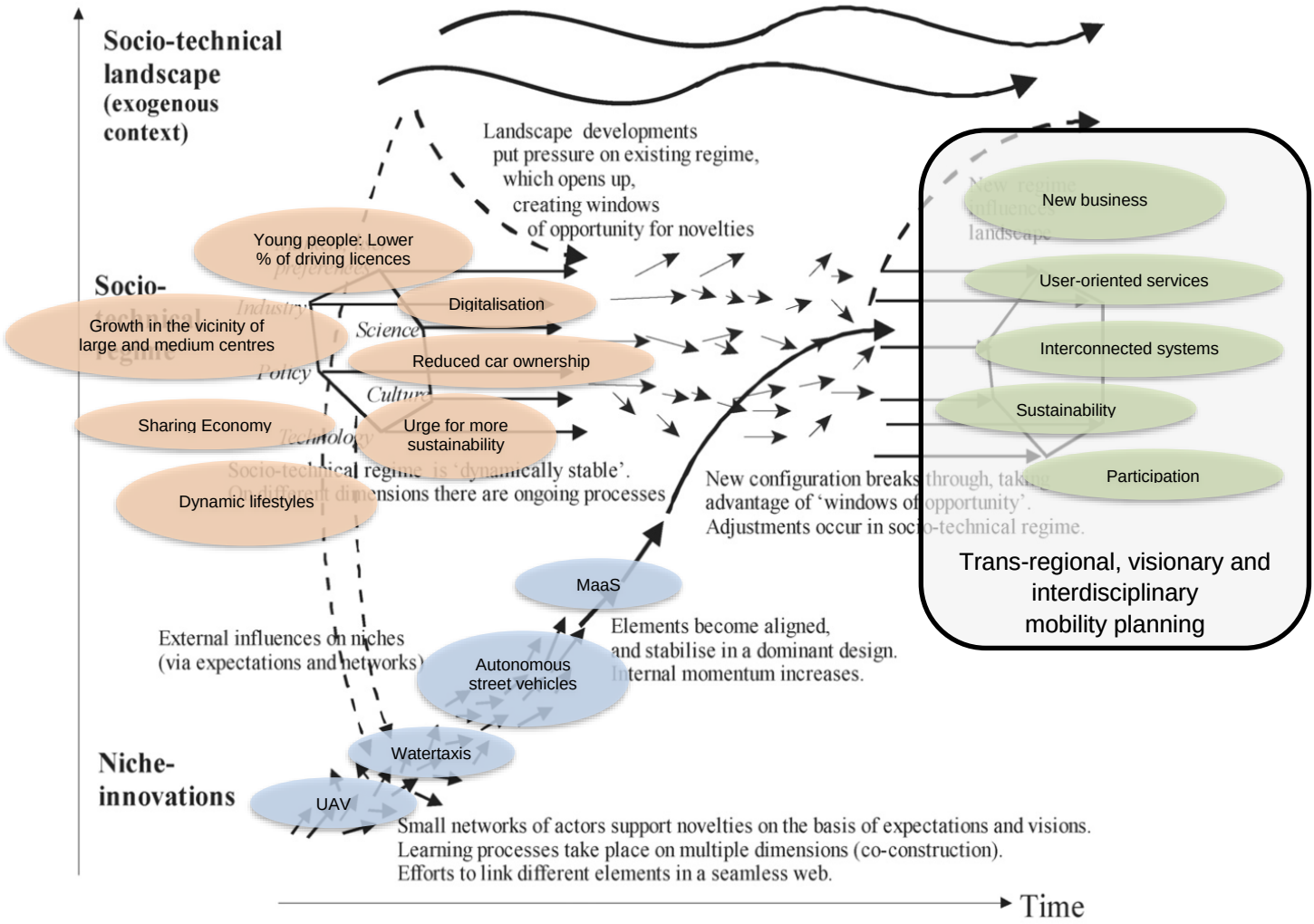


Figure 60: Socio-technical regime of commuting. Based on Geels (2012, p. 474)., modified.

6 Stakeholder network and cooperation[10]

6.1 Challenges and solutions for commuting

The first objective of this project has been to identify the changing needs of mobile workers. The second objective was to increase the sustainability of mobility by supporting the implementation of sustainable and intelligent transportation services. We used data and analysis from Austria, Finland, and Switzerland to analyse how new services could meet the evolving needs of mobile workers and what kind of stakeholder[11] collaboration is needed for a successful implementation process. Therefore (besides the commuter survey described in chapter 4.2 and related recommendations in chapter 8.5, 9.2 and 9.3), we did a stakeholder network analysis in the Canton of Basel-Stadt in Switzerland to expose the structure and the potential decision paths taken in the area of commuting. Furthermore, we collected the viewpoints and opinions of stakeholders in a survey among stakeholders in Austria, Finland, and Switzerland.

The steps described in the previous chapters have focussed on the needs and behaviours of individuals or groups and therefore have given a general view on ongoing and future trends in commuting. In this chapter it is been considered that there are actors, whose agency and power make their viewpoints more critical compared to transportation users. Our analysis of those stakeholders, their importance, their interrelations and their role in the potential transformation of commuting schemes have mostly focused on the case study of the Canton of Basel-Stadt in Switzerland, while the two other Smart Commuting case areas have been partly included. By combining the insights from this stakeholder analysis and the analysis of commuters' needs and preferences a more comprehensive picture about commuting design principles can be drawn (Figure 61).

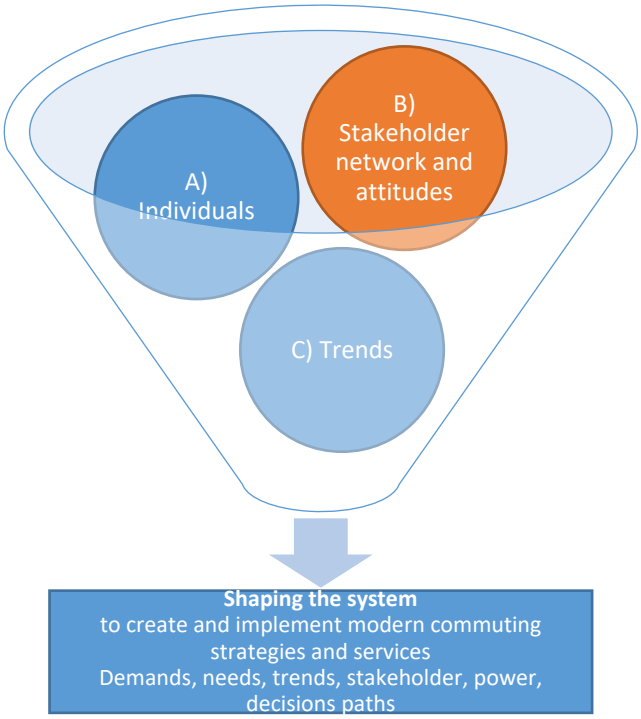


Figure 61 Research framework for creating commuting design principles.

[10] Härri, F., Michl, T., Hoppe, M., Surakka, T. and Hawelka, M., 2018. Smart and Mobile Work in Growth Regions. Deliverable 2.2: Stakeholder network and cooperation.

[11] The term 'stakeholder' will be defined in more detail in section 6.2.2.2. For now, we see a stakeholder as an entity or person, which has a certain interest in the subject and a position to influence the development.

Based on the methods of stakeholder network assessment (see Reed et al., 2009), as a first step, we identified the goals and the scope of the assessment, as well as the borders of the topic of commuting. Next, we identified stakeholders and their relations and analysed stakeholders' perceptions and opinions. Finally, we inferred the needed actions concerning the involvement and engagement of stakeholders for future processes.

Following Lienert et al. (2013) and Prell et al. (2009)[12], we combine the quantitative methodology of social network analysis to identify stakeholder-clusters and key-stakeholders with the qualitative approach of stakeholder analysis for interpreting the results of social network analysis. One of the purposes of our stakeholder network analysis was to find out who plays essential roles in the network and therefore can be considered a key stakeholder. In general, and for the case study in the Canton of Basel-Stadt, we used the following guiding questions to analyse the stakeholder network and its members:

- Who are the stakeholders influencing commuting?
- How are these stakeholders connected and how intense are these connections?
- Are there distinct groups (clusters) of stakeholders within the network?
- How is the stakeholder network structured? Are there stakeholders essential for the connection of different parts of the network?
- What are their motivations and needs concerning their involvement in the area of commuting?

We assume that the influence of key stakeholders on other actors is relatively high. However, the importance of stakeholders is not the only relevant variable here. Therefore, we surveyed the identified stakeholders to assess their perceptions of ongoing trends (which shape their actions in everyday activities) as well as their roles as potential facilitators of future development activities. This survey's goal was to provide a general idea about stakeholders' roles in the innovation processes of the commuting regime. Based on our conclusions the roles and potential of stakeholders in sustainable transport transformation can be understood and supported.

Excursus: Definition of MaaS

Mobility-as-a-service (MaaS) describes service concepts, which combines planning, booking and paying of multimodal journeys, usually by using a smartphone application. MaaS typically includes all forms of transport, such as human powered mobility, public transportation or vehicle sharing services. MaaS offers users personalised service packages, completely tailored according to their needs for mobility, as well as their personal preferences. It provides multi-modal travel-chains based on real-time information and user preferences. For the user this means an easy access to various forms of mobility through a single application and, instead of various tickets and payment procedures, one single payment channel. It therefore provides mobility which meets user needs better and which makes the planning of travel chains more easy (MAAS-Alliance, 2017).

For transport operators MaaS can entail new business models. The new way to organize transport operations can optimize their business activities, open up new market segments or expand the client base, as MaaS can provide opportunities to meet unsatisfied mobility needs. Another goal of MaaS, is to provide an alternative to the use of the private car. (MAAS-Alliance, 2017)

6.2 Stakeholder network

The analysis aims to understand and evaluate stakeholders in the context of a specific policy, project or organisation in the past, present and/or future, and it includes the activities of stakeholders in the

[12] Note that these authors work in the field of natural resource management and not in transportation research. However, the general idea of involving stakeholders to understand development processes better and to reach a certain goal are similar to our study.

discussion, learning and decision processes. Stakeholder analysis in general increases the understanding of relations between stakeholders, their perceptions, standpoints, backgrounds, visions and other aspects that influence their roles and actions. Together with stakeholder analysis, the toolsets of social network analysis (SNA) is useful[13] as its primary purpose is "a systematic and quantitative analysis of the relationships among the actors" (Lienert et al., 2013, p. 135). We, therefore, conducted a stakeholder network analysis in four steps (Figure 62):

Step 1 Defining the context (chapter 6.2.1)

At first, the scope of the study is defined. We delineate the thematic field within which the stakeholder analysis takes place.

Step 2 Identify the processes (chapter 6.2.2)

The identification of stakeholders is made on the basis of participation in different formal processes, where stakeholders communicate and/or cooperate in the thematic field. These processes are specified in a way that all relevant processes within the context defined in step 1 are included.

Step 3 Identify the stakeholders (chapter 6.2.2.2)

The stakeholder is defined in this step to address the goals of this analysis appropriately. We will propose to use a stakeholder-concept on an institutional level, which then also requires naming specific persons that represent the stakeholder. All stakeholders involved in the processes identified in Step 2 make up to the final stakeholder list.

Step 4 Assemble and analyse the process networks (chapter 6.2.2.4 and chapter 6.2.3)

The assembled networks consist of the stakeholders identified in the previous step (nodes) and their connections (edges). In this final step, we identify the edges that connect the nodes in each process specific network and then merge these process networks. The resulting meta-network is assessed and visualised with SNA to differentiate intensely interconnected clusters from loosely connected single actors. This visualisation helps to understand potential information flows and to identify stakeholders with prominent positions in the network.

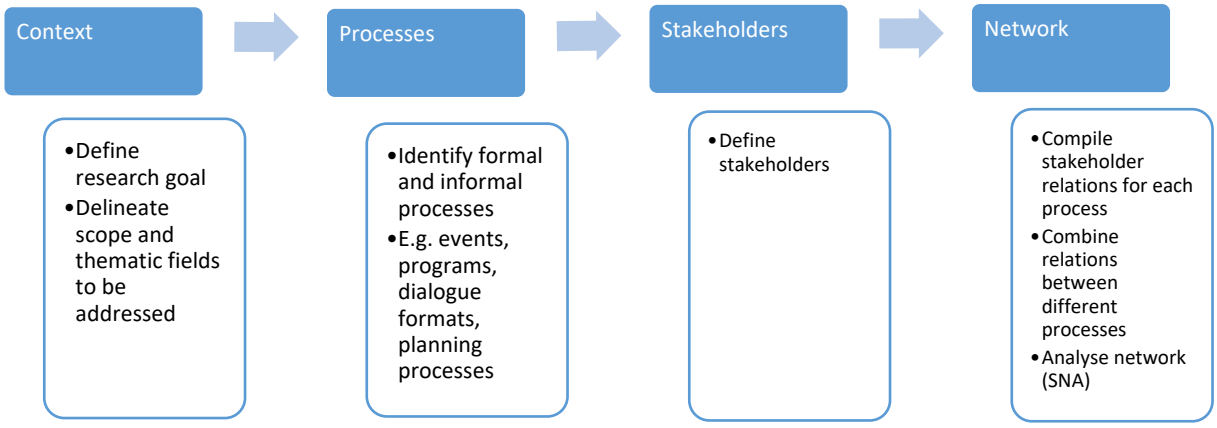


Figure 62: Steps for analysing the stakeholder network.

The procedure is iterative and can incorporate insights from later steps into the earlier ones. For instance, the identification of some stakeholders in step 3 might help to find processes for step 2 that

[13] The benefits of combining stakeholder analysis and social actor approaches such as SNA has been pointed out by Grimble and Wellard (1997).

have been previously overlooked. The data gathering was conducted with a database tool[14] incorporating the elements listed in Table 6.

Table 6: Database elements for the stakeholder network data collection.

Table	Important Elements	Intended usage
Processes	• Name • Description • Timeframe and budget	The basis for the associated lists of stakeholders and connections
Stakeholders	• Name of the institution • Stakeholder category • Address and contact	The basis for the quantitative network analysis with other software tools. Stakeholders are the **nodes** in the network.
Persons	• Name and contact information • The stakeholder that this person is representing	Persons that represent a stakeholder for qualitative analysis.
Connections	• Stakeholders that are connected • Process, of which the connection is part of • Type of connection • Directedness	The basis for the quantitative network analysis with other software tools. Connections are the **edges** of the network.

6.2.1 Methodology

The 'context' of the stakeholder analysis needs to be defined, providing "a clear focus with clear system boundaries" (Reed et al., 2009, p. 1946) to frame the theme within which we address stakeholders[15]. This definition helps to reduce the potential number of stakeholders to be addressed (Varvasovszky and Brugha, 2000), which is especially crucial for participatory stakeholder processes, but also when a comprehensive understanding of the stakeholder network is required.

The goal of this study is a sustainability transformation of commuting. More precisely, we aim at finding out how organisational and technological innovations (i.e., 'intelligent and sustainable transportation services') can be implemented to support such a transformation. The stakeholder network to be assessed therefore includes everyone who is concerned with the development and implementation of commuting strategies and concepts, as well as with related fields that have considerable influence on commuting behaviour. It is essential to understand the policies and governance, including their consequences, in this part of the transportation system to identify potential mechanisms of change.

The term 'commuting' in this deliverable refers to all mobility that is connected to work or education and is composed of periodically used transportation solutions with fixed origin-destination-relationships (usually: home-work/place of education and work/place of education-home). In the canton of Basel-Stadt in 2015, commuting traffic consisted of 100'561 inbound commuters, 24'412 outbound commuters and 60'933 commuters within the canton (Statistisches Amt des Kantons Basel-Stadt, 2017; T11.5.01, T11.5.05, own calculations). As the Smart Commuting Project has a regional focus, we will focus on the

[14] Microsoft Access tool was used for the stakeholder network process and connection analysis

[15] Note that Prell et al. (2009) point out that having the researchers define the issues and goals of the stakeholder analysis results in a reflection of their interests and therefore a certain bias. As the objective of this study is to better understand stakeholder processes and only in a second step to point out approaches for interventions, we consider this aspect less critical than for participatory processes.

travel-to-work area of Basel and treat stakeholders on superordinate spatial and organisational levels compared to being an integral part of the *regional* stakeholder network.

6.2.2 Network characterisation

6.2.2.1. Decision and development processes

The goal of SNA is to identify and analyse a network composed of all social ties between *all actors* (Borgatti et al., 2009). However, the field of commuting is broad and includes a high number and variety of associated actors. Entities involved are, e.g. public authorities, transport companies, politicians, lobbyists, employers, non-governmental organisations, interest groups and others. With the high number of stakeholders, the task of capturing *every* formal and informal connection can hardly be empirically handled. As we want to analyse and understand stakeholder relations from a policy and governance perspective, we focus on the 'decision and development processes' and apply an approach for stakeholder-connection identification that reduces the complexity. This approach considers only formalised networks, such as planning, policy coordination, events and activities, and communication platforms and address the stakeholder network from a **formal** governance and policy perspective.

This approach has the drawback that it does not capture personal relations between stakeholders which exist beyond formal and official connections and which can be important to address when developing new commuting schemes. This approach also does not include stakeholders who are not part of the identified processes but might become important in the future. This restriction to formalised processes limits the insights from the specifically 'social' aspect of SNA. However, we consider this simplification of the network important for gaining systematic insights.

The decision and development processes need to be assembled in a structured and intersubjective way for the analysis. We targeted formalised processes in which stakeholders communicate, collaborate or cooperate to achieve a goal. Such goals are diverse and can be, e.g. the construction of new infrastructure, the exchange of knowledge through regular meetings, development of a policy framework, information campaigns for the public, cooperation agreements, or developing business models. This small list of examples shows that these processes differ concerning their methods, their spatial and temporal extent, the level of detail in their goals and the number of involved stakeholders.

There are different methods, which can be employed to identify the processes. All of them should be used in combination and in several iterations to make sure that the network gets as complete as possible. Derived from the different approaches of stakeholder analysis (see e.g. Lienert et al., 2013), we used the following methods to create a comprehensive list of relevant processes. The first method was desk research of scientific literature and internet sources. The second method involved asking the stakeholders who were already identified if they know processes that have been overlooked in the first method – drawing on the principle of a snowball-sampling-approach (Kivits, 2013; Lienert et al., 2013; Luyet et al., 2012; Prell et al., 2009).

The identified processes were categorised according to their subjects and goals. For a better generalisation, these categories were also compiled into groups (Table 7).

Table 7: Categories of decision and development processes in the context of commuting.

Group (analysis)	Category (survey)	Description
Communication	Event / conference	Conference where stakeholders meet and exchange knowledge and opinions
	Mobility management	Mobility management processes with the goal to change the mobility behaviour of employees
	Mobility study	Research projects on traffic, transport, and mobility
Cooperation platform	Transport association	A consortium of public transport operators which provides homogenous services
Innovation platform	MaaS	Mobility-as-a-Service initiative
	Pilot project	Demonstration initiatives for innovations
Policy	Public participation	The inclusion of political stakeholders in planning and discussion processes
	Strategy and policy	Discussion and negotiation processes, which produce legal and policy frameworks for future actions
Project	Infrastructure cycle path	New or improved cycling infrastructure
	Infrastructure Park&Ride / Bike&Ride	New or improved infrastructure linking individual and public transport
	Infrastructure public transport	New or improved public transport infrastructure
	Infrastructure road	New or improved road infrastructure

The identified stakeholder processes were entered into the database. For the case study in Basel-Stadt, an additional 'Pendlerfonds' (commuter fund) checkbox was added, which indicated whether a process is funded by 'Pendlerfonds' (see excursus). For every process, a list of all involved stakeholders was filled into the database.

Applying these methods on the Basel-Stadt case, three essential information sources for possible processes were identified:

a) The 'Verkehrspolitisches Leitbild und Massnahmenplan' (transportation policy framework and action plan; see excursus) (Regierungsrat des Kantons Basel-Stadt, 2015) which is a relevant process itself, but it also points out a whole variety of different other processes.

b) The 'Pendlerfonds' (commuter fund; see excursus) (Amt für Mobilität des Kantons Basel-Stadt, 2017). The commuter fund supports mostly infrastructural projects that are all relevant for this analysis.

c) The agglomeration program of Basel (Agglo Basel, 2016) which combines both abovementioned policy tools and provides a general outline for the future development of the whole agglomeration (with a focus on transportation).

In total, 61 processes were identified and added to the database (Table 28, see appendix). More than two third of the processes were either: Infrastructure projects or policy-related processes (Figure 63).

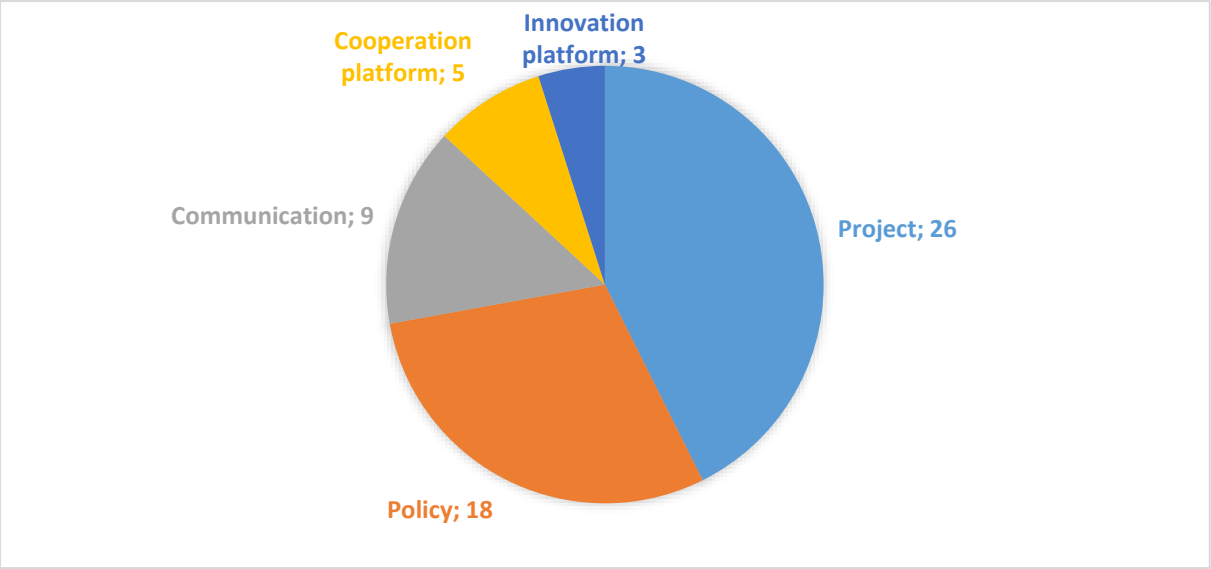


Figure 63: Grouping of cooperation processes, data: ZHAW.

Excursus: “Pendlerfonds”= commuter fund

The ‘Pendlerfonds’ (commuter fund) of the Canton of Basel-Stadt has two purposes. It aims at reducing pressures on public parking spaces and supporting a mode shift from private car to public or intermodal transport. The fund supports projects which help to reach these goals such as building park-and-ride / bike-and-ride facilities, central parking areas, and public transport infrastructure primarily for commuters. Public authorities and private entities can apply for funding for their projects as long as the projects are aligned with the goals of the fund. The fund is administered by the cantonal mobility office in Basel-Stadt, but the applicants can be situated outside the canton as well, however, they have to be inside the agglomeration of Basel. The monetary basis of the fund are parking fees and it is estimated to be between 2 and 3 million CHF per year in the long term. (Amt für Mobilität des Kantons Basel-Stadt, 2017)

Excursus: «Verkehrspolitisches Leitbild und Massnahmenplan» = transportation policy framework and action plan

This policy framework builds on the Constitution of the Canton of Basel-Stadt, which stipulates the transportation system to be sustainable. The framework stresses the importance of accessibility, quality of life, safety and cost efficiency. It gives priority to public transportation, which means facilitating economically feasible, environmentally friendly and energy efficient mobility. The main policies supported are dense and mixed spatial and settlement development, prioritising modes of transport that need less space and the efficient use of existing infrastructure and mobility services. For these goals, the action plan focuses on seven themes, which are not only targeted to the Canton of Basel-Stadt but in fact to the whole region: 1. Walking and cycling, 2. Public transportation, 3. Road traffic, 4. Parking spaces, 5. Urban freight transport, 6. Public road space, 7. Mobility management. (Regierungsrat des Kantons Basel-Stadt, 2015)

6.2.2.2. Identification of stakeholders

Stakeholders are individuals, groups, organisations or institutions “that are or perceive themselves as being affected by or interested in the decision-making on a certain issue” (van de Kerkhof, 2001, p. 4). They might be any group of people, organised or unorganised “who share a common interest or stake in a particular issue or system” (Grimble and Wellard, 1997, p. 175). For the sake of analysis it is necessary to focus on stakeholders, whose decisions and actions can contribute more to systemic stability or change than others’ actions and therefore, are conceived to have a higher relevance for the system. For that reason we have focused on interest/action groups, institutions, organisations, and persons representing political, social, cultural and economic power.

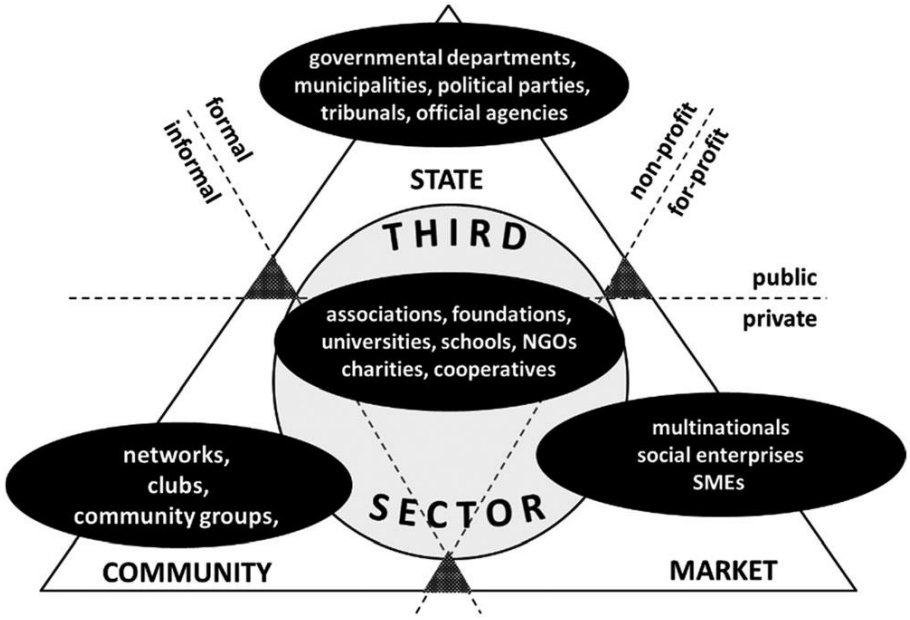


Figure 64: Fields of stakeholders on an organisational level (Avelino and Wittmayer, 2016, p. 637).

Similarly to the processes (6.2.2), we distinguish different categories of stakeholders within the analysis. From an applied stakeholder participation perspective[16], it is proposed to distinguish “four major societal groups […]: companies, research bodies, government and public interest groups and the public” (Quist and Vergragt, 2006, p. 1034)[17], which are used in a similar way by Avelino and Wittmayer (2016) (Figure 64). Adapted to the needs of our research, we developed a stakeholder categorisation (Table 8) based on institutional affiliation and associated interests of the stakeholders in Basel. It provides an overview of the different types of stakeholders and allows quantifications and characterisations of the sample.

[16] Such a perspective is considered useful as one of the goals of this study is to find out how systemic change can be facilitated.

[17] E.g. van Asselt et al. (2001, p. 7) propose the same categorisation; however, they see the public (“citizens”) also as a separate category.

Table 8: Categories of stakeholders in the context of commuting mobility[12].

Aggregated Stakeholder Category	Detailed Stakeholder Category	Descripion
Administration	Public administration national	National/federal government or authorities
	Public administration canton / Land / region	Administration and government entities on the hierarchical level of the Canton (CH), Bundesland (D) or Département (F).
	Public administration regional	Administrative level between Canton (etc.) and municipal level, e.g. Landkreis (D)
	Public administration municipal	City or village administration/government entities
	Regional cooperation platform	Publicly funded platforms/organisations which focus on international cooperation on a regional level, e.g. Euregio
Associations & NGO	Chamber of Commerce	Chambers of commerce as representatives of companies
	Citizen group	Interest groups representing citizens, often based in a specific urban district
	NGO and lobby	Non-governmental organisations and lobby groups, often associations or foundations, who promote and support specific development directions
Industry	Company/industry	Companies or industry (other than transportation)
Planning & Research	Consulting and planning	Private research, engineering, consulting and planning offices
	Research institution	Public research institutes, e.g. universities
Political party	Political party	Political parties
Transport company	Public transport company national	Provider of public transport on a national level, e.g. national railway company
	Public transport company regional	Provider of public transport on a regional level
	Public transport company local	Provider of public transport on a municipal level
	Transport association	A consortium of different public transport operators which provides homogenous services
	Transport company (other)	Companies providing transportation services such as taxi, carsharing, bikesharing, etc.

6.2.2.3. Case Basel: Stakeholder collection

From the 61 decision and development processes (see chapter 6.2.2), 268 involved stakeholders could be identified, of which more than 1/3 is administrative or governmental entities (see Figure 65, Table 29 and Table 30 in the appendix for categories and locational characteristics). The majority of stakeholders are located in Switzerland (204), followed by Germany (45) and only a few in France (18)[18]. The cantonal mobility office of Basel-Stadt is involved in 39 processes, whereas most of the stakeholders are involved in only one process (Figure 66). This already indicates that not too many stakeholders play essential roles from a network perspective but there are some who might be of crucial importance.

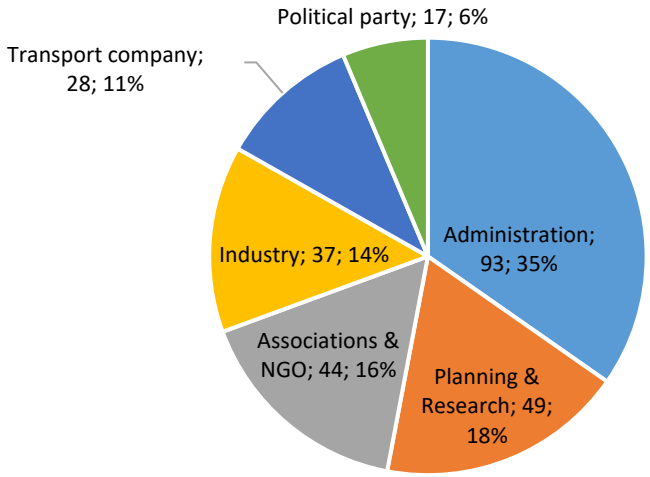


Figure 65: Stakeholders according to categories, data: ZHAW.

[18] The number of cross-border commuters is more evenly distributed: 46% are from Germany and 53% from France (1st quarter 2017; Statistisches Amt des Kantons Basel-Stadt, 2017, t03.5.01).

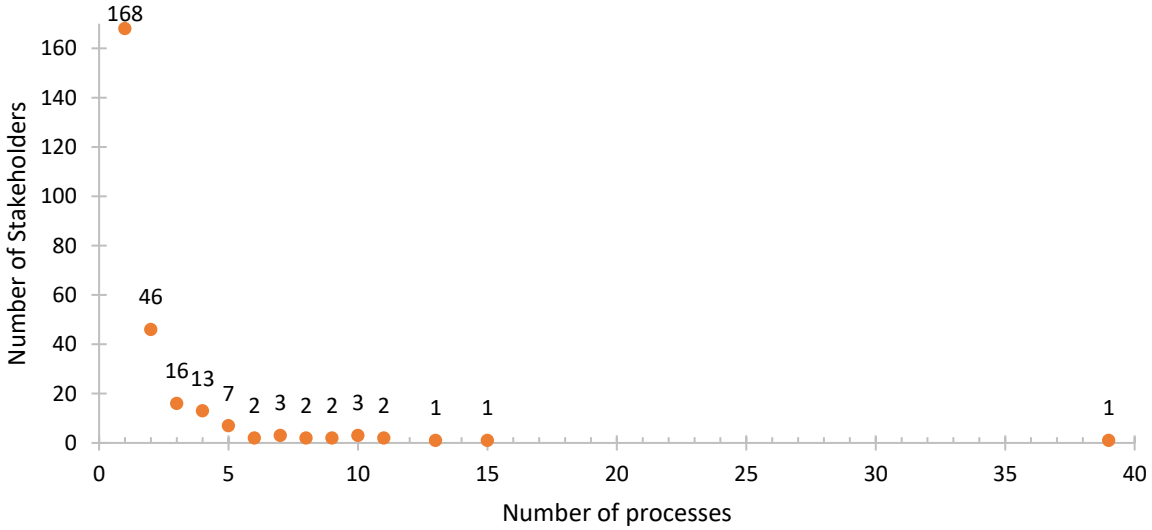


Figure 66: The number of stakeholders according to the number of processes they are involved in, data: ZHAW.

6.2.2.4. Network creation

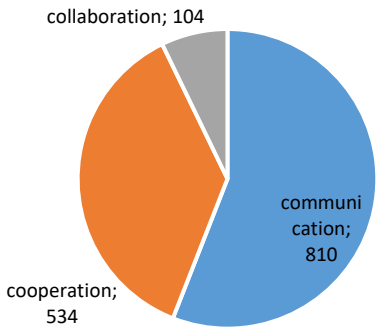
The general idea of social network analysis (SNA) is the assessment of nodes and edges, where nodes represent stakeholders and edges indicate the ties (connections of any kind) between them (see also Figure 73 on p. 102). If persons or institutions/organizations are considered relevant stakeholders (chapter 6.2.2.2), the ties between them need to be identified and characterized for each decision and development process. The complete stakeholder network can be assembled by combining all the partial process networks (chapter 6.2.3.2).

For stakeholder involvement processes, five degrees of participation have been distinguished in literature: information, consultation, collaboration, co-decision and empowerment (Luyet et al., 2012). We used three categories of participation[19], with *cooperation* being the highest-ranking category that includes *collaboration* and *communication* (Table 9, and Figure 67).

Table 9: Categories of stakeholder connections.

Category	Description	Hierarchy
Communication	Exchanging knowledge or opinions about goals	1
Cooperation	Working together to achieve goals	2
Collaboration	Working next to each other to achieve goals	3

Figure 67: Stakeholder connections according to categories, data: ZHAW.



[19] Closest relation concerning practical implications.

For the Basel case, we identified a total number of 1'448 connections between the 268 stakeholders. More than half of the connections are related to communication whereas more than one third are actual cooperation connections between different stakeholders.

To assemble the full network of formalised stakeholder connections, we merged all the networks of single processes. The information about the category of the ties was aggregated in the way that the highest occurring hierarchy level (see Table 9) was assumed for the overall network. This loss of information barely affects the analysis of the network and the information can be retrieved still when analysing the tie structure of a single process.

Also, we calculated *how many* processes the same two stakeholders are sharing as an indicator of the intensity of the connection between them. This variable can be used for weighting the edges. The 1'448 connections in the Basel study produce 1'201 edges in the merged network. This means an average of 9 connections per stakeholder with a maximum of 101 and a minimum of 1 connection for a stakeholder (see 'degree centrality' in chapter 6.2.3.1).

6.2.3 Results of the network analysis

6.2.3.1. Basic metrics and node centralities

The goal of the stakeholder network analysis is to assess the interactions and power relations between stakeholders – and therefore their importance and a potential influence on the development of sustainable commuting. Reed et al. (2009) differentiate three dimensions of power: 1) condign power through exercising force and regulations, 2) compensatory power through rewards or bribes and 3) conditioning power through manipulation of beliefs. Furthermore, power itself can be considered on two scales: on a macro scale as the power of a network or on a micro scale as the power of one entity within a network (Hanneman and Riddle, 2005). In our approach, we focus on the latter[20].

The analysis of the network takes place in three steps. First, the general characteristics of the network are described and assessed through standardised SNA methods (6.2.3.1). Second, visual analysis helps to structure the network through separating and identifying distinct groups of stakeholders (6.2.3.2). In the third step, the insights from previous steps are integrated, and a holistic picture of the stakeholder network is created with a focus on power and influence of stakeholders. The network was mainly analysed with the open-source software 'gephi'[21] (Bastian et al., 2009).

Table 10 shows some metrics of the stakeholder network. The diameter of this formal and institutional network, which does not contain personal ties, stays under six connections commonly postulated by the 'small world phenomenon'. Even though only a small percentage of all possible connections is actualised, the potential for stakeholders to get in touch with each other through one or two connections is relatively high. These variables, characterising the network as a whole, do not yet explain in detail how the stakeholders are connected. Therefore, the stakeholders and their positions in the network (i.e., their node-centrality) is described next.

Table 10: General metrics of the stakeholder network (Descriptions: Heymann, 2014, p. 619 f).

Variable	Description	Value for case study Basel	Explanation
Diameter	The longest distance between any two nodes in the network (i.e., how	5	All stakeholders could get acquainted with each other via a maximum of four others in between. However, for most stakeholder

[20] Note that the power which a stakeholder holds through their position in a network is not necessarily practiced to a full extent and thus needs to be considered as 'potential power' (Reed et al., 2009).

[21] Version 0.9.1

	far apart are the two most distant nodes)		pairs this is less, as shown by the average path length (see below), which shows a generally high level of connectivity. ●⇔○⇔○⇔○⇔○⇔●
Average path length	The average distance between all pairs of nodes	2.68	On average, there are 1 to 2 nodes between two stakeholders, who have not been involved in the same process. The individual evaluation of each stakeholder is possible through centrality variables.
Density	The share of realised connections from all the possible connections. A complete network has all possible edges in it and a density equal to 1.	0.034	3.4% of all the possible links between stakeholders in the network are realised. As the stakeholder network can be seen as an open system, this figure has only minor explanatory power.

Degree centrality

Degree centrality calculates how many edges are adjacent to a node. “The more ties an actor has then, the more power they (may) have” (Hanneman and Riddle, 2005) because more connections mean more options for communication, influence, cooperation, etc.

The average degree centrality of the stakeholder network is 9, i.e., on average, every stakeholder is connected to nine others. Figure 68 shows the distribution of this value, illustrating that there are many stakeholders with few connections and few stakeholders with many connections. The most important stakeholders according to degree centrality are cantonal and other (semi-)public organisations (Table 11). This result is not surprising, as the identified formalised processes usually included governmental actors. As the Canton Basel-Stadt is the dominating centre of the agglomeration, the importance of its institutions is also not surprising. However, also other administrative actors in the region, from Germany and France, have many connections to stakeholders and serve as connectors. This is also true for those stakeholders whose primary job is to connect others, such as Agglo Basel, Interreg programs and other communication actors. Concerning the stakeholders’ location, especially those from France show a high average degree centrality (Figure 69); most likely because the identified processes primarily included the potentially most critical French stakeholders, which are included in many processes, whereas from Germany and Switzerland also less important stakeholders were included.

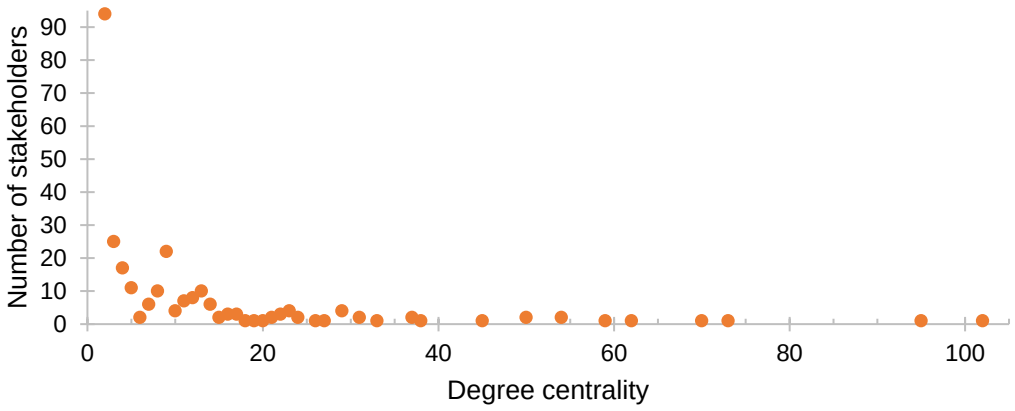


Figure 68: Frequency of degree centrality, data: ZHAW.

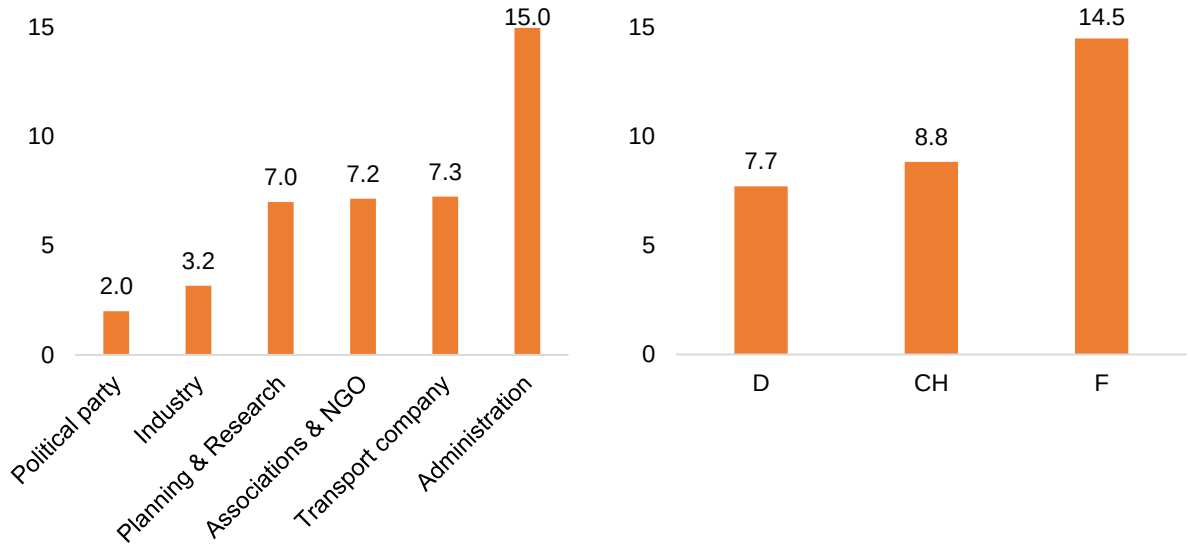


Figure 69: Average degree centrality according to stakeholder category and country, data: ZHAW.

For a better understanding of the importance of the connections between stakeholders, it is useful to assign weights to the ties (see excursus on next page). In our case, the number of processes, in which the connection between two stakeholders appears, is used as the weight. The resulting weighted degree centrality distributions are displayed in Annex Figure 112, Figure 113, and Figure 114. The cantonal Mobility Office of Basel has an outstanding position here (Table 11). However, the general composition of the top-ranked stakeholders is rather similar to the one without weighted connections.

Table 11: Top 20 stakeholders according to degree centrality and weighted degree centrality[16].

Degree centrality		
	Stakeholder	Value
1	Kanton BS	101
2	Amt f. Mobilität Kt. BS	94
3	Agglo Basel	72
4	Tiefbauamt BL	69
5	Bau- und Verkehrsdepartement BS	61
6	Kanton BL	58
7	Bau- und Umweltschutzdirektion Kt. BL	53
	Handelskammer beider Basel	53
9	INFRAS	49
	SBB	49
11	CC3F	44
12	Landkreis Lörrach	37
13	Regionalverb. Hochrhein-Bodensee	36

Weighted degree centrality		
	Stakeholder	Value
1	Amt f. Mobilität Kt. BS	170
2	Kanton BS	139
3	Agglo Basel	126
4	Tiefbauamt BL	100
5	Kanton BL	82
6	CC3F	77
7	Bau- und Verkehrsdepartement BS	74
8	Bau- und Umweltschutzdirektion Kt. BL	68
9	Handelskammer beider Basel	62
10	SBB	56
11	Regionalverb. Hochrhein-Bodensee	54
12	Landkreis Lörrach	53
13	INFRAS	51

	Haeseli & Hilti GmbH	36
15	Planungsamt BS	32
16	Bundesamt für Verkehr BAV	30
	Basler Verkehrsbetriebe BVB	30
18	IHK Hochrhein-Bodensee	28
	Interreg Oberrhein Rhin Superieur	28
	Kanton AG	28

14	Basler Verkehrsbetriebe BVB	41
15	Direction des Routes et des Transports; Haut-Rhin	38
	Kanton AG	38
17	Haeseli & Hilti GmbH	36
	Planungsamt BS	36
19	Abteilung Verkehr Kt. AG	35
20	Interreg Oberrhein Rhin Superieur	33

Excursus: weighting of edges

Weights can be assigned to edges to indicate the strength of the connection between two nodes. The analysis of strong and weak ties in a network (Granovetter, 1983, 1973) provides deeper insights on how the network works. “Actors sharing a strong tie tend to: (i) influence one another more than those sharing a weak tie; (ii) share similar views; (iii) offer one another emotional support and help in times of emergency; (iv) communicate effectively regarding complex information and tasks; and (v) be more likely to trust one another” (Prell et al., 2009, p. 503).

Closeness centrality

A stakeholder’s power is not only exerted through direct connections but also by his position in the network. “Actors who are able to reach other actors at shorter path lengths, or who are more reachable by other actors at shorter path lengths have favoured positions” (Hanneman and Riddle, 2005). A stakeholder might have many connections, but only within a part of the network. The Stakeholders with the highest closeness centrality value have the shortest average connection to *all* other stakeholders and can distribute knowledge efficiently in the network and this way support implementation and spread innovations.

In Basel case, the cantonal Mobility Office has the highest value (Table 12) in the network. On average, public administration stakeholders have higher closeness centrality than stakeholders of other categories. However, as the network is rather small (diameter 5, see Table 10), the variation of the closeness centrality values between the stakeholders are also rather small (Appendix Figure 115). The same applies when looking at the average values for the three countries in the agglomeration[22].

[22] The average closeness centrality of French stakeholders is slightly higher. This might be due to the fact that the focus of many processes is on the German-speaking regions and therefore only the stakeholders with a higher relevance are included from France.

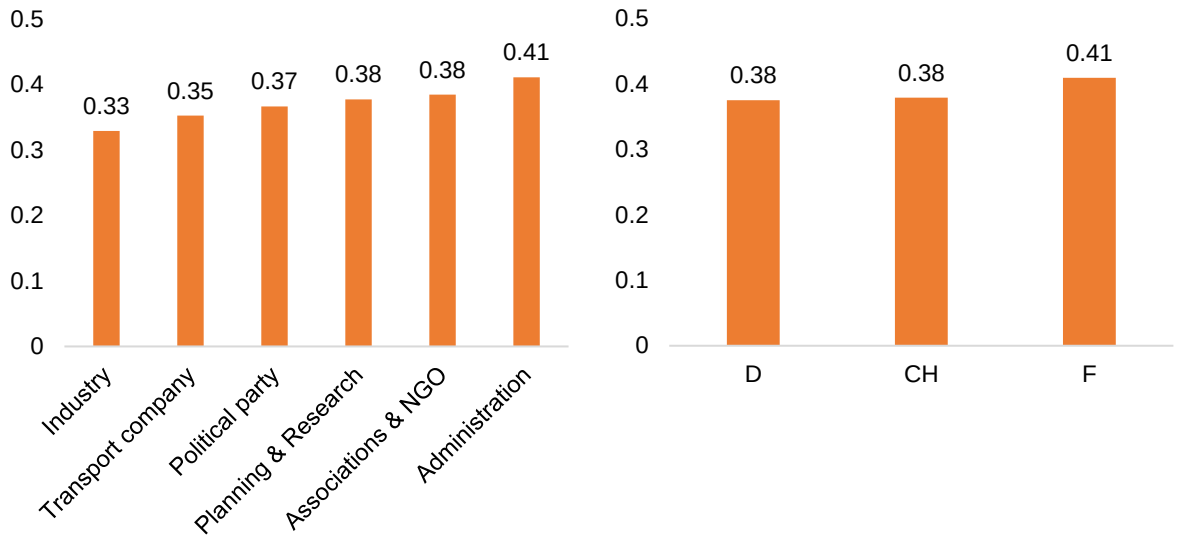


Figure 70: Average closeness centrality according to stakeholder categories and country, data: ZHAW.

Table 12: Top 20 stakeholders in closeness centrality, data: ZHAW.

	Stakeholder	Closeness centrality
1	Amt f. Mobilität Kt. BS	0.59
2	Kanton BS	0.57
3	Bau- und Verkehrsdepartement BS	0.55
4	Kanton BL	0.52
5	Agglo Basel	0.52
6	Tiefbauamt BL	0.52
7	SBB	0.51
8	Basler Verkehrsbetriebe BVB	0.51
9	Handelskammer beider Basel	0.50
10	Bau- und Umweltschutzdirektion Kt. BL	0.50
11	Landkreis Lörrach	0.49
12	INFRAS	0.49
13	CC3F	0.48
14	Regionalverband Hochrhein-Bodensee	0.48
15	Planungsamt BS	0.47
16	Gruner AG	0.47
17	Interreg Oberrhein Rhin Superieur	0.46
18	BAV	0.46
19	Kanton AG	0.46
20	Pro Velo beider Basel	0.46

Betweenness centrality

Another aspect of power relations is the measure of 'betweenness' of stakeholders, which refers to their position in the network: the more indirect connections *between stakeholders* run through one node, the more power this one stakeholder has (Hanneman and Riddle, 2005). Actors with a high value of betweenness centrality can be seen as pivotal stakeholders, i.e., their role is of particular importance for the existence of the network (see also Figure 73 (c), (d) on p. 102). Whereas high closeness centrality means good options for spreading information/innovation, high betweenness centrality makes it possible to control information flows and the spread of innovations. If a stakeholder with high betweenness centrality decides not to support specific development, some part of the network might be excluded (e.g., due to missing knowledge).

Especially administrative stakeholders but also transport companies have relatively high betweenness centrality values[23] (Figure 71). Private companies in planning & research, who work as contractors for administration and public companies, have an essential role as well. They are communicators who connect different stakeholders. Switzerland has by far the highest average betweenness centrality for its stakeholders (Figure 71). This unbalance is affirmed by the ranking of stakeholders according to

[23] In case of our network the normalised values of the betweenness centrality are very small, because 94 stakeholders have only one connection, i.e. they cannot have a position between two (or more) others. Therefore, the betweenness centrality value of those stakeholders is 0.

betweenness centrality, where again the cantonal Mobility Office is on the first place (Table 13). The expectation that the pivotal stakeholders for formal development processes in commuting in the Basel area are located in Switzerland is therefore confirmed.

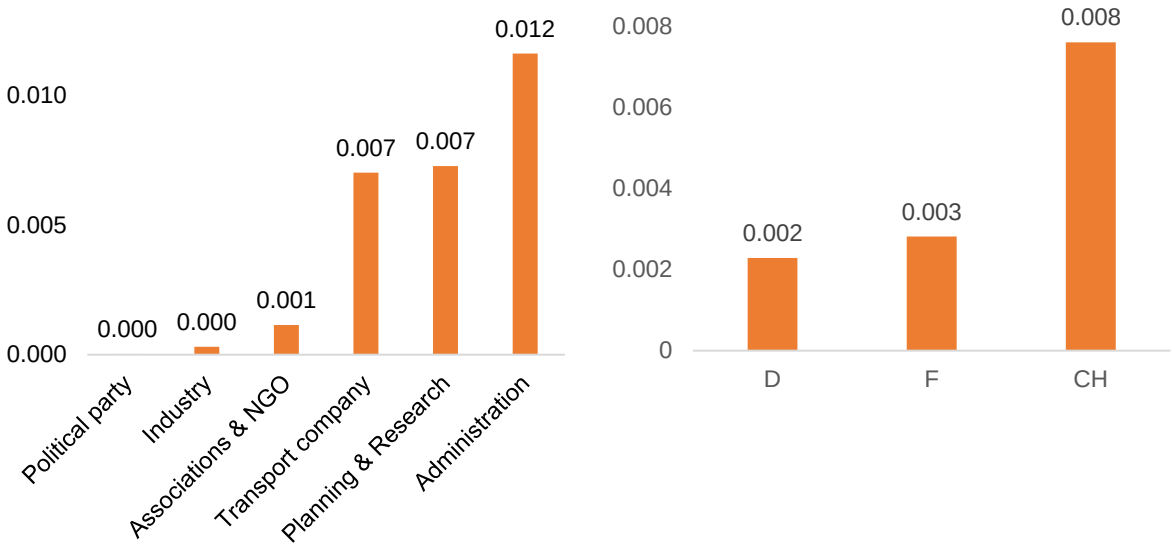


Figure 71: Average betweenness centrality according to stakeholder categories and country, data: ZHAW.

Table 13: Top 20 stakeholders in betweenness centrality, data: ZHAW.

	Stakeholder	Betweenness centrality
1	Amt f. Mobilität Kt. BS	0.23
2	Kanton BS	0.23
3	Haeseli & Hilti GmbH	0.21
4	Bau- und Verkehrsdepartement BS	0.14
5	Tiefbauamt BL	0.12
6	INFRAS	0.10
7	Agglo Basel	0.09
8	PostAuto Schweiz AG	0.06
9	Bau- und Umweltschutzdirektion Kt. BL	0.06
10	Kanton BL	0.04
11	RVL Regio Verkehrsverbund Lörrach GmbH	0.04
12	SBB	0.04
13	Basler Verkehrsbetriebe BVB	0.03
14	Landkreis Lörrach	0.03
15	Handelskammer beider Basel	0.03
16	Gruner AG	0.02
17	Interreg Oberrhein Rhin Superieur	0.02
18	Kanton AG	0.01

19	CC3F	0.01
20	IWB Industrielle Werke Basel	0.01

Eigenvector centrality

Eigenvector centrality is a different approach on node centrality. Whereas degree, closeness, and betweenness centrality consider the numbers of edges or connections for a node, eigenvector centrality takes into account the properties of adjacent nodes, to which the node in question is connected. “A node is central to the extent that the node is connected to others who are central” (Heymann, 2014, p. 620) and therefore eigenvector centrality “takes into account the entire pattern in the network” (Bonacich, 2007, p. 555). Comparing the three countries in the region with this value, Switzerland has an even higher margin to France and Germany than in betweenness centrality (Figure 72). Concerning the stakeholder categories, administrative stakeholders again have the highest average centrality value (Figure 72), which also becomes apparent when looking at the list of nodes with the highest values in Table 14.

This indicates that the Swiss stakeholders are not only well-connected concerning their number of links, they are also linked to the “right” actors having high centrality values. On the other hand, political parties and industry stakeholders show the lowest average eigenvector centrality, as they usually appear as providers of viewpoints and cooperation partners in specific processes[24].

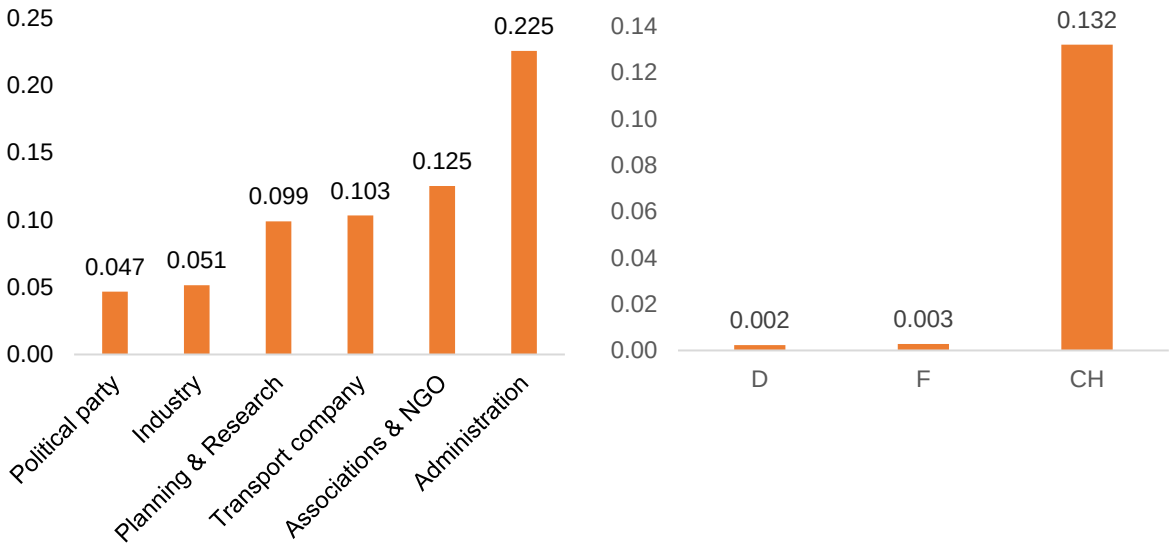


Figure 72: Average eigenvector centrality according to stakeholder categories and country, data: ZHAW.

[24] This small centrality is true for the formalised network process perspective. However, political parties can have quite some influence through the government (Stakeholder “Kanton BS”) and industry through the provision of technology.

Table 14: Top 20 stakeholders in eigenvector centrality, data: ZHAW.

	Stakeholder	Eigenvector centrality
1	Amt f. Mobilität Kt. BS	1
2	Kanton BS	0.94
3	Agglo Basel	0.86
4	Kanton BL	0.73
5	Tiefbauamt BL	0.73
6	Bau- und Umweltschutzdirektion Kt. BL	0.70
7	Handelskammer beider Basel	0.68
8	Bau- und Verkehrsdepartement BS	0.66
9	CC3F	0.63
10	Regionalverband Hochrhein-Bodensee	0.61
11	SBB	0.61
12	BAV	0.53
13	Landkreis Lörrach	0.52
14	Basler Verkehrsbetriebe BVB	0.50
15	Planungsamt BS	0.49
16	INFRAS	0.46
17	Ministerium f. Verkehr Baden-Württemberg	0.43
18	IHK Hochrhein-Bodensee	0.43
	IHK Südlicher Oberrhein	0.43
20	Abteilung Verkehr Kt. AG	0.41

Summary

We calculated the average rank from degree centrality, weighted degree centrality, closeness centrality, betweenness centrality and eigenvector centrality values to get an overall image of the centrality of the different stakeholders.The cantonal Mobility Office has an outstanding position in the network, which according to its mandate it is supposed to have. The top 20 list contains the core stakeholders from all the regions of all three countries, the most important transport companies and stakeholders responsible for coordinating regional actors (Table 15). Even though an arithmetic mean of these values on an ordinal scale is statistically not strictly correct, it still gives an indication where a stakeholder is in an overall ranking.

Table 15: Top 20 stakeholders in average centrality rank, data: ZHAW.

Average centrality rank	Stakeholder
1.2	Amt f. Mobilität Kt. BS
1.8	Kanton BS
4.2	Agglo Basel
4.8	Tiefbauamt BL
5.4	Bau- und Verkehrsdepartement BS
5.8	Kanton BL
8.1	Bau- und Umweltschutzdirektion Kt. BL
9.5	Handelskammer beider Basel
9.9	SBB
11.3	INFRAS
11.6	CC3F
12.4	Landkreis Lörrach
13.1	Basler Verkehrsbetriebe BVB
14.7	Regionalverband Hochrhein-Bodensee
17.1	Planungsamt BS
19.1	Interreg Oberrhein Rhin Superieur
19.2	BAV
19.6	Kanton AG
22.8	PostAuto Schweiz AG
24.2	CCI Sud Alsace Mulhouse
24.2	IHK Hochrhein-Bodensee

6.2.3.2. Network structure and stakeholder groups/clusters

As a second perspective for analysing the positions of stakeholders (or stakeholder groups), it is essential to look at the network topology, revealing to *whom* precisely the stakeholders are connected, i.e., how the nodes are connected with each other

The basic network layouts are line networks, ring networks, and mesh networks (Borgatti et al., 2009). In reality, networks are incomplete and combined versions of these basic types with often hierarchical structures, for example, if a node connects sub-networks. In Figure 73, we illustrate five different types of idealised layouts to characterize these hierarchies in networks. ‘Disperse single nodes’ (a), where all stakeholders are separated without any connection between them and no power can be exerted over others by anyone. ‘Perfectly connected network’ (b), where there is no dominating stakeholder and the stakeholders are fully interconnected, which makes it easier to apply participatory methods. ‘One dominating node’ (c), where one stakeholder coordinates the network, and all connections run via this

stakeholder. This gives this stakeholder a considerable power by being able to control information flows in the network. On the other hand, the network operability is vulnerable due to its dependency on just one stakeholder. 'One dominating group' (d), where a group of stakeholders is closely interconnected while the rest of the stakeholders are only loosely connected to the network, if at all. This gives the stakeholders within the dominant group an advantage over the less-connected ones. 'Competing groups' (e), where there are two or more groups of interconnected actors. If there are connections between the groups, it may either mean competition or effective collaboration. In this situation, 'pivotal stakeholders'[25] who have connections to one or more stakeholders in different groups can play a key role. The identification and active involvement of these actors is likely to influence a participatory transformation process positively.

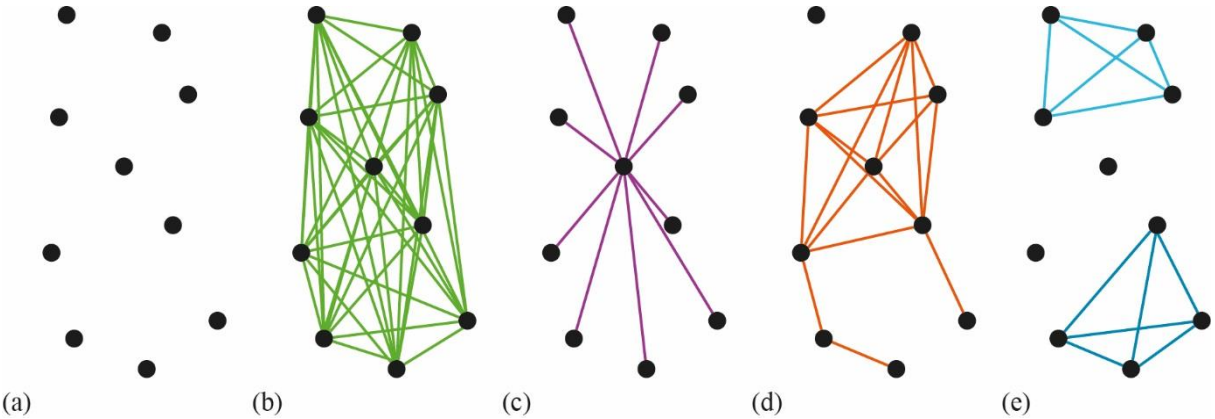


Figure 73: Scheme of different network layouts: (a) disperse single nodes, (b) perfectly connected network, (c) one dominating node, (d) one dominating group, and (e) competing groups, own illustration.

The identification and delineation of stakeholder groups can be done statistically as well as visually. The software package gephi (Bastian et al., 2009) provides different options for assessing both methods. Modularity algorithms[26] are the most useful for our case. They detect clusters of nodes, i.e., groups which have strong internal connections and less strong connections to other groups (Heymann, 2014).

After calculating the modularity variables for each node, we visualised the results and calculated statistical metrics for the clusters. The visualisations were generated with the following steps: 1) 'Force Atlas' algorithm for a base layout, 2) 'Noverlap' algorithm to prevent overlapping nodes, 3) 'Labeladjust' algorithm to make all names of the nodes visible, 4) colouring of the nodes according to their cluster-affiliation, and 5) visualisation according to additional variables (e.g., weighted edges, see Figure 74) with different node colours to better describe the clusters.

In the Basel dataset, we identified six clusters in the network with weighted edges and eight groups with unweighted edges (see Appendix Figure 117). We consider the version with weighted edges to be more precise, as the weight of a tie is a (rough) proxy for the regularity and frequency of the interactions between two stakeholders. Therefore, in this deliverable, we focus on the interpretation of these six stakeholder clusters (Figure 74). We also considered the variables 'country' and 'category' as well as the different centrality values (see also Appendix Table 34) for the describtion of the clusters in more detail.

[25] As pivotal stakeholders have many connections to different types/groups of stakeholders, an above average potential for influence can be expected from these stakeholders.

[26] Gephi uses Louvain Modularity (Blondel et al., 2008).

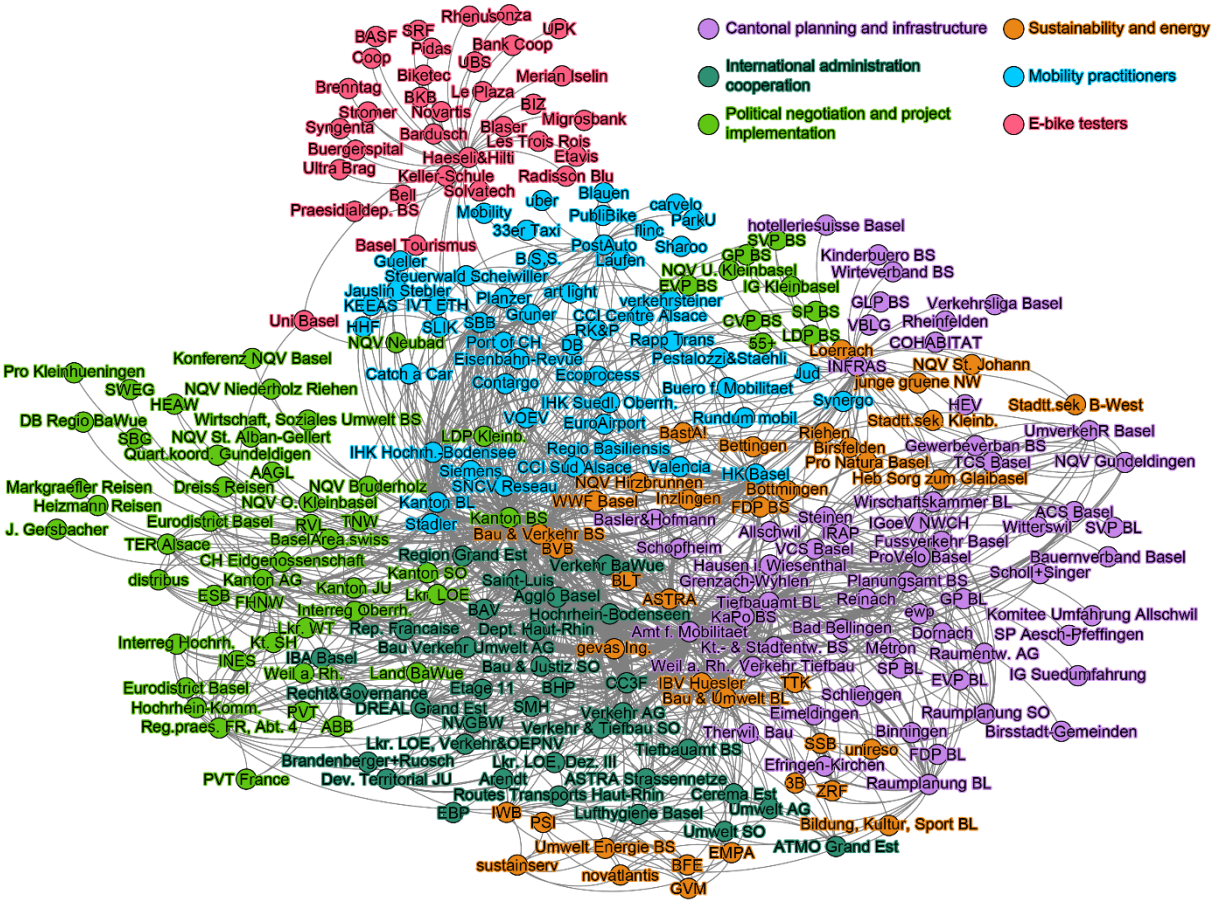


Figure 74: Stakeholder clusters based on weighted edges, data: ZHAW.

Cluster 1: Cantonal planning and infrastructure

This cluster is the largest one, comprising 58 stakeholders in total. Stakeholders in this cluster are mostly Swiss (83%) and it comprises 25% of the Swiss stakeholders in the whole network. As there are no French stakeholdes in this cluster, the remaining ones are German (17%). The cluster includes many stakeholders with high centrality values and therefore the average centrality of stakeholders in this cluster is higher than in most other clusters. Together with the mobility office of Basel-Stadt, other cantonal core administrative stakeholders are part of this cluster. With lower centralities, but in higher numbers, there is also some municipal administration represented; mainly those who have been involved in the implementation of commuter fund infrastructure projects.

Cluster 2: International administration cooperation

This cluster is one of the two more international ones and at the same time the second smallest (34 stakeholders). 50% of the French stakeholders of the whole network can be found in this cluster, which corresponds to 1/4 of the members in this cluster. 80% of the stakeholders in this cluster belong to the administrative category. Many of those work together internationally, as networkers, or coordinate the processes in the international region (e.g., Agglo Basel). This networking role is also shown by the highest average centrality values (except in betweenness centrality) among all clusters.

Cluster 3: Political negotiation and project implementation

Together with cluster 2, this is one of the two most international clusters. In contrast to cluster 2 however, the category affiliation of the stakeholders is more diverse. It is a less administrative cluster and includes more practitioners; about 40% of all transport companies in the whole network belong to this cluster. Also, NGOs, associations, and political parties are represented stronger than in other clusters. If the

diversity of categories AND countries is considered, this second biggest cluster (55 stakeholders) is the most diverse of all.

Cluster 4: Sustainability and energy

This cluster is rather small (37 stakeholders) and mainly dominated by Swiss organisations. The stakeholder categories in this cluster are rather diverse, such as in cluster 3 (only difference is that the shares of categories 'Transport companies' and 'Research&Planning' are switched). The list of involved stakeholders shows a focus on sustainability topics, but also energy (research) is represented.

Cluster 5: Mobility practitioners

Cluster 5 is the third biggest cluster (50 stakeholders), and again a 'very Swiss' cluster (80%). 'Research&Planning' stakeholders have the highest share (40%), with many of the stakeholders being specific transportation planning/consulting companies. Still, this cluster includes about 35% of transport companies in the network. However, compared to cluster 3, these companies are bigger and mostly active on an (inter-)national level (e.g., SBB, DB, PostAuto). It is notable that this group has a meager share of administrative stakeholders, i.e., this cluster contains actors, who are responsible for the implementation of projects and strategies, but with less direct contact to governmental/administrative stakeholders.

Cluster 6: E-bike testers

This cluster stands out as it is almost entirely separated from the rest of the network[27]. The smallest of all clusters (33 stakeholders) contains stakeholders involved in an e-bike testing program which took place between 2012 and 2014 (Basel Unterwegs, n.d.). Most of them are not part of any other processes, i.e., have no connections to other stakeholders. Furthermore, there are no connections between the participants of the process, and the coordinating company (Häseli & Hilti) has a central function in this part of the network. From a network perspective, these stakeholders are therefore less relevant.

Overall conclusions

The identified clusters' absolute sizes vary between 58 and 33 stakeholders. Generally speaking, all clusters are dominated by Swiss stakeholders, due to their absolute number in the network (Appendix Figure 118 and Table 30). However, there are certain differences between clusters, as the share of Swiss stakeholders varies between 50 and 100%. German stakeholders are particularly strongly represented in only one cluster (cluster 3; around 1/3), and similarly French stakeholders in one cluster (cluster 2; around 1/2). Concerning their closest connections, the non-Swiss stakeholders are rather separated from each other. From the viewpoint of stakeholder categories, there are some interesting findings. Besides the 'administrative' stakeholders (who are the majority in 4 of the clusters), the appearance of the remaining stakeholder categories is more or less focussed on one or two clusters only.

[27] Note that this cluster is likewise present in the network with unweighted ties (Appendix Figure 117; light green nodes).

6.3 Stakeholder's attitudes towards changes in transport and mobility

Identifying the importance of stakeholders by desk-research and analysing the corresponding stakeholder network (chapter 6.2) helps to understand the relations between different organisations, associations, companies, and other stakeholders in the context of commuting. Meanwhile, it provides only a part of the picture, as this analysis does not reveal the opinions, individual peculiarities and characteristics of stakeholders. The goal of this chapter is, therefore, to show how stakeholders perceive their roles in transformation and innovation processes and, more specifically, how they evaluate current issues and trends in this context. This task was undertaken with the means of a stakeholder survey.

6.3.1 Methodology

Whereas the stakeholder network analysis was primarily focussed on the Basel case study, the stakeholder survey was conducted in all the three case areas of the project. Thus, results of Korneuburg (Austria) and Growth Corridor Finland are included in this chapter.

During March 2017, we conducted expert workshops in Winterthur (Switzerland) to define the goals of stakeholder analysis and involvement. These workshops were mainly targeted at the members of project's external advisory board, which consists of experts – practitioners as well as researchers – from the field of mobility. In addition to the members of the advisory board, researchers of our project and the representatives of the practice/implementation partners participated in the workshops. The overall aim of the workshops was to identify successful cooperation strategies, challenges, and best-practices in stakeholder processes related to mobility innovations, and this way provide a foundation for the different parts of the survey.

Three main questions were elaborated in the brainstorming sessions of these workshops, followed by a group discussion and aggregation of the results:

- Workshop 1: What are the challenges/barriers when trying to implement innovation – in a (regional) stakeholder network? (Figure 121)
- Workshop 2: Which best-practice in this process[28] have you experienced? Could you identify success factors? (Figure 122)
- Workshop 3: Are there key actors or institutions, which are crucial for implementing new technologies or concepts, and therefore could support socio-technical innovation like MaaS? (Figure 123, Figure 124)

Questionnaire

For the design of the survey, the results of the workshops were combined with the insights from the previous network analysis, and questions related to the upcoming tasks of the project (Haahtela et al., 2018; Haerri et al., 2018b). The resulted questionnaire contained four themes, which were operationalised through a set of 33 questions. The themes, represented by central research questions, were:

- How do stakeholders perceive certain trends/innovations in the context of their activities?
- Which are the (positive as well as negative) experiences that stakeholders had encountered when they were involved in different cooperation projects/processes concerning commuting?
- What are supporting factors and challenges for the stakeholders concerning the implementation of innovations in commuting?
- How do stakeholders perceive the implementation of MaaS and what would they need for supporting it?

[28] "This" referring to stakeholder participation processes in which the workshop participant had participated and which were discussed in the setup of the workshops.

In total, the stakeholders received 31 questions targeting these themes and two questions characterizing the stakeholders themselves. Most questions were slider or multiple choice questions[29]. However, some of the questions had a more exploratory character, e.g., questions about personal experiences in stakeholder processes, and therefore were implemented as open questions to ensure that the possible answers would not be limited by the researchers.

The questionnaire was implemented as an online survey with the software-package 'questback'/'unipark' and contained seven pages (excluding 'language-selection' and 'end' pages):

- Trend assessment
  How do the stakeholders perceive general mobility trends?
- Innovation assessment
  How do the stakeholders perceive the importance of different technical / organisations innovations in mobility?
- Activities evaluation
  Which experiences did the stakeholders have in their activities and interactions with other stakeholders in the field of commuting?
- Supporting factors
  How important do the stakeholders consider different supporting factors[30] for the implementation of innovations?
- Challenges
  How important do the stakeholders consider different challenges/barriers for the implementation of innovations?
- Needs and motivations: MaaS
  How important do the stakeholders consider MaaS for future commuting and which roles can they imagine for themselves in the development of this mobility concept?
- Stakeholder properties
  From which countries are the stakeholders from and to which stakeholder categories do they identify themselves?

The final full version of the questionnaire can be found in the annex of this deliverable. The questionnaire was developed in English and then translated into German, French, and Finnish.

Survey

We conducted the survey in all three case study areas of the "Smart Commuting" project in August and September 2017. The stakeholders were invited to participate via email and received a reminder about one week after the initial contact. If there had been contacts with the stakeholders before, the researchers sent personalised emails. In Basel, all stakeholders identified in the network analysis were invited to participate. In Finland, similar public collaboration processes (such as developing Sustainable Urban Mobility Plan) were identified in the case area and the participants or the steering groups of these processes were invited to participate. In Austria, existing contacts of the research partners were used and asked to distribute the survey further. Table 16 shows the number of obtained contacts and the completion rate according to each case study area.

[29] Though wherever applicable, the option "other" and a field for an open answer were provided.

[30] The lists of supporting factors as well as challenges/barriers were identified in the expert workshops.

Table 16: Sample sizes, return rates and related metrics of the stakeholder survey.

Study area	Sample size	Completed datasets (respondents reached the last page)	Completion rate
Basel	143	40	27.97%
Growth-Corridor Finland	104	65	62.50%
Korneuburg/Austria	40	14	35.00%
Total	**287**	**119**	**41.46%**

6.3.2 Characteristics of the sample

We analysed the results according to each case study area (Korneuburg, Austria; Growth Corridor Finland and Basel, Switzerland) and each stakeholder category (see Table 17). Participants of the survey were asked to designate their affiliation to one of the 17 stakeholder categories identified in the stakeholder network analysis (see chapter 6.2). To facilitate the survey analysis and the interpretation of the results these 17 categories were aggregated into seven categories.

Table 17: Detailed and aggregated stakeholder categories.

Stakeholder categories (detailed)	Aggregated categories for analysis
Public administration canton / Land / region	Administration
Public administration, municipal	
Public administration, national	
Public administration, regional	
Regional cooperation platform	
Chamber of Commerce	Associations & NGO
Citizen group	
NGO and lobby	
Company	Industry
Consulting and planning	Planning & Research
Research institution	
Political party	Political party
Public transport company, local	Transport company
Public transport company, national	
Public transport company, regional	
Transport association	
Transport company (other)	
Other	Other

In the Swiss and Finnish sample, the stakeholder category ‘Administration’ was the most represented one with shares of 43.6% and 57.8%, respectively. In the Austrian sample, the most important stakeholder category was ‘Planning & Research’ with 35.7% share of the responses. Also quite strongly represented where the two categories ‘Associations & NGO’ and ‘Transport company’ (Figure 75). The number of sample size varies from 14 in Austria, 39 in Switzerland, to 64 in Finland.

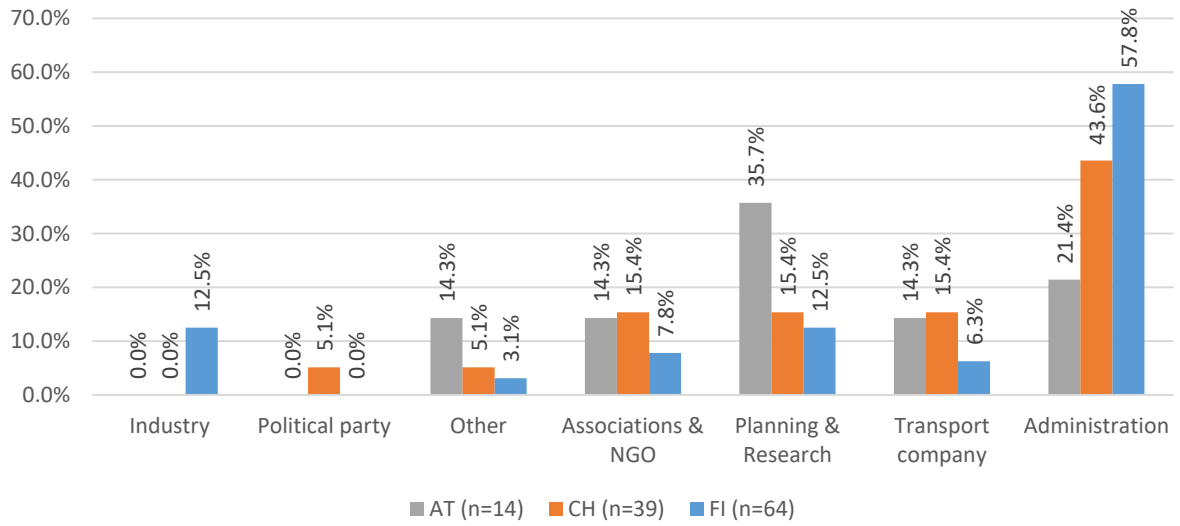


Figure 75: Distribution of the aggregated stakeholder categories according to the case study area, data: ZHAW, Aalto University, tbw research.

6.3.3 Stakeholders and the trends in mobility

It is crucial to understand stakeholders’ views and opinions concerning recent trends in mobility to improve efficiency, sustainability, and suitability of the current commuting systems. This helps to understand the perspective on which stakeholders base their decisions and provides a basis on how to approach a systemic transformation from a stakeholder perspective. Based on the trend catalog (Hoerler et al., 2018) five main trends in mobility and spatial planning – with high relevance in producing pressure to change mobility strategies as well as providing opportunities for a change towards MaaS - were chosen for further investigation regarding stakeholders’ attitudes towards them – i.e., whether these trends require stakeholders to adapt in their strategies and work in the field of commuting.

6.3.3.1. Intermodality of journeys

Regarding the increase in the intermodality of journeys, the smallest share of stakeholders expecting a change due to this trend is in Austria with 57.1%. In Switzerland, at least 64.1% of all stakeholders think that this trend will have an influence on their strategies and priorities within commuting, while in Finland around 80% of stakeholders anticipate that this development will cause at least a moderate adaption of their strategies and goals within commuting (Figure 76). This result may be a consequence of the already persisting discussions regarding multimodal mobility solutions in Finland and the fact that stakeholders have already identified multimodal transportation as an important factor for future commuting systems (LVM Finland, 2015).

When looking at the distribution within stakeholder categories summarized for all three case areas, big differences can be observed between the groups: In ‘Administration’ category 88.8% of the surveyed stakeholders anticipate a need to change their strategies due to this trend. Stakeholders in ‘Transport company’ category also show an above average awareness towards this trend. The stakeholder category ‘Planning & Research’ is the group with the least amount of stakeholders (42.2%) who anticipate an impact on their work and strategies in commuting due to this trend.

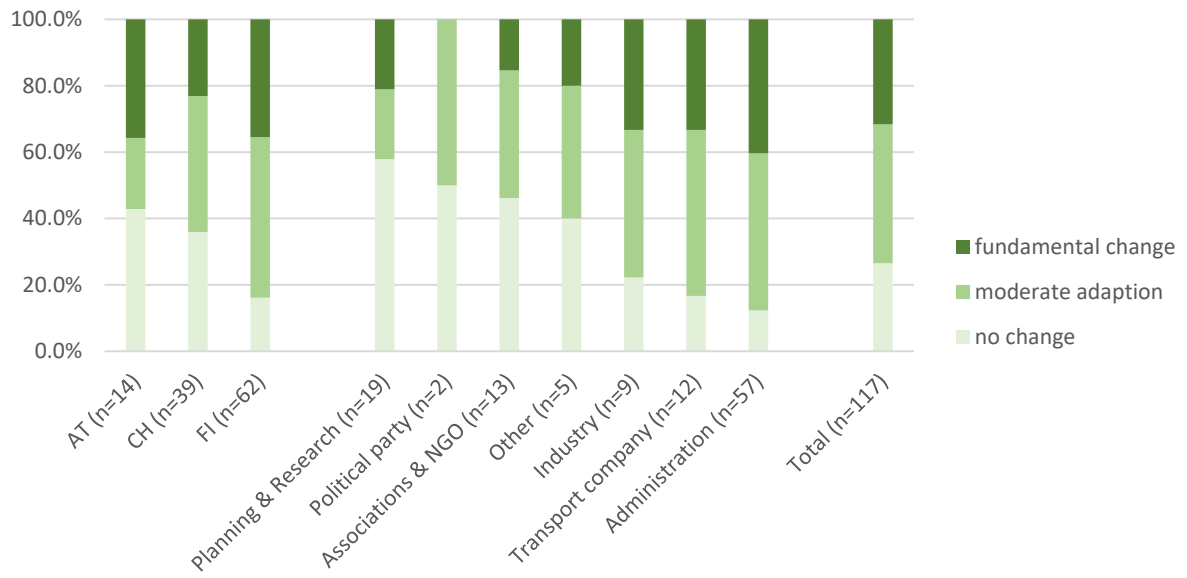


Figure 76: Stakeholder's estimation of the impact of the increase in the intermodality of journeys on their strategies and work concerning commuting, data: ZHAW, Aalto University, tbw research.

6.3.3.2. The average distance of commuting trips

In contrast to stakeholders' attitude towards increasing intermodality, Swiss stakeholders see the increase in commuting distances more relevant than Austrian or Finnish stakeholder (Figure 77). In Switzerland, 81.1% of all stakeholders anticipate a need to change their strategies in commuting due to this trend. This result may be linked to the high general awareness of this trend in Switzerland, also reflected in the Swiss media (e.g. Imfeld, 2017). In Austria, 57.1% of all survey participants think the same and in Finland 64.5%. In Finland, however, only 6.5% state this trend will have a "fundamental influence" on their strategies, while the shares are 28.6% in Austria and 35.1% in Switzerland.

From the stakeholder category 'Transport company' 83.3% think that this trend will cause a change in their strategies. The category 'Administration' think very similarly. The stakeholder category with the least concern is 'Industry', where only 44.4% state that this trend will influence their work and strategies related to commuting and none of them expects a "fundamental change".

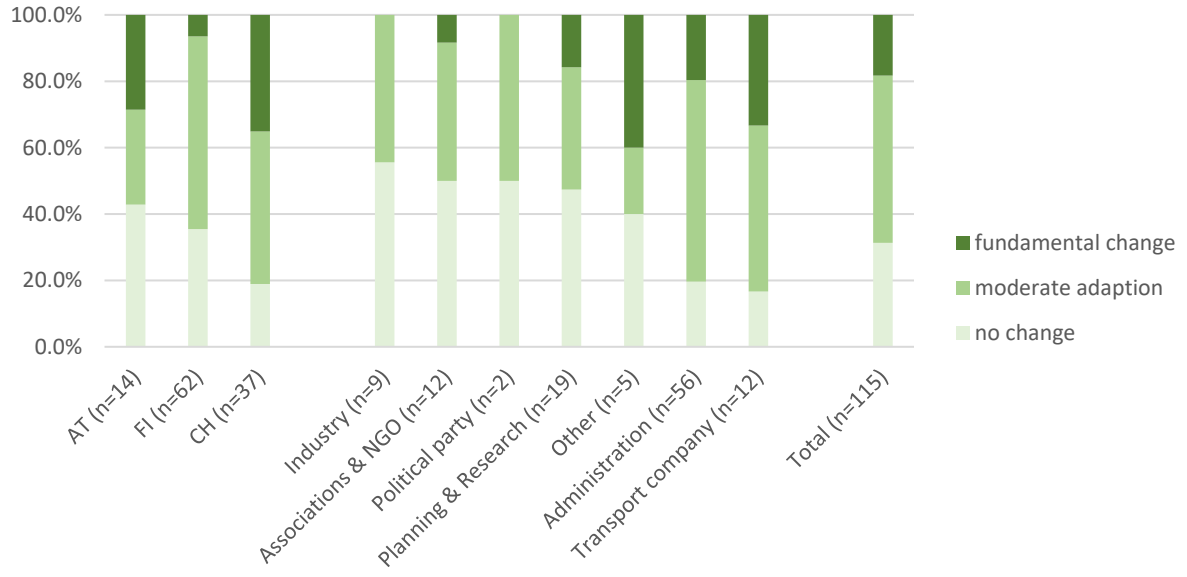


Figure 77: Stakeholder's estimation of the impact of the increase in average distance of commuting on their strategies and work concerning commuting, data: ZHAW, Aalto University, tbw research.

6.3.3.3. Road congestion

From our three case areas, according to INRIX (2016), in Switzerland commuters use the most time for travelling during peak hours when traffic congestion occurs typically (Switzerland ranks 14, Austria 22, and Finland 29 of the 38 countries participating in the congestion study). Therefore, it is not surprising that Swiss stakeholders anticipate the most significant change in their strategies and priorities within this context (Figure 78). Compared to 70.3% of all Swiss stakeholders anticipating a moderate or a fundamental change in their strategies caused by this trend, in Finland it is 65.6%. Interestingly, the share of Austrian stakeholders anticipating "no change" for their strategies is almost as big as the shares of Switzerland and Finland put together. In Austria, only 42.9% think that the increasing road congestion will have an influence on their work and strategies within commuting.

Regarding the stakeholder categories in all of the countries, the stakeholder category 'Industry' sees this trend influencing their strategies the most: 77.8% of the stakeholders in this category perceive this trend as moderately or fundamentally influential. The next biggest shares are in category 'Transport company' with 75% and 'Administration' with 70.9%. This result may be because these stakeholders are more directly affected by congestion, e.g., transport companies vehicles are slowed down by congestion or companies' deliveries reach their destination late due to the bad traffic situation. In contrast, stakeholders in the category 'Planning & Research' show a below-average concern regarding this trend.

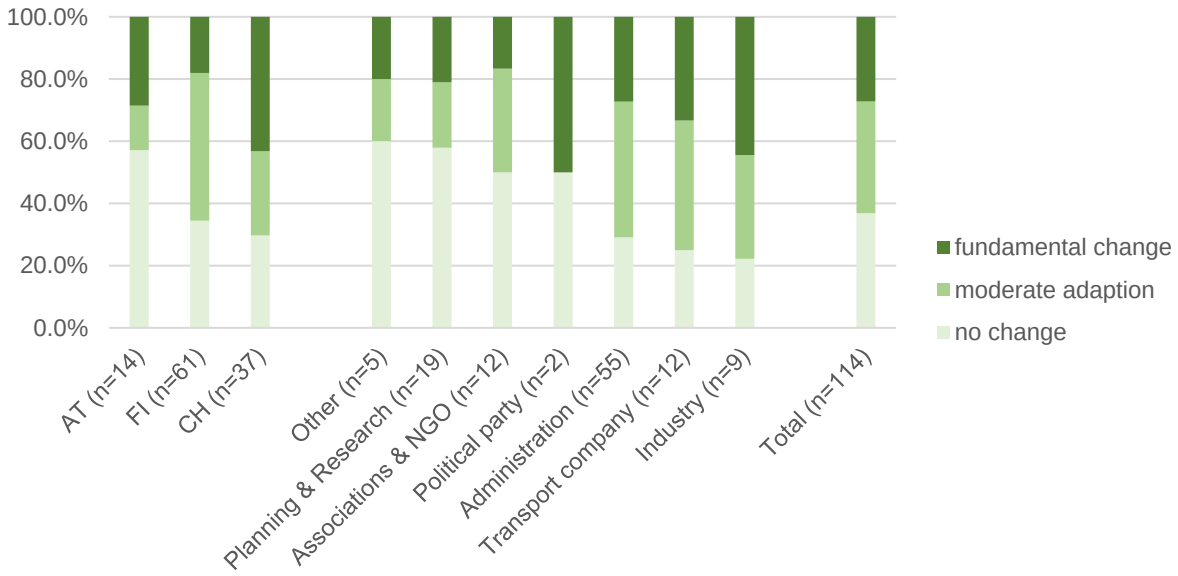


Figure 78: Stakeholder's estimation of the impact of increasing road congestion on their strategies and work concerning commuting, data: ZHAW, Aalto University, tbw research.

6.3.3.4. Population and employment growth

The increasing trend in the population growth in the surroundings of large and middle-sized cities received the most uniform feedback among the three case areas (Figure 79). Almost 50% of all stakeholders anticipate a need for fundamental change in their strategies and priorities to adapt to these changes in population and employment, and 27% (AT and FI) to 35% (CH) anticipate a moderate adaption of their strategies due to this trend.

Between the stakeholder categories, again the category 'Administration', with 87.5% of the respondents, see this trend more influential compared to the other stakeholder categories. The next biggest shares are in the categories 'transport company' with 75% and 'Industry' with 66.7% of the surveyed stakeholders. The stakeholder categories 'Planning & Research' and 'Political party' show the least concern (50% of the respondents) that this trend will affect their strategies and work related to commuting.

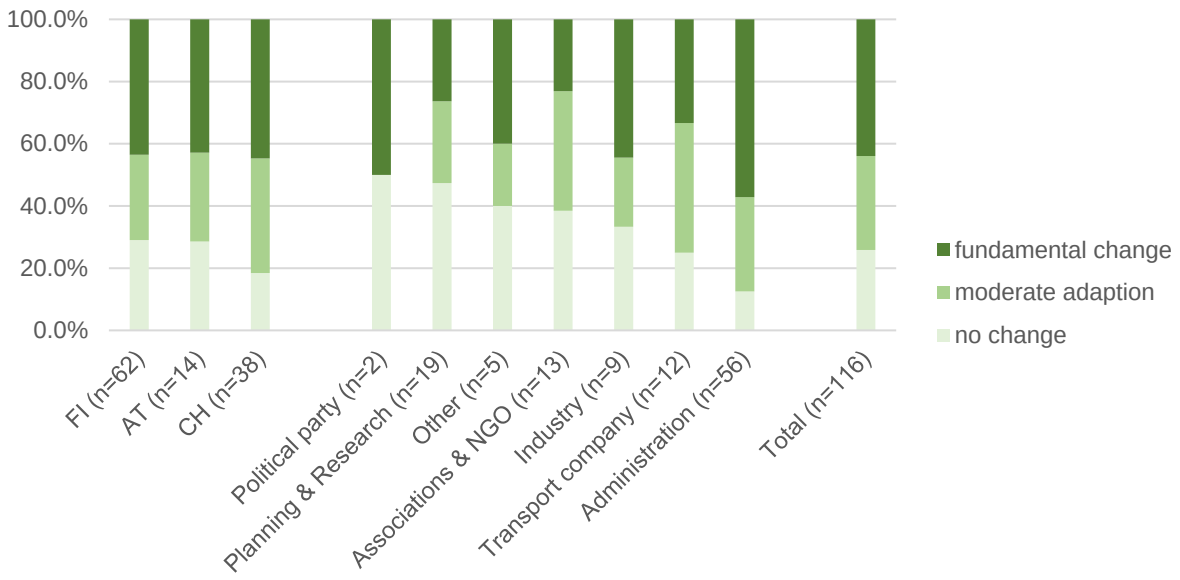


Figure 79: Stakeholder's estimation of the impact of population and employment growth in the surroundings of large and middle-sized cities on their strategies and work concerning commuting, data: ZHAW, Aalto University, tbw research.

6.3.3.5. The number of car sharing users

Regarding the increasing trend in the number of car sharing users, around 60% of all the stakeholders estimate a fundamental change of their strategies and priorities is needed (Figure 80). In Switzerland, however, this share is a bit lower. There, only 50% of the stakeholders think that this trend requires an adaption of their strategies and priorities. This Swiss result may be due to the already high customer and transportation service density level in Switzerland (Loose, 2010), which has required an adaption of organisations' strategies in the past.

According to stakeholder categories, the overall results are quite uniform with an anticipated need for fundamental or moderate strategy adaption getting a share of around 50% of the respondents. An exception is the stakeholder category 'Industry' where a high share of 77.8% of all stakeholders anticipates a need to change their strategies.

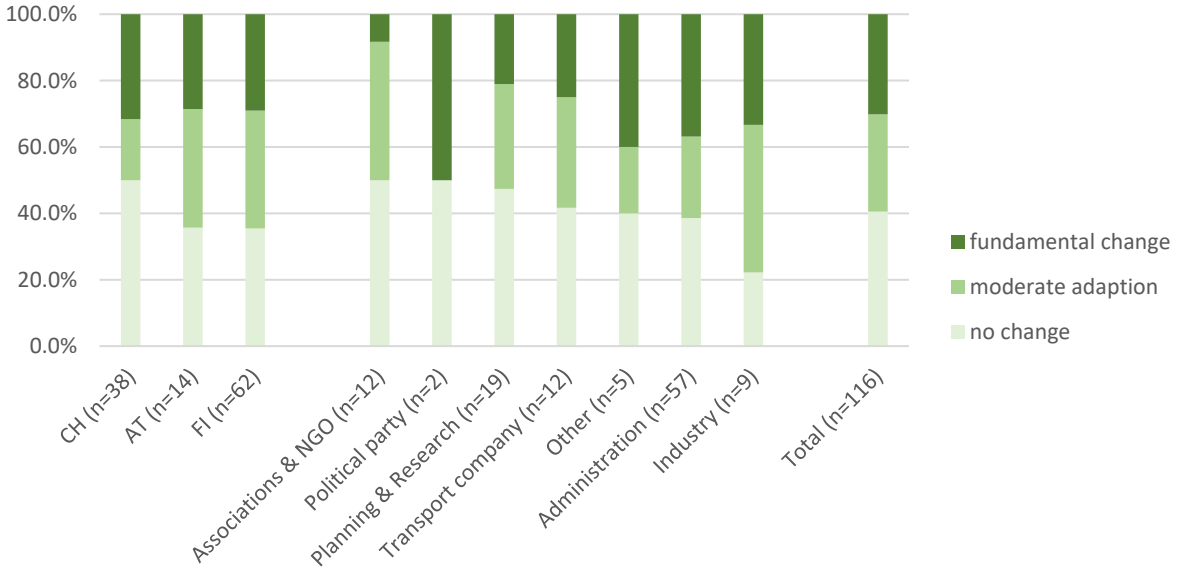


Figure 80: Stakeholder's estimation of the impact of an increase in the number of car sharing users on their strategies and work concerning commuting, data: ZHAW, Aalto University, tbw research.

6.3.3.6. Conclusion: Trend assessment

Stakeholders see these trends generally as quite influential for their work and strategies. For every surveyed trend, more than 50% of all the stakeholders anticipated that these trends would create at least a moderate influence on their strategies. This general result indicates a high level of awareness in all the three case study areas regarding recent trends.

If a technological trend is already well progressed in a particular country (e.g., high spread of car sharing users in Switzerland), it might be that stakeholders are expecting the need for an adaption of their strategies to a lesser degree, as they may already be used to cope with this particular trend.

If, however, a trend is apparent and comes with challenges (e.g., “amount of road congestion” or “population and employment growth in the surroundings of large and middle-sized cities” in Switzerland) the stakeholders tend to be above average concerned by these changes.

In Switzerland, around 80% of all the surveyed stakeholder anticipate a change in their strategies due to the trends “population and employment growth in the surroundings of large and middle-sized cities” and “increasing average distance of work commuting trips”. This share is around 10 to 20% percent more than in the two other case areas in the survey.

In Finland, around 80% of surveyed stakeholder anticipate a change in their strategies due to the trend “increasing intermodality of journeys” reflecting the greater visibility of MaaS schemes in Finland compared to the other case areas.

In Austria, the trend “population and employment growth in the surroundings of large and middle-sized cities” is seen as the most relevant trend for Austrian stakeholders - around 70% of all the surveyed stakeholder anticipate a change in their strategies due to this development.

Some stakeholder categories show a specific sensitivity for particular trends. For example, stakeholders in the category ‘Industry’ show a particular interest in technology trends and trends which affect their business directly (e.g., traffic congestion). The trend “longer commuting distances” however, which affects their employees (but not the company itself) received little attention.

6.3.4 Stakeholders and innovations in mobility services and technologies

After having examined stakeholders’ attitude towards trends in commuting from a strategical viewpoint, in the second part of the survey participants were asked to give their personal opinion on innovations in commuting. Based on the trend catalog (Hoerler et al., 2018), five technological innovations in commuting were chosen for further investigation regarding stakeholders’ attitudes towards them – i.e., whether they support, approve, or oppose them.

6.3.4.1. Privately owned autonomous cars

The innovation “Privately owned autonomous cars” is by far the one, of which the stakeholders are most sceptical (Figure 81). In Austria, around 90% of all the surveyed stakeholders are neutral towards or oppose privately owned autonomous cars. In Switzerland, the same share is still high at 80%. In Finland, the attitude is different with around 55% of stakeholders being neutral towards or oppose, and around 45% would approve or actively support this innovation.

According to the stakeholder categories, especially stakeholders in the stakeholder category ‘Industry’ are above average favourable towards privately owned autonomous cars: 66.7% of the stakeholders in this category state that they would approve or actively support this innovation. This figure is significantly lower in the other stakeholder categories. The categories having the most negative attitude are ‘Associations & NGO’ with 33.3%, ‘Transport company’ with 25% and ‘Administration’ with 24% of the respondents either opposing or disapproving this innovation.

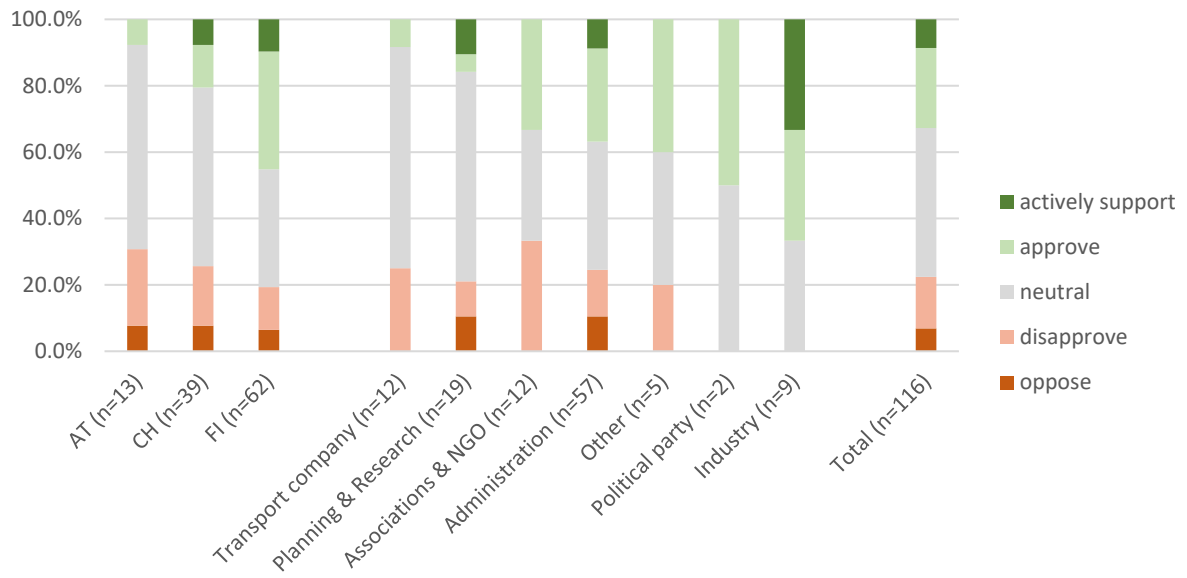


Figure 81: Stakeholder's attitude towards the innovation 'privately owned autonomous cars', data: ZHAW, Aalto University, tbw research.

6.3.4.2. Shared autonomous cars

From a stakeholder perspective, autonomous vehicles are seen in a lot more positive way when they are used within a sharing system (Figure 82). In Austria and Switzerland, around 50% of all the stakeholder would approve or actively support this innovation. In Finland, even 80% of the respondents would do this. With values between 0% to 7%, the share of stakeholders which would disapprove or oppose this innovation is quite small.

When analysed according to stakeholder categories, this favorable opinion towards this innovation persists. Only in the stakeholder category 'Planning & Research' 10.6% of the respondents are opposing shared autonomous vehicles. The stakeholder category 'Industry' shows the biggest support, with a share of 55.6% respondents stating that they would actively support this innovation. Interestingly, the share of stakeholders in the category 'transport companies' actively supporting or approving shared autonomous vehicles (both 33.3%) is quite high. At the same time, also a significant share of stakeholders in this category (8.3%) disapprove this innovation.

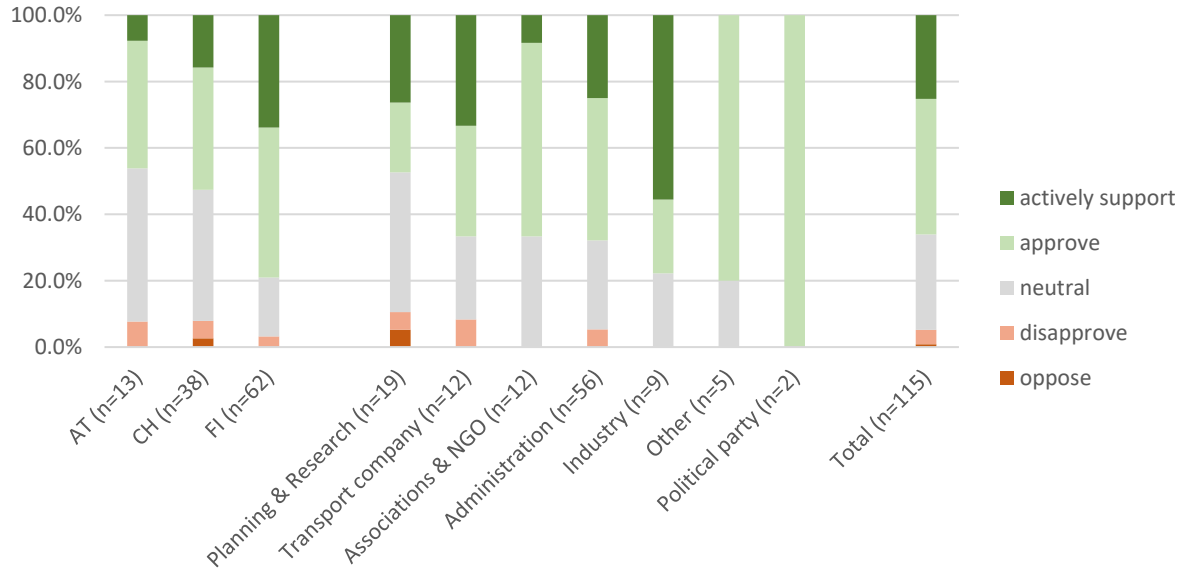


Figure 82: Stakeholder's attitude towards the innovation 'shared autonomous vehicles', data: ZHAW, Aalto University, tbw research.

6.3.4.3. Car-sharing system

Car sharing systems are generally seen positively among stakeholders (Figure 83). Only 5% (Switzerland) to 15 % (Austria) of all surveyed stakeholder are neutral or would disapprove of this innovation. In all three case areas around 80% to 90% of all stakeholder would actively support or approve a further spread of this kind of mobility services.

When analysed according to stakeholder categories, notably category 'Industry' shows the highest share of active supporters (66.7%), but at the same time has the highest amount of disapproving stakeholders (11.1%). Existing strategies and the line of business of a certain company might be the reason for this discrepancy. The least amount of active supporters can be found in the category 'Transport company' (16.7%). However, no disapproving or opposing positions can be noted here.

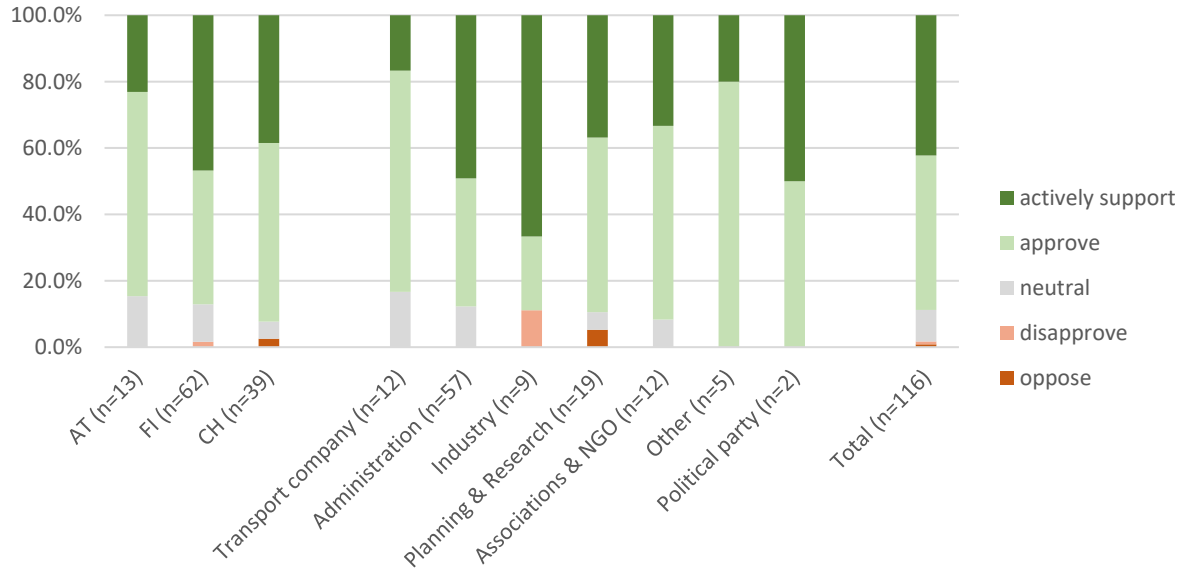


Figure 83: Stakeholder's attitude towards the innovation 'car-sharing systems', data: ZHAW, Aalto University, tbw research.

6.3.4.4. Mobility as a Service (MaaS)

Examining the applicability of Mobility-as-a-Service (MaaS) offerings for commuting is one of the Smart Commuting projects' focal points. [31] In the survey results, it became apparent that all stakeholders without any exception see MaaS concepts either as a neutral or positive development in transportation. In Finland, more than half of all the stakeholders state that they would actively support MaaS (Figure 84), around 30% would approve it, and about 10% are neutral towards this new mobility concept. In Switzerland, the attitude towards MaaS is also favourable, yet less enthusiastic compared to Finland: Around 30% of Swiss stakeholders would support MaaS, about 40% approve it, and approximately 30% are neutral. In Austria, there were only approving (53.8%) or actively supporting (46.2%) answers. However, the "actively supporting" share of responses is lower compared to Finland.

When looking at the responses of stakeholder categories, the results are a bit more varied. Especially the stakeholder category 'Industry' representatives show a significant acceptance for MaaS. This support for the concept may come from the fact that innovations potentially create new markets and room for new business models from which these industry actors would benefit, even though they do not offer transportation services themselves. In contrast, stakeholders in the category 'Administration' and 'Associations and NGOs' show below-average enthusiasm compared to the average of all stakeholders.

[31] For a short definition of MaaS, see chapter 6.3.7.

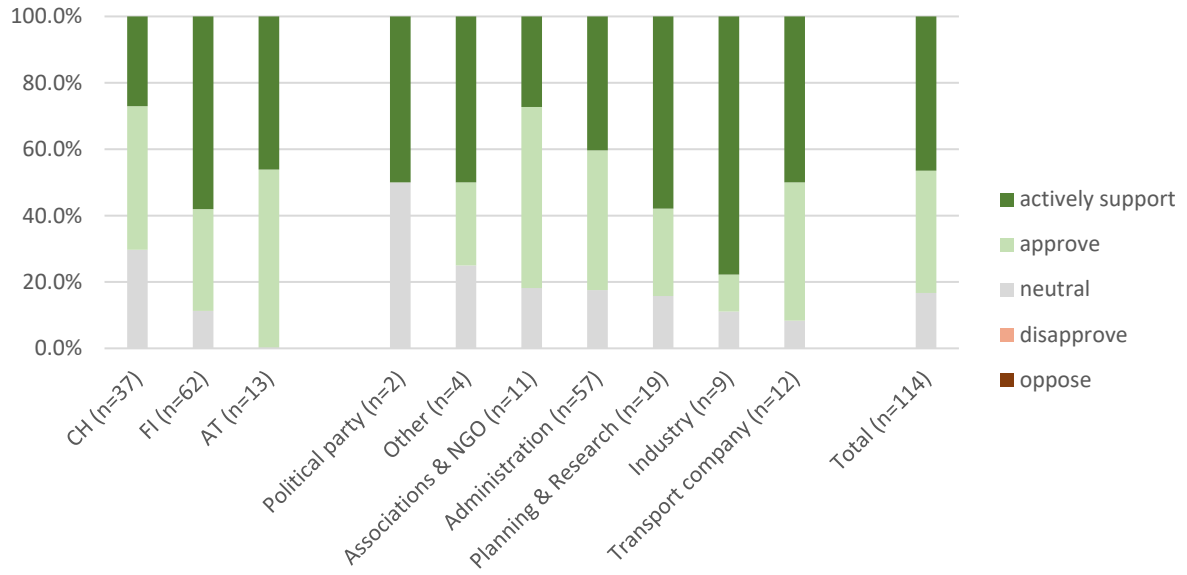


Figure 84: Stakeholder's attitude towards the innovation 'Mobility as a Service (MaaS) offerings', data: ZHAW, Aalto University, tbw research.

6.3.4.5. Congestion charges and city tolls

The innovation 'congestion charges/city tolls' again creates a bit more scepticism among stakeholders (Figure 85). Only around 20% of all the stakeholders would actively support congestion charges. In Finland, around 20% of all the surveyed stakeholders would also disapprove or oppose this push-measure[32]. Only in Austria no opposition or disapproval towards this innovation could be observed.

Looking at the stakeholder categories, the categories 'Planning & Research' and 'Transport company' show above-average support and approval (68.4% and 58.3%, respectively) of the implementation of city tolls. The category 'Industry' also shows high active support and approval (55.6% in total) but at the same time above-average disapproval or opposition (22.2% in total). Also interesting is the fact, that stakeholders of the category 'Administration' have the highest disproval and opposition share with 28.6% in total.

[32] Push measure: A coercive measure that forces an entity (in our study, commuter) to change its behaviour.

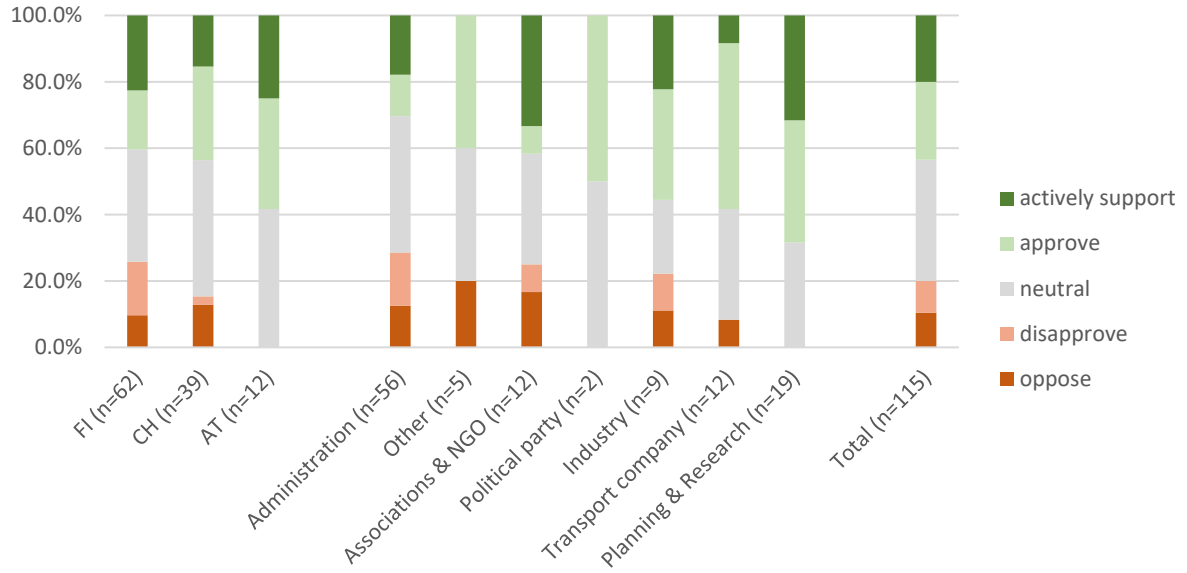


Figure 85: Stakeholder's attitude towards the innovation ‘congestion charges/city tolls’, data: ZHAW, Aalto University, tbw research.

6.3.4.6. Conclusion: Innovation assessment

Finnish stakeholders seem to be quite in favour of innovations in commuting ergo they see the surveyed innovations more positively than Swiss or Austrian stakeholders. However, regarding innovations, which restrict or limit accessibility (push-measures) like congestion charges, they are more on the opposing side.

Stakeholders from all the three case areas are rather opposing and sceptical towards the innovation ‘privately owned autonomous cars’. We suspect that the stakeholders expect an adverse sustainability effect if this innovation thrives. This result is not surprising taking into account the fact that autonomous cars may lower the price of individual motorised mobility and therefore increase the overall adverse sustainability effects on current transportation systems (Wadud et al., 2016).

Car sharing is seen quite positively in general. However, in the survey we did not specify if the sharing system also comprises ride sharing. Therefore it is not known which form of sharing the stakeholders thought while answering the survey.

MaaS is the only innovation that no stakeholder answered with “disapprove” or “oppose” choices.

From the stakeholder categories ‘Industry’ is especially interesting: While some of the stakeholders in this category would actively support a particular innovation, others are actively opposing it. The choice ‘neutral’ is not often used by this stakeholder group. This result may be due to existing strategies or the line of business a particular company represents.

The stakeholder category ‘Administration’ shows below-average enthusiasm towards the surveyed innovations.

The stakeholder category ‘Transport Company’ shows a surprising high openness for innovations considering that these may disrupt the traditional mobility market.

6.3.5 Stakeholders and barriers/challenges regarding implementation of innovations

To successfully implement innovations in commuting one needs to know which conditions in the operating environment currently support technological implementation (“supporting factors”) or whether they are still a challenge (“barriers”). Therefore, we asked the respondents to state to what extent they consider certain conditions to be supportive factors. The list of factors was elaborated in cooperation between project partners, reflecting common obstacles in implementation covering fields such as

technical practicability, market-readiness, framework in various respects, economic feasibility, collaboration or motivation for innovation. Each respondent was asked to evaluate six factors with respect to them being a supporting factor for implementation or not, under the pretext that these conditions would be fully realised. For the factor ‘Practical proof of concept’, for example, this means that a successful pilot would already exist. As a second aspect, they had to assess whether these same factors currently present a challenge for stakeholder processes or not. These results were evaluated together in a diagram (Figure 86).

This consolidated analysis showed that in particular ‘state of technology development’ was considered an essential supporting factor for the implementation of new technologies. If the technology is not sufficiently developed, innovation cannot be fully exploited. Accordingly, a ‘Practical proof of concept’ was seen as an influential supporting factor. Interestingly, the factor considered least supportive was ‘economic viability’. This result could be an indication that stakeholders could consider investing in new technologies, even if their return on investment is not yet fully known.

At present, respondents still see all the surveyed factors as challenges, but mostly on a low level. The factor ‘policy and legislation’ was considered to be the main barrier to the introduction of new technologies. Stakeholders also noted that working and communicating with other stakeholders is not a significant challenge. This view may be because stakeholders can imagine implementing innovations on their own, or that the cooperation between stakeholders is easy. To shed more light on this topic, we asked the respondents also to share their positive and negative experiences from cooperation between stakeholders in open text fields (see next chapter).

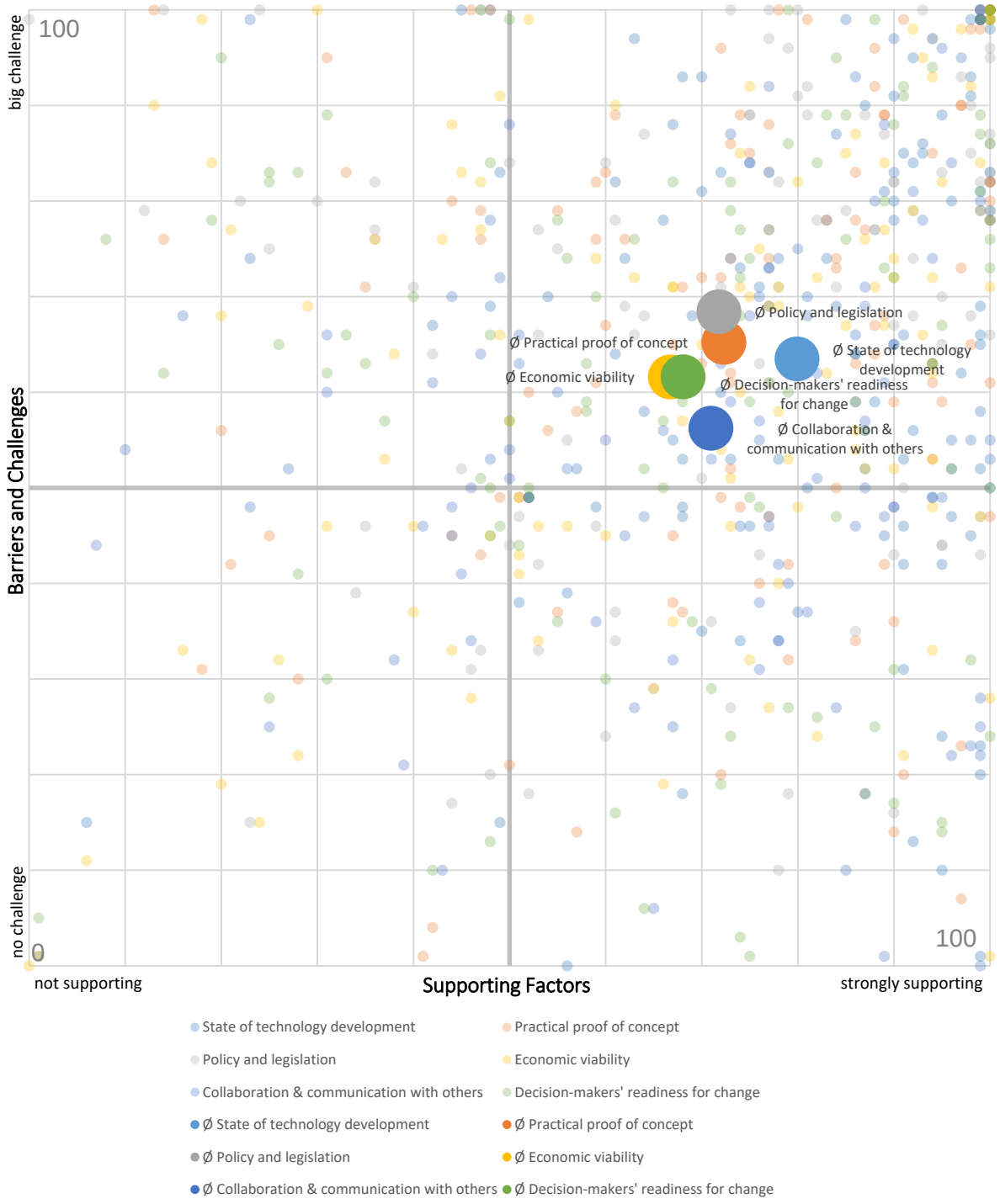


Figure 86: Stakeholders' opinion regarding supporting factors and barriers/challenges for implementing innovations (N=110 to N=115), data: ZHAW, Aalto University, tbw research.

6.3.6 Stakeholders' experiences in cooperation processes

In the next part of the survey, we enquired respondents about their experiences in cooperation processes related to commuting with three questions: First, stakeholders were asked to answer, in which context they had been already involved in cooperation processes. The two remaining open questions provided the respondents a possibility to state positive and negative experiences from these stakeholder processes.

Regarding the current involvement of stakeholders, the following results became apparent in the analysis:

- **Administration:** Stakeholders belonging to this category are generally involved in many types of participation contexts. The most prominent ones are 'Mobility management program' (75.5%) and 'Strategy and policy development' (78.5%). However, also the contexts 'Pilot project' (59.6%), 'Mobility study/report /investigation' and 'infrastructure project' (both 61.4%) were often named.
- **Associations & NGO:** The analysis revealed that stakeholders belonging to this category are less involved in stakeholder processes compared to other stakeholder categories. Their share in the answer "None" with 8.3% is the highest compared to the other stakeholder categories. The context in which they were involved most extensively is 'Mobility management program', 'Event/conference' and 'Membership in a transport association', with all three having a participation ratio of 41%.
- **Industry:** Even if the sample size of this category is not very big (N=9), every type of involvement context is stated by the stakeholders of the category 'Industry'. The most often mentioned were 'Event/conference' and 'public participation processes' (both 77%). Therefore, the stakeholders of this category are involved above average in public participation processes, even more than stakeholders of the categories 'Administration' (50.9%) or 'Associations & NGOs' (33.3%).
- **Planning and Research:** For this stakeholder category three primary contexts can be observed: 'Mobility study' (75%), 'Mobility management program' (65%), and 'Strategy and policy development' (60%) are the most important contexts, in which these stakeholders were involved. Other contexts were mentioned at below average shares.
- **Political party:** Stakeholders of this category are mostly involved in 'Public participation processes' (100%). The next important contexts are 'Event/conferences', 'Mobility study' and 'Strategy and policy development' (all 50%).
- **Transport company:** Not surprisingly, the context 'Membership in a transport association' (66.7%) is the most prominent context for stakeholder belonging to this category. Also 'Strategy and policy development' (58.3%), 'Mobility study', 'Mobility management program' and 'Mobility as a Service (MaaS)' (all 50%) are important contexts.
- **Other:** Stakeholder belonging to the category 'Other' were primarily involved in 'Mobility study' -processes (50%). Other contexts were represented at below average shares.

The overall analysis of this question shows that the three contexts 'Strategy and policy development' (63.6%), 'Mobility management program' (61.9%) and 'Mobility study/report/investigation' (57.6%) are the most prominent participation contexts in which survey respondents were already involved. Interestingly the context 'Mobility as a Service (MaaS)' is represented below average with a participation ratio of only 30.5%. Especially when considering the high-level interest the stakeholders have in MaaS (see chapter 6.3.7), this result reveals a significant potential for involving more stakeholders in the planning and operational activities of MaaS schemes.

Figure 87: Contexts, in which stakeholder were participating within the topic of commuting (according to stakeholder-category), data: ZHAW, Aalto University, tbw research.

In the following open questions, stakeholders had the opportunity to describe both the positive and negative experiences they have had in these participation contexts. The most important result from the Finnish responses is the mentioned “enthusiasm for new mobility solutions like MaaS and cooperations”. This enthusiasm was the most common description given by Finnish respondents as an answer to the open question about their positive experiences during experienced cooperation processes. Respondents also indicated that Finland is a relatively small country where different stakeholders know each other. The Finnish stakeholders also share a “common motivation in their willingness to cooperate” and they stated that key issues and development activities had been recognised within the themes of these collaborations. The intention behind this shared vision is to create an excellent starting point for the upcoming change towards more sustainable commuting. The cooperation experience between the various stakeholders was mainly seen positive by the Finnish survey participants. On the other hand, Finnish respondents believe that some changes happen too slowly. There are also respondents who claim that some stakeholders are more conservative than others; the difference between forerunners and laggards being significant according to them. For example, some stakeholders claim that cooperation with Finnish natural monopolies in the transportation sector is not sufficiently fluid. Overall, according to the answers, there are different opinions and ideological differences about the role of the

public sector in this paradigm shift. Moreover, it was mentioned that the interests and needs of large cities and smaller communities are not fully aligned.

Interest in new mobility solutions and cooperation in the transportation sector has risen significantly in the Basel region, according to stakeholders. Respondents state that most of the stakeholders understand the need for change, and attitudes among them advocate more sustainable alternatives. The quality of life was mentioned as a positive result from the cooperation, and respondents appreciated the promotion of active means of transport (e.g., cycling and walking). The positive experiences also included the fact that stakeholders and companies from different modes of transport want to work together, exchange knowledge and learn from each other. In Switzerland, even companies who have a monopoly, such as the Swiss Federal Railways, have demonstrated their commitment to exchange knowledge and cooperate. In the Basel region, there are unique challenges. For example, some influential lobbyists (e.g., automobile associations) are firmly focused on maintaining their power and very conservative about new mobility innovations, according to survey participants. Perhaps only typical for the Basel region also, there are considerable differences between the development cultures in the various countries (CH, DE, F). It was mentioned that some actors in the Basel region are more cautious and slower in adapting and implementing new ideas. Also, compared to the two other countries of the region, the attitude towards (organisational) mobility management is not so favorable in Germany according to stakeholders.

Stakeholder survey in the Austrian case area reveals that the general acceptance towards innovations is increasing in Austria. According to stakeholders, a change in thinking is happening, generating awareness and sensibility for the importance of intermodal mobility solutions in commuting. Even in companies with strong hierarchic structures and company offers such as company car allocated for private use, topics like "mobility management", "alternative mobility offers", and pilot projects are well received. Also, stakeholders described a fruitful exchange of experiences, where innovations are created through networking, and that often one partner takes the initiative, but others willingly participate. On the negative side, the stakeholders mourn that change processes generally take too long in Austria. According to stakeholders, this slowness may be due to obstructive structures such as current policies in commuting and hierarchies, but also because existing working conditions and material assets are not always changeable quickly. Also, a persisting rivalry between the taxi industry and car rental operators was stated as an obstacle in collaboration processes by the stakeholders.

6.3.7 Mobility-as-a-service (MaaS)

6.3.7.1. Stakeholder and the perceived relevance of MaaS

Stakeholders were surveyed about two specific aspects regarding their opinion towards MaaS. First, whether they see MaaS important for their own (business) activities, and second if they see MaaS relevant for commuting and mobility in general. When presenting these two factors in one diagram (Figure 88), it becomes apparent that Finnish stakeholders rate MaaS more relevant for future commuting schemes than for their own activities in commuting. In Switzerland, the results are more evenly distributed: those stakeholders considering MaaS important for commuting see it also important for their activities and vice-versa.[33] This result can indicate that Finnish stakeholders act and think more based on promoting systemic innovations than on their immediate interests. Austrian stakeholders' opinions are located in between Finnish and Swiss stakeholders and show the most linear distributed trendline of the three countries. It becomes apparent that the overall positive attitude and openness towards MaaS persists in these aspects, especially regarding stakeholders' opinion that MaaS will be relevant for future commuting schemes. The results are similar in Switzerland, Finland, and Austria; in all three countries over 35% of stakeholders consider MaaS a mobility offer, which will become very relevant for future commuting schemes.

[33] This effect is demonstrated by the polynomial trendline (3rd degree). This trend/regression type was chosen as it showed the highest trendline reliability, especially as the data fluctuates quite heavily. $R^2 = 0.4437$ (CH) / $R^2 = 0.3406$ (FI) / $R^2 = 0.1091$ (AT).

In contrast, the estimations regarding the relevance for stakeholders´ activities differ between Finland and the two other countries. In Switzerland and Austria, a higher share of stakeholders (around 30% and 35%, respectively) consider MaaS to be very relevant for their own (business) activities. In Finland, this share is lower (15.9%). However, around 40% of the Finnish stakeholders state that MaaS is “rather relevant” for them. Only approximately 20% chose this category in Switzerland and Austria.

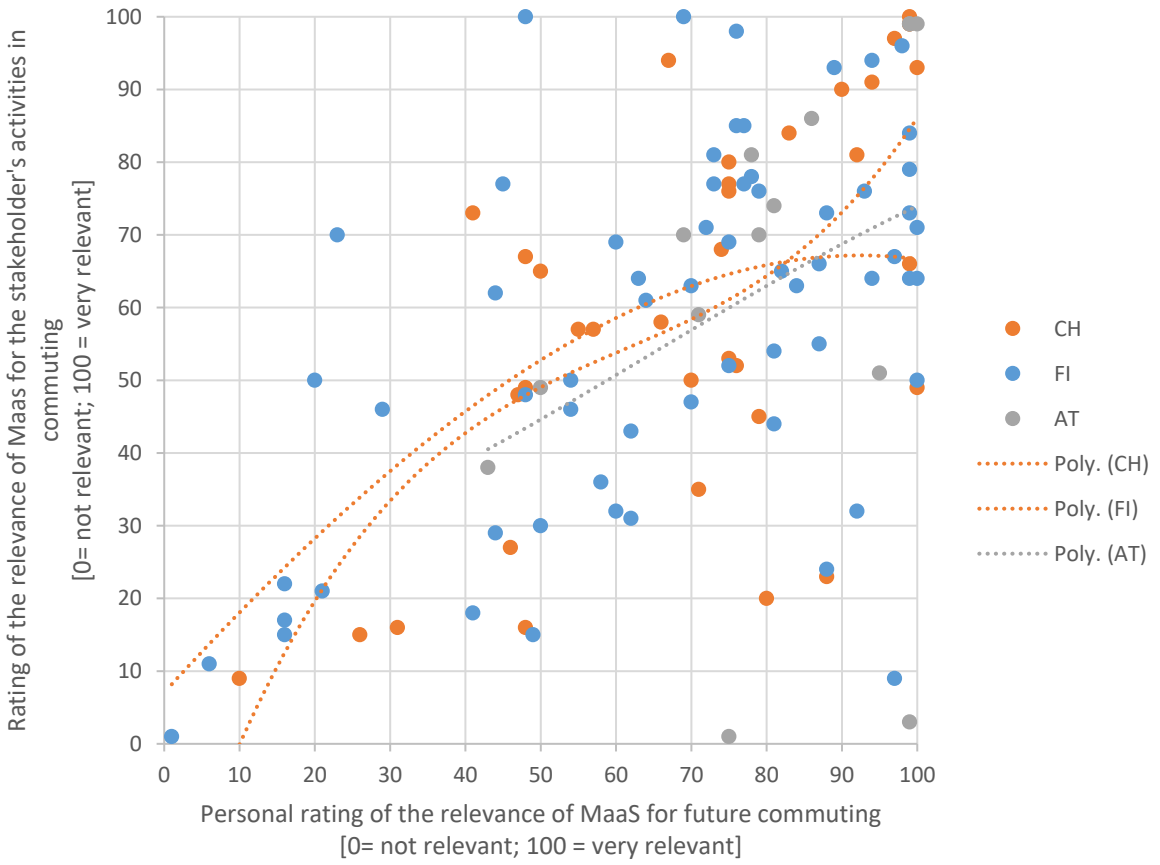


Figure 88: Perceived relevance of MaaS for future commuting and stakeholder's activities in commuting, data: ZHAW, Aalto University, tbw research.

6.3.7.2. Stakeholders’ participation in MaaS

In the final part of the survey, participants were asked what motivational factors could encourage them to participate in the development and implementation of MaaS. The results generally shows that Finish stakeholders can think more motivationg factors for them than Swiss and Austrian stakeholders (Figure 89). This result raises the question of whether stakeholders in Finland are more open to active participation in MaaS. Only the aspects ‘environmental benefits’ and ‘market-readiness’ are considered by Swiss stakeholders to be more motivating – environmental benefits has even one of the highest share of all items in the three countries. In Austria, two items ‘Compatibility with organisation strategy’ and ‘opening of new markets’ are seen as more motivating factor than in Finland or Switzerland.

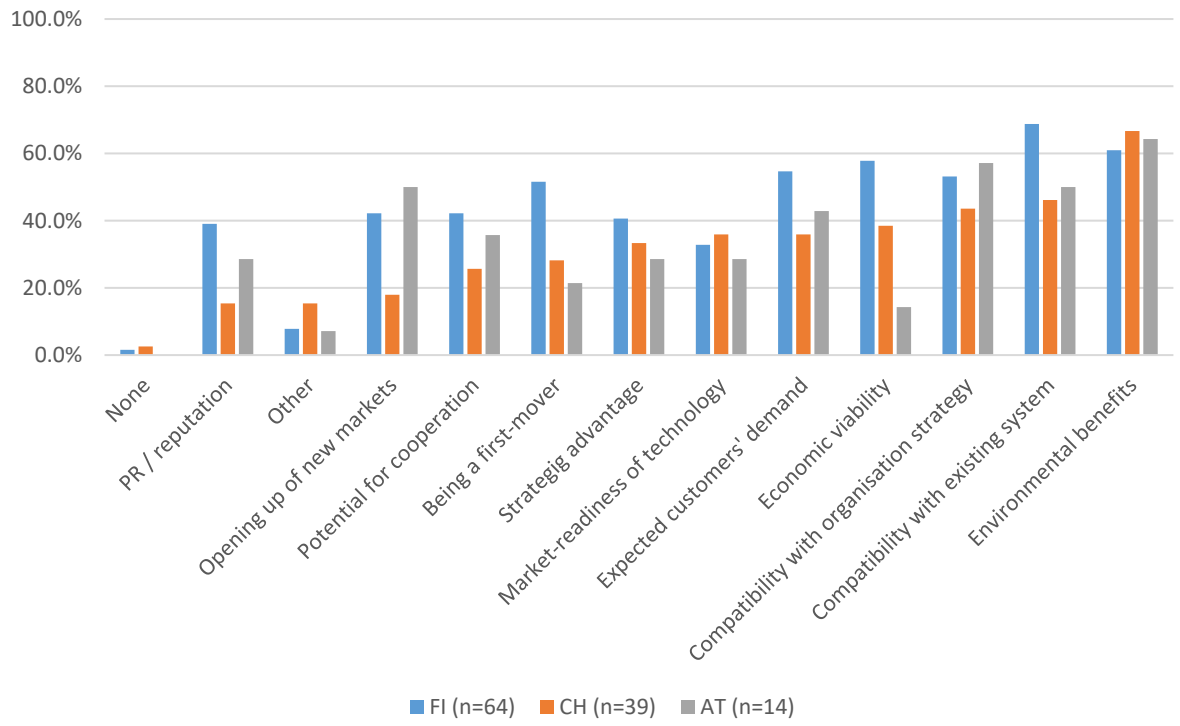


Figure 89: The share of stakeholders who consider these factors as a motivation for MaaS development, data: ZHAW, Aalto University, tbw research.

This result supports the argument that the Swiss and Austrian stakeholders are somewhat more conservative than Finnish stakeholders or that MaaS is not seen as a separate offering from the well-developed public transport in these countries. The main motivating factors for stakeholders in general are compatibility with their strategies and with existing mobility offers. Also, economic considerations seem to be important, in particular, the possibility of winning new customers and being a first mover, but only if also economic efficiency is ensured.

Another goal of the stakeholder survey was to find out which active roles stakeholders could imagine for themselves when contributing to a possible MaaS implementation. The overall proportion of stakeholders who can imagine themselves some role in the implementation of a MaaS offer is higher in Finland and Austria than in Switzerland. Accordingly, the share of "none" answers in Switzerland is twice as high as in Finland (Figure 90). In Austria, no stakeholder chose the “none” option. However, even in Switzerland, more than 80% of all stakeholders could imagine an active role. This result reveals the resources that stakeholders are potentially willing to provide to the implementation of MaaS scheme - under certain conditions.

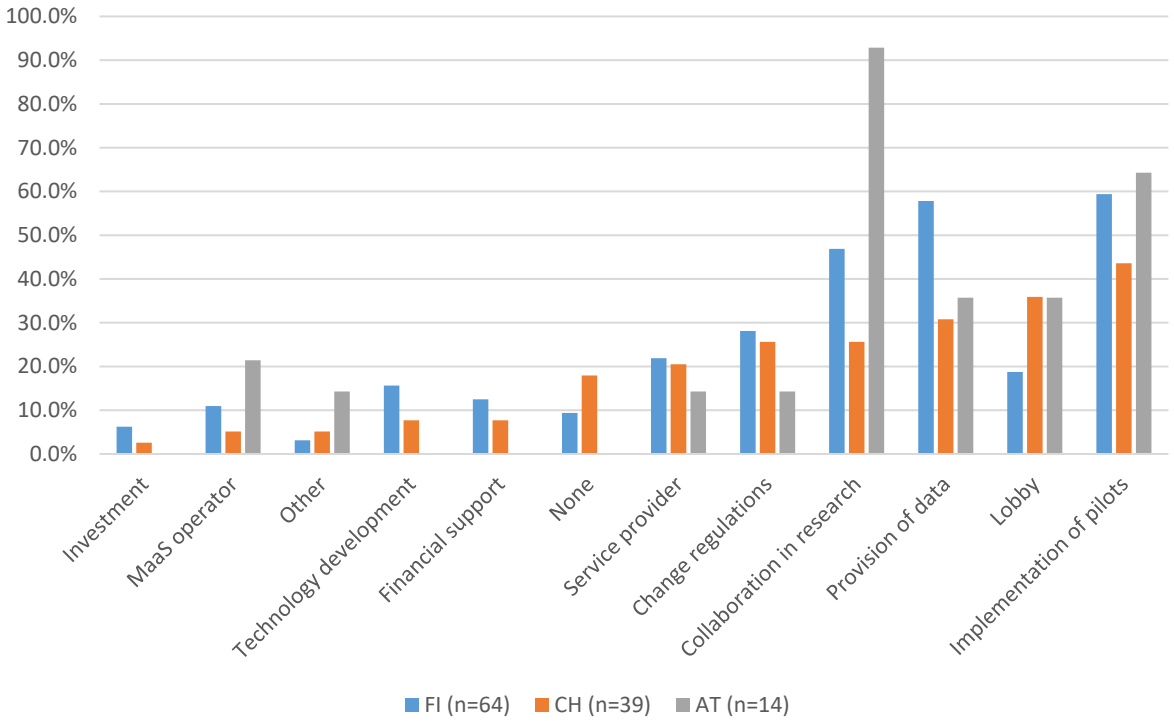


Figure 90: The share of stakeholders who can consider these roles for themselves in MaaS development, data: ZHAW, Aalto University, tbw research.

The only active role that more Swiss stakeholders could imagine for themselves compared to Finnish counterparts is lobbying. The share of those who can imagine themselves being as service providers within a MaaS ecosystem is equal between Switzerland and Finland. In Austria, several peaks in results become apparent, while other roles are neglected. More than 90% of all Austrian stakeholders could imagine themselves collaborating in research projects, and over 60% to be part of pilot implementation. For both roles, this is a higher share of responses than for stakeholders in both Finland and Switzerland.

6.4 Influence, importance and the potential roles of stakeholders

Our study followed the goal of providing a comprehensive approach for characterizing stakeholder interactions in the area of commuting and gaining knowledge about their attitude towards new mobility solutions like MaaS. Based on the activities in the case area of Basel, we created a stakeholder network, which imparted helpful insights about the different stakeholder roles and their collaboration network structure in decision processes in commuting. Also, the most relevant actors could be identified. Based on the results, the Canton of Basel-Stadt and its subsidiaries are the most important actors, which reflects their position at the centre of the agglomeration and where commuting is mostly directed in the area.

6.4.1 The stakeholder network analysis for the city of Basel

Taking into account the comprehensive results of the stakeholder network analysis (see chapter 6.2.3), estimations regarding the power and influence of individual stakeholder groups can be made. For each stakeholder category, five different centrality analyses (degree centrality, closeness centrality, betweenness centrality and eigenvector centrality) were performed. In all of these analyses, the category ‘Administration’ shows the highest degree of centrality. According to Hannemann and Riddle (2005), this can be a strong indicator that stakeholders belonging to this category are the most influential. Also the categories ‘Transport company’ and ‘Planning & research’ show a quite high degree of centrality, especially when looking specifically at the betweenness centrality. These measurement of power relations are thus basically based on stakeholder’s position within the network. Stakeholders belonging

to one of these three most influential categories (‘Administration’, ‘Transport company’, and ‘Planning & research’) can, therefore, be seen as pivotal stakeholders. As quite many connections between other stakeholders run through them, their role for the existence of the network can be considered especially important.

The interpretation regarding the stakeholders in the category ‘Associations & NGO’ is somewhat different. While they show a high significance based on the degree centrality (number of ties) and eigenvector centrality (to how many central stakeholders they have a connection), their results in the betweenness centrality (how many indirect connections run through them) are quite low. Hence, these stakeholders have contacts to many other stakeholders, but are overall not deeply involved in the stakeholder network and therefore can be expected to have a less influential role for the functioning of the network. The two remaining stakeholder categories ‘Industry’ and ‘Political party’ are the stakeholders with the least influence and importance in the stakeholder network. This position may be because these stakeholders mostly appear as providers of input and cooperation partners in specific processes.

To further classify stakeholders, participatory stakeholder research can be helpful. It tries to classify stakeholders according to their power, to develop targeted approaches and strategies and to involve the actors most effectively. Besides, the ‘importance’ of processes for stakeholders needs to be considered; i.e., for which stakeholders does the addressed development have the highest importance. Prell et al. (2009) point out that the ‘top-ranked stakeholders’ are often prioritised in participatory projects, which may lead neglecting weaker stakeholders to some degree. The empowerment of those neglected stakeholders, however, can create substantial improvements as well, depending on their position in the network. Of course, a stakeholder could be pivotal from a network structure perspective, though not too relevant from a traditional participatory stakeholder analysis perspective.

Additionally, the performed stakeholder network analysis helped to test one of our hypotheses. As expected, the official institutions such as the Office of Mobility of the canton Basel-Stadt are very much at the centre of the network and therefore have a quite high influence on processes related to commuting. It should be noted though, that we described the stakeholder network with its quantitative quality characteristics, which describes the possible influence of particular stakeholder (-categories) according to their centrality and reveals stakeholder clusters. This approach may answer the questions *where* measures to make commuting more sustainable need to be done to be effective. However, it does not reveal the views, opinions, and experiences of the individual stakeholders and therefore does not answer the question *how* these measures should be designed. We addressed this issue with the online stakeholder survey, where stakeholders were asked about their view on trends, innovations, supporting factors/barriers and their experiences in stakeholder processes. Additionally, we conducted the survey in all three of the Smart Commuting case study areas, which made it possible to compare the case areas and assess the generalizability of the obtained results. Also, as part of the survey, we conducted an in-depth enquiry about one of the project's focal themes, the Mobility-as-a-Service services.

6.4.2 Stakeholders’ attitudes towards changes

The survey showed that stakeholders see the surveyed socioeconomical and cultural trends (see chapter 6.3.3) generally quite influential regarding their work and strategies in commuting. This result shows a high level of general awareness in all three case study areas about the changes in operating environment. General awareness may help to motivate stakeholders and decision makers to improve and change commuting by introducing new mobility solutions and other strategies. However, if a certain mobility trend is already well progressed in a particular country (e.g., wide spread of car sharing users in Switzerland), the survey indicated that stakeholders may not expect the need for an adaption in their strategies, as they may have already be used to deal with this specific trend. In Switzerland and Austria, stakeholders are mainly concerned with spatial and socio-economic trends, such as population and employment growth and increasing distance between work and living place. In Finland, travel behaviour trends (e.g., multi-modality) and technical innovations are seen as more relevant. Additionally, technical innovations were rated very positively by Finnish stakeholders, and they were quite in favour of new mobility systems in commuting. However, innovations, whose sustainability effects are controversial are

also seen less favorable by stakeholders in the three case areas (e.g., privately owned autonomous cars). One interesting finding regarding the implementation of new sustainability systems is that the stakeholder category 'Administration' often shows somewhat above-average disapproval towards innovations.

Regarding MaaS, the survey revealed, that one of the prerequisites for a successful MaaS implementation already seems to be fulfilled. The general acceptance of this systemic innovation among decision-makers is positive. The surveyed stakeholders also assume that MaaS will play a rather significant role in future mobility systems. Also, their openness for active contributions is generally high, as surveyed stakeholders could imagine themselves in many different roles in MaaS implementation cases. However, investments and financing may remain a challenge, as only a few stakeholders could anticipate these roles for themselves. Thus, when compared to the very modest openness of the individual commuter (see Hoerler et al., 2018), stakeholders' openness towards new mobility solution like MaaS is higher.

The consolidated analysis concerning supporting factors and barriers for inducing a change in commuting showed that in particular the factor 'state of technology development' is considered an essential part of the implementation of new technologies. From the factors, 'economic viability' was considered least critical. Therefore, it may be that the surveyed stakeholders could consider investing in new technologies, even if their return on investment is not yet fully known. However, in the context of the above-mentioned lack of willingness to invest or finance MaaS implementation cases, this could also indicate that stakeholders do not see 'economic viability' as a supportive factor, as they do not even consider to invest in innovations financially and therefore don't pay attention to this factor. Regarding persisting challenges, the respondents see all the surveyed factors also as barriers, but mostly at a low level. The factor 'policy and legislation' is considered to be the primary obstruction to the introduction of new mobility systems. Stakeholders also noted that working and communicating with other stakeholders is not significantly difficult. However, this viewpoint is put in perspective when the open-text responses regarding stakeholder's positive and negative experiences in collaborations are considered. Indeed the stakeholders of all three countries highlight very positive examples of collaboration experiences with other stakeholders. Most often mentioned aspects are the increasing openness to change and innovation in commuting among some stakeholder groups. Concrete examples of such groups or stakeholders mentioned by respondents are the Swiss Federal Railways in Switzerland, traditional private companies in Austria or public administrations in Finland. Still, some stakeholders are seen as more challenging to collaborate with: In Finland, the national railway company VR is mentioned, in Switzerland the Car-Lobby and in Austria, there exists a persisting dissension between taxi companies and car rental companies. Therefore, it seems that many challenges in this area persist but stakeholders are observing a paradigm change.

6.4.3 Policy development

Combining the findings of the network analysis and the stakeholder survey it becomes apparent that stakeholders belonging to the category 'Administration' often have a pivotal function[34] in collaboration network and can therefore generally be seen as influential due to their many ties to other stakeholders. Hence, their views and actions are relevant for the future development of the commuting system. However, the online survey revealed that the stakeholders of this category partially show a lower enthusiasm for innovations. While this may be understandable when it comes to innovations that are questionable regarding environmental sustainability, such as privately owned autonomous vehicles, their lower enthusiasm for congestion charges surprises. Thus this stakeholder category is crucial to push changes in this field forwards. Even stakeholders of the category 'industry' (private, nontransportation companies) were more in favour towards congestion charges. Although they did not show disapproval, 'Administration' was also somewhat less enthusiastic towards MaaS and car-sharing

[34] Pivotal: Pivotal stakeholders within SNA-networks are crucial for the existence of the network.

systems. Creating awareness and support in this field through administrative actions reveals one starting point in creating successful measures and form conditions for MaaS.

Another starting point is the current readiness to contribute to innovation implementations such as MaaS actively. Therefore, to support the development towards a better and more sustainable commuting among all stakeholders, additional participatory processes need to be actively promoted. One possible framework for these processes can be seen in Figure 91. A challenge, however, is the lack of willingness to finance and to invest in this field. Therefore, special consideration should be given to this subject, e.g. through public-private-partnerships. Also, individual policy recommendations should be developed for each stakeholder category and be confirmed with relevant participatory processes.

One promising starting point for implementing new mobility solutions is the general openness towards innovations and new mobility trends of the (also very influential) stakeholders in the category 'transport company'. Even if some stakeholders report challenges in collaboration with public incumbents, their enthusiasm to implement new systems and solutions is a great stepping stone for inducing changes in the current transportation market and making commuting more sustainable and user-friendly.

One striking observation was the difference in the structures of stakeholder networks in our case regions. Even though our methodology was identical in Switzerland, Austria and Finland, the response and completion rate was profoundly different between the three case areas. Even within the case area Basel, the types and numbers of participating stakeholders are very diverse depending on their country of origin (CH, F, DE). While more people are commuting daily from France to Basel than from Germany to Basel, the number of identified France-based stakeholder is much lower than the number of German stakeholders.

This observation may indicate that there persist cultural differences in stakeholder collaboration between countries and regions. Thus, when mobility planning needs to be done trans-regional (like in Basel), this aspect needs particular attention.

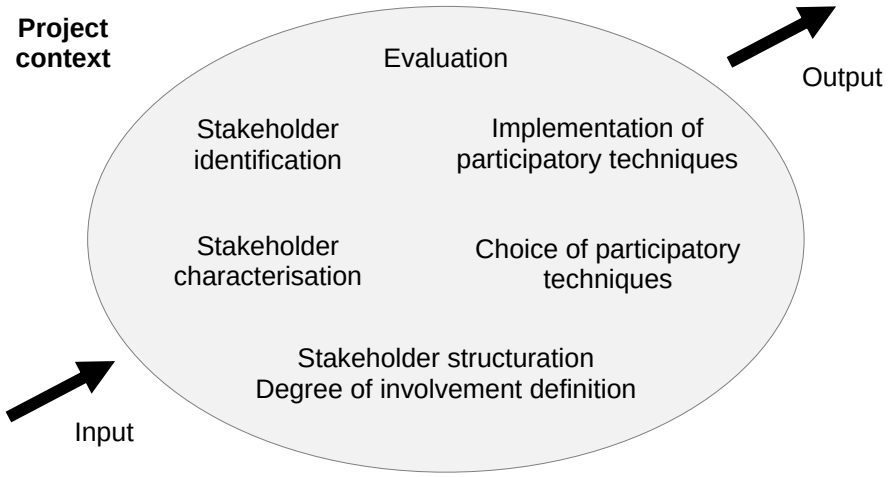


Figure 91: Framework for stakeholder participation (based on Luyet et al., 2012, p. 214).

The stakeholder network as well as any developments in mobility are embedded in the context of a given social, economic, technological and political environment. From this perspective, an implementation of MaaS as a mobility innovation as well as a general transformation towards sustainable mobility is considered as an overall shift of the system – as labelled by the term "socio-technical" regime development. This refers to the idea that society, decision makers and technological innovation do develop in interaction. To better understand this overall systemic change the socio-technical regime as relevant for mobility is described in the following chapter.

7 Socio-technical regime[35]

The relevance of the so called socio-technical regime relates to the assumption that mobility and transport technologies are embedded in an environment of socio-cultural, economic, political and technological frame conditions (for socio-technical regime approach see also chapter 5.2.2 and 5.5). As a consequence changes in the mobility system are always linked to a change within the socio-technical regime. The regime might enable or hinder an innovation and will be affected by innovation in turn, e.g. by new social trends or political regulations coming up.

Understanding the socio-technical regime is helpful when analysing the empirical results about the user needs in the three countries, e.g. when estimating the impact and success factors of different business models and when formulating policy recommendation for different stakeholders. Thus, the socio-technical regimes affecting the development of new mobility concepts in the three countries were analysed. Based on this information and expert interviews, the most probable near-future state of sustainable and intelligent transport services in the implementation regions can be estimated and the transition paths towards these near future situations can be described in respect to different regime level changes in each participating country. In the following chapter, first background information, basic information and a comparison of the three countries is described. Different technologies that have an impact on mobility and commuting in the near future are outlined and policies and legislation affecting commuting and mobility are discussed for the three countries and the case studies.

7.1 Background

Concerning commuters mobility as part of todays' socio-technical regime especially the working world conditions and given mobility services with their degree of sustainability are relevant in the context of the research question of the Smart Commuting project. Thus, the background description addresses these issues as well as the question of effects of commuting and the relevance related to the socio-technical regime.

7.1.1 Work-related mobility

The mobility of the workforce is continually increasing. A Eurofound study[36] 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[37]). The commuting distance is influenced by a large number of factors, such as the income of the residents of the central city[38] 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

[35] Haahtela, T., Viitamo, E., Surakka, T., Asamer, J., Härri, F. and Hawelka, M., 2018. Smart and Mobile Work in Growth Regions. Deliverable 3.1-3.3: Current socio-technical regime in the chosen regions.

[36] 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

[37] HSY (2014) Commuting. Web page (In Finnish), accessed 18.5.2017. Available at: https://www.hsy.fi/fi/asiantuntijalle/seututieto/tyopaikat/Sivut/Sukkulointi.aspx

[38] Shenn Q. (2000) Spatial and Social Dimensions of Commuting. Journal of the American Planning Association, Vol. 66 (1), pp 68-82.

services also need to be considered when re-conceptualizing multi-locality[39]. Also, the ever-increasing mobility of workers brings along the increase in CO2 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.[40]

7.1.2 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 integration of various forms of transport services into a single mobility service accessible on demand."[41] 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 advantage42. 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

[39] 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.

[40] 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

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

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

with the end users[43]. 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[44].

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.[45]

7.1.3 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[46]. 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%

[43] 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.

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

[45] 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

[46] 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.

compared to 1990[47]. In Finland, the number of electric vehicles has doubled in recent years[48], but the starting point has been modest to say at least compared to other Nordic countries[49].

When the popularity of electric vehicles reaches higher levels, the demand response and relevant incentives in smart electric grid become relevant factors50. 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.51

7.1.4 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[52], 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[53] – 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.

7.1.5 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.

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[47] 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

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

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

[50] 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

[51] 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

[52] 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

[53] 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

Governance embeds different stakeholders through mechanisms of market, network and hierarchy to drive the decision-making[54]. 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 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[55] to different areas.

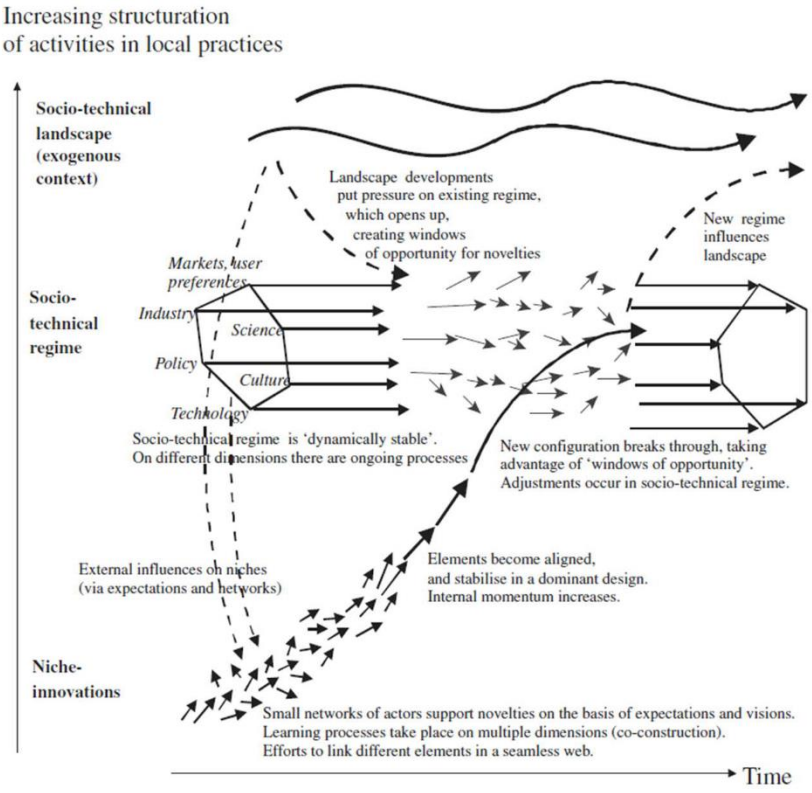

Figure 92: The socio-technical framework of Geels (2001).

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

- Technology and innovations
- Policies and legislation

[54] 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.

[55] 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.

- 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.

7.2 Comparison of 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[56], 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 18: 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

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

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.

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 19: 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[57]. 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

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

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.

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[58]). 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.[59] 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.[60] 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.[61]

7.3 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[62]
2. Shared, electric, autonomous mobility[63]

[58] www.istmobil.at

[59] http://www.leibnitz.at/buergerservice/leibnitzmobil/ (German)

[60] https://www.railanddrive.at/de (German)

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

[62] https://peec.stanford.edu/sites/default/files/160401_automotive_2030_-_peec_vp.pdf McKinsey 2016 Automotive Revolution – perspective towards 2030

[63] https://www.morganstanley.com/ideas/car-of-future-is-autonomous-electric-shared-mobility

3. Electrification, automation, connectivity, MaaS transport, demassification, delivery[64]
4. Electrification, automation, shared mobility[65]
5. Connected, electrified, shared[66]

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[67].

7.3.1 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.

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

[64] http://www.blurb.com/b/8222797-the-end-of-traffic-and-the-future-of-access

[65] 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

[66] https://www.ibm.com/blogs/internet-of-things/automotive-future-iot/

[67] https://www.pwc.co.uk/economic-services/ukeo/pwcukeo-section-4-automation-march-2017-v2.pdf

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[68].

- Improved sensors are another significant area of improvement including cameras, radars, lidars[69], 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.

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[70] . 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

[68] https://www.nvidia.com/en-us/self-driving-cars/drive-px/

[69] “laser illuminated detection and ranging"

[70] https://www.swissinfo.ch/eng/first-autonomous-transport-service-in-switzerland-inaugurated/43541214

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.

7.3.2 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[71]) 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[72]. 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[73]. Hybridization with this engine could be used for accelerations and other situations where more power is needed sporadically.

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[74]. 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[75].

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,

[71] http://docketpublic.energy.ca.gov/PublicDocuments/17-IEPR- 07/TN217132_20170417T164544_Global_EV_trends_and_forecast.pdf

[72] https://www.ft.com/content/471cd6e2-60bc-11e7-91a7-502f7ee26895

[73] http://www.express.co.uk/life-style/cars/870841/Mazda-petrol-cars-engine-breakthrough-SKYACTIV-X

[74] https://electrek.co/2017/07/04/electric-car-norway-tesla-model-x/

[75] https://electrek.co/2017/11/03/ultra-fast-electric-car-charging-network-unveiled-by-bmw-mercedes-ford-volkswagen/

23.3% of all sold bicycles were E-bikes[76]. These light solutions offer a viable way to solve the last- mile problem.

7.3.3 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 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.

7.3.4 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

[76] http://www.velosuisse.ch/files/Velo%20Statistik%20Schweizer%20Markt%202016.pdf

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.

7.3.5 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.

7.3.6 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.

7.4 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

7.4.1 Austria

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[77]. 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[78]. The modal share of private cars has decreased from 34% to 27%[79] 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[80]. The aim of Wiener Linien is to find 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

[77] https://www.wienerlinien.at/media/files/2017/facts_and_figures_2016_213708.pdf

[78] https://www.wienerlinien.at/eportal3/ep/channelView.do/pageTypeId/66533/channelId/-3600061 (English)

[79] https://www.fahrradwien.at/wp-content/uploads/2016/01/modal-split-2014-2015.png

[80] 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

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.

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.[81] In Vienna, multimodal services based on the smile-project like WienMobil (further developed by Upstream) and wegfinder (further developed by iMobility) provide easy 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[82] 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 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[83] 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.

[81] https://www.vor.at/

[82] https://westbahn.at/en/

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

7.4.2 Switzerland

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.

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[84]. 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.

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.

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, 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

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

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.

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.

High-quality public transport for a reasonable price

The travel costs with public transportation in Switzerland are subject to extensive public debates[85]. Regarding the high financial amounts involved, this is not surprising - In 2014, the overall system costs for public railway transportation in Switzerland accounted for 8.6 billion Swiss francs (around 10.3 billion euros[86]). This is an increase of 13% from 2010 to 2014[87].

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%[88]. This increase in ticket prices often leads to incomprehension among public transport users and therefore drives the aforementioned public debate[89].

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

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[85] 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).

[86] Exchange rate 31 of October 2014, see http://de.exchange-rates.org/Rate/EUR/CHF/31.10.2014

[87] BFS, 2017. Kosten und Finanzierung des Verkehrs. Strasse und Schiene 2014. Bundesamt für Statistik BFS, Neuchâtel.

[88] WBF, 2013. Entwicklung der Fahrkosten im Strassen- und Schienenverkehr. Eidgenössisches Departement für Wirtschaft, Bildung und Forschung WBF, Bern.

[89] Brupbacher, M., 2014. Sind die ÖV-Preise in der Schweiz wirklich überteuert? Tagesanzeiger Datenblog.

(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[90]) 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.[91]

7.4.3 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[92]. 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 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 CO2 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.

Finnish climate policy targets

European Union expects Finland to reduce CO2 emissions by as much as 38% by the end of 2030. The transportation sector should halve the CO2 emissions before 2030, which means 5,5 Megatons less CO2 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:

[90] Exchange rate 16 of October 2017, see http://de.exchange-rates.org/converter/CHF/EUR/3860

[91] Sträuli, C., Killer, M., 2016. Angebot und Preise des ÖV Schweiz im internationalen Vergleich. LITRA Informationsdienst für den öffentlichen Verkehr, Bern.

[92] http://tilastokeskus.fi/til/tyti/2014/02/tyti_2014_02_2014-03-25_tau_009_fi.html

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 CO2 emissions in Finland for produced energy are 183 kg CO2/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 CO2 emissions of electricity consumed in Finland. Therefore, with more emission-free production, the electrification of vehicles will reduce CO2 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.

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.

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.

7.5 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 93 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.

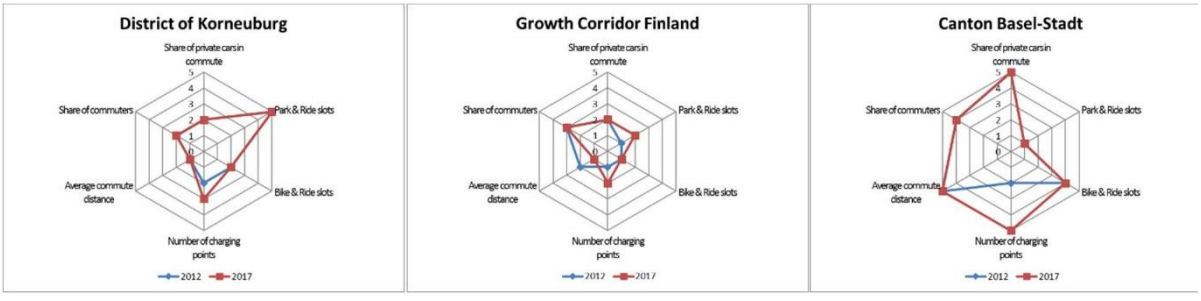

Figure 93: Net graphs of the areas from left to right: District of Korneuburg in Austria, Growth Corridor Finland, and Canton of Basel-Stadt in Switzerland.

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:

Share of private cars in commute, Average commute distance and Share of commuters

- For the "2012 situation" in Korneuburg, we have used the study made by Planungsgemeinschaft Ost[93] 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[94]. 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

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 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[95] 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

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[93] 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/

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

[95] 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

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

7.5.1 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 94), the modal split in commuting from Korneuburg to Vienna between car and public transportation is 71 to 29%[96] (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/.

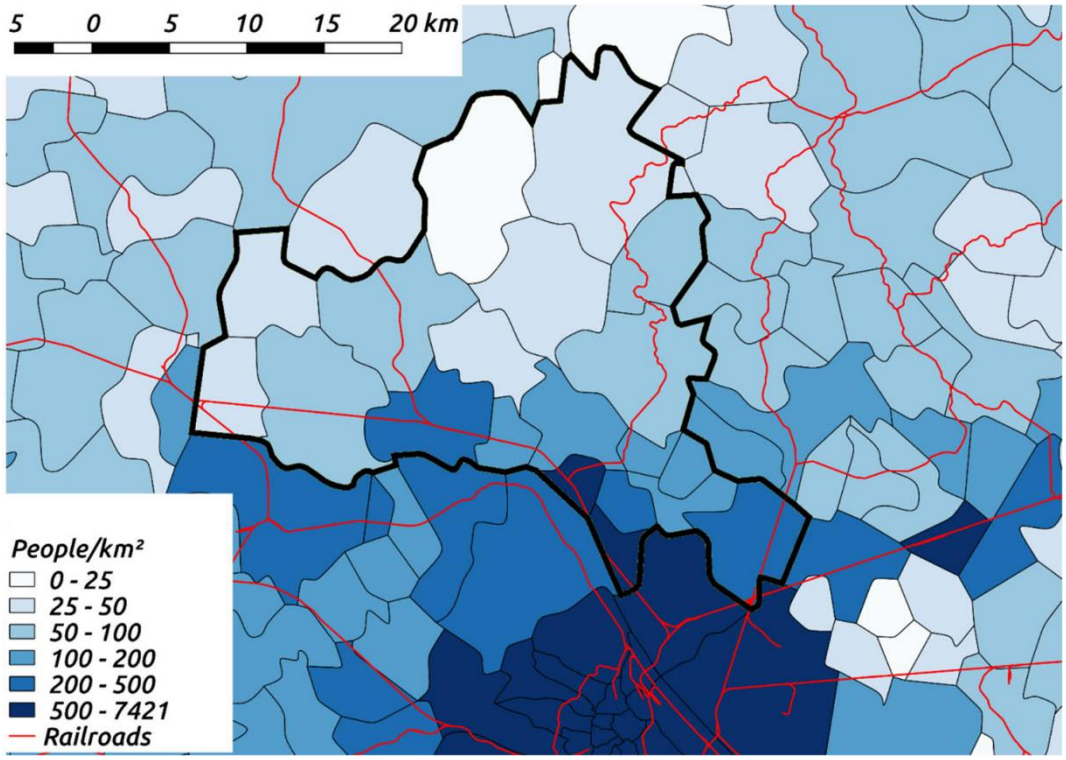

Figure 94: Population density and railroad lines in the district of Korneuburg.

[96] 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/

7.5.2 Finland: Growth Corridor Finland

The Growth Corridor Finland[97] (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 95) GCF stretches from Helsinki to Tampere as a string of cities (Figure 96), 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.

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.

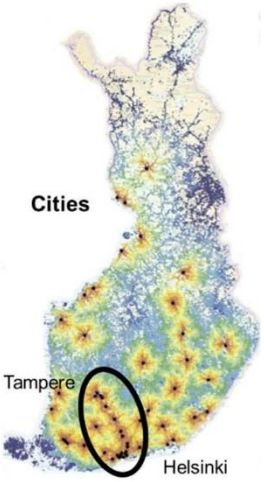

Figure 95: GCF as a string of cities.

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

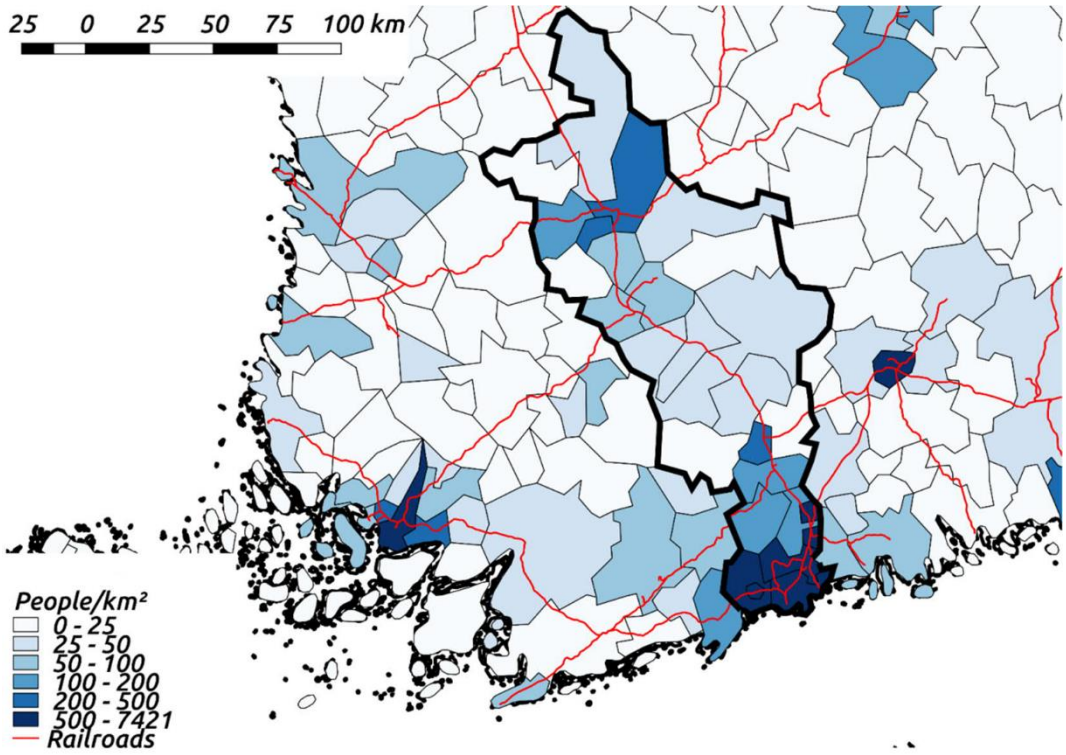

Figure 96: The population density and railroad lines in the main geographical area of Growth Corridor Finland.

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.

7.5.3 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[98].

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[99]. 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 97). 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

[98] 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

[99] Sohn C., Reitel B., & Walther O., 2009.

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 98).

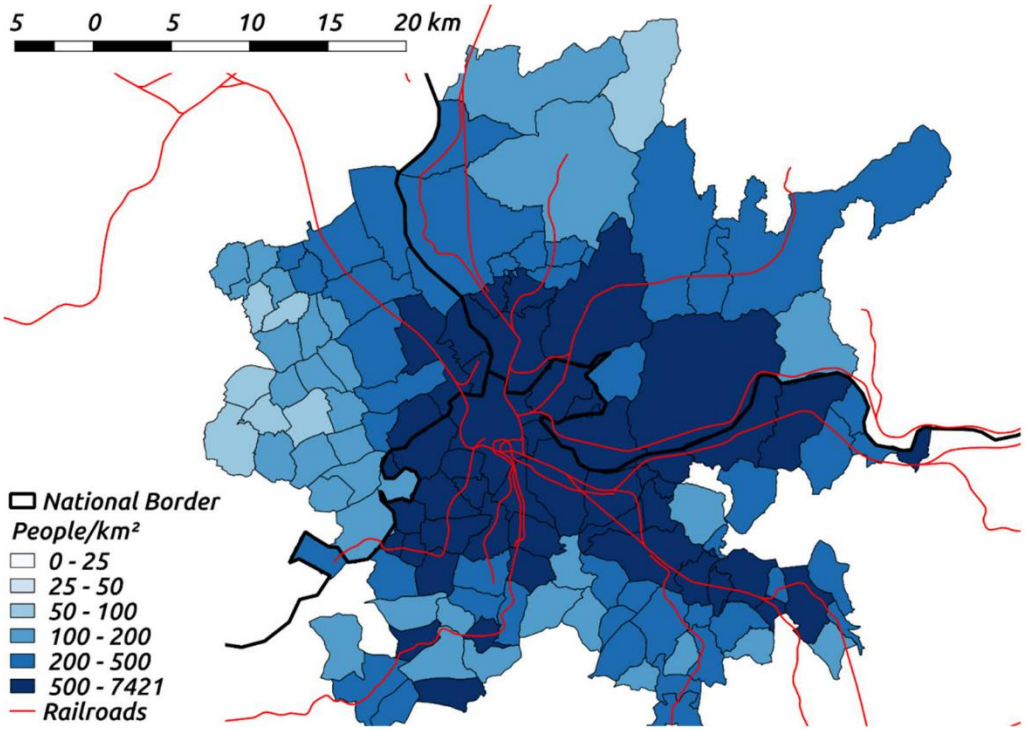

Figure 97: The population density and railroad lines in Basel and surrounding areas.

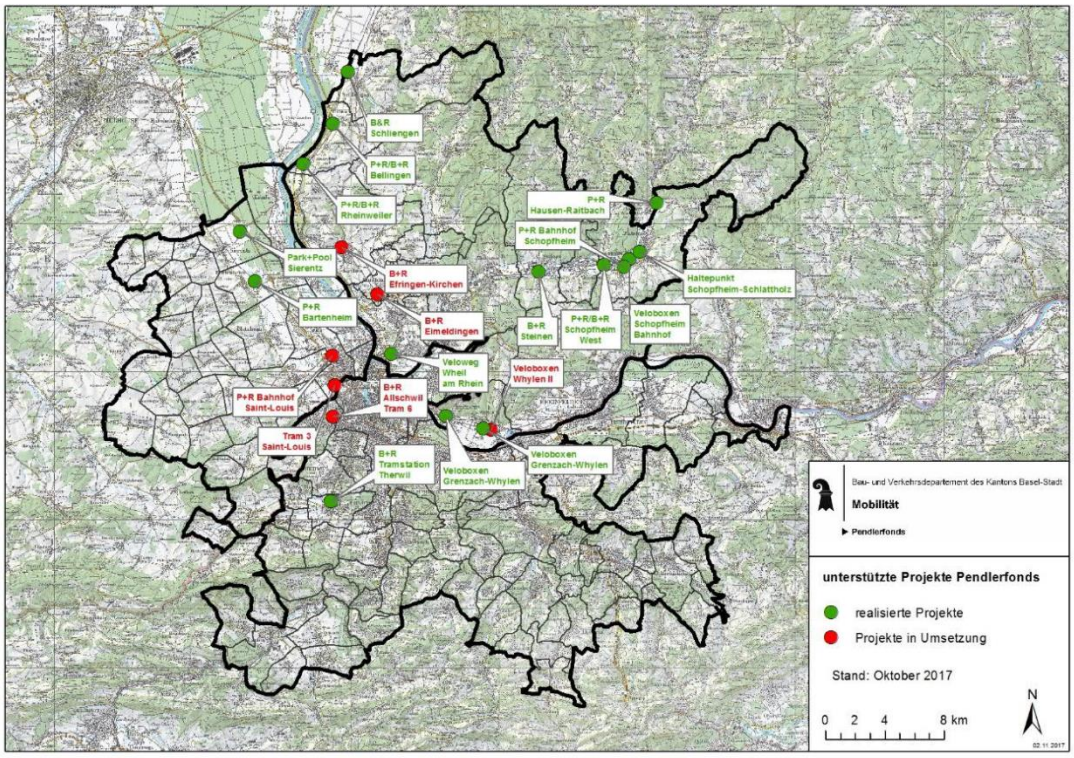

Figure 98: Pendlerfonds supported projects. Picture copyright: the Department of Mobility in the Canton Basel-Stadt, used with permission.

7.6 Conclusion

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. [100]

7.7 Examples of 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.

7.7.1 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

[100] For examples of mobility services in Austria and Finland see Haahtela, T., Viitamo, E., Surakka, T., Asamer, J., Härri, F. and Hawelka, M., 2018. Smart and Mobile Work in Growth Regions. Deliverable 3.1-3.3: Current socio-technical regime in the chosen regions.

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 %.

7.7.2 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.

7.7.3 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.

7.7.4 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.

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[101]. 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[102]. 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[103]. In Switzerland, bike sharing is still a niche. PubliBike,

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[104]. 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[105]. 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[106]. 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[107], many citizens claimed that the bikes are cheaply made and that they occupy existing bicycle stands[108]. Even the media picked up the subject extensively, and other municipalities in the canton of Zurich banned O-Bike from their territory92[109]. 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[110].

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,

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[101] De la Fuente Layos, L.A., 2007. Passenger mobility in Europe. Eurostat (European Commission)

[102] 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).

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

[104] Publibike, 2015. Newsdetail - PubliBike - Velos und E-Bikes in Selbstbedienung mieten - Eine Dienstleistung von PostAuto, SBB und Rent A Bike [WWW Document]. PubliBike. URL https://www.publibike.ch/de/newsdetail.html (accessed 11.1.17

[105] Rohrer, J., 2014. Jederzeit ein Velo zur Hand. Tages-Anz.

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

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

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

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

[110] 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).

which sometimes leads to perfectionism or lack of courage[111], 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.

7.8 Conclusion

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 chapter 11 (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

[111] 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)

Müller-Möhl, C., 2012. Schweiz: Scheitern verboten. Zeit.

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.

Considering the context of the socio-technical regime as described here and the results of the trend analysis, commuter survey and stakeholder analysis design principles and strategies for sustainable mobility solutions can be developed as described in the following chapter.

8 Design Principles and Strategies for Sustainable Mobility Solutions[112]

The Smart and Mobile Work in Growth Regions (Smart Commuting) project explored new ways of combining work and life with new intelligent transport system services and new concepts for supporting sustainable commuting. Mobility needs in Switzerland continue to increase with economic development and settlement growth. Rising income, an active lifestyle and the increase in population because of migration contribute further to these developments. This trend has consequences for society and the economy: long or cumbersome commuting can reduce labour productivity and restrict time for other activities such as leisure, recreation or family. Effects are for example quantified by cost of congestion, which was estimated for Switzerland to be around 1.9 billion in 2015 (ARE 2018). The increasing number of commuters and ever-increasing commuting distances are also pushing existing transport systems to their capacity limits, increasing energy consumption and emissions that are harmful to health and the environment.

Labour mobility is increasingly generating negative impacts on social, economic and ecological areas. The relevance of this topic is steadily increasing, especially in heavily congested metropolitan areas. Cities with a high proportion of commuters such as Basel have to adapt their mobility strategies to these changed conditions. Opportunities presented by new technologies can be exploited to improve the sustainability of mobility systems. Within this context, the applicability of intermodal planning and booking systems such as "Mobility-as-a-Service (MaaS)" was examined.

The overall objective of "Smart Commuting" was 1. to identify the potential for energy and CO_2 emission reduction of commuter mobility, 2. to identify starting points for a change towards sustainable mobility and 3. to develop strategies related to individual mobility behaviour as well as for companies and urban transport and mobility planning. The project followed an integrative approach to developing commuter mobility solutions. Trends in society and the working environment were taken into account as a reason

[112] Härri, F., Michl, T. and Hoppe, M., 2018. Smart and Mobile Work in Growth Regions. Deliverable 2.3 und 6.1: Design principles for sustainable mobility and commuting strategies.

for the demand for mobility and as a starting point for measures. The aim was also to support decision-makers from politics and planning in order to shape the change process towards sustainable mobility.

Based on this analysis, in this report design principles for sustainable mobility are illustrated. Together with best practice from other cities they serve as a basis for evaluating the current mobility concepts of Basel City with regard to commuting. General conclusions are drawn from this concerning potential improvements of strategies and measures supporting sustainable and smart commuting in Basel and in other European Cities.

This project was 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) within three case studies in Finland, Austria and Switzerland.

8.1 Overview and Research question

In order to provide a concept for commuting strategies applicable for a variety of European cities, first a basic principles relevant in sustainable commuting that can be used as guidelines for mobility planners and companies were elaborated (8.2). Best practice of other cities in successful policy on commuting as another valuable source was analysed (8.3) and used as a basis to evaluate the strategy of Basel Stadt (8.4). Strategic documents, planning the mobility within the canton and city were analysed based on the recommended design principles derived in the third chapter and in comparison with best practice of other cities. The proposed measures of the canton were investigated and conclusion about its appropriateness regarding sustainability were drawn. Potential problems or needs to improve their approach in order to support new mobility service implementations are discussed. The adaptability of the results is considered by suggesting a starting points for smart and sustainable commuting to be adapted in other European Cites.

As one of the main goals and motivation underlying the project and sustainable commuting strategies itself is to reduce resource consumption and emissions to improve quality of life, a qualitative energy and CO_2 reduction potential of a change of mobility behavior in commuting is investigated for the Basel commuter groups as derived in chapter 4.2.2.

The paper therefore investigated the following research questions:

- What are the **design principles** for sustainable mobility strategies in commuting?
- Which **experiences** from other European Cities can serve as best practice examples?
- Are **strategies** of the canton **Basel Stadt** supporting sustainable mobility based on design principles, and in comparison with best practice of other cities?
- Which are the **general conclusions** and starting points for supporting sustainable commuting in **European cities**?
- How big might be the **effect** of applying such strategies, how big is the **potential** in reducing **CO_2 emissions** from commuter traffic for Basel and for Switzerland?
- Which commuter groups would have the highest **energy** and **CO2 emissions reduction potential**?

8.2 Basic design principles for sustainable commuting

Mobility demand and transportation have side effects on the environment and health especially related to emissions as well as in financial terms due to its long-term character of investment. Thus, aiming for sustainability is even more important as a guiding principle. Policy and planning increasingly try to integrate sustainability in decision making for their long-term strategies and implementation of projects.

The current understanding of sustainability relies on the definition from the United Nations' Brundtland Commission (1987), which is a "development which meets the needs of current generations without

compromising the ability of future generations to meet their own needs". Even if the core of this definition is both plausible and reasonable it is subject to differing interpretations due to its high level of abstraction included in generalized needs as well as in the stated time gap of generations between action and effect. How to implement the normative notion of sustainability in concrete planning and decision making in practice?

Even if sustainability is a concept with a broad range of definitions depending on the perspective there is a core inherent in most of the definitions. This core includes the preservation of natural resources as well as the economic and social basis (for discussion see also Hoppe 2014). In order to apply this basic understanding of sustainability in practice guiding principles for decision can be helpful.

If the common basis of the manifold sustainability definitions is summarized some key aspects appear: use and consumption of resources as well as harm and danger towards society and environment should be minimized; the concept integrates social, economic and environmental issues; the perspective is on global, large scale, long-term and future oriented thinking. Translated to transport this means that the transport system should provide safety and quality of life via access for all, should support economic competitiveness as a basis for society and wealth and should minimize the negative effects on people and environment, including climate.

Preserving resources and ensuring the economic base adress the basic issues for the society and the economy – while the social system should be optimized (Figure 99). Adressing all three dimensions, as included in the most sustainability definitions, meanst interests of all three need to balanced, there is a need to innovate in order to transform the transport system for reaching this goal. For all dimensions main principles, as contributing to the overall goal of long-term system sustainment, can be formulated. On the resource dimension it is about consumption and effects on nature and society – thus, energy, climate responsibility and the goal of sustainment of eco-diversity and habitats should lead decisions.

In the dimension of the society the transport system needs to provide accessibility to ensure equal opportunities of life, education and both access to health services but also avoid harm of health. The economic principles are related to providing the basis for the society – not as an end in itself. To fullfill this function competitiveness needs to be strengthened which is related to infrastructure as preconditions for economic development; whith regards to the society employment would need tob e enabled, again serving the society.

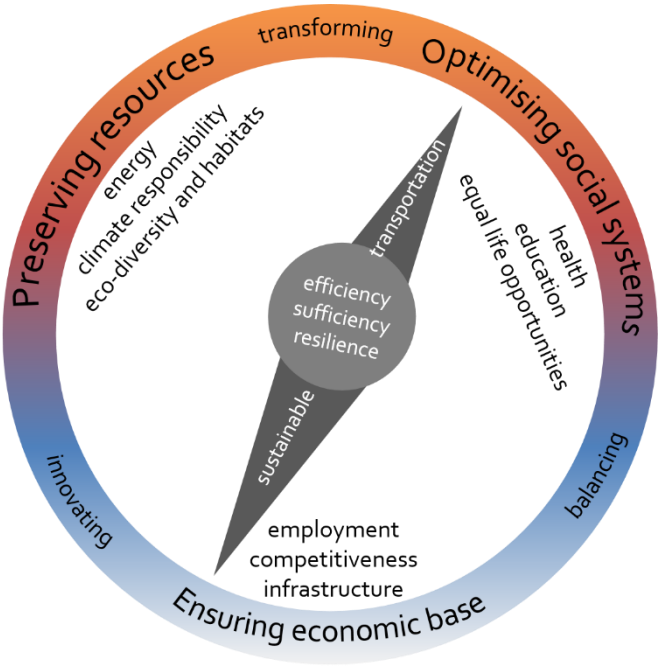

Figure 99: Sustainable transport compass.

According to our research approach on sustainable mobility, which is based on a synthesis of recent definitions of sustainability and criteria defined for sustainable transport in literature, we used main principles to assess Basels strategies in terms of sustainability. According to this, the design of transport system components, new solutions, re-design of the given system and strategies should:

1. Be based on sufficiency concerning investment and consumption of any resources, and. Sufficiency stands for self-regulation concerning defining a state of «enough»
2. Increase efficiency in the use of resources. Efficiency means the best return on investment ratio with maximation of return and minimation of investment,
3. Provide systemic resilience, which means resistance agains impact or disturbance of the system for systemic and self preservation as ability to regenerate.

The described principles should be considered for the design in transport, when it comes to:

- The design of services: decisions for modes and related services, frequencies, licences and concessions or operators in public transport,
- The design of infrastructure: planning of streets, lines, access and rules for use or maintanance of infrastructure
- The financial design: setting up price policy, subsidies and fees/taxes, investment and searching for investors should use sustainability principles as guiding lines for decisions,
- The design of demand steering: implementing incentives, barriers or information services and providing support should consider effects in terms of sustainability as described by the principles.

As a consequence guiding principles in decision making should help to **avoid** to create the need for additional mobility demand by creating incentives and barriers dedicated to this goal; thus, rebound-effects can be prevented. Measures should support to **shift** mobility to low emission modes such as active modes and public transport; this includes a critical estimation and monitoring of effects as a shift is not per se leading to more sustainable mobility, e.g. energy consumption in public transport needs to be considered and compared to alternatives as their are many unefficiencies around. Shift is also about shifting energy consumption from fossile to alternative energy sources. Incentives can be set by free or subsidiesed monthly/yearly tickets for public transport or eco-bonuses for biking and walking, to mention only a few options. The **reduction** of the use of energy and a preference for saving technologies and organisation of mobility is another guiding measures, which can be realized by mobility sharing options, such as ride or vehicle sharing or smart mobility solutions, e.g. Mobility as a Service.

- with special focus on commuting following the described principles means:
- avoid rebound and demand driven development of infrastructure and services,
- aiming for time and regional balanced demand by avoiding to build for peak-hours
- set up diverse strategies for increasing speed, frequency and accessibility, aiming for reducing regional disparities with orientation on level of «sufficient mobility»
- provide flexible mobility solutions, especially for less accessible regions and areas
- developing an integrated planning focus on the whole mobility and transport system with consistent strategies for different modes (e.g. restriction for car commuting combined with support of active modes and public transport) towards higher level strategic goals
- develop and implemente efficiency criteria for all modes, including public transport as well.

In order to ensure success of strategies there is a need for measurable indicators developed on the basis of the principles. These indicators facilitate the comparison of different options concerning their effects on different dimensions of sustainability and could be used for monitoring the effects of measures in and after the implementation process.

8.3 Experiences and best-practice for commuting in Europe

Mobility management and sustainable commuting are topics that are not only discussed within Swiss communities but are also addressed around the world. Especially in Northern European countries such as United Kingdom, France, Germany or Denmark, best practice examples can be derived. In this respect, the following chapter envisions to recap the most striking strategies targeting sustainability in commuting. From a systematic keyword-based desk literature and online research innovative approaches across Europe appeared.

An example that received a lot of attention was the implementation of London's congestion charging scheme, which was introduced in February 2003. It is designed in a way that all vehicles entering the defined area, from Monday to Friday, have to pay a specific amount. It encloses the major government, business, shopping and entertainment districts in the city of London. It is not operation during the night from 18:00-07:00 and allows for certain exemptions such as motorbikes, taxis or electric vehicles. The fee is payable either online, by phone, by SMS, at a designated shop or by post. What is special however, and distinguishes itself from other congestion charging schemes at that time, is the way in which the charge is enforced. With a network of almost 200 cameras, the entry and exit points are monitored by taking pictures of the license plate. The data then gets processed, encrypted and sent to the London congestion charge data center, where those that have been market as "not paid", are manually checked (Kaparias and Bell, 2012).

The scheme has been proven to be very successful. Congestion could be reduced by around 30%, which lasted (when taking an upward trend in congestion over decades into account) even into five years after the introduction of the charging scheme. 30% less cars were registered after enforcing the charge, which were substituted by public transport (around 55%), cars avoiding the charging zone (30%) and car users that switched to slow modes, carsharing, taxi or motorcycle (around 15%) (Transport for London, 2008).

The charging scheme of London has been recognized and copied by many international cities and is a good example on how such a system can be successful and accepted by the wider public. Another good practice is the Vélib' Bikesharing system, which has been introduced in Paris in 2007 and has today's highest bike to citizen ratio in the world (1 bike per 97 inhabitants). Its success is given by the 10 year public private partnership between the city of Paris and the advertising firm JCDecaux. It was given the right to install advertisements throughout the city while the revenue from the bikesharing system goes to the city's general budget (Koning, 2014). Since the introduction of the system, the percent of commuters using Vélib has doubled within 5 years, indicating its use for commuting purpose (van Heijningen, 2016).

In Bremen, a city in northern Germany, mobility hubs that bring together transit, cycling, carsharing and taxis to one location were introduced to reduce overall car traffic and relieve the parking situation, strengthening the focus on multimodality as compared to the Paris bikesharing that focused on one system. The so-called "Mobil.Punkt", which can be translated to "mobility point" is located close to a public transport station and are accessible by bike, foot or bus. They provide carsharing and bike parking stations and are operated by the public administration. Local carsharing provider can use this stations if they fulfill certain criteria (e.g. "Blauer Engel" certificate or a minimum number of own carsharing stations). With this attractive, convenient and good communicated transport hubs, the city could effectively foster carsharing and concludes, that almost 35% of the carsharing users replace their car with carsharing, which corresponds to around 4'000 replaced cars (Glotz-Richter and Karbaumer, 2016). As such, the parking situation and congestion could be significantly improved.

The last best practice example focused on slow mobility, especially the use of bicycles for commuting. Since 1970, Copenhagen pursued a pro-bicycle strategy, tailoring road and transport policy to the needs

of cyclists as well as giving cycling a positive image through the media. The newest cycling strategy was adopted in 2012 and foresees a 50% share of bicycle commuters in 2025. Until now, already 45% of the total employed population of Copenhagen cycle to work or education. Several small and large interventions enabled the success of the city and to become a city of cyclists. These include the greening of cycle routes and the incorporation of an iconic elevated super cycle highway, which enhances the experience of cycling and puts the bike user in the centre with clear segregation from cars. The routes are designed to be convenient and safe, also separating the car and bike users by trees or curbs. Furthermore, planning with the public transport providers is necessary; commuters are permitted to bring bicycles on local trains for free encouraging multimodality and increasing convenience (C40 Cities, 2016).

What all of these best practice examples have in common, is that sustainability in commuting or mobility in general does not work by only providing infrastructure. Good public and private partnerships and the effective use of the media to reach the wider public is inevitable. Further focus should be given to address the needs of the target groups. This can be done by providing public events and joint planning of the strategies with the actual mobility users and thus learn about their needs. Lastly, the various transport provider should cooperate and facilitate multimodality (e.g. a holistic and convenient booking system) enabling to easily switch between public transport and slow modes.

8.4 Evaluation of Basel's strategy

In this chapter, we aim to set the derived recommendations on how to achieve sustainability in commuting into the perspective of traffic and regional planners – in this case, the canton of Basel-Stadt. The strategies and planned measures of the canton are contrasted to this best practice catalogue and conclusions on the appropriateness to reach a sustainable commuter environment is drawn. The findings should support the canton in their approach and might reveal gaps that could still be strengthened in face of sustainable commuting.

Numerous strategic documents of the canton Basel-Stadt regarding mobility planning are available. These include:

- Agglomerationsprogramm Basel (2016)
- Verkehrspolitisches Leitbild und Massnahmenplan
- Wirtschaftsfreundliches Mobilitätsmanagement Basel
- Kantonaler Richtplan
- Gesamtverkehrsmodell Region Basel (GVM)

Considering these various reports and papers, this section evaluates the planned and proposed measures of the canton by comparing them to the recommendations derived in chapter 8.2. Further insights are given by comparing the strategy of Basel with experiences by other cities, which had to cooperate with new mobility technologies.

One of the main recommendations derived from our studies is to respond to the increasing need for flexible, part-time work, fostering work-life balance (see chapter 8.2. This asks for more individual and flexible mobility offers enabling to combine sideline-task such as childcare and education with commuting. This would further require supporting tele-working and thereby decreasing negative impacts of rush hour commuting. The "Verkehrspolitische Leitbild" of the canton Basel-Stadt discussed to reduce rush hour commuting by having more flexible working hours but did not propose any specific measures and examples. Nonetheless, they state to strongly cooperate with representatives from business such as the Handelskammer beider Basel. The Handelskammer beider Basel released the mobility management program, in which they go into more depths on how to implement and use mobility management in companies or administrations. They thus recommend using more homeoffice or tele-working and therefore comply with our guiding principles. Specifically, IT infrastructure and software

must be available to those wanting to make use to work at home, yet they also warn to not neglect social interactions and thus propose to have a certain limit of home-office days. However, less is known about the use and success of the mobility management program, as an evaluation of the program hasn't been conducted so far.

Good examples and focus on sustainable transport modes are given in the "Verkehrspolitische Leitbild" of the canton Basel-Stadt. They emphasize to use active mobility (e.g. walking, cycling) as it has the least environmental and land-use impact. Yet, it is also made clear that the personal car could still be the most sustainable way of travelling in rural regions, especially if capacity is fully used. Here, PT comprising of a low stocked diesel bus may be less sustainable. It is planned to increase the safety of pedestrians and the ease-of use for cyclist by creating more parking areas and allowing to turn right during red lights. Furthermore, the concept of a main cycle route within the agglomeration focusing on commuting by e-bikes is developed. Such developments are important, as experience in other cities such as Zurich has shown, that the technologies will come regardless of the actual readiness of the city. An example is the case of O-bike, a free-floating bikesharing system from Singapore. The operators distributed 900 bikes within the city but faced many oppositions and difficulties, as the city was not ready and communication was neglected. Furthermore, the quality and service frequency of these bikes were criticized as well. The critics were so strong that O-bike went insolvent this year (Petrò, 2018). By enhancing the facilities for active mobility modes, creating a secure space for cyclists and increasing bicycle parking places, the canton Basel-Stadt paves the way for innovative mobility technologies, which will come eventually.

Another important aspect is the efficient use of existing infrastructure. The "Kantonaler Richtplan" recommends to construct new infrastructure only if necessary and if jointly planned with land use and traffic administrations. Similarly, the "Verkerhspolitische Leitbild" of the canton Basel-Stadt gives importance on the efficient and effective use of the existing infrastructure, mentioning the use of sharing systems as well as new work-time models to decrease the capacity shortages during rush hours mentioned in the beginning of this chapter. Yet it is not clear, how exactly the canton plans to effectively use the existing infrastructure. Here, further solutions regarding the flattening of peak-hours and reclaiming infrastructure during defined time periods would be advisable. This could include for instance, reclaiming parking lots and streets for pedestrians during low use levels, creating a more attractive and save environment for slow modes and citizens.

The set goal of reducing 10% car-based traffic between the timeframe of 2010-2020 will not be reached, as stated in the "Verkehrspolitische Leitbild" (Bau- und Verkehrsdepartement des Kantons Basel-Stadt, 2015). Thus new ideas and concepts, besides the mentioned mobility pricing, could help to achieve this goal in the future. Such ideas could comprise of mobility as a service solutions, effectively combining the various travel modes also offering shared trips to and from rural regions, decreasing the need for a personal car.

To conclude, on the strategic level the canton has a strong focus on making active mobility more attractive, good parking management, increasing cooperation beyond cantonal borders and tries to implement mobility management. What is missing however is the integration of new mobility services such as carsharing, ridesharing or mobility as a service to provide more flexible PT and to better connect rural areas with the city center. As people in less connected areas do have a low satisfaction with their commute, such mobility management offers, could generate a shift from the private car to more PT and sharing usage. Furthermore, stronger efforts to go into the diverse needs and characteristics of transport users could enhance the acceptance and use of the proposed measures. This could include, for instance, the specific targeting of young commuters, as they tend to be more open towards new mobility services, allowing to increase adoption and therefore spread the awareness to the general population. The attractiveness of PT could be further increased by reducing the perceived costs, as our study showed that cheaper tickets would motivate the commuters most to use more PT(Hoerler et al., 2018). Generally, we would motivate to focus more on measures and collaborations that foster the actual implementation of sustainability measures and mobility management.

8.5 Starting points for supporting sustainable commuting

The Smart-Commuting project has collected and evaluated numerous empirical data in the three case study areas of Basel-Stadt, Growth Corridor Finland and Korneuburg. On this basis, recommendations for mobility strategies for growth regions can be made as to how commuter mobility could be handled in a more sustainable way. Commuter flows are constantly increasing in the urban regions of Europe. The results are traffic jams at peak times, overloaded public transport (PT) systems and rising costs. At the same time, lifestyles and working methods are becoming more dynamic and versatile. Classic offices could be replaced by mobile or home-office workplaces; flexible working time models and part-time work are increasing. Mobility strategies must be adapted to this development. Technological developments and new business models in particular can contribute to a better-organized, environmental friendly mobility. The study focused in particular on new digital service concepts such as Mobility-as-a-Service (MaaS), which combine the planning, booking and payment of mobility in one system. The potential of such systems for a shift from individual auto mobility to more sustainable modes of transport, such as public or active transport, was investigated. Regions and policy makers must create the necessary and appropriate framework conditions to enable such systems and to develop their respective potential. In order to do so, commuters needs and frame conditions have be understood. Thus, strategy recommendations for commuter regions, especially for administrations and legislators, are elaborated below – based on a summary of project results.

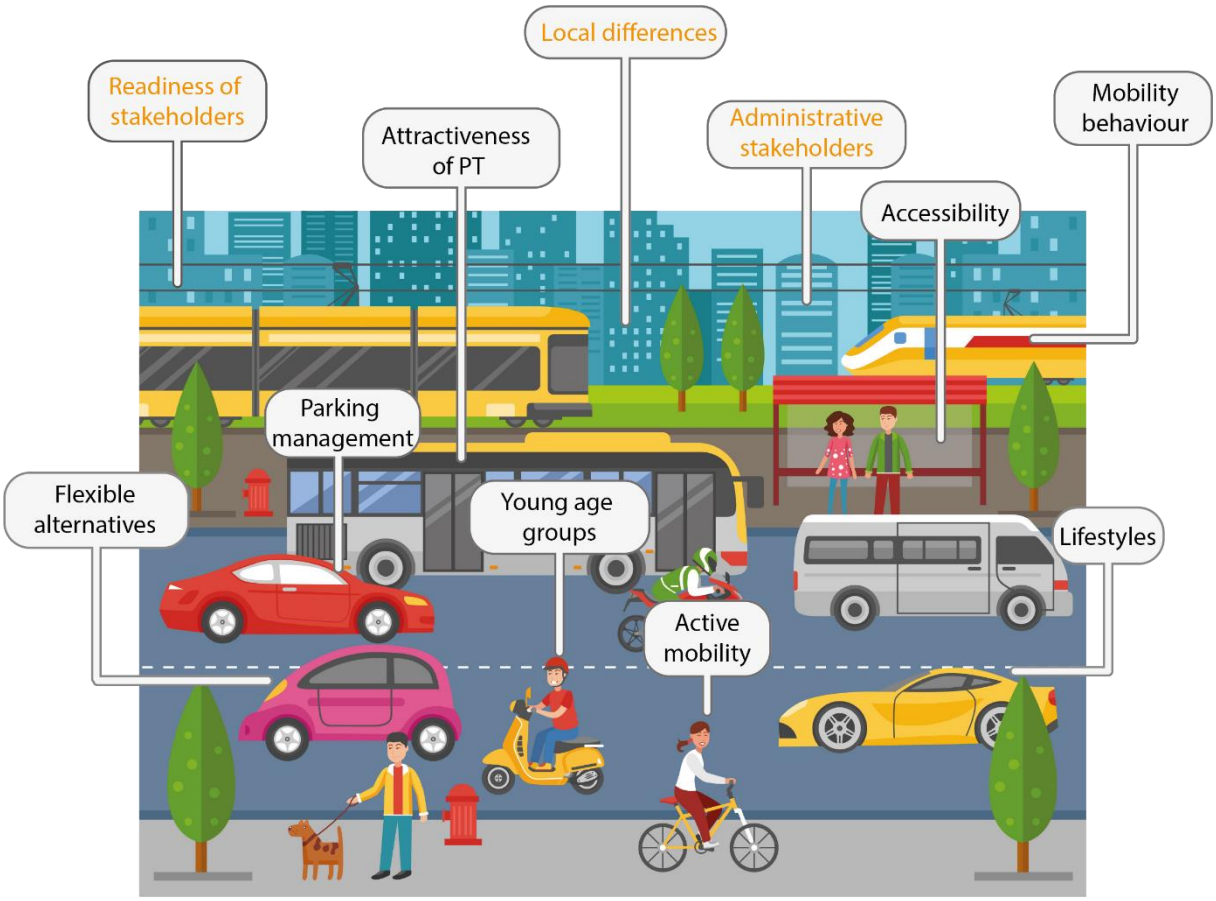

Figure 100: Overview of starting points towards sustainable commuting, adapted from Lesinski (2016). Orange: Stakeholder level, black: commuter level.

8.5.1 Commuter focused strategies

Digging into the details of commuting behaviour and underlying reasons revealed a number of starting points for measures in order to push and pull for more sustainable commuting. The data show the motivation for different mode choice reflecting the importance of certain qualities in transport as well as a variety of needs and differences between users – but also how similar some modes are characterized from an individual point of view, which is more (car and bike in terms of flexibility) or less (bike and walking) surprising. This points to the fact how important a combination of different measures is in order to meet the needs of different users groups, which have been characterized in this project.

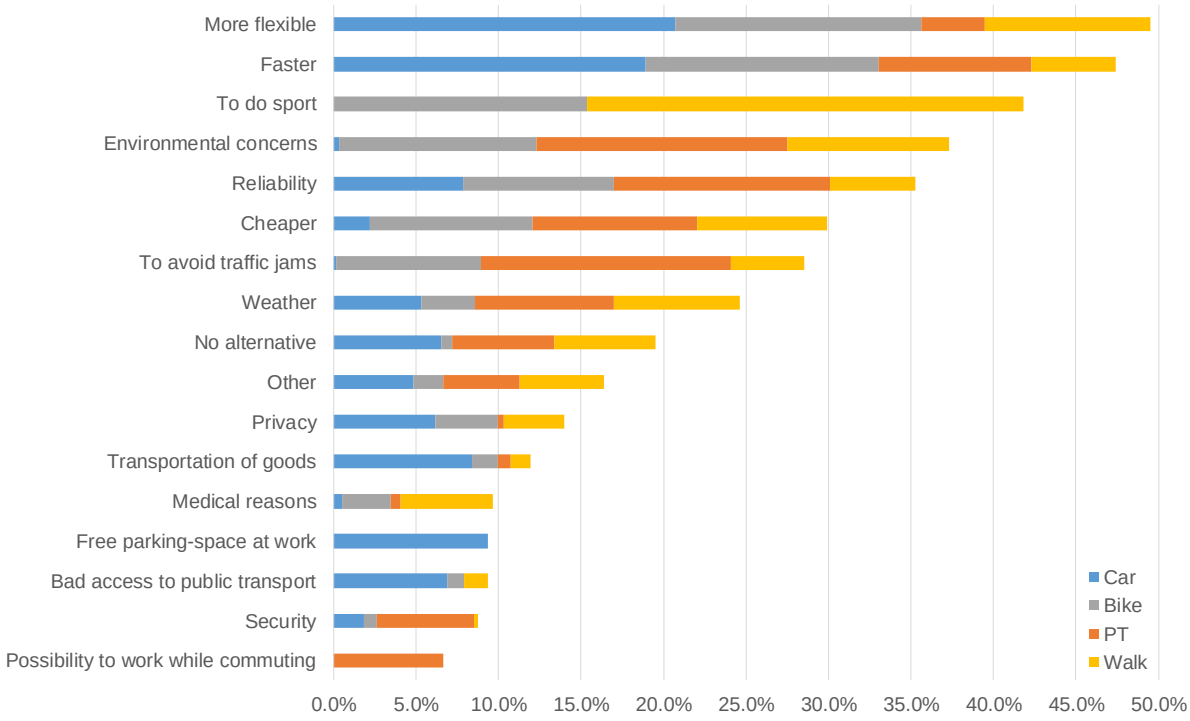

Figure 101: Reasons for the use of respective transport mode for commuting to Basel - daily, often, sometimes as percentage of the total of all answers (N=550, multiple answers were possible), 2016; data: ZHAW.

Trends in lifestyles and work-life

Employment and work arrangements strongly influence the need for commuting trips in terms of distance and frequency. Few years ago, full-time work was the general rule (Bundesamt für Statistik, 2017). Today, part time employment with additional sideline tasks (family, education) is getting more and more important and therefore increases the need for more dynamic and individual mobility solutions. The trend to a more dynamic and individual work-life balance can be underlined by our data for Basel. Around 62.5% of respondents do have a full time job, whereas around one third stated that they are doing a part-time job. This trend should be taken into account by coordinating mobility strategies with employment strategies and by creating incentives for companies to promote part-time and flexible work. This not only meets the demand of employees regarding their type of employment, but could also reduce their need for rush hour travel.

Around one fifth of the surveyed employees stated that they also perform teleworking from home, and 6% stated that they work during their commuting trip. These numbers show that even if the classical form of working at main workplace is still dominant, there is a noteworthy share of people used to work non-place dependent and there is still potential to allow more people to do so as this allows for better work-life balance. Teleworking can help to reduce commuting travels and should therefore be taken into account within mobility strategies. By creating incentives for employers and employees (e.g. financial support for infrastructure at home), home-office can specifically be promoted. Mobility management of companies is a promising field for going that direction.

Addressing mobility behaviour

When comparing commuting distance with commuting time it became apparent, that the data spread regarding the distance is far bigger. When planning commuting trips people consider their investment of time. Therefore, faster commuting modes tend to increase the mean commuting distance while not lowering the mean commuting time. As our analysis showed, a high commuter distance is associated with a lower probability of enjoying the journey. Thus, especially for long distance travel faster services should be established with care, as these faster connections also increase the number of commuters for whom this connection is considered attractive. At the level of spatial planning affordable housing near work centres or a stronger mix of industrial, commercial and residential housing could contribute.

Reasons for commuting during peak hours

Due to high infrastructure investments, cost and low efficiency peak hour traveling is one of the main issues in commuting. Therefore, it is necessary to identify the reasons, why people actually commute during peak hours and according to that, this aspect was also included in the survey. By far the most chosen answer of people commuting during peak hours was “requirement of job” with 72%. In addition, important factors are “childcare” (18.2%), “company culture” (21.6%) and “habit reasons” (18.7%), while “better connectivity/timetable” was less mentioned as a reason (9.8%). This leads to two promising areas were participatory processes in commuting could be located: Within companies (see “mobility management in companies” projects) and by improving childcare in close distance to the living area of employees. Company culture and habits point to the fact that a cultural shift is necessary – around one fifth of commuters seem to be driven by “business as usual” either on their own side or on the companies’ side or both.

Promoting active mobility

Considering reasons of why respondents use the bicycle for commuting or walk, it becomes clear that the factor “sport” is on top of the list for both. Nonetheless, the reason “faster” is also a very strong incentive for using bicycles, as are the “flexibility” aspect and because it’s “cheaper”. Interestingly, flexibility and fast travel are also mentioned as main reasons to commute by car. This might be explained by the fact, that both bike and car provide similar benefits – differing by the commuting distance they are appropriate for. In addition, the findings of the regression analysis show that it is more likely for commuters using active modes to enjoy their travelling than users with no predominant mode of travel.

Of the surveyed commuters in Basel, 95% have at least one bicycle in their household. Therefore, reasons why bicycles are rarely used for commuting are not due to missing vehicle access, but for other factors. A clear strategy for improving bicycle is therefore needed. This comprises for example improving the infrastructure for active mobility, communicating and promoting the sport and health aspect while considering the fact, that active mobility commuter enjoy their commute more than commuters using other forms of transport.

Another strategic focus of future-oriented mobility strategies could be electric bikes or E-Bikes. Around one fifth of the surveyed households in Basel possess one or more E-Bikes, and a bit under one fifth of the respondents use an E-Bike on a regular basis for their commute. This may indicate that E-bikes are specifically used for commuting activities. Supporting E-bikes by promoting events, creating (financial) incentives, special parking spaces for E-bikes and power sockets, can further push an promote this technological trend, which can be considered as being more sustainable compared to the private car. This is only true, if E-bikes do not replace conventional bikes. Thus, promoting measures would have to address car-drivers as a target group.

Ensuring accessibility in rural areas

An analysis on regional differences of the mean satisfaction with the current commuting mode was performed in Basel. A “satisfaction index” was created by calculating the mean values of all satisfaction items queried in the survey (for single items see 4.2.1.6). This overall satisfaction index was then calculated for every municipality in the Basel area. It became apparent that the satisfaction is higher

within the larger municipalities, generally fitted with better mobility services. While this insight for itself is not surprising, it highlights a big issue that during the next years, the biggest growth in terms of jobs and citizens will most likely occur in the surroundings of the larger areas (see Haerri et al., 2018a). The issue of low satisfaction with the commuting situation is therefore likely to get even worse if no countermeasures are taken. Future mobility strategies should focus on the development of new mobility services for outskirts and rural areas. This could be achieved by improving the access to the PT network and by promoting less traditional forms of transport like call-a-ride, ride-sharing, carpooling, MaaS and so on providing more flexibility and accessibility.

Promoting flexible and user-oriented alternatives

Car users appreciate the high flexibility by car considering this mode as faster. More than a third of all respondents also stated that they needed the car to transport goods, which is an aspect that new mobility systems like MaaS or new sharing systems can easily offer, especially by combining different and more sustainable modes of transport. For new commuting strategies and solutions it is necessary to design user oriented services addressing the commuters' characteristics, specific needs and possibility to manage their travel in accordance with daily activities. As the results show, commuting itineraries are often combined with other activities. Apart from purchasing, "social activities", "leisure" or "sports" are often combined with commuting.

Another aspect in the context of flexibility is information about services. In our survey, 40% of commuters in Basel stated that they consult the internet for timetables or route information on a regular base plus another 27% who do it sometimes. This shows that users are open to regular advice on their best travel alternative via their mobile phone or the Internet, which is a promising prerequisite for the use of MaaS. Legislators and policy makers should therefore create conditions for the establishment of such user-oriented and tailor-made mobility solutions. This can be the opening of booking systems or promoting market entries for new companies and start-ups.

Effective parking strategy

One, often mentioned aspect why people use the private car was the factor "free parking-space at work", reflecting the strong effect of such incentives. Mobility management in companies and policy makers should address this by prohibiting both free and cheap parking spaces in towns and at work. Parking management should be undertaken wherever possible. This is especially the case when new buildings are planned or when companies are relocating or expanding. Combining the zero-incentive parking strategy with support of use of actives modes and public transport eases the shift of commuters to more sustainable modes.

Increasing the attractiveness of public transport

PT users in Basel consider their mode of transport more often as a cheaper alternative compared to other modes of commuting. In addition, respondents liked the "reliability" and the possibility "to avoid traffic jams". The factor "weather" is also quite popular among the respondents. In addition, the factor "faster" seems to have a positive impact on the attractiveness of PT as well as the "possibility to work during commuting", which is still a relevant reason for some users. The survey also comprised a question about factors that would motivate participants to use more PT. On top of the list is the item "cheaper tickets". These results show, which factors users' value in PT and thus where the focus should be placed on when planning an increase of attractiveness of PT. Employers can also be involved in these measures, especially regarding ticket costs. In Switzerland, many companies already support their employees by reimbursing tickets.

Addressing young age groups

The higher use of the car among older groups in the Basel survey corresponds to a trend, which can also be observed within other studies. Young people showed a decreasing interest in automotive mobility and driving licences. However, it may be that a peak in this development is reached. Within the last Swiss micro census (2015), it became apparent that the reduction of driving licences among young people stopped. In the Basel commuter survey, similar effects can be seen. However, it should be tried to build upon this trend, especially as young people seem to be more interested in mobility alternatives: Regarding the openness towards mobility alternatives, the group with the highest openness is the youngest. The analysis suggests that age is significantly attributed to higher openness to car-

/ridesharing. As car- or ridesharing is still not widely accepted nor used, there is a need for awareness rising. Policies or information campaigns should especially target young people, which are open for sharing systems.

8.5.2 Stakeholder focused strategies

Administrative stakeholders

As revealed by the network analysis and the stakeholder survey, actors belonging to the category 'Administration' often have a pivotal function in collaboration networks and can be considered as influential due to their many ties to other stakeholders. Hence, their views and actions are relevant for the future development of the commuting system. However, the online survey revealed that the stakeholders of this category partially show a lower enthusiasm for innovations. While this may be understandable when it comes to innovations that are questionable regarding environmental sustainability, such as privately owned autonomous vehicles, their lower enthusiasm for congestion charges surprises. This is an issue, as this stakeholder category is crucial to push changes in this field forwards. Even stakeholders of the category 'industry' (private, non-transportation companies) were more in favour towards congestion charges. Although they did not show disapproval, 'Administration' was also somewhat averagely enthusiastic towards MaaS and car-sharing systems. Creating awareness and support in this field is one starting point in creating successful measures and form conditions for better mobility services. The general conservative attitude of actors from administration would need to be discussed openly. Due to their function, they have the capability to serve as enabler for the implementation of sustainable commuting solutions. If this contrasts with their own role perception awareness about their opportunities and responsibility for shaping the future mobility system would need to be created.

Use the readiness of stakeholders to contribute

Another starting point is the current readiness of stakeholders to contribute actively to innovation implementations such as MaaS. To support the development towards more sustainable commuting among all stakeholders, additional participatory processes need to be actively promoted. A challenge, however, is the lack of willingness to finance and to invest in this field. Therefore, special consideration should be given to this subject, e.g. through public-private-partnerships. One promising starting point for implementing new mobility solutions is the general openness towards innovations and new mobility trends of the (also very influential) stakeholders in the category 'transport company'. Even if some stakeholders report challenges in collaboration with public incumbents, their enthusiasm to implement new systems and solutions is a great stepping stone for inducing changes in the current transportation market and making com-muting more sustainable and user-friendly.

Respecting local differences and circumstances

One striking observation was the difference in the structures of stakeholder networks in the three case regions in Switzerland, Austria and Finland. The response and completion rate was profoundly different between the three case areas. Even within the case area Basel, the types and numbers of participating stakeholders are very diverse depending on their country of origin (CH, F, DE). While more people are commuting daily from France to Basel than from Germany to Basel, the number of identified France-based stakeholder is much lower than the number of German stakeholders. This observation may indicate that there persist cultural differences in stakeholder collaboration between countries and regions. Thus, when mobility planning needs to be done trans-regional like in Basel, this aspect needs particular attention.

8.6 Differences in energy saving and CO_2 reduction potential for commuter groups – a qualitative assessment

While this report mainly addressed managerial strategies and best practice in sustainable commuting, it is of high interest, what impact such measures would have on the environment. In line with the Swiss energy strategy 2050, hypothesized outcomes of sustainability measures are estimated concerning their energy/CO_2 reduction potential. Energy efficiency and use are directly connected to CO_2 emissions, especially in transport where most cars still run on burning gasoline that leads to the creation of CO_2. A main driver in energy efficiency could therefore be a reduction of mobility demand and the change from private car usage to PT as less energy per person is necessary for the transport from A to B (due to low fossil energy carriers used in the electricity mix of Switzerland (BFE, 2017)). Here, it is important to note, that energy efficiency alone does not solve the problem addressed by the energy strategy, as rebound effects mostly diminish the efficiency gains. The following section thus focuses on assessing the CO_2 reduction potential, which can be derived though various measures.

For this qualitative assessment, four main mobility-related attributes of the four identified commuter groups derived in chapter 4.2.2 are investigated. First, the share of car commuting allows guessing the energy/CO_2 reduction potential for a complete shift from private motorized transport (PMT) commuting to PT commuting. Second, the potential of the combination of commuting with shopping and week-day leisure trips so to minimize the need for additional car-trips was assessed. Here, data from the Basel commuter survey gave insights into the extent of how much percent of the groups do already combine shopping and leisure activities with commuting “Often”. Similarly, measures that would decrease workplace visits are discussed and the different trip lengths of the commuter groups assessed. This chapter thus allows insights into the energy saving and CO_2 reduction potential of various measures in a qualitative framework.

The survey participants were asked to state how often they combine commuting with these other activities in answer categories of “Never”, “Rarely”, “Sometimes”, “Often” and “Every workday”. As such, those commuters that combine commuting with shopping or leisure less than “Often” were given a theoretical energy/CO_2 reduction potential by assuming that they would increase their combination of commuting with these activities to “Often”. With an increased combination of commuting with shopping or leisure activities, separate trips for the same purpose can be reduced. According to BFS and ARE (2017), the average distance driven for a shopping or leisure activity corresponds to 4.8km and 10.4km, respectively. Similarly, 50% of shopping and sports/leisure trips during the week were assumed to be covered by the private car, which lies in the range reported by BFS and ARE (2017). An overall qualitative estimate can thus be made for each commuter group with the help of the characteristics listed in Table 20.

Table 20: Characteristics of commuter groups.

Commuter group	% Car commuting	Often combining commuting with other activities*		Trip lengths (one way) in km	Workplace visits per week
		Shopping	Leisure		
Active urban couple	10	42%	20%	7.3	4.10
Single urban PT opportunist	13	60%	23%	37.7	4.23
Semi-urban multimodal family	28	16%	3%	20.1	4.22
Well-of rural couple	35	43%	22%	24.0	4.39

* Combination of commuting with shopping & leisure activities, percent of commuters with answers of at least “Often”.

Out of the four commuter groups, the well-off rural couple shows the highest potential in energy/CO_2 reduction. They tend to rely more on the private car as they live in a rural environment, and therefore show the highest share of car commuting and have the highest number of workplace visits per week. Here, the increasing trend of teleconferences or homeoffice-work could decrease number of car trips –

and as such – energy usage and CO_2 emissions. Their trip lengths and combination of commuting with shopping/leisure activities are found to be average. As this group mainly lives in rural regions where connection to PT is sparse, it will be difficult to motivate them to change to PT for commuting. In order to support a shift away from the private car, better connection services are needed. As such extensions of public services based on traditional public transport (e.g. rail) would require infrastructure and rolling stock investments, increasing energy use and CO_2 emissions (and high financial investment) would be the consequence. To further support a switch from the private car to PT in commuting, with energy and CO_2 emission reduction, MaaS with an increased use of carsharing and carpooling could be a solution. Especially regarding the well-off rural couple, reducing vehicle kilometers without a loss of comfort is possible.

The semi-urban multimodal family and the single urban PT opportunist are similar in their energy and CO_2 reduction potential, as the higher share of car commuting of the semi-urban multimodal family is compensated by shorter trip length. Yet, an increased combination of commuting with shopping and leisure activities would lead to higher CO_2 reductions for the semi-urban multimodal family as they combine these activities far less than the other groups. Here, the provision of leisure offers close to the main workplace areas that are targeted to families could increase this combination.

The last group, the active urban couple, has the lowest share of car commuters, trip lengths and workplace visits per year. Hence, the energy and CO_2 reduction potential of a shift from PMT to PT is low compared to the other groups. However, the combination of commuting with additional activities could still lead to a reduction of energy and CO_2 emissions of the active urban couple.

Generally, the energy and CO_2 reduction potential of a shift from PMT to PT will be higher than minimizing the car trips for shopping and leisure activities as commuting distances are generally much longer (average of 22km one way compared to 4.8km and 10.4km for shopping and leisure, respectively). Yet, such a shift is very ambitioned and does not take into account hurdles like accessibility, travel time, comfort and low enjoyment of PT. The analysis of the Smart Commuting project found out that especially comfort and enjoyment of travel were rated significantly lower for PT compared to PMT (see chapter 4.3.1.6), highlighting the difficulties and starting points when designing policy strategies aiming to achieve the shift to more sustainable modes of transport. Contrary, the argumentation to combine commuting with other activities might face less barriers as it could also save time and costs.

In sum, policy measures aiming at reducing car-based energy use and CO_2 emissions of the canton Basel-Stadt should be tailored to the high reduction potential of the well-off rural couple commuters and provide easy-to-use, accessible mobility services for families as well as for active urban commuters that want to connect shopping and leisure activities with commuting to work.

Leisure mobility is responsible for 44% of the average daily distance driven and almost double than that of commuting (24%) (BFS, 2017d). Furthermore, airborne mobility demand is rising strongly (BFS and ARE, 2017). It is thus also important to address these fields in policy. While this study only assessed the energy use and CO_2 emissions, other negative impacts are associated with car-use (e.g. noise, health) and need to be taken into account in the debate on reducing car use.

8.7 Summary and outlook

Smart and sustainable commuting requires to consider strategies on the commuter and stakeholder level. Especially administrative stakeholders should include sustainable commuting in their agenda as they have a role model function, a strong network as well as power to push implementation of innovation for sustainability into practice. Through collaborations with transport companies, which are generally open towards new and innovative mobility services, sustainability in commuting can be addressed and spread to the wider public. Here, measures that focus on the different needs of commuters have a higher adoption potential. High effort should be given to lead commuting away from the private car, offering

convenient and save slow mode routes and ensuring good connectivity to rural regions by public transport. Flexible working hours and co-working spaces with less need for long travel can foster this transition by reducing peak-hour commuting and thus enhance the satisfaction with public transport.

Concerning the case of Basel-Stadt it has to be stated that the percentage of car commuters is already the lowest among all cantons (BFS, 2017e). Still, capacity shortages are rising due to the trend of increasing commuter distances and population growth. Actions are taken to secure a safe, efficient, low emission and accessible transport system in the future, which is also addressed on the strategic level. The canton has a focus on mobility services, expanding existing railways systems, increasing highway capacities while decreasing car-mobility in the city. Due to its proximity to Germany and France, actions are planned to support communication beyond the cantonal borders and to better manage the different PT systems. Despite structural efforts, attention is given to parking management and an attractive pedestrian and cycling environment. While these measure should invoke a shift from the private car to more slow mode and PT use, behavioural aspects such as acceptability, openness and differing needs are crucial and so far less considered.

We thus propose to increase the cooperation of canton with the private and public sector regarding mobility management and participation. Fostering mobility as service, enabling accessible and sustainable transport modes in rural regions, while at the same time promote flexible working-hours. Furthermore, we encourage to incorporate a strategy on how to evaluate the divers transport-related projects regarding their effect on the whole sustainability perspective, especially in the ongoing mobility management measures.

Concerning potential effect of measures on energy use and CO_2 reduction the estimated potential is highest for the well-of rural couple, followed by the semi-urban multimodal family and single urban PT opportunist. We see a low potential in CO_2 reduction for the active urban couple as they show a low usage of the personal car in commuting and short commuting distance. Still, effects on commuting would need to be supplemented by addressing leisure mobility and air-mobility as important drivers of CO_2 emissions from transport. Despite the smaller CO_2 emissions in commuting as compared to leisure and air travel, it is important to address it. Changes in mobility behaviour of working trips allow to get used to other transport modes and ways to travel. After investing in monthly or yearly tickets for public transport, a bike or E-bike, these alternatives not only appear more familiar, but also cheaper compared to the car on daily mobility decisions – for non-work-related activities. This might create halo effects on leisure mobility etc.

Nonetheless, sustainability includes not only the environmental aspects but also economical and societal. Therefore, the planned measures of the canton are highly relevant and essential in fostering the satisfaction of its citizens and economic stability but when it comes to the not less important discussion of climate change, the efforts in decreasing CO_2 emissions would need to be intensified.

Commuting behaviour and related traffic issues are symptoms of societies working and living world. Mobility bears the burden of the modern working world with people trying to manage different requirements of their daily life. Recent changes of the economy and the working world as well as upcoming new technologies would allow for more flexibility of work concerning place and time as well as for more quality of life due to time savings by replacing physical through digital mobility. Focusing on mobility issues actually tries to cure a disease by addressing the symptoms. In order to go for underlying reasons for steadily increasing mobility in commuting and elsewhere linking life and work in a better way is necessary. Mobility issues could contribute to this by showing alternatives for the trips still unavoidable. As such, the planning of urban spaces and mobility should go hand in hand, as mobility is altered though the built environment and mobility itself influences the attractiveness of cities and thus also influences mobility behaviour. By increasing the attractiveness of the local environment, such as greening of streets, widening pedestrian and cycling lanes and decreasing car velocity people could be incentivised to commute more by foot or bicycle.

In addition to strategies mainly for stakeholders in policy or administration companies play a key role when it comes to commuter mobility. Working hours, mobility situation and working location are mainly defined by the employer. Mobility management in companies can contribute to improve the situation for both, commuters as well as the mobility system in terms of reducing overload in peak hours. Thus,

conclusions from the analysis as described in the previous chapters were drawn with focus on mobility management and combined with expert opinion to give recommendations for mobility management as described in the following chapter.

9 Guidelines for mobility management in companies[113]

In order to change commuting situation towards sustainable mobility making use of new mobility solutions and services such as Mobility as a Service mobility management for companies could be one tool for implementation. Both programs provided by cantonal and cities administrations as well as consulting companies focused on supporting mobility management exist. Up to now, few companies made use of this options and established mobility management within their organisation. Thus, based on in-depth interviews motivations, challenges and best practice related to this topic were analysed – in order to give recommendations on how to push mobility management as an effective tool for sustainable mobility in commuting.

9.1 Research questions and methodology

In a first step frame conditions influencing future commuter mobility were identified and analysed. In the following steps, attempts were made to put this knowledge into practice. Based on our case study Basel, Switzerland, concepts and policies for commuting of the city of Basel were analysed. The city of Basel addresses mobility management in companies as a part of their general mobility strategy. Corporate mobility management can influence commuting mobility behaviour of employees through their employer and at the same time address current sustainability issues. Our goal was to assess best practice experience in mobility management projects and to discuss typical issues. According to the research questions, attempts were made to gain a better understanding of how mobility management works and how the current issues are approached.

Following research questions were examined in the study as described in this report:

- What is mobility management in companies and what characterizes typical mobility management projects?
- What are the current issues when performing mobility management in companies?
- What are solutions for those issues (best practice)?

Five in-depth expert interviews (with six experts in total) were conducted in order to answer these research questions.

- Interview 1: Representative of a **public-transport company**
- Interview 2: Representative of an **active-mobility lobby group**
- Interview 3 and 4: Representative of **consulting firm for mobility management**
- Interview 5: Representative of a **car-pooling implementation project within a private company**

All experts are active in the field of mobility management in companies, except for interviewee 1. He is responsible for a new mobility services and not directly involved in mobility management. However, this

[113] Härri, F., Hörler, R. and Hoppe, M., 2018. Smart and Mobile Work in Growth Regions. Deliverable 6.2: Guidelines for mobility management in companies.

new mobility services has a clear focus on commuter mobility and could therefore be used for mobility management.

The interviews were analysed according to following schema:

A) the usual processes and steps of a mobility management project were highlighted (chapter 9.2.2) together with the motivation leading to such a project (chapter 9.2.1)

B) experienced difficulties of the experts were identified (chapter 9.2.3),

C) possible approaches to solutions were derived from the experts' point of view, and

D) based on these findings, areas of activities were identified and a catalogue of recommendations created (chapter 9.3). Due to the explicit request of the experts, the statements in this report are presented anonymously.

9.2 Mobility management in companies

In the discussion with experts on mobility management, some areas appeared as crucial for successful implementation of such programs. First, motivation is essential. As mobility management is neither a must nor part of the core business in companies, there is a need for strong commitment to successfully implement such programs, create acceptance of employees and to continue in the long term. It turned out that the way of how mobility management is forced makes a huge difference; there are characteristics of successful processes in planning and implementation of such programs, as well as success factors contributing to acceptance and support especially from management side. We discussed these issues as well as how to deal with inevitable challenges within this implementation with experts and derived the following key aspects for mobility management in companies.

9.2.1 Motivation

A critical aspect in mobility management is the (lacking) motivation of companies for implementation, as cost-benefit ration often is not obvious. Getting an idea about potential motivating factors based on the experience of experts within this field was the goal of the part of the interviews dedicated to this topic. In Switzerland mobility management is forced by the Swiss Federal Office of Energy (SFOE), which has launched the "SwissEnergy for Communities" programme as part of its Energy Strategy 2050. The strategy contains measures leading away from large-scale technological energy generation towards decentralized, optimally networked structures strengthening the position of cities and municipalities and their municipal or regional supply companies. Keywords mentioned in this context are Smart Grid, Smart Mobility, Smart Home and Smart Cities. Networked and interconnected solutions are seen indispensable for a sustainable energy future: The scope of action of cities and municipalities is therefore becoming just as important as the over-regional or national view of energy, climate and transport policy. The Energy City Programme is also part of many cantonal energy policies (Trägerverein Energiestadt, 2016). The program "Mobility Management in Companies" is embedded within these strategies. With it, SwissEnergy supports companies and public authorities in the implementation of mobility measures and in the introduction of comprehensive mobility management. With mobility management, companies and communities should benefit from reduced costs for operational mobility by optimizing parking spaces and vehicle management. Also increased efficiency in business travel and internal company transport, optimised and fair expense regulations are goals of this program. Also, as SwissEnergy points out, mobility management should help companies to gain an image as a modern employer and business partner responsible towards the environment and employees (EnergieSchweiz für Gemeinden, 2018).

According to SwissEnergy, the program offers companies and communities a wide range of support. Companies benefit of free input advice from independent mobility experts and receive financial contributions for an in-depth analysis of the companies' mobility situation. The program also offers an exchange platform in order to provide access to services, instruments and implementation examples. Companies and administrations that wish to improve their company-internal mobility with a conceptual approach and have at least 50 employees can request support from this program.

The following advantages of the Mobility Management in companies program are highlighted (EnergieSchweiz für Gemeinden, 2014).

- *reduced mobility costs*
- *a more efficient use of company vehicles and parking spaces*
- *better coordination*
- *and cooperation with the municipality*
- *better accessibility*
- *satisfied and healthy employees (less illness, fewer accidents)*
- *a better image*
- *more active cooperation with the companies and the generation of synergies*
- *efficient use of the traffic infrastructure*
- *a higher attractiveness of the location*
- *a better quality of live and living*
- *a new mobility culture (also for leisure mobility)*
- *high credibility thanks to mobility measures in municipal companies and the opportunity to address topics such as "energy city" and "sustainability"*

In order to create impact with these kind of programs motivation of companies to participate is a precondition. Thus, understanding which kind of benefits and motivational aspects could help were analysed within the expert interviews. Mobility experts were asked about motivation and goals behind mobility management. As motivations for performing mobility management in organizations following aspects were mentioned:

"And that's also what we did with that project then you have to use a new mindset and so on. -– Interview 1, 2017

Interviewee 1, a representative of a public-transport company, stated, that the company "has to become more dynamic, more corporate, let's say like a shareholder cooperation" (Interview 1, 2017), due to the ongoing change within the mobility market. According to the interviewee, during the last 40 to 50 years, nothing substantial changed within the mobility market. Now some shifts between the different transport modes can be observed, multimodality becomes more and more important. He compares this evolution with the effect of the introduction of the mobile phone, which he sees as quite dramatic. Today, 92% of normal PT-tickets are sold through machines (phones and vending machines). Around 10 years ago, according to the interviewee, this amount was only a fraction. This offers the possibility for new market players. Everybody wants to become a "mobility integrator and mobility service provider" (Interview 1, 2017). He mentions companies like "Google" and "Uber". According to his points of view, the focal point of many players in this area will switch away from specific assets (timetable, trains, buses etc.) towards the organization of the interface to these assets. He mentions the example of the internet platform "booking.com" which arranges hotel bookings but does not offer or maintain own hotel facilities. He thinks that what "booking.com" is doing for the hotel industry, can also be done for mobility and that much business potential lies in this area. He thinks that the term "Mobility-as-a-service (MaaS)" sums up the development towards this trend. He draws a future where people do not buy services related to specific mode of transports like train or bus tickets, but where they just order journeys from place A to place B. A service provider then organizes the journey according to the needs of the

"Disruptive things are ahead of us" – Interview 1, 2017

"Which means the game is not about assets anymore but it's about organizing the interface to these assets" – Interview 1, 2017

"What do you need really? What the costumers need is mobility, you know". – Interview 1, 2017

customer. This fundamental paradigm shift offers also the possibility to bring the environmental issues more to focus, according to him. These systems could e.g. promote the ongoing trend of sharing economy and reduce car ownership. According to the interviewee, it all comes down to the mobility demand of the customer. In his opinion, this requires a paradigm change within its company, including a change in thinking and acting on management level. In the words of the interviewee: “And that’s kind of […] what we are seeing ahead of us. […] It will probably take more time but if these disruptions come, our business model might also change” (Interview 1, 2017).

An interesting new term used by the interviewee is "innovation dilemma". It describes the difficulty of a company where current business models are in competition to new business models and thus innovation is slowed down. He explains this effect based on a project he’s in charge – a new mobility service. According to him, a new mind-set was needed in order to lead the project to success. And this is where, according to the interviewee, “innovation management” is needed. On the personal level, new ideas and mind-sets need to persist. This change within his company led to the implementation of a so-called "incubator", a new department that can operate largely independently of the rest of the company (also see chapter 9.3.1). According to him, this was an extremely successful measure for a planned innovation or a new mobility system to “start with full force and try to go to the next step” (Interview 1, 2017).

“Projects that are planned now will be built in 10 to 15 years or even later” – Interview 2, 2017

In contrast, a certain technology-scepticism could be observed in the second interview. The interviewee stated that solutions addressing the current mobility issues are often searched within technologies, with some questionable results - today people in Switzerland drive their car approximately as long as they walk (around 30 min each). For society and health issues, this is can lead to some questionable effects. These are also topic, which need to be addressed within mobility management, according to him. Especially when considering, that changes in mobility come with a major time delay. If a sustainable change in mobility wants to be achieved, it needs to start now. (Interview 2, 2017)

According to the third interviewee, mobility management initiatives need especially to be conducted with the goal of reaching new business areas. Public transport providers and traditional actors in the mobility area are more and more under pressure, particularly in financial aspects. New mobility concepts and services in the area of mobility management help mobility providers to reach new business areas and industries. (Interview 3, 2018)

“Especially PT-lines in areas with weak demand are increasingly coming under pressure. In such a situation, if we can say that we have an alternative, then that is a good thing.” – Interview 2, 2018

“The whole exciting thing personally I find, is to tackle the topic with target groups which are not so affine on this topic. Be it with political groups, with communities, or with companies that do not yet see it that way.” – Interview 2, 2018

The reason why they perform and promote mobility management, according to the fourth interview, has to do with personal attitudes, values and the realization that the focus of mobility development clearly needs to be on sustainable mobility. In addition, mobility management is seen as a crucial part of the strategy for a municipality to obtain the “Energy City”- label. The label shall certify a consistent and result-oriented energy policy. Municipalities that aim to obtain the “Energy City” label undergo a comprehensive process that leads them to sustainable energy, transport and environmental policies (Energiestadt, 2018). Promoting Mobility management, especially in companies, can help to achieve this goal. In Switzerland, according to interviewee 4, there are currently 425 energy cities. All these municipalities can benefit from the mandate “Mobility for Energy Switzerland for municipalities”, where 34 energy city consultants provide consulting in the area of mobility management. These consultants have access to various resources, recommendations and concepts (e.g. BFE, 2018; EnergieSchweiz für Gemeinden, 2017a, 2017b). It is very motivating, according to interviewee 4, when improvements and insights can be seen in the persons respectively organisation being consulted. It is particularly important, whether local and

regional benefit is emphasised. This generates "food for thought" for all participants, leading to “great exchanges and finally, to great mobility management projects” (Interview 4, 2018).

As, according to interviewee 4, mobility management has a clear focus on sustainable mobility, it was asked if this sustainability aspect for companies performing mobility management is relevant - beyond the marketing effect. According to interviewee 4, sustainability is still seen as a marketing tool. However, incentives to seeing sustainability in a “bigger picture” are increasing. Generally, the “pressure of suffering” is increasing (see chapter 9.3.7) with mobility becoming a burden for companies. On the one hand, awareness of the hidden costs of mobility (parking, health, satisfaction of employees) has recently increased; on the other hand, companies are increasingly confronted with official requirements when moving or expanding their premises. Additionally, the situation on the labour market is difficult in many business sectors in Switzerland. This means that the demands and expectations placed on an employer, especially on the part of sought-after specialists, are increasing. Mobility is therefore directly related to the attractiveness of the job. Mobility management projects often arise for a specific reason: a move or an acute lack of parking space, sometimes due to production expansion, which consumes parking spaces. Considering the future development, the interviewee is very curious how the mobility system will develop. Autonomous vehicles could lead to a reduction in stress when commuting in multimodal private transport. This could therefor threaten the attractiveness of public transport (Interview 4, 2018).

> “Currently, 12’000 more people leave the labour market than enter *(per year)*. In the future, this number could rise to 50’000. This means that there is an enormous tightening of the work competition among companies and I see this as a great opportunity for companies in terms of sustainability.” – Interview 4, 2018

Interviewee 5, who was responsible for implementing a car-pooling project, approached the issue from another angle; when asked about the motivation to perform mobility management, he answered the question mostly related to their car-pooling project. According to the interviewee, past car-pooling projects (except for the region of Ticino in Switzerland) were not successful (see chapter 9.3.13). The two main drivers why they tried to implement carpooling, is the evaluation and dispersal of the smartphone, which makes it technically possible and easier to find a driving partner. The second driver was the fact that companies are becoming increasingly restrictive in parking management. For employees it is therefore getting more expensive to park with a personal car, making it worthwhile for employees to use carpooling. These were the two starting points, which were pursued within the car-pooling project (Interview 5, 2018). Here, it was possible to see how technologies can serve as enabler for new mobility services from an expert's point of view and that it is necessary to appropriately exploit the opportunities and possibilities that may arise from those.

Summarizing aspects of motivations one can say that on the side of consultants and transport providers ‘hard facts’ like business opportunities are more important, while on the side of companies rather ‘soft factors’ like image plus pressure due to lacking (parking) space, regulations or a specific local situation are considered as motivating factors. Being part of the business for the supply side and having the character of nice-to-have topic on demand side leads to an uneven trade connection. Regulatory frame conditions have the power to change the situation in this context, if use of limited space or transport infrastructure financed by public investments is linked with certain rules and restrictions.

9.2.2 Process

> "The overall goal of mobility management is to promote sustainable mobility." – Interview 3, 2018

For acceptance of and commitment to mobility management programs of both employers and employees the implementation process is main important. Goals and benefits need to be clear for all participants and the procedure must be comprehensible. Although these factors differ from company to company some general aspects could be identified by the interviews and desk research. When it comes to goals a definition of mobility management helps, explaining the term as one which is used to describe strategies, action concepts and measures that cover all modes of transport, which aim at efficient, socially and environmentally compatible transport and are based on information, communication, organization and coordination (Mobilservice, 2018). In order to do so, mobility management should meet modern mobility needs and at the same time reduce the volume of traffic. It is important to stress that these programs are not an investment only, but are beneficial for companies. According to SVI (2008) the advantages of mobility management are many and varied:

For companies:

- Reduced mobility costs
- More efficient use of company vehicles and car parks
- Better reachability
- Satisfied and healthy employees
- Modern company culture based on cooperation and fairness
- Image enhancement and verifiable facts for sustainability

For communities:

- Active cooperation with companies and profiting from synergies
- Efficient use of transport infrastructure
- Increasing the attractiveness of the location
- Better quality of life and living
- Impulses for a new mobility culture (incl. leisure mobility)
- High credibility thanks to mobility measures in municipal enterprises

In this understanding, mobility management in companies not only requires the active role of the institution, but is beneficial for it. In order to maximize benefits this can be accomplished by considering the following aspects within the implementation process of mobility management (SVI 2008):

- implementing measures within its own sphere of action,
- which are ideally geared to those modes of transport with the greatest possible impact potential
- develop and implement in cooperation with the local community and/or local mobility providers

As mentioned companies may differ, and thus best practice of processes may be different depending on the organisation. Even if it is hard to find specific information on that, the official and national SFOE "SWISSenergy for communities" mobility management program (see chapter 9.2.1) distinguishes between mobility management in companies and administrations, at least.

Concerning the process interviewee 3 does not distinguish between these two entities, as in his opinion any case every consulting assignment takes into account the specific characteristics of the organization to be advised. He summarizes the process of how mobility management consulting works as follows:

Step 1: A first and short consultation is conducted. "Starting points" for mobility measures of a company/administration are identified. This aims at different aspects: What is the company or institution already doing regarding mobility management, e.g. slow mobility, PT or fleet management of their company cars. Even though the company of interviewee 3 is mostly active within the area of public transport, they see mobility management as something, which aims at evaluating all forms of mobility. Interviewee 4 stated that the input consulting is free of charge. Mostly, the consultant contacts the

company in advance of a first meeting, obtains certain information regarding mobility and the company, and then does a 2-hour meeting to point out and roughly analyse potentials, and how certain measures might look like.

Step 2: If the consulted organisation decides to continue the consultation, a two-hour talk to deepen the understanding of the customer is conducted: “There, we look at the different bullet points, if gaps are existing. We want to understand the customer” (Interview 3, 2018):

- Who are they?
- Where are they located?
- What company culture do they have?
- How are they acting?
- Which difficulties arise in terms of the mobility situation? Where are potentials?

> “It depends which demands the customer has. Does he want an action plan? Alternatively, other evaluations? Or does he need assistance for implementing the measures?”
>
> – Interview 3, 2018

Based on the answers to these questions, a short report is created. This is the procedure of the initial consultation. If the consultation proceeds, the procedure changes depending to the customer. Often, according to the interviewee, each consultation is similar from its structure, but the content has to be defined regarding the aspects of the costumer (industry sector; domain; size and emplacement of the company etc.). Therefore, it is necessary to always approach the customer individually. In addition, interviewee 3 understands their mobility management as a consulting service. But it is also possible that it is tried to include some of their own mobility services and show the companies how much e.g. a new bus line would cost and which framework need to be fulfilled if they would like to have that additional mobility services.

How step 2 is carried out, depends on the consulting firm. According to interviewee 4, they changed and expanded this step towards a more concrete analysis with the idea to gain more facts. Companies, especially when financial investments are required, want to assess the effects of their investments in advance. This, according to interviewee 4, is the goal of the expanded consultancy. “We see this step as an in-depth analysis, where you can set priorities, shuttle mobility, business traffic, fleet analysis. This is the basis for defining the fields of action, setting goals and answer the question: What do we want to achieve? For this we have a standardised catalogue of measures. So there are 20 different measures which can be adapted individually to the company and the problem.” (Interview 4, 2018).

As an answer to the question of how freely the measures can be defined and specified by the consultants, interviewee 4 stated, that the objectives of the mobility management consultancy need to be clearly agreed with the client, otherwise it does not work (see chapter 9.3.10). Suggestions can be made by the consultants and this will certainly be discussed with the client. With the catalogue of measures, it is somewhat different depending on the company. Ideally, companies have a working group or a caretaker to develop and evaluate these various measures. From this perspective, the mobility consultant tries to estimate how much the implementation of the measures in the catalogue could costs and how they can be implemented, ideally together with an internal working group of the company or with a so called “caretaker”. (Interview 4, 2018)

9.2.3 Challenges

Due to the rather week character of motivations of soft factors for implementing mobility management challenges arise. Putting mobility management successfully into practice means to do both, 1. strengthen motivation, and 2. address challenges. Thus, understanding the latter is necessary in order to identify fields and starting points of action as well as to design measures is crucial. As the evaluation

of the interviews has shown, challenges can be divided into separate categories. The challenges described in this chapter belong, on the one hand, to difficulties in the implementation of mobility management, and on the other hand, to difficulties that concern the entire mobility system, but are also addressed within mobility management projects.

9.2.3.1. Inefficient forms of mobility are still cheaper

According to interviewee 1, the efficient use of technologies is key in order to gain more sustainability in (commuting-) mobility. He gives the example of the inefficient occupation rate of cars in Switzerland, which is, as he stated, around 1.5 people per car (note: for work-related travels it is much lower, around 1.14 see BFS and ARE, 2001). According to him, public transportation is in general much more efficient, but after all, often considered as being expensive. According to him, much comes down to price. As long as it is cheaper to use fossil fuels than other forms of energy, an "energy carriers substitution" (Interview 1, 2017) which would be needed for a more sustainable mobility system, will not happen. In this context he mentions the danger of rebound effects. With the increasing spread of new technologies, which are not necessarily sustainable, their price usually also decreases. This can lead to uncontrolled processing, like the cars in the 70s. (Interview 1, 2017)

> "As soon as there is something delicious you see everybody wants to eat it to get it for themselves" - Interview 1, 2017

9.2.3.2. Missing culture of change

What makes it difficult in the eyes of interviewee 1 is the missing culture of change in Switzerland, which in general is not very open to disruptive changes according to him. This can be seen in both, in people's minds and in the organisational forms of companies. This manifests itself in a lack of courage to try something new, as well as a general fear of failure. According to him, Switzerland is a very innovative country, but when it comes to implementing (sometimes painful) measures, people withdraw.

> "We have this slow change of culture and this is a very strategic challenge. But we don't yet have the organizations to do it. And, of course, there are the personal challenges, you know?" - Interview 1, 2017

9.2.3.3. Focus on certain modes and parts of the mobility chain

> "In the past, pedestrian walking was important, today it is important and it will be important in the future."- Interview 2, 2017

Interviewee 2, a member of a lobby organisation, criticises, that many actors within the area of mobility have wrong focal points. He mentions three examples: 1) The lack of focus on active modes in mobility measures. This is also the case for public transportation. According to him, 90% of the people walk to a public transport stop, only a few use Park&Ride and Bike&Ride. According to him, this fact is often forgotten. 2) People often seek salvation in new technologies, also when performing mobility management. Instead, the "basic" importance of active mobility like walking or biking is forgotten. 3) Especially PT-organizations (but not only) are not thinking door-to-door but still station-to-station. This would neglect the current needs of mobility users (Interview 2, 2017).

9.2.3.1. Urban rural gap in awareness for sustainable mobility

The urban-rural gap is, according to interviewee 2, a big issue. According to him, a general openness regarding sustainable mobility can be observed among stakeholders of cities. Cantonal stakeholders, which have a more rural view regarding mobility issues, are more car-oriented (Interview 2, 2017). According to interviewee 4, there is also a correlation between the qualities of public transport connections in rural areas and car related travel. If the connections are inconvenient or if an employee has a 30 to 40% longer travel time for the way to work, the choice in favour of the car is clear according to interviewee 4. This also influences the attitudes of the individual mobility users.

> "The canton said: This is a main access road. We said: "That's a future boulevard, a city space for people, which need to be planned appropriately" - Interview 2, 2017

9.2.3.2. Missing parking management

Another issue, especially concerning medium- and large-sized companies, according to several interviewees, is a missing or insufficient parking management. Parking spaces are expensive to maintain, especially when land prices are increasing (Interview 1, 2017; Interview 2, 2017). On the other hand, many companies see free parking spaces for their employees still as an important factor in order to being a competitive employer (Interview 5, 2018, p. 5). Here it is often forgotten that car drivers are clearly preferred in this way and that people who do not drive with the car often feel disadvantaged (Interview 4, 2018). Here, a missing awareness regarding this issue can be observed within companies.

> "In the city of Zurich there exists a minimum and a maximum of parking spaces for a certain construction project. In some other municipalities there exists only a minimum. There is still much work to do from a law-maker/political side." - Interview 2, 2017

On the other hand, many communities do not use the full range of action that would be available to them. For example, there are still many regulations for minimum parking spaces in many municipalities. Both private and public investors must offer a minimum number of parking spaces for new buildings. According to interviewee 2, however, there is a lot going on here. Winterthur, for example, has let down the lower limit and forces existing underground parking spaces to be used: people who live in a house with an underground garage cannot purchase a permanent parking card for aboveground parking spaces. Similar considerations are under way for companies. According to him, such developments can also be observed in other municipalities.

9.2.3.3. Administrative fragmentation

One important issue according to interviewee 2 is the big fragmentation of responsibility within companies and administrations.

Companies: "There are two aspects: 1) Specialisation is increasing (fragmentation regarding the specific implementation) 2) Awareness is increasing that close interdepartmental cooperation and thinking is needed. Both tendencies are existing and it is difficult to unite them, they contradict. It is difficult to focus all these aspects in one administrative body." (Interview 2, 2017).

Administrations: "But we are still far away from the situation which exists for automobiles or PT, where whole federal offices exists. There is no such thing e.g. as a "federal office of pedestrians", but very well a federal office for transport or a federal roads office. Not the same weight is given to pedestrian traffic than PT or automotive traffic. Another issue: Pedestrian traffic is often divided on many administration bodies: E.g. the police is responsible for road markings, the traffic office of Zurich for the general planning and the civil engineering office for the construction. Therefore, three administrative bodies are doing similar things, which makes it difficult. Similar issues persist with PT stations. The PT company constructs the station, the waste bin is constructed by somebody else and the road and pedestrian crossing is done by a civil engineering office etc. Here, we need one responsible administrative body, which is missing in pedestrian traffic. The issue is fragmentation of the responsibilities. As such, we expect that PT-companies, especially, to be more open towards other issues regarding pedestrian topics" (Interview 2, 2017).

9.2.3.4. Missing awareness and courage regarding sustainable mobility

According to several of the interviewed experts, awareness regarding sustainable mobility is not really persisting within many companies. Often, a very car-oriented attitude is persisting within the management and among employees. Some interviewees call it “cemented phenomenons” – Everybody has a car, everybody has free highways and free parking spaces (Interview 3, 2018).

> “If we want to achieve our vision there is much work which needs to be done. Since the twelve and a half years I'm doing this work I realized how little companies or administrations are doing and how little awareness is existing regarding mobility.” – Interview 3, 2018
>
> 2017

“In order to push this process, there are many possible obstruction possibilities. And this may be one reason why companies try to avoid this topic as long as there are no imminent problems” (Interview 3, 2018). Another mentioned aspect in this context is the missing courage to change something. “It is not about the main argument of being a pioneer. One likes to exchange with his peers and orientate. This can be encouraging but can also be an obstacle” (Interview 3, 2018).

9.2.3.5. Attitudes of companies: Old-school working culture

Another issue elaborated especially by interviewee 3 are long established and old school working cultures in companies – leading to resistance against flexible working hours and places. In such cases, employers often want to maintain control over their employees. They are afraid that they will not work properly at home and will not fulfil their obligations. This is a common reason why home offices are not allowed in companies where the actual working tasks would allow it. According to interviewee 3, in the future, when new people are to be recruited, this can be very unattractive from the employer's side. This is an argument where employers have to deal with the fact that not only the mobility market is changing, but also the expectations of the employees. In the past, people used to come and ask: "May I have a free parking space?" Today it is more. Home office and flexible working hours are important (Interview 3, 2018). Interviewee 5 has a different perspective on that. He heard from many companies that many employees’ value free parking spaces and that an attractive employer must still provide free parking spaces (Interview 5, 2018).

> “I often hear "I don't want my employees to do home office because I want to see them.” This is a very traditional way of looking at things without understanding that some trips are no longer necessary with home office. – Interview 3, 2018
>
> 2017

> “Just recently, we were told: "We thought about charging 20 francs [for a parking space]". These are the wrong perceptions! Many still perceive this dynamic far too little”. – Interview 3, 2018

The interviewee also addressed other employer services or prerequisites that do not meet current employee needs and the requirements of sustainable mobility. Free parking spaces are considered the “downfall of everything” (Interview 3, 2018). This does not mean that if all parking spaces were managed, everything would be different. However, certainly less people would go to work by car. Planned countermeasures often do not go far enough. Often, small levies in the double-digit range are considered. According to Interviewee 3, this is clearly too little to start a paradigm shift. In addition, the financial losses due to congestion (stress and time loss) of companies are not taken into account (Interview 3, 2018). In the same notch beats interviewee 4. According to him, employers do generally not care how long their people are stuck in traffic jams in the morning, as long as they are in the

> “We or the consultants are then asked to have a glass ball and tell them "Ok, if you buy three electric cars then this will lead this and that shift" - That's not possible.”- Interview 4, 2018

office on time. To realize that this would be economically correct to care about such things would require “thinking beyond the tip of one's nose”. In addition, according to him, the focus of many small and middle-sized companies is still on cars and parking spaces. When defining measures, companies often expect an estimation of return of investment. For consultants this is very difficult, as little practical implementation cases exist and every company represents its own case (Interview 4, 2018).

> Regarding carpooling, people thought, "oh no then I won't come home when I want to". People feel restricted. - Interview 5, 2018

Another problem mentioned by Interviewee 5 is the lack of courage to take measures that are more drastic. This can even be observed in progressive companies that actively try to put mobility management measures into practice. He gave an example from his case study in which an internal carpooling project was implemented. The consultants had the idea of defining further measures. The very restrictive measures were avoided by the chief executive, as for example he did not want reserved or free parking for carpooling commuters (Interview 5, 2018). According to him, openness regarding restrictive measures is very much related to the pressure of suffering. This means that the more a region suffers from traffic, the sooner it is ready to apply restrictive measures. In Ticino, where the pressure of suffering is higher, carpooling is much more successful than in the German-speaking part of Switzerland, where the pressure is simply lower. In addition, measures can cannibalize each other. The company with the carpooling case study has extremely flexible working conditions - theoretically, you can work 100% from home. However, this raises the hurdles for carpooling, as people felt that they would lose flexibility with carpooling.

9.2.3.6. Attitudes of commuters: Missing openness, habit, perceptions and convenience

One other issue in order to change the mobility behaviour of commuters are stalled views and perceptions of commuters. Interviewee 3 explains this by the means of a discussion in which a politician said that he considers his hour in the car in the morning as a recovery time. Also, the views regarding traffic jams are often surprising. Commuters begin to blank out the traffic jams (Interview 3, 2018). The pressure of suffering caused by traffic jams alone does not seem to be strong enough to persuade people to change their mode of commuting. Interview experts now have gained experiences with carpooling projects. According to them, in surveys, people like carpooling in comparison to other mode of transport (also see Hoerler et al., 2018). However, user prefer not to use it themselves. The topic of sharing has long been prominent in the media and certainly has potential. However, it is still seen as a niche and only part of the people would be really open to this (Interview 3, 2018, p. 3; Interview 5, 2018).

Additional reasons mentioned in this context are habit or family and work constellation. People working by clock time often do not have many possibilities to change their commuting behaviour. However, often people could be more flexible. It has a lot to do with working culture. Often meetings are scheduled at 8 a.m. according to interviewee 3, this shows that there is no awareness of this problem. This is also a question of the understanding of work. Interviewee 3 also states that flexible working hours can be an advantage from the customer's point of view, since someone who came later in the morning stays longer in the office. In addition, not all people are capable at the same time. Some are “morning persons”, others “evening persons”. That would be an advantage for productivity (Interview 3, 2018). Interviewee 5, on the other hand, does not see such great potential. Working hours will not become more flexible in many sectors (retail or shift operations). If someone works in the sales department then the opening time of the

> “We mainly deal with municipalities and administrations. With small companies, also with the Federal Offices, which are after all clients. And that's rather difficult. It is also very person-dependent. There are also different attitudes, values and depending on who you are dealing with in an administration it can be easier or more difficult - Interview 4, 2018

shop is set. This should not be underestimated. Moreover, according to him, those who can commute outside of peak hours do it already and there are those who do simply not mind being stucked in traffic (Interview 5, 2018).

According to interviewee 4, another issue which is a barrier in order to change the current mobility system, are “personal attitudes, missing values and awareness that mobility with more roads and more infrastructure is certainly not the solution and that the focus must clearly be on sustainable mobility” (Interview 4, 2018). This includes other reasons like status symbol or the “feeling of freedom” (Interview 4, 2018) when owing and driving a car. Even when stuck in traffic, car users have their private living space. In addition, that becomes more and more attractive when looking at how cars today are equipped with electronics and comfort devices. “Even if a journey to work is only 3 or 4 kilometres using the bicycle isn’t even considered.” (Interview 4, 2018).

> “Because in the past carpooling has always been a failure if you look at it realistically.” Interview 5, 2018

Regarding the openness of users to consider commuting alternatives, interviewee 5 refers to his carpooling case study. There, the identified demand for carpooling was very low and therefore they were quite disappointed regarding the low openness regarding carpooling. According to him, it certainly takes some effort to overcome the issue of sitting in the car with other people. In Ticino, long-established car pools in particular work well. The initial placement can be done via a special Web- or Smartphone-App. Finally, WhatsApp groups are created and the organization happens completely separated from these systems. In addition, he thinks that carpooling cannot well cope with flexible and dynamic lifestyles, because the needs of all the passengers have to be taken into account (Interview 5, 2018).

9.2.3.7. Childcare and combination of work travels

An important reason why people are on the move at peak times is the situation with childcare. According to interviewee 3, only very few childcare centres are designed to receive children at off-peak times. This behaviour continues due to habit reasons (see chapter 9.2.3.6) after the children are out of school age (Interview 3, 2018). In addition, interviewee 4 sees more flexible childcare as an important lever in order to reduce peak times. In addition, other combination of commuting travels are mentioned, e.g. shopping. Missing transport alternatives or bad PT connections of shopping areas can motivate people to use the car instead of public transport. (Interview 4, 2018)

9.2.3.8. Underestimation of the implementation phase

When it comes to implementation after the consultancy-phase, that is where the problem usually lies within mobility management. Interviewee 4 mentions an example in central Switzerland, where they closely accompanied a larger company, presented a catalogue of measures and drew up an implementation plan. From then on, they wanted to do things on their own. However, a "care taker" was missing. For a successful implementation, it takes manpower, resources. Interviewee 4 thinks this is the phase most companies underestimate (Interview 4, 2018). A second example mentioned by interviewee 4 are location analyses, where the alternatives for commuters from certain regions are analysed within companies. Starting from there it can be defined which measures can be offered and what the difficulties are. What they noticed in many companies: They could present measures to companies and show them what it would cost to implement the proposed measures, yet what is extremely difficult is to show the return-of-investment in advance. That is where companies would say, "We want to know beforehand what this measure will bring" (Interview 4, 2018).

9.3 Success factors and catalog of recommendations

Examples of good or best practice can show how successful implementation of mobility management works. Thus, examples given by the mobility experts are presented here, which are related to the challenges described in chapter 9.2.3 showing how solutions to these challenges can be developed. The potential and benefits can be substantial: “If a company introduces a “power package", e.g. parking

management combined with a discount on public transport tickets, this can lead to a shift of approx. 15%. I'd say this is one of those sizes that's pretty much true" (Interview 4, 2018).

9.3.1 Innovation management

> "If somebody buys an electric car, try at least to also make them a public transport user." Interview 1, 2017

Several of the interviewees mentioned the potential that new technologies like electric cars and sharing services have in fostering sustainable commuting (Interview 1, 2017; Interview 5, 2018). Interviewee 1 sees especially potential for electric cars by combining them with public transport and by making them available by the way of loan or sharing. He recommends to achieve this task by using the positive image of electric cars and by sensitising people on the costs of a personal car. The expert calls the process leading to such considerations 'innovation management'. He considered the creation of so-called "incubators" to be particularly worth mentioning. This is a new department inside a company that can operate largely independently of the rest of the company. This is, according to him, one of the fastest and most effective way to create innovation within a company (Interview 1, 2017).

9.3.2 Creating new business models

> "These new business models have to deal with the need of the customer to go from A to B, not from train station to train station […]. Interview 1, 2017

Sharing economy can be considered as a current socio-economic megatrend (see Haerri et al., 2018a). As mentioned in chapter 9.3.1, experts see implementation of sharing economy within mobility as a big potential in order to gain more sustainability within commuting. However, it is also considered necessary to adapt to these changes via business models, also from an economic point of view. This applies to both mobility providers and non-mobility companies. Sharing economy should not be ignored (Interview 1, 2017). Interviewee 1 gives examples such as Google and Apple, large companies that not only want to cut their slice of the mobility market, but also want to become attractive employers in a fiercely competitive job market by improving the mobility situation of their employees (Dalton, 2017; Dormehl, 2014). What is also becoming more and more important are door-to-door offers, such as Mobility-as-a-Service (MaaS) systems. Interviewee 1 considers it as necessary to address an employee's entire travel chain and not just individual routes. He also mentions the example of a current project within his company together with a car manufacturer. Similar as PT companies, car manufacturers also aim at becoming mobility providers and therefore want to be part of sharing or loaning mobility systems, especially in combination with PT offers (Interview 1, 2017).

9.3.3 Management transformation and intra-company integration

> "Management transformation of [company] helped to create common values and responsibilities for changing it together. That is what we did together with a coach." Interview 1, 2017

Another best-practice example, which is explicitly stressed by Interviewee 1 and 5, is the need to convince upper management in order to push a change within a company. Interviewee 1 calls this process "management transformation". Often, according to him, a so-called "deadlock" regarding new mobility solutions and strategies exist within companies, also caused by upper management. This scepticism is then propagated by all levels of management. It can be dealt with by performing proper research and by showing that a certain offer/measure corresponds to a need of employees and customer. Interviewee 1 achieved this based on a user survey and numerous statements of belief from business partners. Thanks to this positive feedback that gave him credibility, he was allowed to outsource his measure/product to a so-called

"incubator department" within the company (chapter 9.3.1). This gave him the necessary freedom and room for manoeuvre to further develop the product to series production readiness and to finally overcome the “deadlock” (Interview 1, 2017).

Another important point, mentioned in this context by Interviewee 4 is the use of already existing company structures. In this way, e.g. a health department can be integrated in the mobility management process for more sustainable commuting mobility. The formulation of the sustainability target is also very helpful. Or as interview 4 would say: “Almost every company has its ‘sustainability’-website. Some mean it; some take it ‘pro-forma’. This is a chance for us to connect our endeavour by saying to companies: ‘But within your company guidelines its written […]. For example we had a consultancy, we know they have many different management systems (QMS, UMS, Health-management, security-management etc.) and this is a special case. If they apply these management systems with dedication, this is ideal for us and it helps to justify ‘mobility management’” (Interview 4, 2018). It is both person-dependent and structure-dependent according to him. Finally, indicators to measure the effects are needed to analyse the impact of measures and to report to the management on a regular basis (Interview 4, 2018).

9.3.4 Network, stay persuasive and persistent

In connection with the issue addressed in chapter 9.3.3, several of the interview participants explained that consistency and tenacity are necessary for success. Interviewee 1 again refers to his company's pilot project together with a car manufacturer. After numerous discussions and attempts at persuasion, the long awaited turning point for his project came - the car manufacturer agreed to allocate numerous resources for the pilot project. Without this development, it would have been impossible. This was the result of numerous, recurring and constant efforts (Interview 1, 2017).

> “90% of people come by foot to PT-stations. And this is also an issue we want to improve together with PT-associations, that they not only think PT-station based, but that they widen their scope of thinking right up to the front door of their ridership” - Interview 2, 2017

Interviewee 2 gives similar examples; he also emphasizes the importance of remaining persistent. His organization is doing "low level" recommendations for municipalities, every year they organize a conference/meeting addressing this issue. There they try to change approval procedures for construction projects. They aim that pedestrians are always included in these planning processes. E.g. if something needs to be constructed during the public authorisation phase a pedestrian interest group has to give its "ok" to this project and so on. They try this with extensive lobbying and, as mentioned, such "low-level" events aiming at “widing the scope of the participants” (Interview 2, 2017). This lead to a development. According to interviewee 2, 15 years ago pedestrian traffic was almost inexistent within traffic planning, e.g. no competence/jurisdiction within the administrations, and this has changed and he expects that further change will occur towards the situation that more and more people in municipalities/cities and cantons are entrusted with walkability/pedestrian issues. However, according to him, this does not work without increasing know-how: “So, in the administration, knowhow is needed. In addition, we need visions. Many municipalities just wait until somebody makes a construction proposition and if it adheres to the law, it is built. Municipalities need to know what they want and to have a clear picture what they want to have built on their area and actively communicate these restrictions. This includes an interaction between public spaces and private spaces” (Interview 2, 2017).

> “Personal contacts, going from one manager is key. Then suddenly you get a grip within them and slowly (this can take years) you can sensitize them and change something. […] Its really one small step at a time. […] we often start at administrative staff and then we slowly convince their bosses and so on. How bigger the institution, the longer it takes.” - Interview 2, 2017

9.3.5 Highlight the “return on investment”

Another best practice example is identifying, quantifying and demonstrating the return on investment (RoI), especially when it comes to convincing upper management. Interviewee 4 stressed, that they are often asked by consulted companies what the RoI to be expected is (Interview 4, 2018). This is difficult to estimate, but sometimes known empirical values can be used. RoI calculations are usually made on a financial basis. According to interviewee 2 there's a study that the "return on investment" is very big for the health sector compared to the investments for pedestrian traffic. Pedestrian traffic almost doesn't have any external costs, 11 cents per walked kilometre is the economic benefit for Switzerland (=gain minus external costs, infrastructure, impact on environment, accidents etc.). According to him, such figures help fundamentally in order to argue in favour of active-mobility measures in companies, but also towards municipalities. The company of interviewee 2 often tries to use the ‘economic’ way and to show companies that even from an economical perspective, the current parking planning scheme (=underground garages) makes no sense. According to him it is absurd that parking spaces in underground parking are empty (because they are expensive to rent, around CHF 150/month) and above ground the public spaces are crammed with cars because these parking spaces are much cheaper (CHF 25/month). There, a political decision is needed according to him, e.g. people living in houses with underground parking should not be allowed to use long term public parking, e.g. as in Winterthur. Real estate companies are (often) obliged to build parking spaces, but their tenants are still allowed to park their car on long-term public parking. According to him, it needs to be made clear that parking in public spaces is expensive. A proper mobility management it is not only sustainable, but even cheaper. Such argumentation needs rigorous research according to interviewee 1, especially when highlighting sustainability effects (Interview 1, 2017). Interviewee 3 also mentions such costs: “Absurdly, when it comes to costs, I can state that there is not the correct realization where ‘mobility costs’ happen. For example, parking spaces did not fall from space. They cost when they were built and they cost to maintain and exploit them. These costs are often just ‘hidden’ by the ones responsible. When we do mobility management, these costs are often seen as dramatic. But when the real mobility costs are considered, they are not so high anymore” (Interview 3, 2018). Interviewee 4 is convinced that mobility management can be cost-neutral and even financially profitable for a company if applied and calculated correctly. Finally, interviewee 3 adds that an attractive and progressive mobility situation is important for many employees. He can well imagine that in the future, when new people are to be recruited, an unsustainable and old-fashioned mobility situation within a company can be very unattractive from the employer's side of view. Of course, this would also have a financial impact (Interview 3, 2018).

> “Yeah, you know, you have to be analytically rigorous and talk about turn in your business model. […] Then you have to highlight sustainability which makes it easier to justify [the measure] is the right thing to do” - Interview 1, 2017

Furthermore, on the part of the employees, a full costing should be increasingly carried out. According to the experts: “No commuter makes full costing. We often hear from car commuters: No, public transport is so expensive. That's the problem; there is no display in the car that shows how expensive its usage is.” Showing full-costing to car users could help reduce the attractiveness of cars (Interview 4, 2018).

9.3.6 Good PT and active-mobility offerings/infrastructure

According to interviewee 2, proper mobility management is at the same time sustainable and financially cheaper than traditional mobility planning (see previous chapter). However, according to him this only works if PT services and bicycle/pedestrian infrastructure is good enough. In the city of Zurich this works quite well, it is possible to live without a car and especially companies are realizing this more and more (Interview 2, 2017). If the services is appropriate (PT, pedestrian infrastructure etc.) the behaviour

change will come, according to him, sometimes it just needs some small support and moderation. For him, by default, these incentives should be initiated by the Federal Swiss Government (top down) (Interview 2, 2017).

9.3.7 Use a specific “burden of suffering”

> “Others really do have a specific problem (e.g. "parking space pressure"). There, sustainability is not a main driver.” - Interview 3, 2018

Another aspect, which is often a driver in order to motivate companies to perform mobility management according to the interviewed experts, is a specific “burden of suffering”. For companies this is often related to a parking problem, which is often the case when production expansion, company expansion or relocation is imminent and the demand for parking spaces exceeds the limited supply, for example due to lack of space or official requirements. According to interviewee 3, this is the main driver why companies are performing mobility management. This case may also arise when a company is rebuilding or planning new buildings. Often it then receives constraints within the building permit and because of that needs to deal with mobility management. According to interviewee 3, this then has not very much to do with voluntariness or with the thought about sustainability. He has a clear opinion, if there is no pressure from somewhere, no culture change will happen (Interview 3, 2018). Other interviewees represent similar point of views (Interview 2, 2017; Interview 4, 2018). The example of the canton of Ticino is mentioned – According to interviewee 4, the whole canton has a major mobility issue, since a large proportion of border commuters drive to work by car and therefore the transport infrastructure is overloaded, especially near the border. The canton provides a programme that supports companies financially in order to undertake mobility measures. Also the canton decreed “push”-measures: Organisations with more than 50 parking places need to pay a parking-tax to the canton. The canton uses this money to support measures to shift commuting traffic away from the car, e.g. car pooling projects, shuttle buses, ships and so on (Interview 4, 2018). Ticino is the region in Switzerland that has been most successful in these areas (Interview 5, 2018).

9.3.8 Administrations: Using Building permits

For administrative stakeholders the findings described in chapter 9.3.7 could be a big opportunity, according to the interviewees. If a company is designing new buildings, that’s where “you can really change the switches” (Interview 3, 2018) by implementing mobility constraints within the building permits. But not all municipalities are sufficiently fit to be able to put these levers according to him. Interviewee 2 gives other examples – For existing flats, where no new building permits can be issued, voluntary measures can be implemented. For new constructions, more mandatory guidelines can be defined by the administration issuing the building permit. In this case, the potential is higher (Interview 2, 2017). If somebody moves in such a new flat they have to adhere to these rules, which are known from the beginning. According to interviewee 2, it is not possible to defend somebody to own a car. But it is possible to not offer parking spaces. To imply new rules to the tenants of existing flats/buildings is almost impossible (Interview 2, 2017).

> “Yes, political awareness only comes out of the pressure of the problem.” – Interview 4, 2018

> “Within the framework of the building permit, concepts should be demanded from companies.” - Interview 3, 2018

9.3.9 Ensure resources and competences

According to several interviewees, one of the major issues while performing mobility management is the missing courage and attitude to implement far-reaching measures (see chapter 9.2.3.5). Often this is also due to the lack of a person, which has the capabilities and willingness to accompany the implementation of such measures. According to interviewee 4, from 5 to 10 input consultations there are only 1 to 2 concrete projects where a

> “You cannot implement the measures as an external”- Interview 4, 2018

company decides to make a deeper analysis. He mentioned an example of a consultancy case of his company. They and the consulted company invested quite a lot of resources for the consultancy and developed a comprehensive catalogue of measures. From the moment, the measures were planned to be implemented, the consultants noticed that the feedback and responses from their contact person within the company became more and more scarce. In the end, it turned out that the person entrusted with this task in the company had neither sufficient resources nor the competence to implement such measures accordingly. The project was terminated without any implementation (Interview 4, 2018). According to the interviewees a person is needed that has the resources and the competences to implement such measures. Two of the interviewees called such a person a “caretaker”. According to them, this factor is often underestimated. It is person-dependent how well one can manage mobility and implement the measures. In addition, it is best if this “caretaker” is supported by an executive board. (Interview 3, 2018; Interview 4, 2018). Lastly, this caretaker needs to be internal (Interview 4, 2018).

9.3.10 Measures: Target the right user groups

When defining and implementing mobility measures within a company, it is key, according to the mobility experts, to define and target the right user groups. For some experts it is utopian to make car sharing an attractive alternative for a broad section of the population. Certain commuter groups will simply not be motivated to switch their mode of transport. The same applies to other mobility offers such as car sharing. Certain user groups will jump on such offers and some will not. It would therefore be important to spend the (usually very limited) resources on those who would be open to such a change to another mode of transport. Also, according to interviewee 3, it should not be forgotten, that there are still many people who can't use a smartphone (Interview 3, 2018; Interview 4, 2018).

> “The challenge is not the offer, as carpooling has been around for a long time. There are 1000 apps. More apps will not solve the problems either. […] In many things you forget the human being. […]. Some mobility users cannot even operate a smartphone. And there, on the psychological or behavioural level we actually still know very little. There is a great need for research there. - Interview 3, 2018

9.3.11 Measures: No free parking spaces

> “These are subliminal topics that shape the culture of a company. […]. This [parking spaces] is a question of fairness and I think it is very central and the role of mobility management within the company culture is underestimated.” - Interview 4, 2018

One of the goals or measures mentioned mostly by the interviewees is the reduction of parking spaces, which is often connected to a move or a facility expansion or constraint by a municipality. Therefore less occupied parking spaces is often a goal in mobility management. Interviewee 4 also stressed another reason, which can sometimes be a driver behind the reduction of parking spaces: Equality and how mobility is an expression of a modern company culture. “Companies should ask these questions if they are offering fair parking conditions” (Interview 4, 2018). According to interviewee 3, employees not using the car are not rewarded enough, although they do not incur any costs for the parking areas. “Most companies and administrations do not have this unfairness on their radar. The unequal treatment is just about to multiply. Bosses get a better salary, free parking spaces an so on” (Interview 3, 2018). Interviewee 2 sees the same topic from a financial perspective: According to him, it is absurd that parking spaces in underground parking are empty and

above ground the public spaces are crammed with cars because these parking spaces are much cheaper. For him it needs to made clear that parking in public spaces is expensive (Interview 2, 2017).

9.3.12 Measures: Working culture change

Another measure mentioned by interviewee 3 is a fundamental change in the working mentality. According to him, many people do not come up with the idea to check the mails at home and then drive to the company off-peak times (Interview 3, 2018). An example mentioned by interviewee 4 how such a company culture can be fostered is holding small competitions and giving awards, e.g. for the one who rides the longest distances by bike or who comes most often by bike. Some companies have set up small bike clubs in their free time. This gives a competitive culture towards more sustainable mobility behaviour (Interview 4, 2018).

9.3.13 Measures: Car pooling

Carpooling is an efficient measure within mobility management – if accepted and used by commuters. In Ticino in particular, where, according to experts, the pressure of suffering is particularly high, successful implementations have been achieved (Interview 4, 2018). In German-speaking Switzerland, this development is still lagging behind. Interviewee 5 is an expert in the field and accompanies a practical project. Since the evaluation is still underway, he was unable to give many details of the results. However, implementation is proceeding only slowly, according to him. Many resources were invested, an own app and platform was created, events were organized and people were personally accompanied. The trigger for the company to try this measure was a move within a city centre with not enough parking space. The platform is purely accessible for people within this company, so that people are less inhibited to participate in a car pool. According to him, this is a trade-off, but people are sure to be able to sit in the car with colleagues. This can increase the readiness. Regarding the general readiness, according to him, when they invited 100 people to an event, 80 would come and inform themselves, 30 to 40 have then installed the app, which was presented at the event. So a certain willingness could be seen in the case of interviewee 5. Some carpooling groups could then be created. They are now evaluating if they would like to make the platform public or sharing it with other companies. “

> “You can see, therefore, that a lot of knowledge is still needed in this area.” – Interview 5, 2018

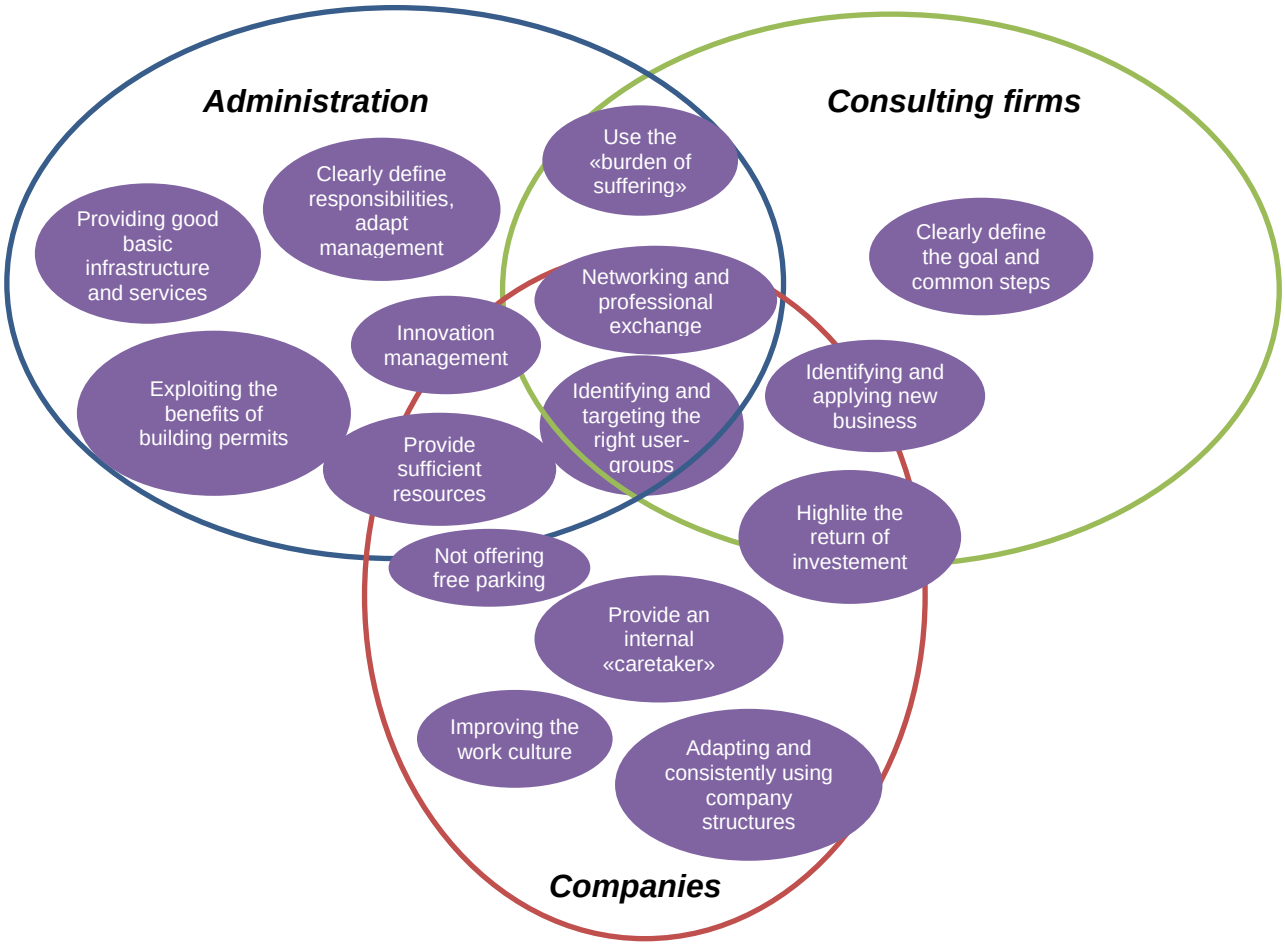

Figure 102: Overview of recommendations for mobility management in administration bodies (blue circle), consulting firms (green circle) and companies (red circle).

Synthesizing identified motivations, knowledge about needs and options for implementation processes of mobility management as well as challenges and success factors main fields of recommendations appear. These fields differ concerning their relevance for companies, consulting and administration (Figure 102). While for administration especially defining and re-shaping frame conditions and providing incentives is necessary, consulting firms could contribute as an enabler to push mobility management in companies. Recommendations for companies cover fields of internally enabling and sustaining the implementation of such programs, which includes flexibility to adapt the organisation to mobility related needs to a certain extend. As overlaps between recommendations fields for companies, administration and consulting already illustrate, in order to force sustainable commuting solutions cooperation is necessary. In the following chapter, it is analysed for the case of Basel how strategies could be developed in administration and companies based on stakeholder workshops.

10 Stakeholder Involvement: Commuting Strategies for System Transformation in the case if Canton Basel-Stadt[114]

The mobility situation and expectations for the future of commuting have changed in recent years: Part-time work, changed forms of work and society or the progressive digital networking have a decisive influence on the relationship between employees and their way to work. Commuting is already an integral part of everyday working life and an important aspect of the attractiveness of the location. At the same time, the challenges with regard to sustainability impacts for cantons and municipalities are continuously increasing. It is therefore apparent that a shift away from the privately owned car paradigm to a more sustainable mobility system is needed. This transformation process however needs the consideration of many stakeholder and disciplines as mobility is embedded within the economy, society and environment. Yet, there is no clear picture on how to tackle this transformation.

In this context, with a focus on canton Basel-Stadt and based on experts assessments, combined with the precedent empirical data collection, in two workshop we developed strategies and design principles for administrations and companies to deal with commuter mobility and transport management. The insights and comments from the experts enables to create a general overview on how to best address sustainability in commuting and derive recommendations for administrations and companies.

The chapter consists of four parts. First, an overview of the methods used in the two workshops is given. Second, the outcomes of the two workshops are shown followed by a discussion of the mobility management in administrations and companies. Lastly, a conclusion together with a script for stakeholders that envision to implement mobility management is presented.

10.1 Goal and methods used in the workshops

10.1.1 Mobility strategies of administrations

The aim of the fist workshop was to identify and prioritise the components and aspects of future mobility strategies of administrations, especially with regard to commuting mobility. According to the project focus of ‘Smart Commuting’ as addressed in other parts of the project (e.g. stakeholder network analysis, chapter 6), the target group were representatives of administrations in the Basel region, preferably working in the area of mobility and commuting (see Table 21).

The three hours workshop focused on active participation while INE held a short input presentation in the beginning, presenting the most striking results from the smart commuting project including trends and challenges in commuter mobility. Afterwards, participants were asked to define, which core topics (divided into economical aspects, society, business and technology) need to be addressed in new mobility strategies. In order to assess the sustainability-effect of these core topics, the ideas of the participants (sticky cards) had to be placed on the sustainability compass developed by INE (Figure 103, description see chapter 8.2). The participants were divided into two groups doing the same exercise.

[114] Hörler, R. and Härri, F., 2018. Smart and Mobile Work in Growth Regions. Deliverable 6.3: Script for the sustainable transformation of commuter mobility within administrations and companies.

Figure 103: Sustainability compass used as basis for first part of the workshop.

The second part of the workshop focused on prioritising the measures and aspects developed in the first step. The classification was made according to the matrix, as shown in Figure 104. On the x-axis the measures are either seen as risks or chances regarding sustainable commuting, while the y-axis defines the need for action. Concrete measures could be placed on the matrix on green sticky cards (see Appendix 15.5.1). The classification was made in two groups.

Figure 104: Classification matrix used as basis for the second part of the workshop. A) risk/high need for action, B) chance/high need for action, C) risk/low need for action, D) chance/low need for action.

10.1.2 Mobility management in companies

The aim of the second workshop was to identify how companies can benefit most effectively from mobility management and which components and aspects must be considered for a forward-looking mobility management in companies, thus having a more narrow view in contrast to the first workshop. Furthermore, the participants were asked what the most important success factors for an efficient and business-friendly implementation are. According to the case example ‘mobility management’ of the ‘Smart Commuting’-project, the target group were representatives of companies, interested in mobility management or practicing it already (see Table 21).

The workshop started with a short input presentation from INE about the potentials and opportunities in mobility management. Participants were first asked to define their reasons to do mobility management. The background of this step was to introduce the general topic, to sensitize and finally to learn from companies the true backgrounds what drives them to perform mobility management.

In a second step, creative mobility concepts were developed with the help of the INE mobility management canvas, a structured poster that fosters thinking outside of the box and simplifies the creation of new mobility strategies (see Appendix 15.5.2). Furthermore, business-friendly implementation strategies for the developed mobility concepts were established (again within the structure of the mobility management canvas).

10.1.3 Participants

Table 21: Overview of participating experts in the two workshops.

Organization	Surname	Name
First workshop: Mobility strategies of administrations (25.06.2018)		
Weil am Rhein, Stadtbauamtsleiter	Renner	Christian
TNW Tarifverbund Nordwestschweiz	Brodbeck	Adrian
Eurodistrict Basel	Duvinage	Frederic
Agglo Basel	Leypoldt	Patrick
Gemeinde Allschwil	Hetzel	Alexander
TBA Basel-Land	Gieshoff	Anne-Caetherine
Amt für Mobilität BS	Kettner	Simon
BFE	Faust	Anne-Caetherine
Präsidialdepartement des Kantons Basel-Stadt, Kantons- und Stadtentwicklung	Bessenich	Salome
Landkreis Lörrach, Langsamverkehr	Visioleck	Leonie
Landkreis Lörrach	Höhler	Ulrich
ZHAW	Härri	Fabian
ZHAW	Hoppe	Merja
Second workshop: Mobility management in companies (04.07.2018)		
Paul Scherrer Institut	Reder	Alexander
Kantonsspital Baden	Vidic	Novica
Lichtensteinische Landesbank	Finsterwald	Ursula
Handelskammer BB	Deiniger	Stefan
ZHAW	Härri	Fabian
ZHAW	Hoerler	Raphael

10.2 Results

10.2.1 Mobility strategies of administrations

10.2.1.1. Components and basics of new mobility strategies for administrations

In this chapter, the priorities in mobility strategies defined by the participating experts are described and divided into the four fields of the sustainability compass (Figure 103).

Economical aspects
The exercise revealed that much attention should be given to slow modes by investing in bike- and active-mobility infrastructure, as well as cargo bikes. Monetary measures that discourage the use of car, such as car taxes, parking fees are also seen as a high priority. However, other basics that were mentioned by the participants were correct wording and communication, avoidance of mobility in the first place (reducing congestion) and the combination of mobility modes.

Society
Various recommendations on how to manage the interaction between society and mobility were given. Mobility should be tailored to specific user-groups, including multimodal offers and a high accessibility. In line with this aspect, cross-border infrastructure and information/connection should be fostered to prevent a “cut” at the border and address cultural differences. Other focus was given to a good work/life balance, offering homeoffice and CO-workingspaces. On the political side, area-specific assessment and measures are required and a strong commitment of the politicians to sustainable mobility. Further attention should be given to an education towards a changed mobility behaviour and how we will work in the future.

Business strategies
Here, mobility management for companies that address business trips and travels has been mentioned. A restructuring of the market and pushing of new players (free-floating and sharing services, E-bike) is also seen as basics for new mobility strategies. The switch from a sustainable mode to a less sustainable one due to these new mobility offers should also be addressed. Lastly, the participants further mentioned to restrict access for cars with less than 2 occupants.

Technologies
On the technology point of view, much attention should be given to the usage of open data / open source. It should be integrated into existing offers such as ridesharing apps. In this respect a “data highway” has been mentioned and multimodal information systems. Furthermore, the participants see a need for cooperation and the definition of responsibilities in new mobility offers like ridesharing. Generally, availability and flexibility of mobility offers should be improved and a longer time horizon in infrastructure projects beyond 2040 would be advisable. In this respect, the question on whether autonomous driving will be shared or private needs to be addressed.

In a perimeter of less than 5 km the high potential for active mobility should be incorporated into new mobility strategies. Lastly, rebound effects of electric mobility needs more attention.

10.2.1.2. Definition of opportunities, risks and development focuses of new mobility strategies

While the focus of new mobility strategies were derived in the previous chapter, the following chapter sets these strategies into the context of the classification matrix, where they were defined as either risk/high priority (quadrant A), chance/high priority (quadrant B) , risk/low priority (quadrant C) and chance/low priority (quadrant D).

In quadrant A of Figure 104 the participants placed those issues or mobility strategies that have a high need for action but also bear a high risk. These include the complexity of new mobility offers where a discrepancy between the users and mobility provider exists as well as missing know-how on how these new offers will influence the whole mobility system. The experts see E-Mobility to be pushed too much, preventing existing other technologies and concepts in their progress. Furthermore, high risk bear the offers for specific user groups, as rebound effects may be different and cultural differences need to be

respected. Lastly, autonomous driving is also given a high need for action while at the same time bearing a high risk as it could induce more traffic when using mostly private and it could also cannibalise the public transport system.

In quadrant B of the classification matrix are those strategies that have a high chance but also a high need for action. These include the coordinated body for dealing with new systems, which need harmonization/standardisation of the apps and concepts used. Here, a dilemma between open source versus security exists. Parking policy is also mentioned by the experts, where alternative drive systems should be incentivized. Autonomous driving in sharing-mode could increase the access to public transport. Furthermore, the “data highway” and multimodal information systems are seen as a big chance, which need to be addressed quite quickly. Regulatory measures, such as vehicle tax, mobility pricing, limitation of car-weight/horse power and restricted access of cars occupied by less than 2 person were also placed in the chance/high need for action quadrant. And lastly, the focus on the potential of distances less than 5km might also have a high chance that could be addressed right away.

No mobility strategies defined in the first step of the workshop were placed in quadrant C of the classification matrix. As such, no measures were perceived as risky but with low need for action.

In the last quadrant (D), the chances with low need for action are defined. The participants only placed sufficiency strategies in this quadrant including behavioural aspects, less traffic, emission levels, leisure travel, company settlement and integrate space and transport.

10.2.2 Mobility management in companies

10.2.2.1. Reasons for mobility management

Table 22 depicts the main reasons of the workshop participants on doing mobility management in their company. The answers were split into five categories, where the category “Parking” seems to be most relevant.

Table 22: Reasons for company mobility management.

Sustainability	Image	Cost	Parking	Other
“It is part of our culture”	“Aiming for better image as an employer”	“Business trips”	“Lack of parking space as basic motivation”	“Regulatory requirements for new buildings”
“It is a federal requirement”	“Role model function”		“Parking problems”	“Promotion of multimodality”
			“Parking capacity limited”	“Creating incentives for employees to commute by bike/public transport”
			“Creating capacities until expansion”	“Maintaining the accessibility of the locations”

10.2.2.2. Defining a strategy – mobility management canvas

In the second part of the workshop, a mobility management process for a specific case example was created with the help of the mobility management canvas developed by INE. This includes the formulation of objectives, the basics, the target group, the preferences of this target group (dervied from Hoerler et al., 2018) and in the second part the inner circle with the concrete mobility measures, their implementation and evaluation (see Annex 15.5.2, p. 248).

The first group chose the case example of the Kantonsspital Baden (KSB) as a case study while the second group chose the case example of the Paul-Scherrer-Institut (PSI) in Villigen, canton of Aargau. The results are shown in Table 23 setting the solutions of the two groups side by side for a direct comparison.

Table 23: Results of the mobility management canvas with the two groups separated by the different fields.

Field	Group 1 (KSB)	Group 2 (PSI)
Goals	• Relieve parking capacities • Improve health of employees • Increase attractiveness as an employer • Increase employee satisfaction • Image cultivation	• Good accessibility • Reducing parking space pressure • Increasing the attractiveness of the employer/Institute
Basics	• 2'500 employees +100 last year with a rising trend • No other car park extensions possible • Location of the company: Baden, centrally located in Ostaargau	• Existing mobility concept PSI • Public transport accessibility criteria • Analysis of residence of employees • Analysis of cycle paths
Target group/person	• KSB opted for the proposed target group “the semi-urban multimodal family” (see Hoerler et al., 2018). • They rarely combine their work paths with other activities • Live in a household with an average of four people • Preferences: • Short travel time / comfort / flexibility / work-life balance / take luggage and people with you / irregular working hours	• PSI opted for an own target group “Habit commuters from the canton of Aargau”. This concerns "all motorists with public transport access within a radius of 5-15 km". • Preferences: • Commute primarily by car / flexibility is important / connect their commuting travel with leisure, children, shopping activities / independence is important / they have short travel times
Measures	• Ridesharing • Financial bonus/Malus • Day care centre • (route restrictions) • Public transport co-financing	• Increasing the parking fee • Increasing the eco-/mobility bonus for employees who commute without a car • Continuation of the (ongoing) Ridesharing-project • Sensitization, lecture series • Bike rental system
implementation	• Information event supported by the management • Concrete rules without room for manoeuvre; deviations regulated • Parking spaces reserved for ridesharing	• Existing at PSI: • Support by the management • Professional support • Contact with authorities • Pending: • Internal Caretaker and internal departmental and organisational connection
Evaluation	• Parking space counting • Parking authorizations, pay-outs • Employee survey • Measuring the utilization of parking quotas	• Employee survey • Improve data situation • Overcoming (cantonal and international) borders

		• Expanding mobility offerings and improving infrastructure

10.3 Discussion

10.3.1 Mobility strategies of administrations

Participants were able to explain what elements they see as crucial components in future mobility strategies of administrations and how they would prioritize them. They see a high need for action for numerous risk factors related to new technologies or mobility offers. As an example, the danger that due to the increasing complexity of the mobility market a discrepancy gap between users and mobility providers will arise was mentioned. This requires a clear consideration of what the needs of users are and how to satisfy them best. New offers should be communicated and brought to the users in such a way that they really add value. The experts also see a further danger in the lack of expertise within the administrations. For example, experts are extremely unsure whether they really want to and should promote electric mobility or whether this will lead to so-called rebound effects. In general, they complain that within the topic e-mobility too much concentrates on the car and not enough on other modalities and alternative drive systems. When designing new mobility services, cultural differences must be respected, especially in a cross-border region like Basel. With regard to autonomous driving of cars, the experts see an extraordinary need to define the framework conditions. Should autonomous driving (SAE level 5) become established for privately owned cars, this would be a dangerous scenario for the experts, as this could very strongly cannibalise public transport in a sharing system. On the other hand, experts believe that autonomous cars could have opportunities if they operate as public transport providers in poorly developed areas, e.g. some rural French or German communities of the commuting region.

This leads us to further aspects with a high need for action where the experts see great opportunities: According to them, a new administrative department is needed that deals exclusively with new (and cross-border) offers and systems, assesses their opportunities and risks and defines the framework conditions accordingly. In addition to autonomous driving, the experts see the dilemma between open source and data protection, mobility pricing and good digital connections as a basic prerequisite (data highway) for new networked and multimodal systems such as MaaS. Another topic with a high need for action and opportunities is a new parking policy, combined with mobility pricing, access restrictions together with minimum occupancy requirements and a proactive vehicle tax policy. In these areas administrations could very well start with so-called "push" measures to start a shift towards more environmentally friendly modes of transport.

The experts see a lesser need for action on the subject of sufficiency. However, it is also possible to improve things there, especially in the areas of traffic and emission reduction and leisure travel especially regarding holiday travels. In addition, experts would suggest for the area of Basel to create a cross-border plan for all modalities and to organize cross border infrastructure regarding tram, bus, public transport and active traffic.

10.3.2 Mobility management in companies

The workshop participants were able to show why they want to perform or want to perform mobility management within their company. In the second part of the workshop, two complete mobility management concept were developed with the help of the mobility management canvas focusing on two practical examples provided by the participants (KSB and PSI).

The experts saw parking space problems as one of the primary motivation/driver behind mobility management. But also new regulatory requirements for building projects was mentioned, as well as intrinsic motivational factors. The idea of sustainability is also anchored in some companies; sustainability is part of corporate values and culture. This statement was most acknowledged by companies close to the federal government in particular, as they would have to set a good example. The factor of job attractiveness was also mentioned twice in the first part of the workshop. It seems as if companies are becoming more and more aware that the mobility situation of employees has an

influence on the attractiveness of the workplace, therefor they want to gain a better image as an employer. They try to achieve this through financial measures (eco-bonus) that creates incentives for employees to commute by bike or public transport. The topic of cost also seems to occupy companies heavily. Companies are increasingly aware that a) parking spaces cost a lot and b) business trips are a major cost driver. Finally, ensuring the accessibility of a location is seen as an important factor. Without accessibility, it is hard to find employees and customers.

The first workshop group created a mobility management concept for the case KSB based on the mobility management canvas. Their goal was to relieve parking capacities, improve the health of employees and to increase their attractiveness as an employer by improving employees' satisfaction regarding their mobility situation. Finally, they want to use these measures for image cultivation. The background of these measures are the strong growth of the workforce of KSB and the fact that the car park cannot be expanded. As a target group, participants opted for the target group "semi-urban multimodal family" (see Hoerler et al. (2018)). The members of this group have the following characteristics: They rarely combine their work paths with other activities, they generally have short travel times, comfort, flexibility and work-life balance are important. They have irregular working hours and like to carry luggage or other passengers with them. Participants want to achieve a mode-switch for this target group by promoting ridesharing combined with financial bonuses for those using alternatives. Accompanying measures such as day care centres and public transport co-financing should create further incentives. These measures shall be implemented with support by the upper management and by defining clear rules. Parking spaces in the car park should be reserved for ridesharing users. The measures shall be evaluated with the help of parking space counting and employee surveys.

The second workshop group created a mobility management concept for the case Paul-Scherrer-Institut (PSI) based on the mobility management canvas. PSI would particularly like to guarantee its accessibility, reducing parking space pressure and increasing its attractiveness as an employer. Here, they can already rely on an existing mobility concept, which represents an additional legitimation for measures. Already undertaken was an analysis of the residence of the workforce and of regional cycle paths. Regarding the target group, they chose all motorists with public transport access within a radius of 5-15 km of PSI. They commute primarily by car and flexibility and independence is important to them. They often connect their commuting travel with leisure, children and shopping activities. A switch to more sustainable means of transport should be achieved by financial measures such as increasing the parking fee at PSI, increasing the eco-/mobility bonus for employees who commute without a car and by continuing the (ongoing) ridesharing-project. Also PSI plans a series of lectures. Finally, they plan to implement a bike rental system within the vast premises of PSI. The implementation with blessing of the management should be achieved with professional support and by contact with the authorities for new/better PT-connections. These processes are already under way according to the PSI representative. Pending is an internal caretaker and a better departmental/organisational exchange. The measures shall be evaluated with the help of employee surveys by improving the data situation and by overcoming borders (regional and international). Finally, for PSI, the PT-system and bicycle infrastructure need to be improved in order to provide a good basis for a mode-switch.

10.4 Conclusion

The transport sector comprises many stakeholders and disciplines, further interacting directly with the society, environment and economy. As such, strategies for sustainability in commuting are manifold. This study enabled to get a clearer picture of the necessary steps that need to be followed to effectively transform the current commuter environment. First, administrations should set the right framework conditions and incentives/restrictions for the rise and use of new mobility system. These include a good concept on how to handle the digitalisation, which changes the way commuters interact with the

transport operator, being less physically connected but monitored within the so-called “data highway”. This change needs to be communicated to the mobility users and data security needs special attention so to ensure high acceptance of the public. Further effort should be given to the consideration of different alternative drive systems, preventing a lock-out of these technologies in contrast to the much promoted e-mobility. Yet, the sharing economy must be a core ideology of these new technologies, especially in autonomous driving and should therefore be fostered and implemented hand in hand with the respective developer. As the experts pointed out, push as well as pull measures need to accompany the framework conditions. The most relevant are monetary measures such as parking fees / eco-bonus for non-car users or CO_2 tax. Here, alternative mobility solutions need to be implemented in parallel enabling the shift from the private car to multimodal offers or enhanced public transport services. These mobility solutions should appeal to the recognised commuter groups with their different needs and communicated as such. Apart from mobility offers, structural changes that fulfil the needs of commuters are crucial, these include showers for bike-commuters or day-care facilities. Lastly, mobility management needs a responsible caretaker and an active promotion and integration into the ideology of the administration/company to reach its highest potential in the sustainable transformation of the commuter mobility.

11 Impact on socio-technical regime[115]

Innovation in mobility such as MaaS are not only affected by a given socio-technical regime, but also influence and change this regime. Concerning this (potential) impact on the socio-technical regime, policy guidelines for supporting smart commuting and related urban design and recommendations to scale up the implementations in different European countries were developed within the Smart Commuting project. Using the cross-case scenarios and transition pathways of the socio-technical regimes this part of the work investigated how the changing socio-technical regime challenges urban design and governance – mainly based on stakeholder perspective.

According to this goals, the work described in this chapter provides general policy guidelines and plan how to scale up the mobility implementations in different European countries – as a synthesis of results of other parts of the project. The recommendations were developed by combining and analysing the results from our survey, focus groups, stakeholder analysis, expert interviews and other collected sources of information.

Previous internal and public reports published during the project have sometimes had very detailed descriptions and recommendations concerning certain topics of mobility and related urban planning. As a result, the “big picture” may not be that easily applicable to other cases by the reader. Therefore, this deliverable condenses the essential recommendations for supporting smart commuting and related urban planning.

11.1 General recommendations for decision-makers

European countries differ significantly from each other culturally and geographically, and the differences within the countries are considerable as well. The specific climate for change, the commitment from various stakeholders and the already existing infrastructure in each country mean that the transition pathways towards the multimodal, sustainable, smart and electrified mobility will be different.

The maturity for the sustainable multimodal solutions, and therefore, also the timeframe for the change will vary from one region to another. As a result, the actions required in each country and region are

[115] Haahtlela, T., Hackl, R. and Hoppe, M., 2018. Smart and Mobile Work in Growth Regions. Deliverable 9.3: Policy guidelines and recommendations.

different and should be considered domestically. Nevertheless, the following ten recommendations hold to the majority of the countries:

1. Better evaluation and awareness of the potential of on-demand services
2. Developing and implementing new last mile solutions for commuters
3. Deliveries and logistics: last mile of goods
4. Platforms and APIs for Mobility-as-a-Service
5. Electrifying transport
6. Shared vehicles
7. Mobility hubs for efficient multimodality
8. Better user-centric planning of services
9. Activating employers and employees
10. Changing the current mobility paradigm

None of the suggestions requires significant investments in infrastructures. The development and solutions are mostly based on acting and commuting smarter as the consequence of exploiting the potential of digitalisation and new mobility services. Technology is neither limiting the development. Instead, the bottleneck is the lack of experience of the users from different mobility alternatives, and how they can be combined together. In addition, the lack of cooperation and some organisational competition between and with large and monopolistic national service providers is another hindrance of development. Therefore, the main message is to increase the knowledge transfer and advance a culture that supports cooperation between different parties. We have to learn from the best practices: the culture of on-going piloting, courage to try and to develop new services and concepts, and to openly share the experiences with others.

11.2 Better evaluation and awareness of the potential of on-demand services

In different countries, there are several new types of on-demand services available and concurrently developed different new concepts. However, there is a lack of in-depth analyses of these alternatives and their overall impacts on the local transport systems. We need to emphasise that these analyses should take into account the cost-benefit analysis of the services as part of the whole sustainable multimodal transport system. When these analyses are done, the findings should be shared between countries. Also, as the new concepts develop further based on the customer feedback and lessons learnt from other cases, the analyses should be part of an on-going activity of developing public transport.

The early findings from different cases on this topic show that when implemented in a smart way, on-demand services in combination with conventional public transport 1) improve the quality of transport system, 2) reduce need to use a private car, and also 3) increase the efficiency of public transport when on-demand alternatives are used instead of having fixed routes and timetables in rural and peri-urban areas.

While markets will gradually solve the development of the new mobility service concepts, governments and cities should give financial support. This support and guidance also enhance the possibility to link the on-demand services to the sustainable and multimodal public transport system and MaaS

framework, whereas purely market-based solutions might not take the sustainability considerations and city infrastructure use into account in their operations.

11.3 Last mile solutions

There is still a need for new concepts and services to enhance the last mile services. The situation with the last mile solutions is similar to the on-demand solutions: there is a significant need for an analysis of different alternatives and their costs and benefits. A detailed study of different implementations and lessons learnt is needed. Also the on- demand services mentioned in the previous paragraphs might be one significant alternative.

Cities are encouraged to try and implement several alternative last-mile solutions in parallel. Instead of trying to choose the “one-best-alternative”, for example in case of bike sharing, cities should try several alternatives (station-based, free-floating, peer-to-peer etc sharing) in parallel. There are also different kick-scooter alternatives available, and furthermore, electrification of different last-mile alternatives is also increasing.

Municipal authorities have, so far, implemented most solutions. However, other organisations with their commuters should also get involved: large companies, business parks, apartments, and campuses have many potential daily users who would benefit if there would be better last mile solutions.

When implementing new last-mile solutions, the cities should also consider new ways to finance the alternatives. The public sector does not need to own the vehicles, equipment and related infrastructure: new concepts and innovations are often public-private partnerships, where the costs and benefits of new last-mile solutions can be shared in several new ways between consumers, service providers and transport authorities.

Supporting active modes is also essential. For example, concerning cycling, there is room for improving the light traffic lanes and systems. This holds both for the 1) new infrastructure investments (more bicycle lanes, road signs for cyclists), 2) updates to the existing systems (better pavements, removing unnecessary kerbs), but also 3) better uptake of the infrastructure (e.g. taking the leaves and snow off). Many Different EU cities should compare their alternatives and share the best practices on this topic.

11.4 Deliveries and logistics: the last mile of goods

One significant driver for the future mobility is logistics and the last mile of goods and groceries. If people would get their groceries and other items delivered directly to their home door or close-by at specific times of day, they might not use a private car for commuting. This development does not only benefit commuters but also elderly people and others who might have it more difficult to do everyday shopping. Therefore, it is essential to support the last mile of goods.

Similarly to the MaaS API and framework development, we suggest supporting the development of shared logistics boxes for sending and receiving parcels independent from any operator. This increases the competition and reduces the risks of global or national postal services to exploit their monopoly power on logistics.

The basic guidelines in this development should be similar to those of MaaS APIs and platforms: networked, open, interoperable, scalable, extendable and distributed. At the same time, these boxes can act as exchange points in sharing economy for any kinds of goods. This in turn also supports sustainability.

We suggest that legislation, construction regulations, and architects take into account this development. Floor plans for the first floor in new apartments should be planned in a way that leaves room for parcel logistics, and other possible alternative uses of that space.

At the same time, cities need to consider if they should somehow limit or set common rules for logistics traffic concerning city zones, timing, parking, emissions and driving routes. Otherwise, increasing parcel logistics and stopping vehicles may jam inner city centre traffic and block pavements from pedestrians and cyclists.

11.5 Platform and APIs for Mobility-as-a-Service

Currently, the multimodality is not a viable choice in most of the EU countries. It is still mostly impossible to buy a single (mobile) ticket for a whole travel chain between two cities. To ease passengers' mobility, governments should foster the development of e- tickets and MaaS APIs.

Also, governments should provide certain national databases and services to support this development. Customer identification, anonymisation and user data management and standardised APIs for these are examples of such strategic parts that should be managed on a country level. There have been many projects to provide guidance for this, but so far, none of these has resulted into a solution that would have become commonly accepted and adapted by the markets.

However, examples from different industries suggest that such a complex network system should be both modular and flexible. The design principles for such a platform and APIs should be neutrality, openness, interoperability, scalability, expandability and decentralisation.

- Neutrality: anyone can become a MaaS operator or service provider on equal terms.
- Openness: the market is open for all MaaS operators and service providers who are ready to share required information (related to, e.g., service description, real- time vehicle location, availability, pricing, ticketing, payments) through common and safe open interfaces
- Interoperability: the system provides compatibility and allows roaming between all parties
- Scalability: system capacity can be increased
- Expandability: new services and business models can be added
- Decentralized: there is no single party controlling the platform development

The purpose is to ensure that the systems are technically robust, scale up in future and that none of the transport modes or actors will have a dominating role. This supports true multimodality and leaves public transport at the core of the transport system.

Gradually the best alternatives will be developed and merged into de facto standards. It is not a problem if national systems between the countries are slightly different. When the previously mentioned principles are followed, the systems will become very similar and allow all service providers to connect their services to the platform.

Once the platform infrastructure modules and APIs are mature enough, the government should provide support for regional transport authorities to make their systems compatible with the common APIs.

11.6 Electrifying transport

The electrification of transport reduces local emissions, global CO2 emissions and provides more silent transport. Quite much has already been written about electrifying transport, but we would like to emphasise the following aspects.

First, more effort should be put on the electrification of buses and public transport. While ordinary private cars are standing most of the time, electrified or not, buses operate throughout the day. Therefore, higher investment costs are offset by lower operating costs. Also, local emissions are reduced more when old diesel buses are replaced with new electric ones.

Secondly, when supporting electrifying the transport, private cars should not be considered and used similarly as in the era of the internal combustion engine. Otherwise, electric cars with lower usage costs

will likely only increase traffic and congestions. The focus should be on supporting multimodality. This can be partly achieved by the optimal location of charging stations and smart park'n'ride charging.

The third suggestion is to provide housing cooperatives small financial aids to install charging stations. Also, new buildings and apartments should already have EV chargers and also readiness (cabling) to extend later the charging opportunities.

11.7 Shared vehicles

Shared vehicles are becoming more popular. This reduces the need for parking places and reduces people's needs to invest their money in something that they need only occasionally. Shared vehicles are also one viable solution to the quite common last mile problem.

Cities could support car sharing by providing dedicated parking lots for them. Similarly, city planning could enforce new office buildings and housing apartments to reserve some of their parking lots for shared vehicles.

Cities and municipalities should also consider sharing some of their own vehicle fleet during weekends and off-hours to citizens. Currently, the vehicles are mostly idle during off-hours, and many people needing a car only occasionally could benefit from using them.

Another car-sharing scheme is the peer-to-peer sharing. In the near future, all manufactured cars should have by default keyless driving and ability to be shared via a mobile app. Cities and government could start programs to support also this form of car sharing as a part of the smart mobility and sharing economy. The municipalities could also consider sharing through these platforms their vehicles when they are not needed.

The message to EU level is to ensure that manufacturers 1) make cars openly shareable by anyone, and 2) car manufacturers do not complicate by technical or juridical means the use of their vehicles for sharing economy.

11.8 Mobility hubs needed for efficient multimodality

Transport hub logic is a good concept for the city and transport planning both inside and between the cities. The efficient use of public transport requires the different modes of transport to be closely interconnected. These hubs act as linkage points between last-mile solutions and fast high-capacity transport. Typically, these hubs also offer other private and municipal services to citizens when they are open.

If it is not possible to use existing hubs to the high-capacity public transport because of the geography and current infrastructure, then cities should consider new services and investments to create such hubs.

11.9 Better user-centric planning of services

City and transport planning should be based both on soft and hard facts. Currently, decisions are based on the top-down decision-making and fine-tuning of the existing solutions. However, in the future, the focus should be on the needs of different customer groups instead of making decisions based on averages.

To overcome this situation, more participatory methods are needed in the city and transport planning. To get more detailed information, mobile feedback collection methods should be used for guiding service development, as the knowledge of peoples' opinions

on new mobility services and their motivations to use them is still partly unknown. One viable alternative would be to use Eurobarometer surveys to get a better knowledge of people's opinions on new mobility services.

11.10 Activating employers and employees

When considering smart commuting, more emphasis should be put on employers and employees. While a general high-quality public transport is the cornerstone, also company specific needs should be taken into account. For example, public transport schedules do not match well with working hours of the shift work, and therefore many employees commute by a private car.

We recommend that public transport planners also survey the large companies and their employees to find ways to improve the use of public transport. The companies could also find ways to increase the sustainability of the employees' commuting. Partly employer- sponsored PT tickets are a recommended way to reduce unnecessary driving. Project case company results also show that different smart ways to combine rides and to schedule them to connection hubs can ease getting qualified employees to commute from a longer distance to a workplace.

11.11 Changing the current mobility paradigm

In the end, there is a need to design and organise mobility in a different way to promote sustainable commuting modes. Instead of providing services based on single modes, the mobility chains need to be addressed by focusing on seamless, intermodal door-to-door trips from a user's perspective. This includes pursuing the goal of optimising the transport system in terms of the resource consumption and emissions. Besides increasing the competitiveness of such an individualised, flexible public transport service, the efficiency is also increased by tapping underused resources.

12 Conclusions and outlook

Sustainable commuting is in the agenda of numerous countries. This project investigated the needs and characteristics of transport users as well as transport providers, analysed trends in the transportation system, set the findings into the context of sustainable commuting and derived a list of measures, especially for the case study of Basel but also for Austria and Finland.

This study revealed that commuters in Basel seem to be particularly happy with ease of use and reliability of the various transport modes. Yet for comfort and enjoyment of travel, public transport shows a significantly lower satisfaction compared to the private car. When asked about aspects that would motivate commuters to a greater use of public transport (PT), a cheaper ticket prize and decreased travel time were mentioned most frequently. Interestingly, no difference in satisfaction between PT and private car were found for these two aspects. We therefore content that price and time measures would be the most effective steering arguments.

High potential in reducing greenhouse gas emissions, lowering traffic jams and enabling access to mobility in rural regions is expected from new forms of mobility solutions like mobility as a service, including all sorts of transport options such as slow modes, public transport, carsharing or ridesharing. Generally, the openness of society to use such options is low, yet younger commuters and low-income groups may be more open towards such mobility offers. Interestingly, stakeholders in the mobility sector are quite open towards these transport services. To close this gap, it is thus encouraged to specifically target commuters that are open towards the new options in order to facilitate the spreading of awareness to other groups and enabling a paradigm shift to more sustainable commuting. More attention should be given to the satisfaction with public transport providers, focusing on cheap and accessible offers as well as providing high comfort. This seems key for fostering a shift from private car to increasing public transport usage.

Mobility management in companies as well as in administrations is essential. The employer should generate a basis for sustainable commuting by pushing/pulling the employees to decrease car use (e.g. parking restrictions, financial bonus) and fostering carpool or ridesharing initiatives. Furthermore, flexible work-hours can be used to decrease rush hour commuting. Public administrations, mobility providers and private companies should join forces, in order to simplify the implementation of new schemes and increase its adoption rate.

Smart commuting is a complex task. It is entwined in interactions between public and private entities, needs and expectations from various stakeholders and the society. Furthermore, transport topics reach out to a plethora of sectors including business, logistics, mobility, accessibility and the environment. As such, a holistic overview is necessary to effectively design sustainable commuting services. This study aims to provide decision makers and transport planners with in depths information about the above-mentioned topics, allowing to make educated and informed decisions, fostering the advance of sustainable commuting. Nonetheless, further research is needed, especially in the fields of shared mobility services such as car- and ridesharing. Here, we expect a growing market and an increasing availability of offers and operators. Whether these offers can effectively reduce car-miles travelled is still very uncertain, as it could also incentivise slow mode travellers to substitute their walking/cycling trip with an easy accessible and shared car. Still, some evidence already confirms its effectiveness in reducing car use but current research base still needs improvements (Transport and Environment, 2017).

12.1 Next steps after end of project

Dissemination activities are planned to go beyond the official end of the smart commuting project. Experiences and competences established during the two-year time period are of high relevance for future projects, especially knowledge in cluster analysis, commuter needs and mobility management strategies. These will, for instance, be used as inputs and basis for work within the Swiss Competence Centre for Energy Research (SCCER) framework. It is further planned to use the developed survey questionnaire in similar projects and further improve the mobility management canvas to yield an effective tool for shaping and creating mobility management strategies.

13 Publications

EU Week, Brussels 2017	**Hoppe, M.** Potential for MaaS in the trinational Basel region
DKG, Tübingen 2017	**Michl, T., Schmelzer, H., Hoppe, M.** Stakeholderprozesse und die Etablierung soziotechnischer Mobilitätsnischen
DKG, Tübingen 2017	**Haerri, F., Hoppe, M.** Mobility-as-a-Service (MaaS) als innovativer Ansatz für die Pendlermobilität.
VNL-Zeitschrift 2017	**Hoppe, M**. Intelligentes mobiles Arbeiten in Wachstumsregionen
ICOMaaS, Tampere 2017	**Surakka, T.J., Haerri, F., Haahtela, T.J., Horila, A.K., Michl, T.** Regulation and Governance Supporting Systemic MaaS Innovations – Towards Innovation Platforms.
Klimafreundlich Pendeln, Brugg 2018	**Haerri, F., Hoppe, M., Hoerler, R.** Smart Commuting, Zukunftsfähiges und nachhaltiges Gestalten der Arbeitsmobilität
TRA Conference, Vienna 2018	**Hoerler, R., Hoppe, M.** Importance of Socio-Economic and Attitudinal Factors in Sustainable Commuting: A Swiss Case Study
Shift Conference, Zurich 2018	**Hoppe, M.** Self-organized mobility :: a solution for Urban Mobility?
Regiosuisse, Lugano 2018	**Hoerler, R., Hoppe, M., Haerri, F.** Smart Commuting – Zukunftsfähiges und Nachhaltiges Gestalten der Arbeitsmobilität
TRB Conference, Washington 2019	**Hoerler, R., Hoppe, M.** Importance of Socio-Economic and Attitudinal Factors in Sustainable Commuting: A Swiss Case Study
Strassenverkehr Schweiz 2019	**Hoppe, M.** Clever pendeln als Alternative zum Stau?

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15 Appendix

15.1 Appendix 1: Country survey

Table 24: Full questionnaire of the commuter survey.

Question(s)	Item(s) and preliminary scale	Additional info
1. Language choice		*Scale: 1x Y* *Defines language of survey*
2. In which country do you live?	Open_____	*Presupposes an independent survey-implementation for each study-region* FI: "municipality"
3. In which country do you work?	Open_____	FI: "municipality"
4. What is your gender?	- female - male - other	*Scale: 1x Y*
5. In which year were you born?	____ (Four digit number)	
6. What is the highest education grade you have completed?	- No school education - Primary education - Secondary education (e.g. high school or vocational school) - Diploma of higher education - Bachelor or equivalent level - Master or equivalent level - Doctoral or equivalent level	*Scale: 1x Y*
7. Which is your current employment status?	- full time employment - part-time employment - incidental work periods - maternity leave - currently without work - student - other:	*Scale: 1x Y to all* *If student -> Show comment that the term "workplace" also refers to "place of study"*
8. How many persons live in your household (including you)?	____ (number)	
9. How many persons in your household are currently working or studying (including you)?	____ (number)	
10. How many persons in your household are younger than 18 years (including you)?	____ (number)	
11. How many of the following vehicles does your household own?	cars: ____ (number) motorcycles: _____ (number) bicycles: _____ (number) e-bikes: _____ (number)	
12. What is your household's total net income per month?	_____ EUR	Dropdown with choice EUR or CHF (variable: hh_currency)
13. Do you hold a driving license?	- Yes - No	*If N: Skip Q24*
14. How would you describe the environment you're living in?	- Rural - Village - Suburban - Urban - City center	*Scale: 1x Y*

15. Are these basic necessities within walking distance from your place of residence?	- Public transport access point - Groceries or supermarket - School or kindergarten - Pharmacy / drugstore - Other public services	*Scale: Y/N to all*
16. Which of the following public transport access points are in walking distance from your home?	- Bus stop - Tram stop - Train station - Subway station - Taxi station - Bike- or Carsharing station Other_____	*Scale: Y/N to all* *If there's more than one Y -> We know the access point is an intermodal hub.*
17. In which of the following places do you work during your typical work week?	- At main workplace - At home - During business trips - During commuting - While visiting a client - At other places: _____	*Scale: Y/N to all*
18. How would you describe the environment your primary workplace is located in?	- Rural - Village - Suburban - Urban - City center	*Scale: 1x Y*
19. How many days you go to your main workplace in average per week?	_____ days	

20. What is the estimated distance between your home and your main workplace?	____ km	
21. Which means of transport do you use for commuting trips and how often?	- Car - as driver - Car - as passenger - Motorcycle - Bus - Train - Tram - Subway/Metro - Bicycle - e-bike - Walking - Other_____	*Scale: 1=never; 5=every workday* *If none of the PT-Answers were chosen, skip Q25.* *If one of the "Car"-Options are chosen: Ask Q30* *If one of the "PT"-Options are chosen: Ask Q31* *If one of the "Bike"-Options are chosen: Ask Q32* *If "walking" is chosen: Ask Q33*
22. Please estimate the daily total time spent for commuting on average?	- ____ minutes	
23. Which other means do you consider for commuting, if any?	Open_____	
24. Do you have access to a private or company owned vehicle for commuting?	- Private vehicle - Company vehicle	*Scale: Y/N to all*
25. Do you use one of the following forms of PT-tickets for commuting?	- Single/return ticket - Daily ticket - Multi-trip ticket - Value on travel card - Season ticket - Route-specific season ticket - Year ticket - Discount card (e.g. discount card for pensioners or students) - Other _____	*Scale: Y/N to all* *Example should be country-specific*

26. How often do you combine workplace commuting with other activities?	- Shopping - Social activities - Picking-up someone - Leisure or Sports - Education - Using public services Other: _____	*Scale: 1=never; 5=every workday*
27. How often do you use the Internet for the following actions related to commuting?	- Information seeking (e.g. routes) - Booking - Paying Other: _____	*Scale: 1=never; 5=every workday*
28. What are you doing while using your main mode of commuting?	- Reading (newspaper, magazine, book) - Working/studying without electronic devices - Using electronic devices for working/studying - Using electronic devices for leisure (music, video, news, games, internet surfing) - Calling - Eating/Drinking - Sleeping - Personal communication with fellow travelers - Other: _____	*Scale: Y/N to all*
29. How satisfied are you with following aspects of your current main mode of commuting?	- Price for services - Reliability / punctuality - Service frequency - Comfort - Travel time - Easy to use - Enjoyment of travel	*Scale: 1 =not at all; 5 = very much* *Answer-categories based on Swiss "Micro-sensus 2010" Q5.29* *Main mode of commuting is deduced from Q21.*

30. Why do you use the car for commuting?	- No alternative - Security - Reliability - Medical reasons - Weather - Faster - Cheaper - More flexible - Privacy - Environmental concerns - Transportation of goods - Transportation of other people - To avoid traffic jams - Free parking-space at work - Bad access to public transport Other: _____	*Scale: Y/N to all* *Answer-categories based on Swiss "Micro-sensus 2010" Q5.26 – 5.29*
31. Why do you use public transport for commuting?	- No alternative - Security - Reliability - Medical reasons - Weather - Faster - Cheaper - More flexible - Privacy - Environmental concerns - Transportation of goods - To avoid traffic jams - Possibility to work while commuting Other:	*Scale: Y/N to all* *Answer-categories based on Swiss "Micro-sensus 2010" Q5.26 – 5.29*

32. Why do you use a bicycle/e-bike for commuting?	- No alternative - Security - Reliability - Medical reasons - Weather - Faster - Cheaper - More flexible - Privacy - Environmental concerns - Transportation of goods - To avoid traffic jams - To do sport - Other: _____	*Scale: Y/N to all* *Answer-categories based on Swiss "Micro-sensus 2010" Q5.26 – 5.29*
33. Why do you walk for commuting?	- No alternative - Security - Reliability - Medical reasons - Weather - Faster - Cheaper - More flexible - Privacy - Environmental concerns - Transportation of goods - To avoid traffic jams - To do sport - Bad public transport allotment - Other: _____	*Scale: Y/N to all* *Answer-categories based on Swiss "Micro-sensus 2010" Q5.26 – 5.29*

34. Which of the following aspects would encourage you to use PT more frequently for commuting?	- Cheaper tickets - Tickets provided by the employer - More comfort in public transport vehicles - Better connecting services (decreased waiting time) - More frequent service - Decreased travel time - Improved reliability - Street tolls for private cars in city centers - Better safety-feeling - Better transport possibilities for luggage/goods - Park & ride offers - Better bicycle-transport opportunities - Better bicycle parking opportunities - Better walking accessibility - Opportunities to work during the trip - Other:_____	*Scale: Y/N to all* *Answers based on Swiss "Micro-sensus 2010" Q9.6*
35. What tools, infrastructure or services would you need to work during trips?	Open_____	
36. Could you imagine using one or more of the following transport modes for your commuting trips?	- Car sharing - Ride sharing (e.g. carpooling) - Bike sharing - On-demand service (taxi, uber, etc.) - Shared on-demand service - Other_____	*Scale: Y/N/haven't heard of it to all*

37. If you commute during peak hours, why?	- Childcare / school opening hours - Requirement of job - Company culture - Habit - Better connectivity / timetable - Other _____	*Scale: Y/N to all* *If no answer to this question -> They don't commute during peak hours.*

15.2 Appendix 2: WP 2.1.1

15.2.1 Tables of the regression analysis

Table 25: SPSS output from the ordinal logistic regression with the dependent variable "enjoyment of travel".

Variables in the Regression	B	S.E.	Wald χ^2	df	Sig.	95% C.I.	
						Lower	Upper
Level: Enjoyment of travel 1	-5.555	.635	76.472	1	.000	-6.800	-4.310
Level: Enjoyment of travel 2	-3.705	.589	39.625	1	.000	-4.859	-2.552
Level: Enjoyment of travel 3	-1.963	.566	12.037	1	.001	-3.072	-.854
Level: Enjoyment of travel 4	-.695	.555	1.564	1	.211	-1.783	.394
Multimodal	-2.162	.333	42.266	1	.000**	-2.814	-1.510
Private	-1.550	.358	18.779	1	.000**	-2.251	-.849
Public	-2.224	.309	51.813	1	.000**	-2.830	-1.619
Active (reference)	0	.	.	0	.	.	.
Household size: 1p	-.116	.329	.124	1	.724	-.760	.529
Household size: 2-3p	-.115	.250	.212	1	.645	-.605	.375
Household size: gt3p (reference)	0	.	.	0	.	.	.
Residence: Rural	-.031	.268	.013	1	.908	-.557	.495
Residence: Semi-urban	-.265	.267	.991	1	.320	-.788	.257
Residence: Urban or centre (reference)	0	.	.	0	.	.	.
Driving licence: Yes	-.477	.367	1.690	1	.194	-1.197	.242
Driving licence: No (reference)	0	.	.	0	.	.	.
Female	-.201	.218	.844	1	.358	-.628	.227
Male (reference)	0	.	.	0	.	.	.
Commuting distance	-.008	.004	3.844	1	.050*	-.015	-2.928E-6
Income per active person	5.923E-5	3.463E-5	2.926	1	.087	-8.638E-6	.000
Age	-.003	.009	.091	1	.763	-.020	.014

** And *, Significant at p <= 0.01 and p <= 0.05, respectively. B, Parameter estimate; S.E., Standard error; df, degree of freedom; C.I., 95% confidence interval for B.

Table 26: SPSS output from the ordinal logistic regression with the dependent variable “openness to car-/ridesharing”.

Variables in the Regression	B	S.E.	Wald χ^2	df	Sig.	95% C.I.	
						Lower	Upper
Level: Openness car-/ridesharing 0	-.210	.794	.070	1	.791	-1.767	1.346
Level: Openness car-/ridesharing 1	.792	.798	.986	1	.321	-.771	2.356
Multimodal	.114	.537	.045	1	.833	-.939	1.166
Private	-1.076	.597	3.251	1	.071	-2.246	.094
Public	.011	.479	.001	1	.981	-.928	.950
Active (reference)	0	.	.	0	.	.	.
Household size: 1p	.342	.424	.650	1	.420	-.489	1.173
Household size: 2-3p	.244	.320	.582	1	.446	-.383	.870
Household size: gt3p (reference)	0	.	.	0	.	.	.
Residence: Rural	.454	.342	1.761	1	.185	-.216	1.124
Residence: Semi-urban	.027	.359	.006	1	.941	-.678	.731
Residence: Urban or centre (reference)	0	.	.	0	.	.	.
Driving licence: Yes	1.112	.554	4.031	1	.045*	.026	2.198
Driving licence: No (reference)	0	.	.	0	.	.	.
Female	-1.588	.550	8.339	1	.004**	-2.665	-.510
Male (reference)	0	.	.	0	.	.	.
Commuting distance	.002	.005	.091	1	.763	-.009	.012
Income per active person	-8.732E-5	5.061E-5	2.977	1	.084	.000	1.187E-5
Age	-.035	.012	8.935	1	.003**	-.058	-.012
Multimodal*Female	.073	.779	.009	1	.925	-1.453	1.599
Private*Female	2.294	.822	7.784	1	.005**	.683	3.906
Public*Female	.509	.699	.529	1	.467	-.862	1.880
Active*Female (reference)	0	.	.	0	.	.	.
Multimodal*Male (reference)	0	.	.	0	.	.	.
Private*Male (reference)	0	.	.	0	.	.	.
Public*Male (reference)	0	.	.	0	.	.	.

** And *, Significant at $p <= 0.01$ and $p <= 0.05$, respectively. B, Parameter estimate; S.E., Standard error; df, degree of freedom; C.I., 95% confidence interval for B.

Table 27: Output from the multinomial logistic regression with the dependent variable mode choice and the reference category private motorized transport.

Variables in the Regression	B	S.E.	Wald X^2	df	Sig.	EXP(B)	95% C.I.	
							Lower	Upper
Multimodal: Intercept	2.571	1.366	3.546	1	.060			
Household size: 1p	.205	.613	.112	1	.738	1.227	.369	4.081
Household size: 2-3p	-.143	.418	.116	1	.733	.867	.382	1.969
Household size: gt3p (reference)	0	.	.	0	.	.	.	.
Residence: Rural	-1.250	.455	7.547	1	.006**	.287	.118	.699
Residence: Semi-urban	-1.260	.495	6.466	1	.011*	.284	.107	.749
Residence: Urban or centre (reference)	0	.	.	0	.	.	.	.
Driving licence: Yes	-1.729	1.113	2.410	1	.121	.178	.020	1.574
Driving licence: No (reference)	0	.	.	0	.	.	.	.
Female	1.112	.367	9.181	1	.002**	3.039	1.481	6.238
Male (reference)	0	.	.	0	.	.	.	.
Commuting distance	.017	.008	4.590	1	.032*	1.017	1.001	1.032
Income per active person	.000	.000	.202	1	.653	1.000	1.000	1.000
Age	-.016	.015	1.136	1	.287	.984	.955	1.014
Public Transport: Intercept	4.029	1.298	9.634	1	.002			
Household size: 1p	.222	.578	.147	1	.701	1.248	.402	3.879
Household size: 2-3p	-.160	.391	.167	1	.683	.852	.396	1.834
Household size: gt3p (reference)	0	.	.	0	.	.	.	.
Residence: Rural	-1.643	.435	14.262	1	.000**	.193	.082	.454
Residence: Semi-urban	-1.251	.454	7.590	1	.006**	.286	.118	.697
Residence: Urban or centre (reference)	0	.	.	0	.	.	.	.
Driving licence: Yes	-2.440	1.068	5.226	1	.022*	.087	.011	.706
Driving licence: No (reference)	0	.	.	0	.	.	.	.
Female	.819	.340	5.789	1	.016*	2.268	1.164	4.418
Male (reference)	0	.	.	0	.	.	.	.
Commuting distance	.009	.008	1.495	1	.221	1.009	.994	1.024
Income per active person	.000	.000	.028	1	.866	1.000	1.000	1.000
Age	-.020	.014	1.937	1	.164	.980	.953	1.008
Active Modes: Intercept	5.051	1.355	13.890	1	.000			
Household size: 1p	-.540	.615	.773	1	.379	.582	.175	1.944
Household size: 2-3p	-.769	.419	3.368	1	.066	.464	.204	1.054
Household size: gt3p (reference)	0	.	.	0	.	.	.	.
Residence: Rural	-2.719	.583	21.732	1	.000**	.066	.021	.207
Residence: Semi-urban	-1.586	.463	11.749	1	.001**	.205	.083	.507
Residence: Urban or centre (reference)	0	.	.	0	.	.	.	.
Driving licence: Yes	-1.360	1.119	1.475	1	.225	.257	.029	2.303
Driving licence: No (reference)	0	.	.	0	.	.	.	.
Female	.675	.373	3.282	1	.070	1.964	.946	4.076
Male (reference)	0	.	.	0	.	.	.	.
Commuting distance	-.076	.020	14.266	1	.000**	.927	.891	.964
Income per active person	.000	.000	2.366	1	.124	1.000	1.000	1.000
Age	-.012	.015	.678	1	.410	.988	.959	1.017

** And *, Significant at $p <= 0.01$ and $p <= 0.05$, respectively. B, Parameter estimate; S.E., Standard error; df, degree of freedom; EXP(B), Odds ratio; C.I., 95% confidence interval for EXP(B). The reference category is private motorized transport.

15.3 Appendix 3: WP 2.1.2

15.3.1 Mobility trend blend

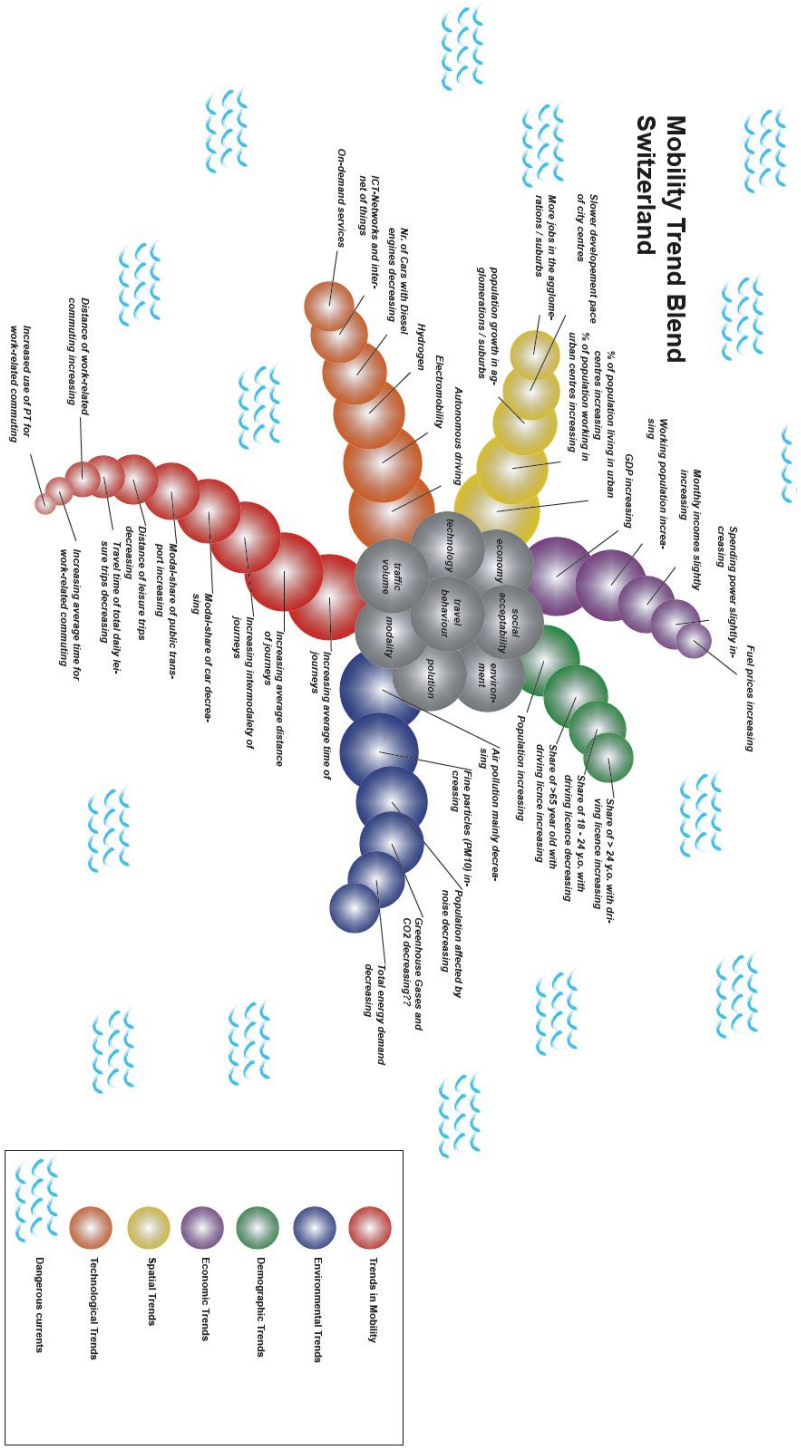

Figure 105: Own work, derived from (Watson and Ben, 2008). CC ShareAlike Licence.

15.4 Appendix 4: WP 2.2

15.4.1 Stakeholder network data collection tool – screenshots

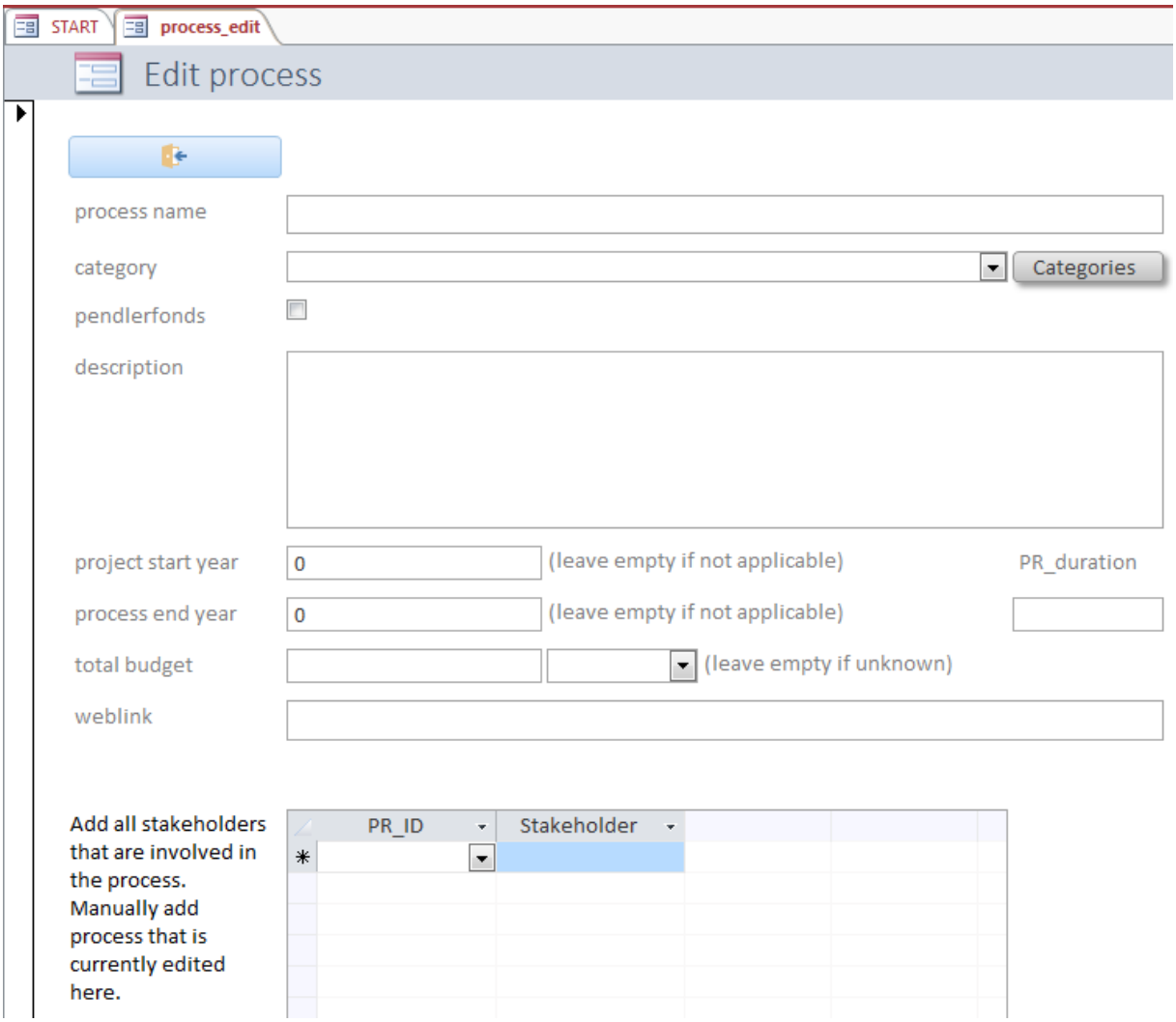

Figure 106: Editing of processes in the stakeholder network data collection tool.

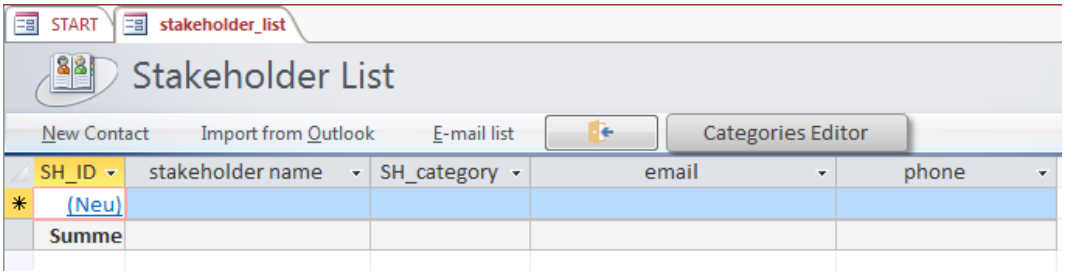

Figure 107: Editing of the stakeholder list in the stakeholder network data collection tool.

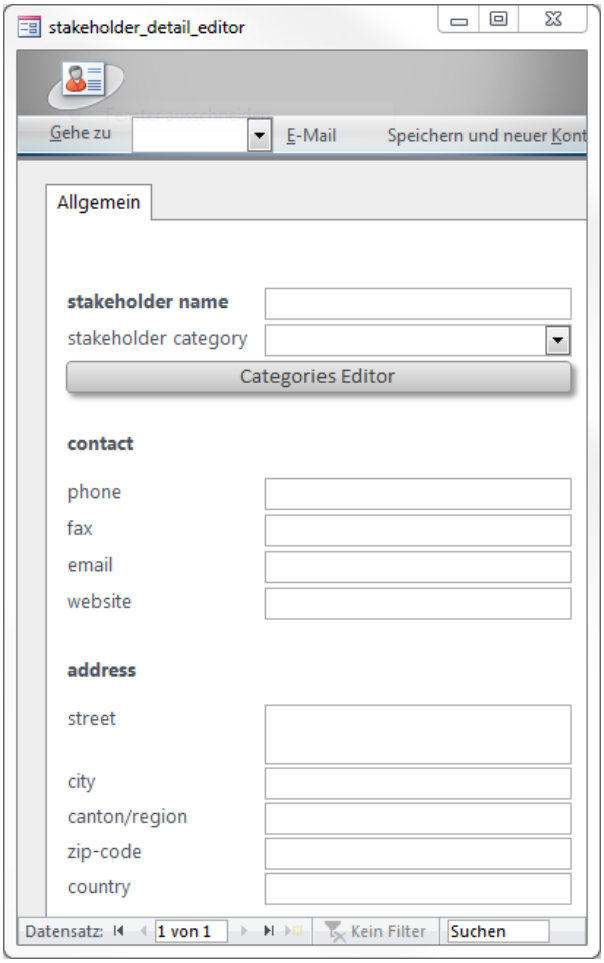

Figure 108: Editing of stakeholder details in the stakeholder network data collection tool.

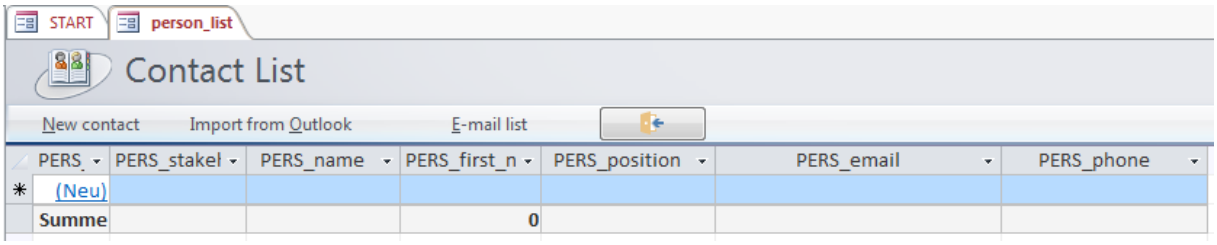

Figure 109: Editing of the stakeholder-representative list in the stakeholder network data collection tool.

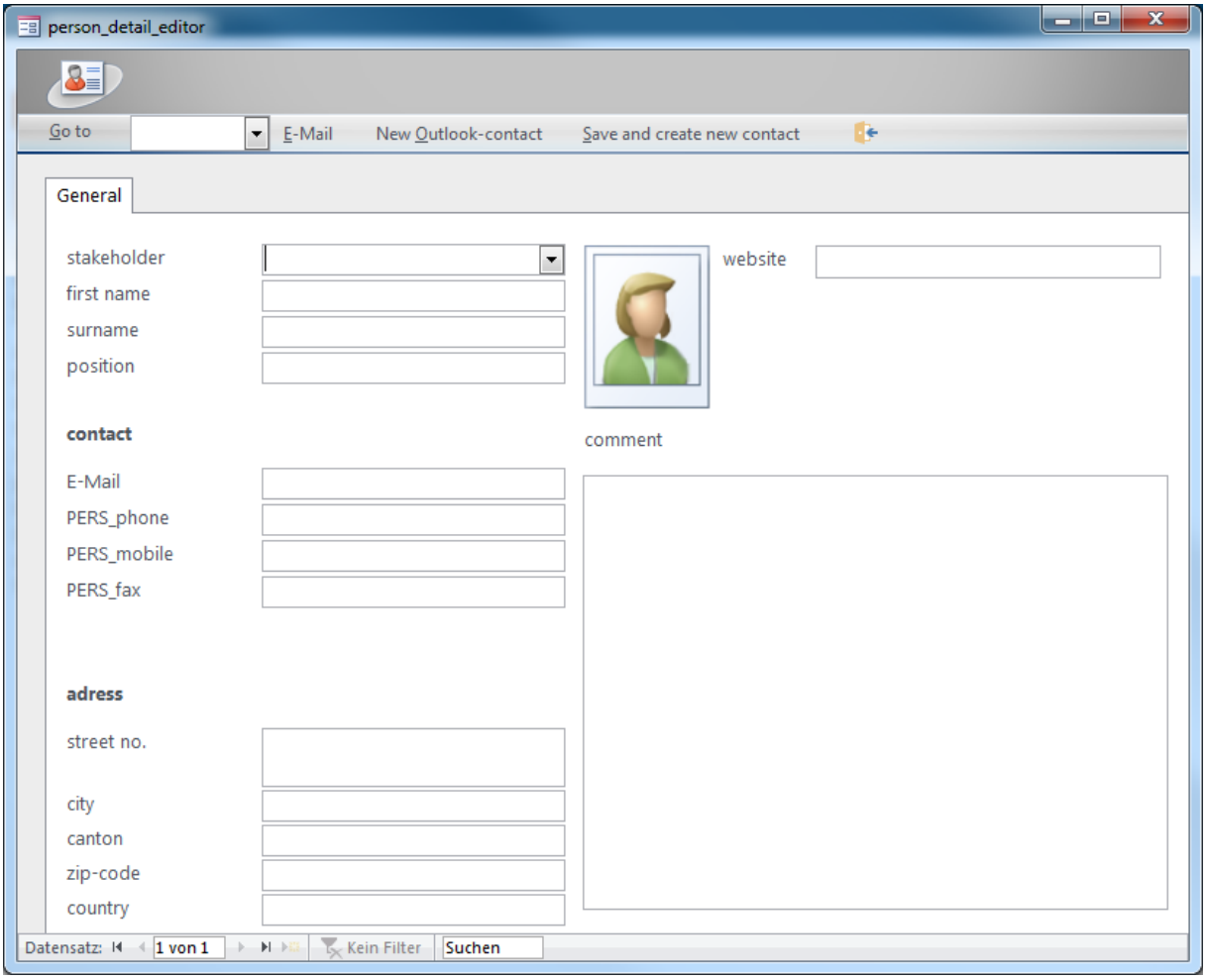

Figure 110: Editing of stakeholder-representative details in the stakeholder network data collection tool.

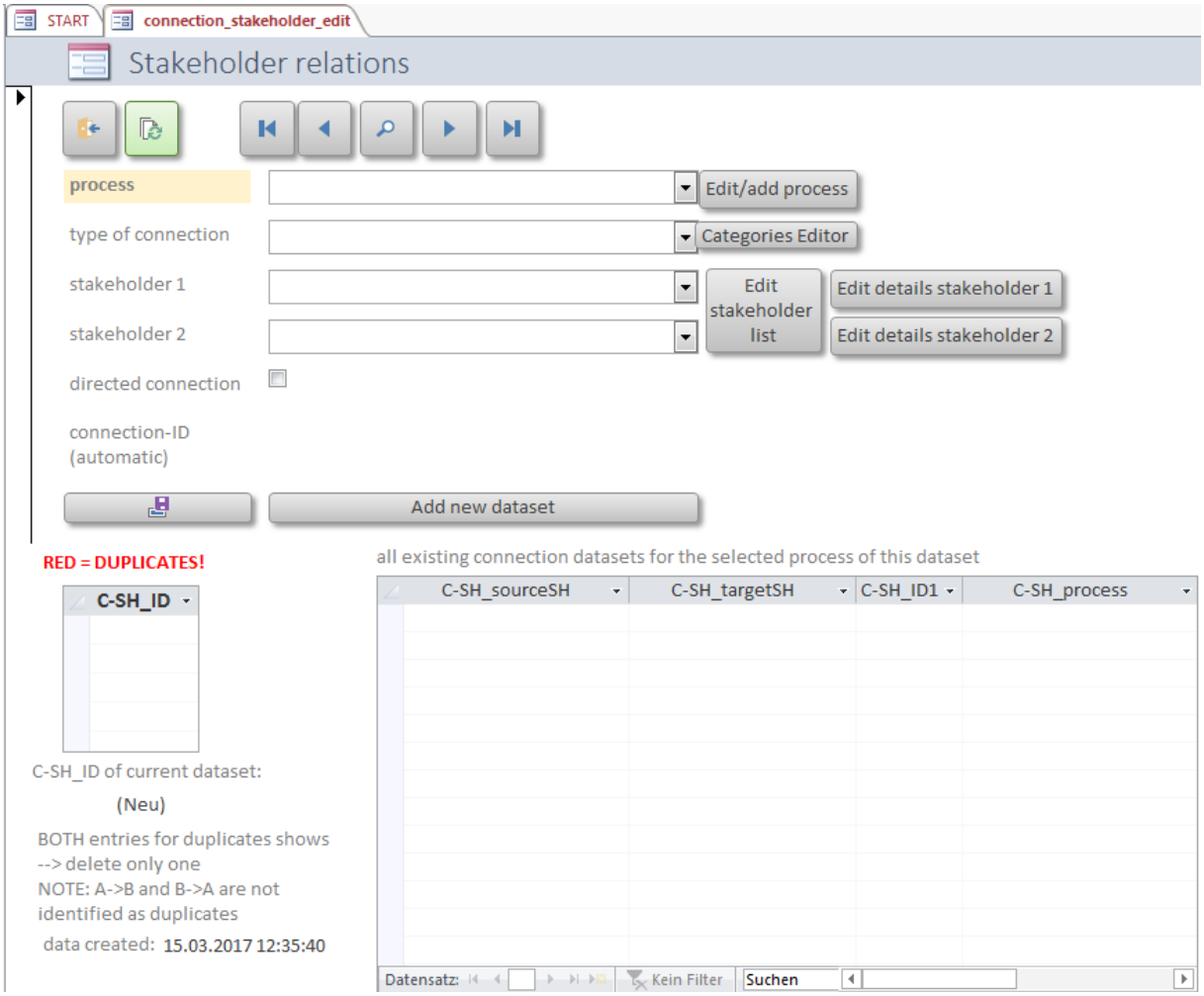

Figure 111: Editing of stakeholder ties in the stakeholder network data collection tool.

15.4.2 Additional figures

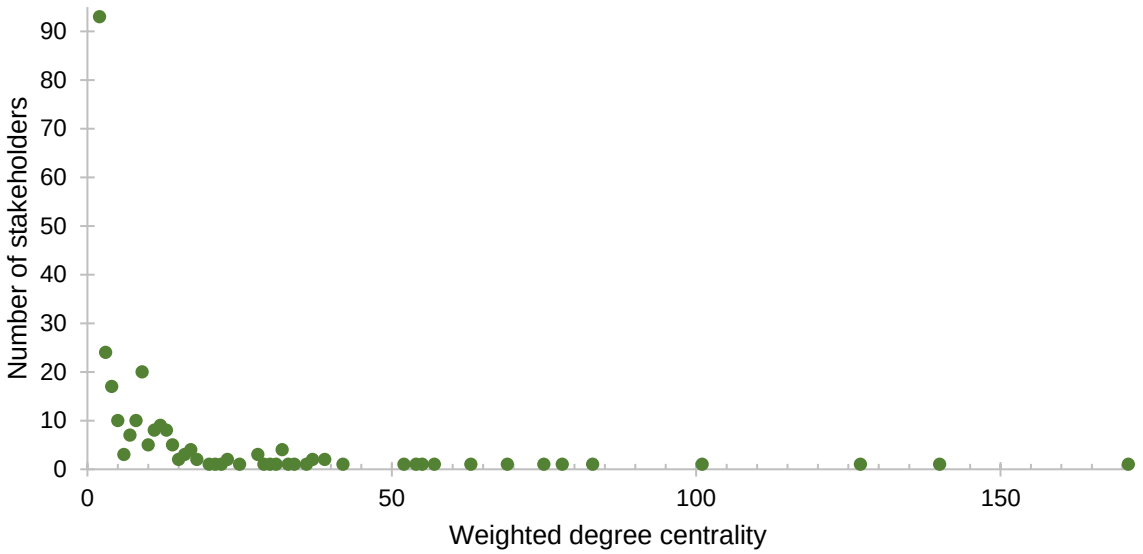

Figure 112: Frequency of weighted degree centrality.

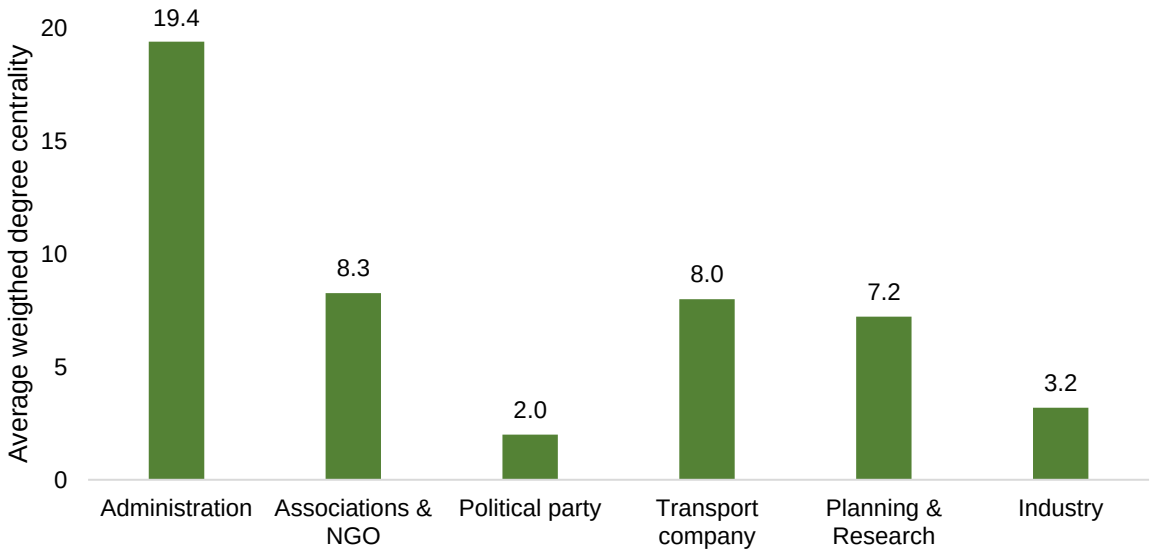

Figure 113: Average weighted degree centrality according to stakeholder category.

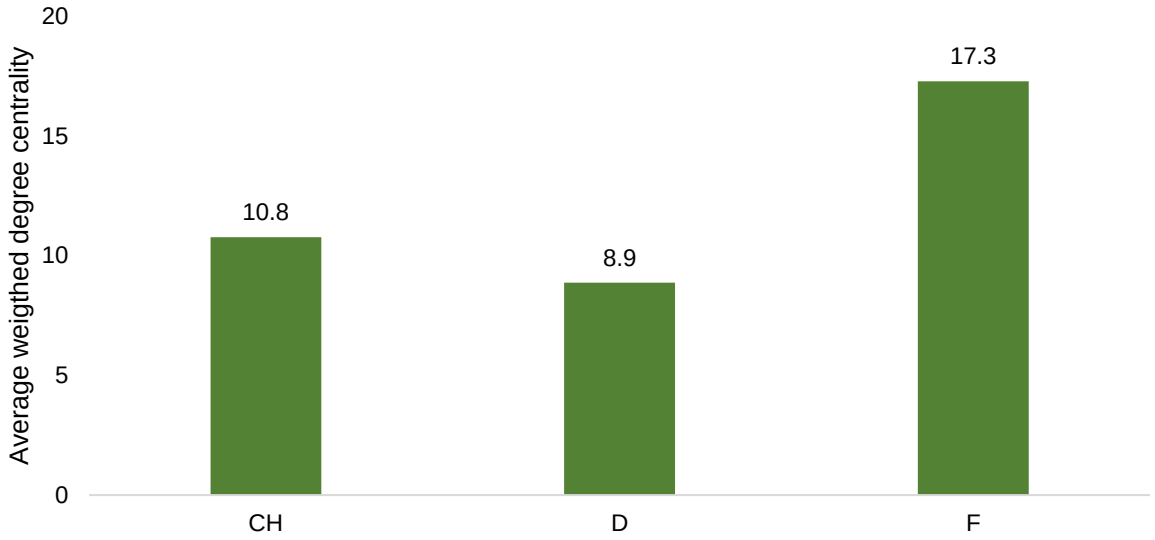

Figure 114: Average weighted degree centrality according to stakeholder country.

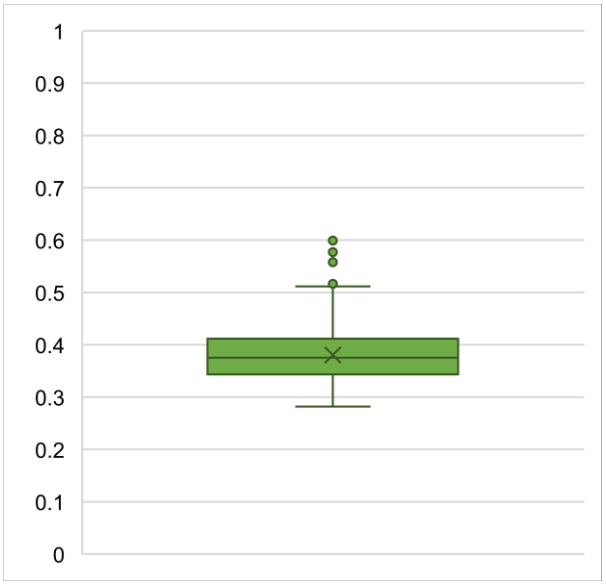

Figure 115 Boxplot closeness centrality.

Figure 116 Boxplot eigenvector centrality.

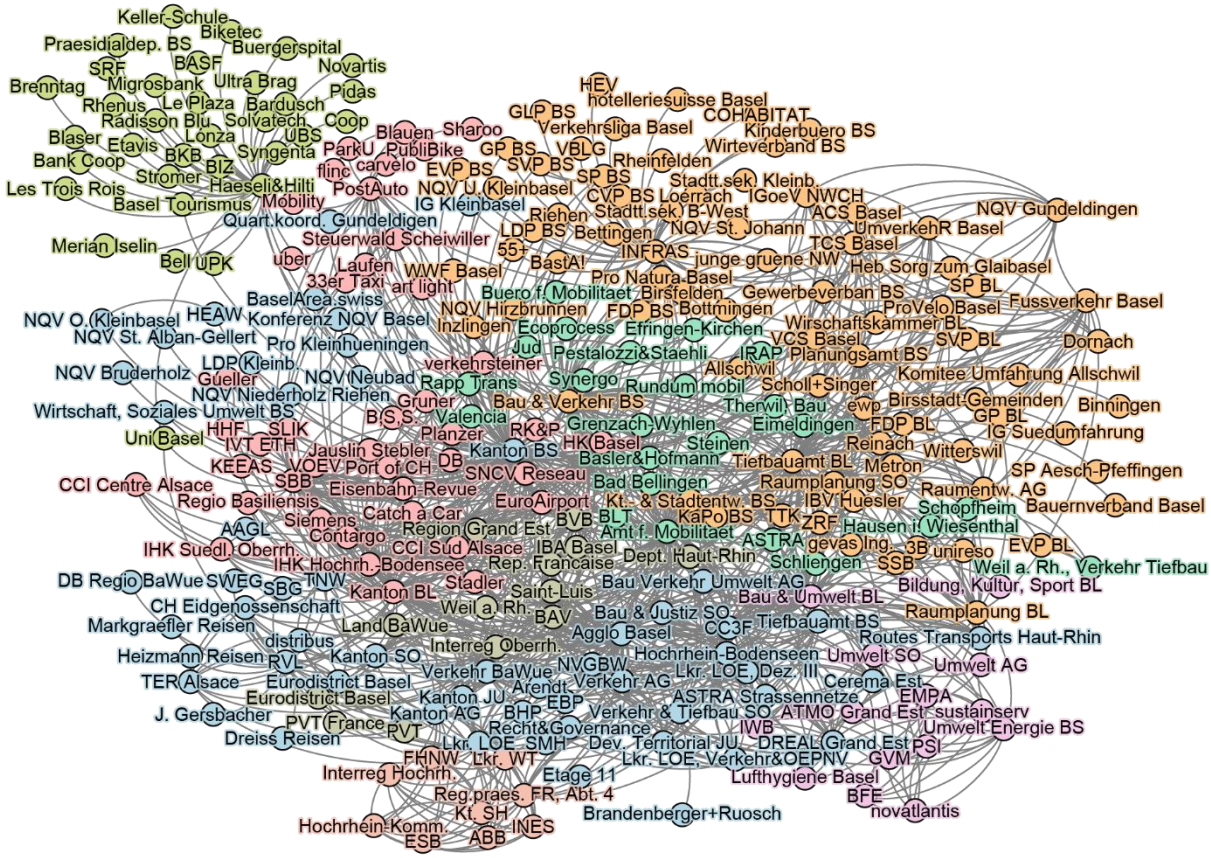

Figure 117: Stakeholder clusters (modularity) based on unweighted edges.

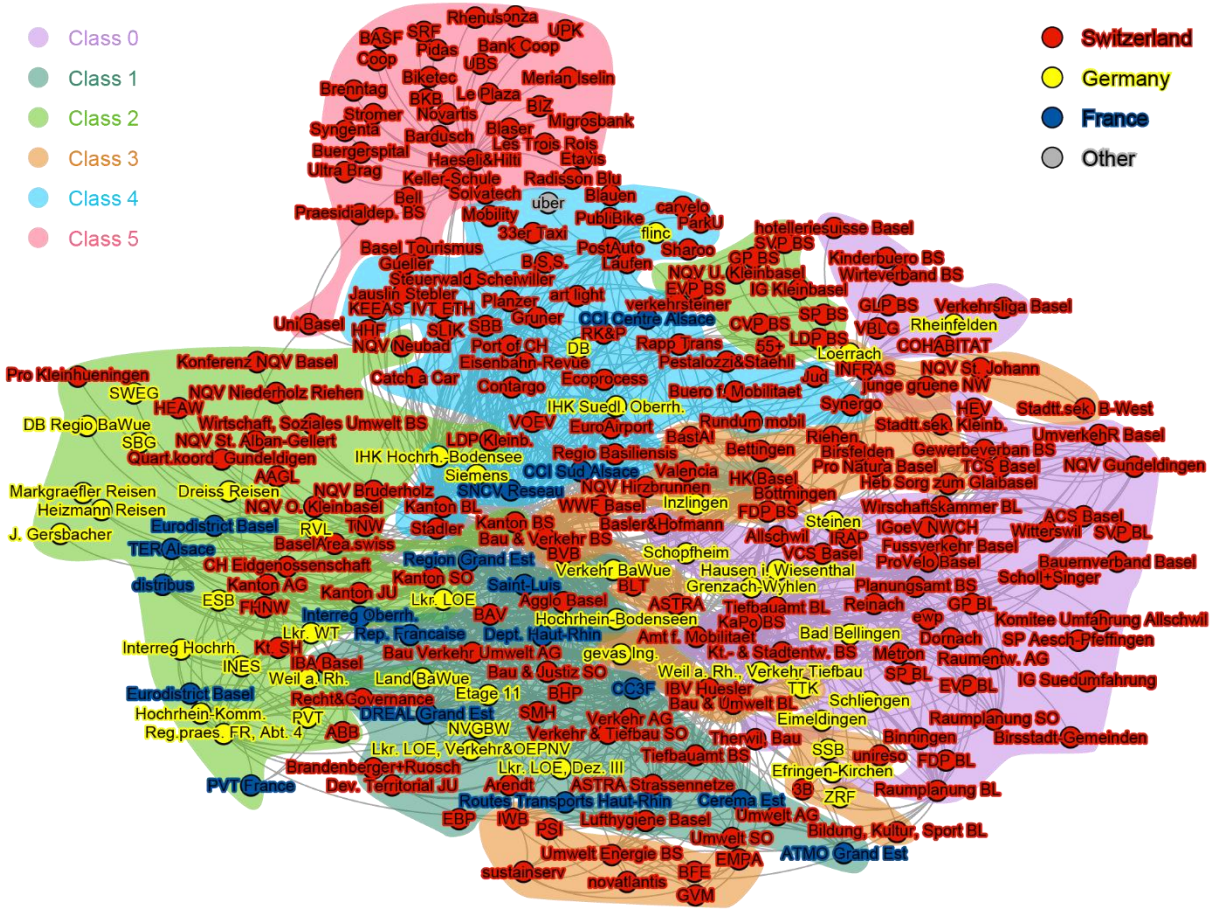

Figure 118: Stakeholder clusters (modularity) with stakeholders according to country.

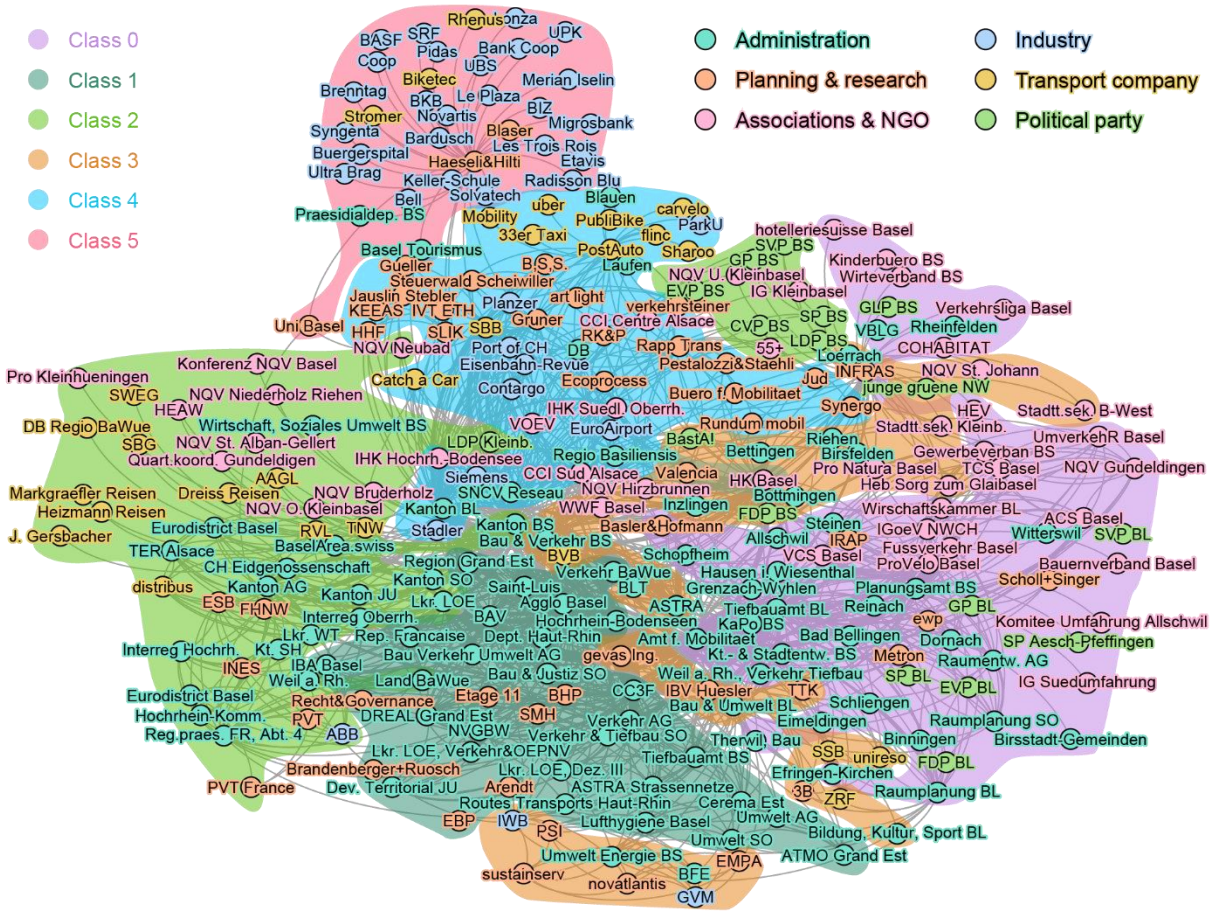

Figure 119: Stakeholder clusters (modularity) with stakeholders according to stakeholder category.

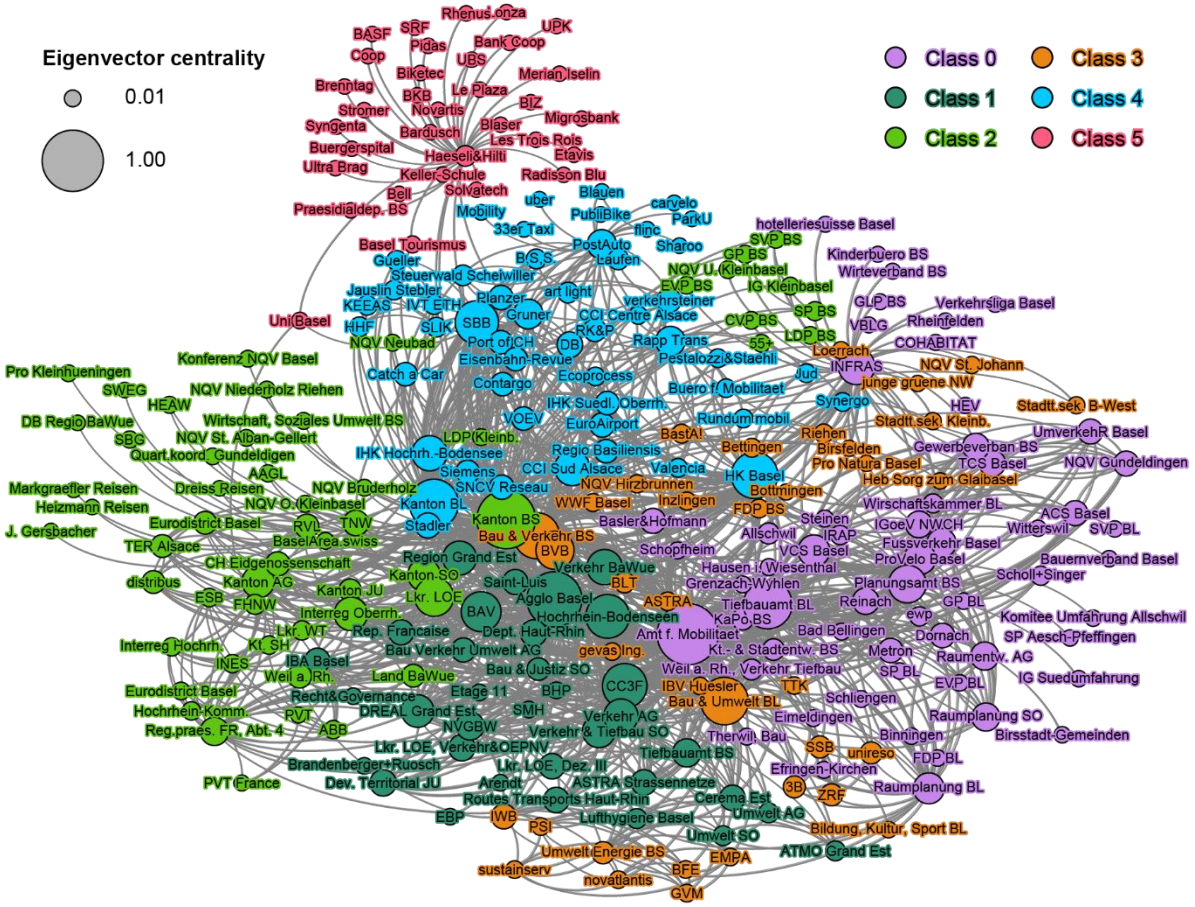

Figure 120: Stakeholder clusters (modularity) with stakeholders according to eigenvector centrality.

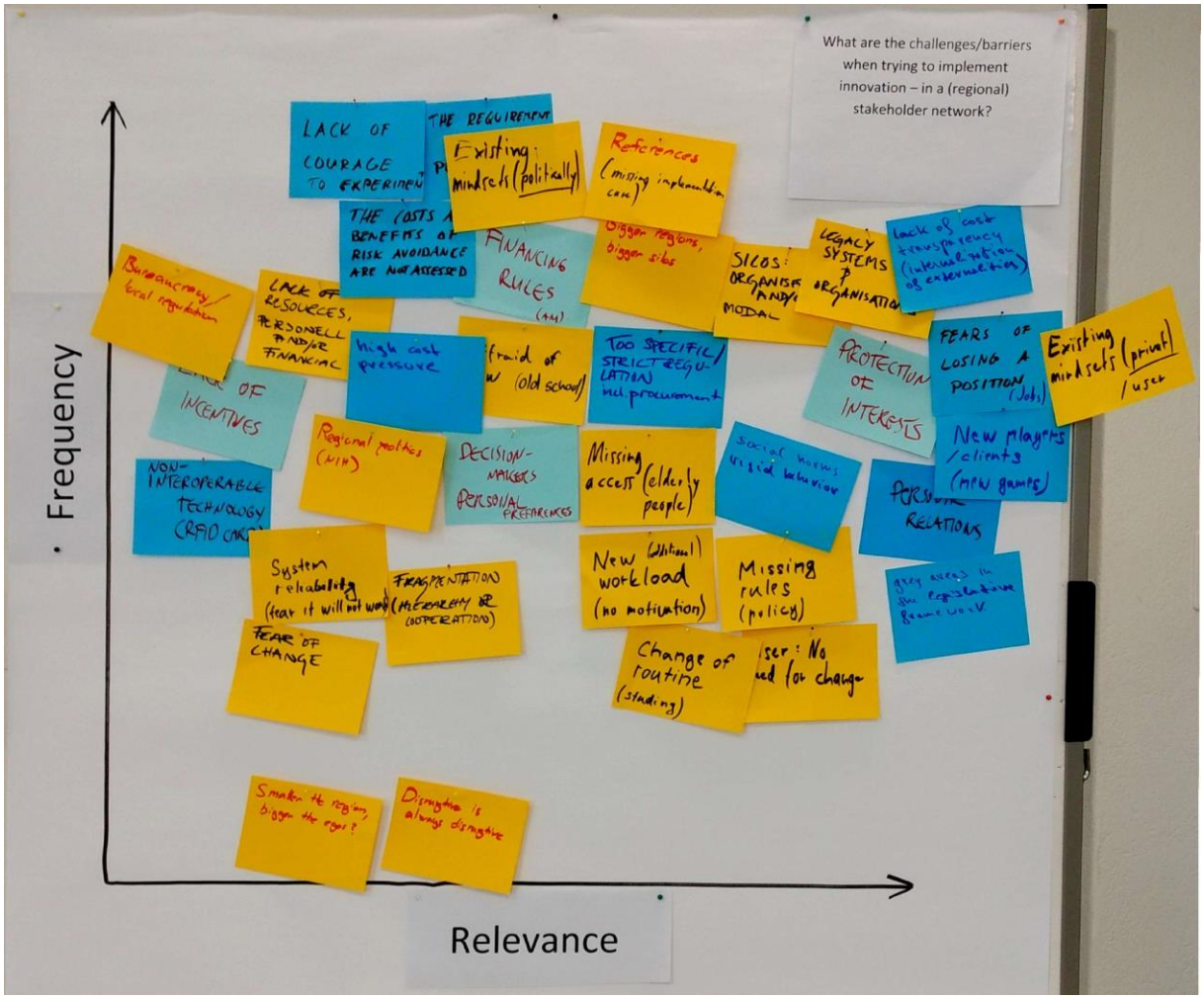

Figure 121: Results of workshop 1 (challenges & barriers).

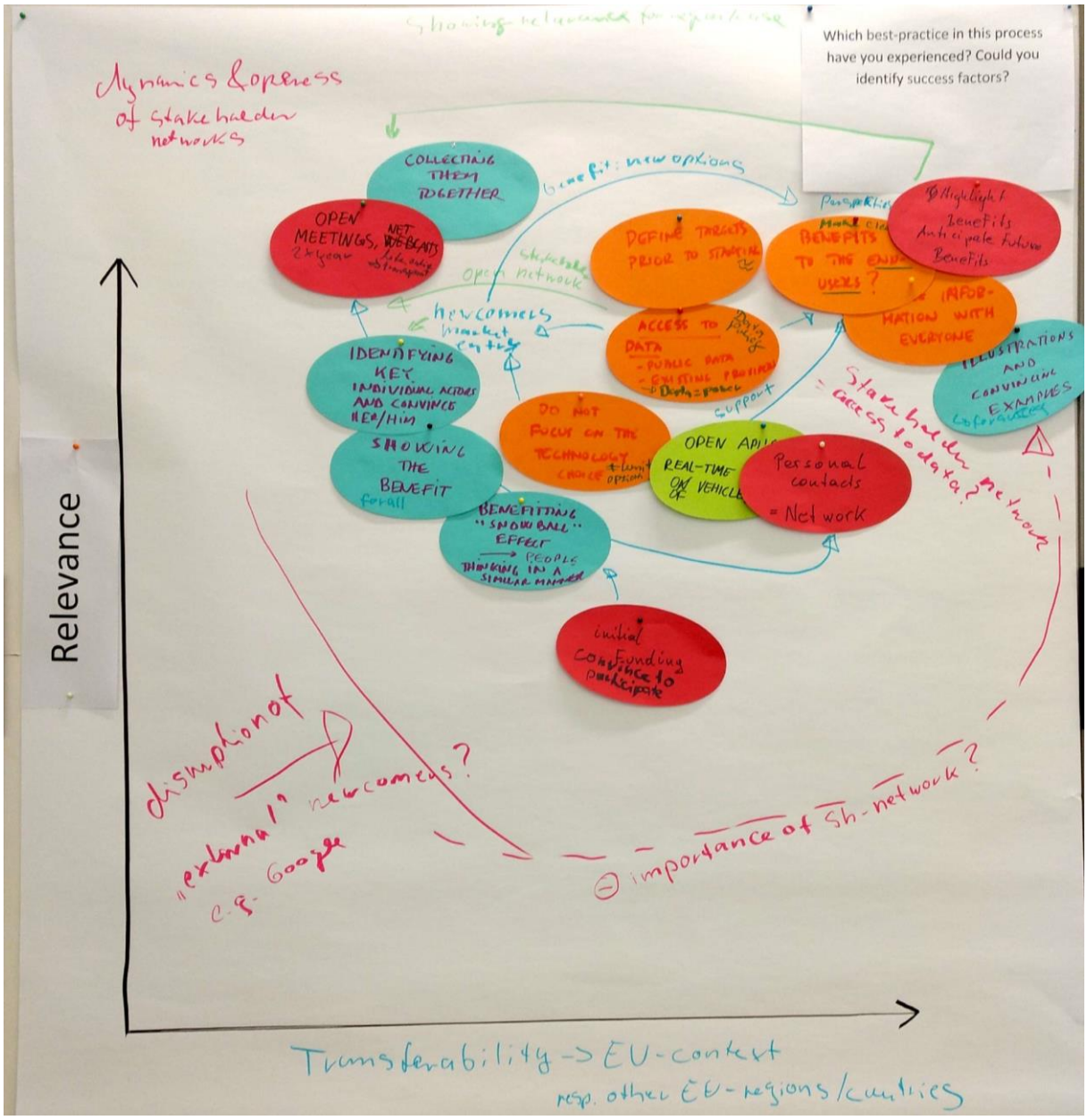

Figure 122: Results of workshop 2 (best practice).

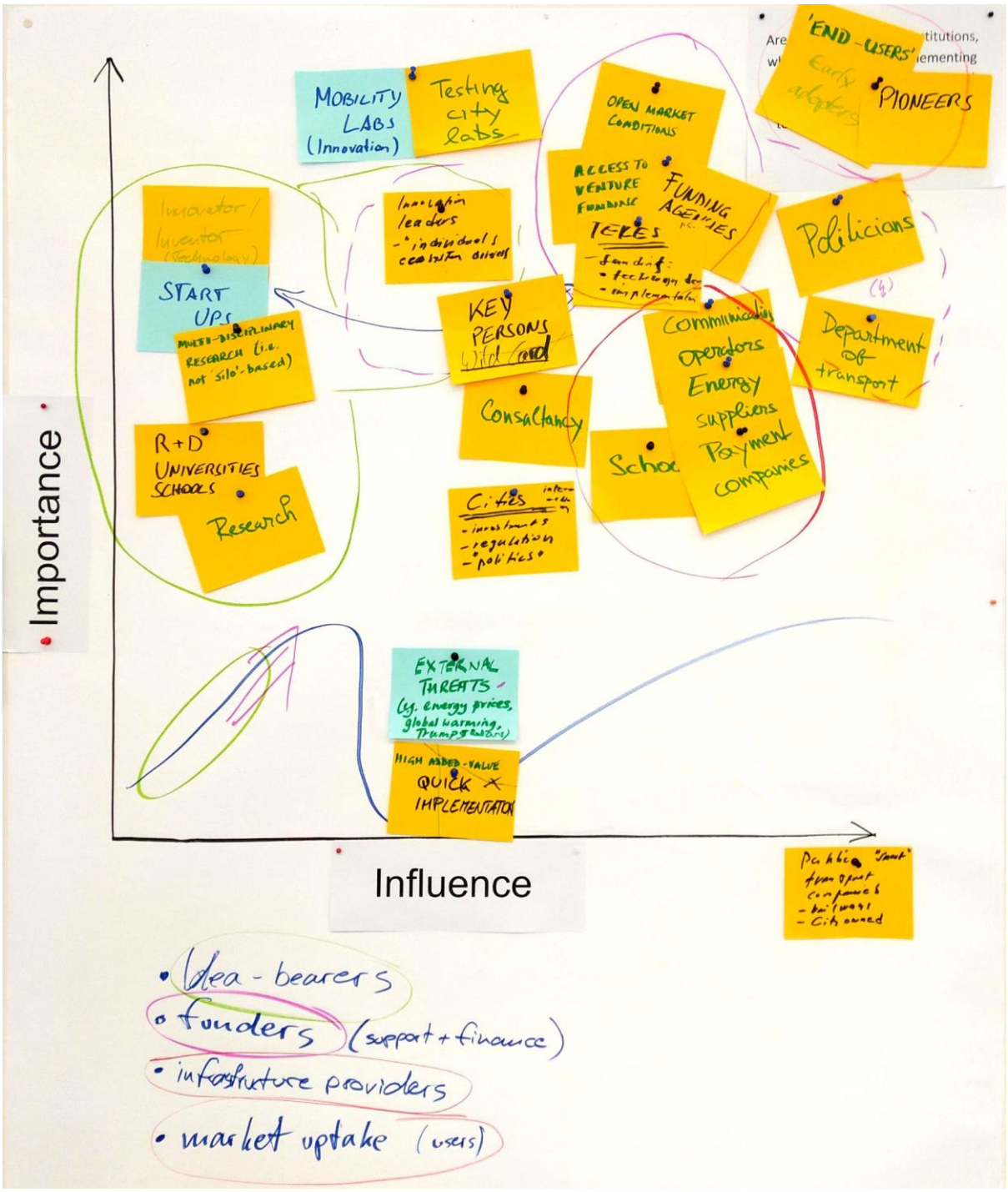

Figure 123: Results of workshop 3 (key stakeholders).

Figure 124: Structured results of workshop 3 (key stakeholders).

15.4.3 Additional tables

Table 28: Number of identified processes according to categories.

Process category	Count
Project	26
Infrastructure Park&Ride / Bike&Ride	16
Infrastructure public transport	6
Infrastructure road	2
Infrastructure cyclepath	2
Policy	18
Strategy and policy	14
Public participation	4
Communication	9
Mobility management	5
Mobility study	3
Event / conference	1
Cooperation platform	5
Transport association	5
Innovation platform	3

Pilot project	2
MaaS	1
TOTAL	61

Table 29: Number of identified Stakeholders according to categories.

Stakeholder category	Count
Administration	93
Public administration canton / Land / region	35
Public administration municipal	26
Regional cooperation platform	13
Public administration regional	11
Public administration national	8
Planning & Research	49
Consulting and planning	40
Research institution	9
Associations & NGO	44
NGO and lobby	22
Citizen group	16
Chamber of Commerce	6
Industry	37
Company / industry	37
Transport company	28
Transport company (other)	15
Transport association	4
Public transport company local	4
Public transport company regional	3
Public transport company national	2
Political party	17
Political Party	17
TOTAL	268

Table 30: Number of identified Stakeholders according to location.

Stakeholder location	Count
Switzerland	204
Basel-Stadt	91
Basel-Landschaft	34
unknown	22
Zurich	17
Bern	16
Aargau	8
Solothurn	6
Lucerne	2
St. Gallen	2
Jura	2
Schaffhausen	1
Fribourg	1
Nidwalden	1
Geneva	1
Germany	45
France	18
USA	1
TOTAL	268

Table 31: Description of the properties of the stakeholder groups.

Cluster No. (Gephi dataset)	0	1	2	3	4	5
Colour in graph (RGB)	198/134/233 pink	46/144/114 dark green	95/198/19 bright green	234/134/21 orange	0/202/255 blue	255/92/129 red
Node count	58	34	55	37	50	33
Country	• Mostly Swiss 1/4 of total Swiss Some German • No French	• Lowest share of Swiss • 1/4 French • 1/2 of total French • Some German	• 1/2 Swiss 1/3 German • 40% of total Germans • Some French	• Mostly Swiss • Some German • No French	• Mostly Swiss • Some German • Little French	• Only Swiss
Category	• Administration dominant • Largest share of total Associations&NGO • High share of total political parties • No transport companies	• Only administration (80%) and planning&research (20%) • No transport companies	• Generally very diverse • 1/4 of Associations&NGO • High share of total political parties • >1/3 of total transport companies	• Generally very diverse • No exceptionally high shares of a category • No high share of any category total	• Especially research & planning • Others equally relevant (besides political parties) • >1/3 of total transport companies	• 3/4 industry • 2/3 of total industry • Others marginal

Centralities	• Highest betweenness • All above average	• Highest values in all except betweenness (here: lowest)	• No peculiarities	• No peculiarities	• No peculiarities besides rather low betweenness	• Lowest values in all except betweenness

Table 32: Stakeholder countries according to modularity.

	Share of country within the cluster				Share of cluster concerning country total			
Cluster	CH	D	F	other	CH	D	F	other
0	82.8%	17.2%	0.0%	0.0%	23.6%	22.2%	0.0%	0.0%
1	55.9%	17.6%	26.5%	0.0%	9.4%	13.3%	50.0%	0.0%
2	56.4%	32.7%	10.9%	0.0%	15.3%	40.0%	33.3%	0.0%
3	83.8%	16.2%	0.0%	0.0%	15.3%	13.3%	0.0%	0.0%
4	82.0%	10.0%	6.0%	2.0%	20.2%	11.1%	16.7%	100.0%
5	100.0%	0.0%	0.0%	0.0%	16.3%	0.0%	0.0%	0.0%

Table 33: Stakeholder categories according to modularity.

	Share of category within cluster						Share of category concerning category total					
Clusetr	Administration	Associations & NGO	Political party	Transport company	Planning & Research	Industry	Administration	Associations & NGO	Political party	Transport company	Planning & Research	Industry
0	44.8%	32.8%	12.1%	0.0%	10.3%	0.0%	28.0%	43.2%	41.2%	0.0%	12.2%	0.0%
1	79.4%	0.0%	0.0%	0.0%	20.6%	0.0%	29.0%	0.0%	0.0%	0.0%	14.3%	0.0%
2	34.5%	21.8%	12.7%	20.0%	9.1%	1.8%	20.4%	27.3%	41.2%	39.3%	10.2%	2.8%
3	35.1%	18.9%	8.1%	10.8%	21.6%	5.4%	14.0%	15.9%	17.6%	14.3%	16.3%	5.6%
4	12.0%	12.0%	0.0%	20.0%	40.0%	16.0%	6.5%	13.6%	0.0%	35.7%	40.8%	22.2%
5	6.1%	0.0%	0.0%	9.1%	9.1%	75.8%	2.2%	0.0%	0.0%	10.7%	6.1%	69.4%

Table 34: Average centrality values according to modularity.

Cluster	Degree centrality	Weighted degree centrality	Closeness centrality	Betweenness centrality	Eigenvector centrality
0	9.6207	12.3793	0.3909	0.0082	0.1492
1	14.4706	18.9118	0.4093	0.0039	0.2518
2	8.8000	10.2727	0.3751	0.0069	0.1163
3	8.1622	9.2973	0.3898	0.0069	0.1185
4	9.9000	11.1000	0.3925	0.0046	0.1695
5	2.1515	2.1515	0.3128	0.0067	0.0117

15.5 Appendix 5: WP 6.3

15.5.1 Workshop results mobility strategies in administrations

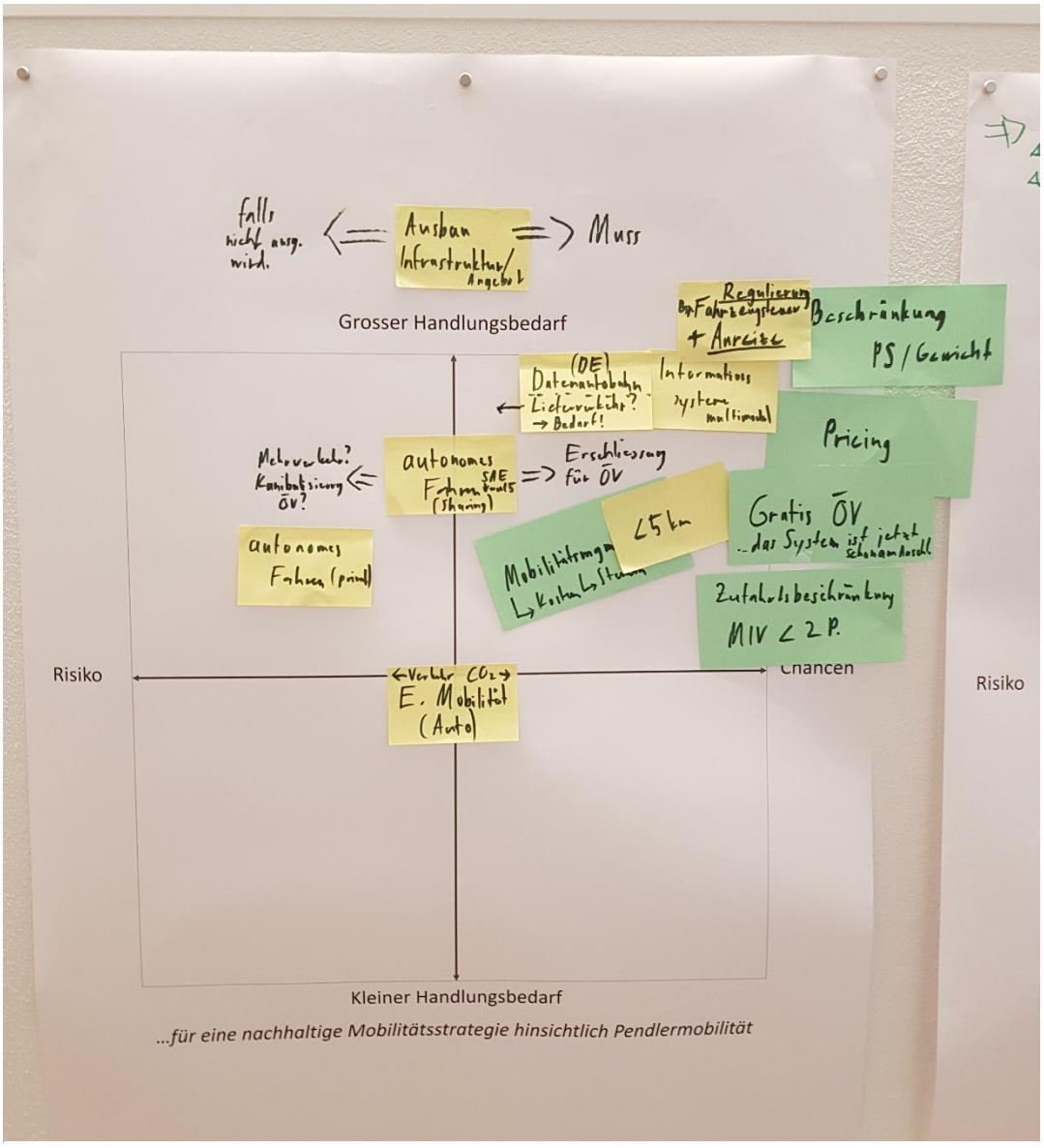

Figure 125: Results of Part 2 / Group 2. Yellow: Aspects as defined in part 1. Green: Measures.

15.5.2 Workshop results mobility management in companies

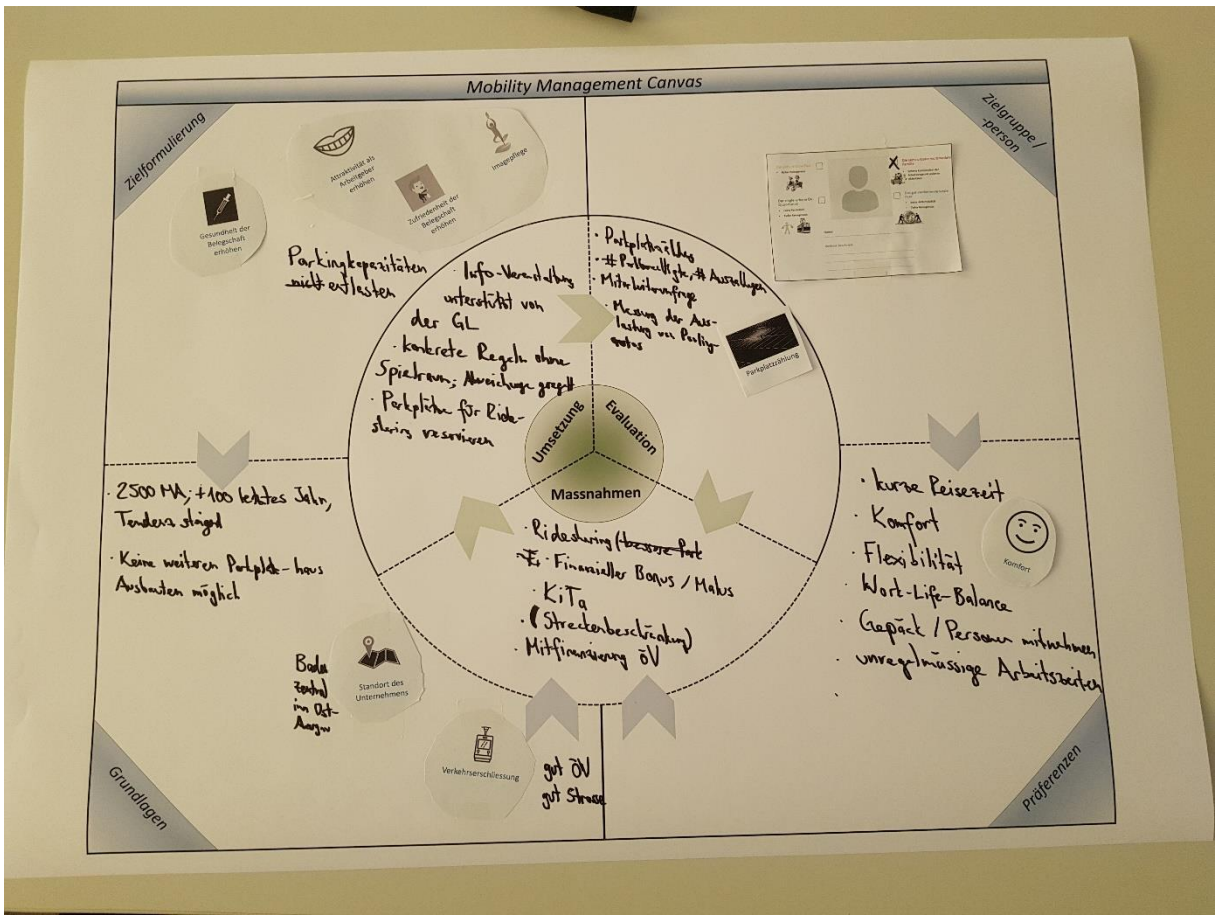

Figure 126: Mobility management canvas results of the workshop: mobility management in companies, Group 1.