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Summary of WP Student Team

Exploration of the development of urban mobility in Germany until 2040 through the criteria of efficiency, sustainability and accessibility

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Exploration of the development of urban mobility in Germany until 2040 through the criteria of efficiency, sustainability and accessibility

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Abstract group work

This working project is an analysis of the development of future urban mobility in Germany until 2040. The three stakeholder perspectives of the *public sector*, *private companies* and *consumers* are investigated in detail, to understand their roles in the process. Ultimately, the three factors *efficiency*, *sustainability* and *accessibility* of urban human mobility were identified to be the areas for necessary improvement of the mobility sector. As a result of the paper, an evaluation model was developed to help public sector officials decide on different mobility initiatives, focusing on the three areas of improvement and their respective inclusion by the initiative.

Abstract individual work

This individual part of the work focuses on the public sector's perspective on urban mobility development. The three parameters *efficiency*, *sustainability* and *accessibility* have been identified as main levers to improve urban mobility. Measures in these areas have been implemented but further improvements are needed, according to research. In addition, experts were interviewed to explore qualitative insights to the fields infrastructure, public sector, transportation and smart mobility. In the end, the experts agreed, that especially in the field of sustainability, the public sector must act more strongly by implementing restrictions and incentivize coherent actions by companies and inhabitants.

Keywords: Mobility, public sector, German urban mobility development, efficiency, sustainability, accessibility, public transport

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1 Introduction (Group part)

1.1 Relevance of the topic and problem statement

The urban mobility ecosystem in German cities is currently characterized by inefficiencies, insufficient accessibility for users and a lack of contribution to the sustainability goals to which Germany has committed itself. The main problems lie for example in a massive consumption of fossil energy resources as traffic is responsible for about 33.5% of carbon emissions (European Environment Agency, 2022). The utilization rates of public transport are low, especially in smaller and medium-sized cities, and create an enormous economic dependency on government subsidies. Furthermore, the traffic volume in Germany generates, on average, 40 hours of congestion in cities on an individual base per year (INRIX, 2021). Many urban mobility problems can be traced back to the dominant use of private motorized transport. According to the Federal Motor Transport Authority, more than 48 million personal cars were registered in Germany in 2021, and the trend has been rising steadily for years (Federal motor vehicle authority, 2021). However, personal cars not only have the worst carbon footprint compared with other means of transport but are also characterized by low utilization and usage rates (Federal Environmental Agency, 2019). The global trend of rapid urbanization can also explain the growing relevance of this topic. For Germany, it is expected that 85% of the population will live in cities by 2050 (United Nations, 2019). In the context of urban mobility ecosystem, three main stakeholder groups interact with each other. These are the public sector, private companies, and consumers. The common objective of these stakeholders is to develop a better urban mobility ecosystem, which can be achieved by reduced use of private motorized transport through the growing use of optimized public transportation systems, the creation of flexible, modern and more sustainable mobility offers by private companies in combination with improved accessibility and an attractive price-performance ratio from the consumer's point of view.

1.2 Objective of the work and outline

This dissertation aims to analyse the current status and the assumed development of urban mobility in Germany until 2040. Thereby, the interactions of the three identified stakeholder groups *public sector, private companies,* and *consumers* are considered. The transformation process is evaluated based on the indicators of *efficiency* in operational terms, *sustainability* reflected in a decreased carbon footprint, *and accessibility* related to consumer affordability and access.

The literature review first presents the megatrend urbanization and the development of mobility. Afterward, the three stakeholders, their interaction, and their roles are elaborated, which is defined as urban mobility ecosystem in the scope of this work. Furthermore, a comprehensive overview of Germany's current urban mobility situation and related challenges are given. Next, this work will present three main analyses focused on individual topics. In the third section, the public sector perspective on future urban mobility development is subject to exploration. Especially how the public sector develops public transportation toward being more sustainable, efficient and accessible. Furthermore, an investigation is conducted on how the public sector steers the general industry-overarching mobility market toward a more sustainable mobility approach. Chapter four covers the trends of *autonomous driving, connectivity, electrification* and *shared mobility* from now on, named ACES trends. Their respective disruptive potential and impact in the context of urban mobility are evaluated. Moreover, the private sector's role within the existing market environment is also elaborated because of its responsibility for research and industrialization of new technologies and innovations. Section five, covering the consumers' perspective, aims to understand how people in urban areas in Germany choose their means of transportation. In this context, the factors which influence consumers' mobility option selection and perceived advantages of personal car use or alternative mobility options use regarding these factors are analyzed. Finally, the conditions under which consumer behavior and preferences regarding the various means of transportation may change in the future are

outlined. After that, the findings of the individual analysis are brought together, and a conceptual model for qualitative analysis and comparison of mobility initiatives is introduced. Finally, the findings and gathered insights are brought together in the conclusion.

2 Literature Review

2.1 The global megatrend of urbanization

Urbanization and especially the continuous development of rapid urbanization, is considered one of the global megatrends that significantly impacts social cohabitation, political decisions, and economic development (PwC, 2022a). Nevertheless, a uniform global definition of the terms ”urbanization”, “city”, “urban area,” or “rural area” has been lacking, and thereby, international comparability is limited. In the context of this thesis, the authors rely, regarding the term and process of “urbanization”, on the definition of Paul Knox: “Urbanization involves a complex set of economic, demographic, social, cultural, technological, and environmental processes that result in an increase in the proportion of the population of a territory that lives in towns and cities, an increased concentration of population in the larger settlements of the territory, and an increasing density of population within urban settlements” (Knox & McCarthy, 2012). Regarding the differentiation of cities and settlements, the authors rely on the methodology degree of urbanization (DEGURBA) developed by the EU and OECD. The DEGURBA is defined as the proportion of the total population living in urban areas (European Commission, 2012). This concept includes criteria for population density and the total population. It is computed using maps of built-up areas and population density obtained from satellite images and national censuses. Hereby it is differentiated between an *urban center*, which consists of contiguous grid cells with a density of at least 1.500 inhabitants per km² and a total population of at least 50.000 and an *urban cluster*, which consists of contiguous grid cells with a density of at least 300 inhabitants per km² and a total population of at least 5.000 (European Commission, 2022). Based on this methodology, 828 cities clustered by their respective urban center size were identified for Europe (European Commission, 2012).

In addition, it is expected that the global population will grow from 7.98 billion to 9.6 billion inhabitants in 2050, which will predominantly lead to growing cities and is mainly due to strong growth rates in Asia and Africa. The share of the urban population, meaning the degree of urbanization, will continue to increase and rise from 55% in 2018 to 68% in 2050 (United Nations, 2019). In the context of Europe, a stronger development of the urbanization rate to approximately 83,7% by 2050 (72% in 2015) is prognosticated; for Germany, a development to 84,3% is expected (United Nations 2019; Statista 2018a). Even if both the growth rates and the absolute number of inhabitants in European/German cities are significantly lower compared to other areas on a global level, the change towards an urbanized society is accompanied by similar challenges and opportunities. An enormous level of productivity characterizes cities, and urbanization is seen as a driving force in terms of increasing prosperity and general economic performance. This is reflected, for example, in the fact that 80% of the global GDP is generated in cities (World Bank, 2022). At the same time, cities offer unique advantages and positive effects, such as the high concentration of economic activity, which reinforce and favor this development (PwC 2022a; Zhang 2015). Besides the positive economic effects, many challenges like sustainable infrastructure scaling, waste reduction, or rising informal housing and employment sector emerge through urbanization. Cities are responsible for consuming 75% of natural resources and cause 80% of carbon emissions (World Bank, 2022). Based on the current development of the ongoing and emerging climate crises, cities will have a crucial role in tackling the issue and solving the problem towards less environmental pollution, resilience, and more efficient resource consumption (United Nations, 2017). Furthermore, uncontrolled and rapid growth in some areas leads to rising social problems though crime, income inequality, and housing unaffordability (Zhang, 2015). However, another central challenge, as also dealt with in this thesis, is to cope with the growing demand for mobility and the expansion of the relevant infrastructure to meet the higher absolute number of inhabitants on the one hand and the general increasing demand for mobility. Current urban areas are characterized by

unsustainability and inefficiency regarding their handling of mobility, which leads to high opportunity costs that are exemplary, reflected by 154 hours lost in traffic jams each year per person in 20 of the world´s most congested cities (Boston Consulting Group, 2019).

2.2 Development of urban human mobility

Over the years, human mobility has changed drastically. Not only the means of locomotion have changed, but also the key factors of human mobility, namely convenience, environment, user experience and costs of mobility solutions have improved, driven by groundbreaking innovation (Rajat Dhawan, 2019). Additionally, the access to even intercontinental mobility and especially to everyday commuting solutions became standard in many parts of the earth's regions. Consequently, the development of human mobility over time has not only changed the way of living, but also the international exchange in travel, trade and physical interaction.

This development is often seen as a continuous cycle of development with steady innovation and linear development over time. A famous quote of Henry Ford says "If I had asked people what they wanted, they would have said faster horses" (Rajat Dhawan, 2019), showcasing the difference between vertical and horizontal innovation, being the source of this misperception. Continuous progress in the development of mobility solutions, such as advancing car models are horizontal innovations, as existing products got improved, but mobility was not fully reinvented in the sense of severely improving all four factors of mobility development (convenience, environment, user experience and cost). According to McKinsey, there have been two main inflection points, when mobility changed drastically (Rajat Dhawan, 2019). These inflection points describe phases with erratic development, followed by phases of vertical innovation such as product improvement, in the shape of a "S-curve" (Luo, Lui, Liu, & Zhang, 2018). The first inflection point happened in 1908, when Henry Ford released the "Model T" – the first engine powered car that was accessible for the broader middle class. The "Model T" was the first real point of inflection through its innovative combination of reliability, innovation, and especially affordability, which enabled Ford to sell personalized and

mechanized mobility to the masses (Rajat Dhawan, 2019). The result was the first real car, satisfying people's needs regarding the factors of mobility innovation: lower transportation costs, greater comfort, and a better driving experience. Despite compromises, Ford's "Model T" and this first inflection point has been one of the greatest business success stories in history. Over time, mainly horizontal improvements took place and shaped today's mobility landscape, comprising not only (private-) cars, but also services and products building on the initial invention, such as taxis, busses, motorcycles, etc. (Rajat Dhawan, 2019).

According to McKinsey, the second main inflection point is currently happening. Existing pain points with the traditional car are about to be resolved through new car generations that will seamlessly become part of a larger mobility network. These pain points comprise (fatal-) traffic accidents, traffic congestion, suboptimal infrastructure (solely focused on cars) and environmental burdens. With the new inflection point, connectivity, autonomy and electrification will moderate these pain points and lower their impact (Rajat Dhawan, 2019).

Generally, cities and their infrastructures are heavily shaped by cars and road transport. Nevertheless, also other forms of urban human mobility emerged over time, such as railways and other public transport (Lazo, 2021). Apart from technological development, also societal change in mobility usage emerged, disrupting the way consumers use mobility. Options such as car sharing services, less costly taxi substitutes such as Uber or Bolt and modern and convenient public transport options are driving consumers away from self-ownership of a car to the more flexible and convenient service offerings (Deloitte, 2022). Furthermore, cities in developed countries start to target strict emission reduction in urban traffic for the future. In order to realize these goals, many cities promote and support alternatives to cars, such as bicycles and walking. For this purpose, the German Federal Ministry for digital and transport has launched the special financial aid program "City and Country". A total of around 1.04 billion euros is now available for the period up to 2024, for cities to apply for (BMDV, 2022).

All in all, technological advances, changes in use patterns of mobility by customers and governmental targets, such as carbon emission reduction, will continue to shape the future of mobility. Also, the reduction of pain points like air pollution, noise pollution and blocked streets will influence the development of new mobility solutions. Therefore, players from the private sector must comply with these indications and limitations to develop new and future proved mobility solutions. Furthermore, the state must increase the public's usage of public transport options, as it is a viable option that is sustainable, efficient and mostly pain point free (Federal Environmental Agency, 2022c). In conclusion, consumers, the private sector and the public sector will define the future urban mobility through their interaction over time (McKinsey & Company, 2020).

2.3 Stakeholder identification

As in any other market, the urban mobility market fundamentally comprises providers and customers (Bwl-lexikon, 2022). Urban mobility encompasses a wide range of products and services. From products such as cars from OEMs like Volkswagen or bicycles from bike manufacturers like Cube, to individual mobility-as-a-service offerings like cabs, ride service providers like Uber and electric scooter providers like Bolt, to public transport offerings like subways, commuter trains and buses (Federal Ministry for Economic Development and Cooperation, 2022). The target customers are usually private customers who make use of the offers. There are also customized offers for business customers who want to buy or lease car fleets for their company, issue their employees mobility vouchers for public transport and cabs, or provide company cars or bicycles to their employees (Handelsblatt, 2010). The German urban mobility market is thus designed as both a business-to-customer market and a business-to-business market.

However, the role of the public sector in this market is special. In this market, more than in almost any other, the public sector itself acts as a provider of mobility on a large scale, with over 10 million different passengers having used public transport services in 2019 alone (VDV,

2020). As such, the public sector is a relevant player on the provider side.

Furthermore, the state, i.e. a part of the public sector, has a function as market regulator (Federal Agency for Civic Education, 2022). In February 2010, the Federal Constitutional Court ruled that a minimum level of participation in social, cultural and political life is part of a humane standard of living. Mobility thus becomes a fundamental right that can best be guaranteed by the national public transport system (Westfälische Nachrichten, 2017). Therefore, the public sector is obliged to keep its own mobility services, namely public transport, accessible and efficient, so that the citizens of Germany can make use of mobility services to a reasonable extent. Affordability of tickets and availability of stops in reasonable proximity to the place of residence are thus the basis of accessibility. To achieve adequate efficiency, the state must provide public transport connections that are as seamless and intelligently linked as possible.

In order to serve *sustainability* as the final factor, the public sector is on the one hand responsible for making its public transport services climate-friendly. On the other hand, the state must intervene in the private mobility market beyond the limits of its own services. In order to meet climate commitments such as the paris climate agreement, the public sector must realize major carbon emission reductions in the mobility sector and do so on the private market side as well. Thus, it must set the regulatory framework through taxation, bans and incentives for private mobility providers, and thereby play an overall steering role.

All in all, there are three relevant main stakeholder groups interacting in the mobility development spectrum. In the following sections of this master thesis, these stakeholders and their interaction will be the subject of investigation.

2.4 Situation Germany

In the following part, key figures regarding Germany's demographics and mobility are presented.

2.4.1 Demographic situation in Germany and German cities

Germany is a country with 83.24 million inhabitants as of 2021. The annual growth rate over the past five years was 0.1 percent (Statista, 2022g). The German federal statistical office does not expect the German population to neither grow nor shrink significantly within a time horizon until 2040 (Federal Statistical Office, 2022 b). The demographical split counts 51.46m inhabitants in working age (between 20 and 66 years), while 15.41m people are younger than 20 years and 16.37m people are 67 years old or older (Statista, 2022e). Unlike the absolute number of inhabitants, the proportion of German inhabitants in working age is expected to decrease by four to six million until 2035 (Federal Statistical Office, 2019). The average age of German inhabitants is 44.6 years (Statista, 2022f).

The situation in urban areas differs from the rest of the country. Growth in inhabitants and recent years can be observed for nearly every city and continued growth between 5 and 16 percent, depending on the city, is expected (City of Munich 2020; Citiy of Cologne 2018; Senate Department for Urban Development, Building and Housing 2021; Statistical Office for Hamburg and Schleswig-Holstein 2021; State Statistical Office of Hesse 2019). The average inhabitant's age is lower for most cities compared to the country-wide average (40.9 years in Frankfurt, 41.6 years in Munich, 42.1 years in Hamburg, 42.7 years in Berlin) (Statista, 2022h). German cities are expected to domicile more young and old inhabitants in the future, leading to a situation similar to the overall German situation, in which the population in working age decreases in absolute and relative numbers (Statistical Office for Hamburg and Schleswig-Holstein 2021). Overall, we can expect a situation in which more people live within Germany's big cities and urban areas in general, leading to an increased need in mobility there.

2.4.2 Mobility situation in German cities

2.4.2.1 Need for mobility

Regardless of the place of residence, German residents leave their homes on a daily basis for similar reasons. Three occasions are the most common throughout every German city. The first

is the way to an individual's workplace or educational institution, being accountable for around one third of the traffic volume. Almost another third is due to individual's mobility needs for grocery shopping or other private errands. A little under a third falls under leisure activities (Agora Verkehrswende 2020). Individuals that reside in Germany's urban areas cover an average distance of about 37 kilometres per day, without significant differences between big cities and metropolises. In contrast, looking at summative daily average travel times, people from metropolises (>500,000 residents) take on average 9 minutes longer than big cities (100,000<x<500,000 residents) residents and even 14 minutes more than residents from small cities (20,000<x<100,000 residents) to reach their destinations, while metropolitan residents use on average 92 minutes for their daily mobility (Agora Verkehrswende 2020).

2.4.2.2 Mobility differences between cities

While individuals have similar mobility needs within German metropolises and cities, big differences throughout the cities' current mobility situations can be detected. There are three main dimensions forming the mobility structure of each specific city, meaning how people meet their mobility needs in form of choosing a mobility option. The first dimension is the spatial structure of a specific city and its transportation offering. A city's spatial structure highly influences and, in some cases, limits the spectrum of mobility options used by individuals within that city. The second dimension is a city's politics, planning, and implementation, which in some cases influences the mobility offering of for example public transportation services and might either facilitate or complicate private companies' operations. The third dimension is the residents' perceptions and orientations, as individuals are the consumers of products and services, in this case mobility options (Agora Verkehrswende 2020). So, while analysing and evaluating cities' mobility situations, we need to keep in mind that different cities deal with different prerequisites, such as a city's specific spatial structure, and therefore also have differing initial situations as starting points when looking into their future mobility structures.

2.4.2.3 Mobility structures

Figure 1 shows the average mobility split for metropolises, big cities, small cities and very small cities (<20,000 residents). The first learning from this illustration is that the smaller the city, the greater the proportion of the distances covered by car. Further, it is notable that with a declining number of a city's residents, the proportion of distances covered by public transportation decreases. This phenomenon can also be seen for distances covered by bike and on foot. In conclusion, it can be stated, that the dominance of car usage increases with a decreasing number of residents.

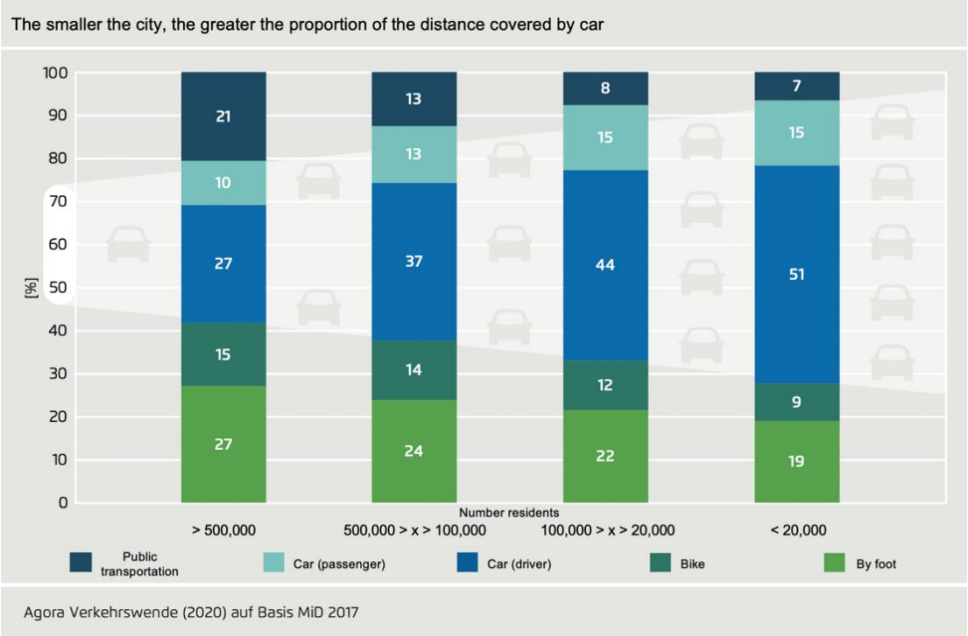

Figure 1 - Mobility structure and number of residents – translated from Agora Verkehrswende (2020)

2.4.2.4 Means of transportations

The following part serves as an overview of different means of transportation within German cities. Furthermore, the great differences between the cities are demonstrated.

Personal cars

Personal cars are the most used mobility option not only worldwide but also within the German society, being accountable for around 57 percent of the covered distances travelled (Federal Ministry of Transport and Digital Infrastructure 2019). Germany's policy makers are trying to initiate the desired shift in transportation, but the sobering truth is that on January 1st of 2022,

more cars were registered in Germany than ever before, counting 48.5 million (Federal Statistical Office, 2022a). This number increased from 41.7 million in 2010 by around 16 percent over the past twelve years (Berliner Zeitung 2021). In the beginning of 2021, 77 percent of German households owned at least one car, and of the 42 million existing German households, around 12 million or 29 percent owned more than one car (German Federal Environmental Agency 2022a). On average, a German household owns 1.14 cars (kfW Research, 2022).

The degree of motorisation (meaning how many cars are registered per 1,000 residents) throughout Germany has increased from 532 private cars per 1,000 residents in 2000 to 580 cars in 2020. Since temporarily deregistered vehicles were added to the inventory up to 2007 only, the increase in the motorisation rate is even higher in practice (Federal Environmental Agency 2022a). As outlined in Figure 1 the proportion of an individual's distances covered by car increases with a decreasing number of a city's residents, indicating the relevance of a private car for daily tasks and errands. The proportions of different cities' households that do not own a private car as well as the degree of motorisation for different cities clearly confirm this observation. In German metropolises, on average 43 percent of households do not own a private car, while for big cities this value equals 33 percent, and for small cities only 23 percent (Agora Verkehrswende 2020). These values are the arithmetic mean of the values of cities in the specific category, not weighted by number of inhabitants of such cities. In this regard Berlin can be highlighted, as every second household manages to get along without a personal car. The motorisation rate of the city is 335, being one of the lowest of all European metropolises, and way lower compared to other German metropolises (Hamburg: 436, Frankfurt: 449, Cologne: 453, Munich: 493) (Berliner Zeitung 2021; Agora Verkehrswende 2020).

To conclude, various numbers show a relatively low usage per resident of private cars in urban areas. On the other hand, this by no means mitigates the problems arising from the very high absolute private car usage in urban areas, and current trends do not show any signs of declining.

Public transportation

The proportion of distances covered by public transportation differs between cities and correlates positively with the size of the city in terms of number of residents. For metropolises, this proportion equals 21 percent, for big cities 13 percent, and for small cities and rural areal the proportion is below ten percent, as can be seen in Figure 1. Berlin shows the highest proportion with a share of 26 percent of the distances travelled. The highest usage for public transportation as a mobility choice can be detected for routes to work (40 percent) and educational institutions (28 percent) (Center Nahverkehr Berlin 2021).

Public transportation must play a key role in the desired transport turnaround in urban areas, which is currently not the case. For 94 percent of Germany's residents, the next public transportation stop is reachable within 400 meters, for metropolises this value is even higher in some cases (Federal Ministry of Transport and Digital Infrastructure 2019; Center Nahverkehr Berlin 2021), indicating an increased usage potential. Under certain conditions, many Germans would be willing to use public transportation more often (Federal Ministry of Transport and Digital Infrastructure 2019). One problem might be long travel times, as these are between 1.94 and 2.24 times higher compared to car usage within German metropolises (Mobility Institute Berlin, 2021). In metropolises such as Berlin and Hamburg, 40 respectively 38 percent of the residents over 18 have a monthly or annual pass, which shows the potential for an increase in usage rate of public transportation (Agora Verkehrswende 2020).

Carsharing

As of the beginning of 2022 around 3.4 million German people have registered on carsharing platforms, a number that increased by 18 percent within one year. 243 providers distributed over 30,000 car-sharing vehicles among 935 German cities (German Carsharing Association, 2022). Large cities are better equipped with carsharing vehicles than small ones. Throughout metropolises there are also large differences in offer density, with a range from 0.21 to 2.1

carsharing vehicles per 1,000 inhabitants. Exeptional to this, the city with the highest density is Karlsruhe (around 313,000 inhabitants), with 3.2 vehicles per 1,000 inhabitants, followed by Munich with 2.1 vehicles per 1,000 inhabitants (Agora Verkehrswende 2020).

Carsharing vehicles emit on average 15 percent less carbon dioxide than the average new private vehicle in Germany, as the fleets are predominantly made up of small and medium-sized vehicles, making carsharing less environmentally harmful compared to the average German resident's private car. Moreover, car sharing relieves traffic congestion by leading to a reduction in the number of private vehicles needed. Each carsharing vehicle replaces between three and ten private vehicles, depending on local conditions. In densely populated areas of large cities, the replacement rate can even exceed 10 vehicles (Federal Environmental Agency 2022a).

(E-)Bikes and walking

As Figure 1 shows, the proportion of an individual's distances covered by (e-)bikes and on foot increases with an increasing number of a city's residents. In metropolises, around 42 percent of the distances are covered by bike (15 percent) or on foot (27 percent). The proportion of distances covered by (e-)bikes varies within the range of metropolises (from seven percent in Stuttgart to 24 percent in Bremen). The spatial structure of a specific city is a crucial determinant in this regard (Agora Verkehrswende 2020). In urban areas, an e-bike is on average the fastest mobility option to cover distances up to 7.5 kilometres. Since about 40 percent of the distances covered by car in urban areas are less than 5 kilometres, this holds extreme shift potential from cars to bikes (Federal Ministry of Transport and Digital Infrastructure, 2019). The proportion of journeys made on foot ranges from 23 to 33 percent and is similarly high throughout metropolises and big cities. Frankfurt records a high value of 33 percent, making it the strongest pedestrian city in Germany (Agora Verkehrswende 2020).

2.4.3 Current challenges Germany faces in urban mobility

In the context of the transformation of urban mobility, Germany as a whole is confronted with several challenges. These are problematic indicators that vary in severity from city to city or metropolitan region to metropolitan region but can be found throughout Germany.

First, there is a lack of investment in infrastructure in German cities. The total investment backlog for road and transport infrastructure is estimated at €39.6 billion (German Association of Cities and Municipalities, 2022). This affects the entire mobility sector, including related infrastructure such as train stations. In addition, in the context of the expansion of urban infrastructure projects, there are massive delays as well as extreme increases in cost, which not only hinder the progress of the actual project but also have a negative impact on the implementation of other projects due to possible budget cuts that may result. A current example is the construction of the second S-Bahn main line in Munich, which is delayed by at least 25 years compared to the original plan (2035 instead of planned 2010) and already exceeds the costs by a multiple (Deutsche Bahn AG, 2022b).

Another challenge lies in securing the country's energy supply and transport infrastructure, which has become even more critical due to the changed geopolitical situation caused by the Russian invasion of Ukraine. In addition to the aspect of security of supply, this also resulted in massive price increases of more than 100% in some cases compared with the previous year in energy procurement (Destatis, 2022). This had an impact on both the operating cost structure of the operators and the affordability for users. Even though Germany is in a continuous and growing expansion of renewable energies, the increasing electrification in the transport sector is creating a growing demand for electricity to ensure the security of supply in the long term and sustainably (Federal Environmental Agency, 2022b).

The demographic development of the German population, which is already the second oldest population in the world with a median age of 47.8 years, is also becoming a challenge in the

context of mobility (World Data, 2022). Therefore, the administration and private companies must develop and implement appropriate concepts tailored to dynamically changing mobility behavior to enable a large number of older citizens to remain mobile into old age.

Another point to be mentioned is the economic efficiency of local public transportation. At the national level, ticket revenues of €10 billion are countered by expenditures of €13 billion to operate the transportation system, resulting in a subsidy requirement of €3.2 billion (Roland Berger 2019; Statista 2022i). Even though it is normal on an international level that public transport is subsidized on a large scale, Germany is faced with the challenge of reducing the current need for subsidies. However, the degree of coverage and the profitability of the respective transport company varies significantly between the individual cities and depends, among other things, on factors such as the size of the city (VDV, 2021).

3 Individual Part I: Investigation of the public sector's perspective on how to steer the development of efficient, accessible, and sustainable urban mobility in Germany (David)

3.1. Introduction

Germany's future urban mobility development depends to a large extent on the public sector. The public sector in Germany comprises the state per se, the 16 federal states, their districts and communes, and the municipal unions (bpb 2016). The public sector in Germany comprises the state per se, the 16 federal states, their districts and communes, and the municipal unions (bpb 2016). Ultimately, public authorities like courts, government bodies and agencies decide on main determinants like governing law, public investments, and on support or interventions to initiatives. In relation to mobility the players in the public sector play a major role in developing the sector with a high degree of influence and direct actions to address the visions for Germany (Federal Ministry of Home Affairs 2022).

On the one hand, public sector entities initiate and invest in targeted projects to drive mobility development and exert direct influence in this regard. One example of this are key infrastructure

projects at the federal level, such as the major expansion of the Deutsche Bahn rail network, for which the federal government is providing a total of 13.6 billion Euros in 2022 alone (Deutsche Bahn AG 2022a). Likewise, projects are also taking place on the level of individual federal states, such as the announced digitization of urban traffic in Hamburg, initiated by the city administration and carried out via numerous individual projects (City of Hamburg 2022a).

On the other hand, the public sector steers development indirectly. Here, the state acts as a guiding force by setting "guard rails" for the private sector and citizens. One way in which the public sector operates accordingly is through legislation that sets binding limits for market participants. For example, the ban on new combustion engine registrations from 2035, enforced at EU level, or the law on autonomous driving in Germany, which in essence permits the approval of fully autonomous vehicles as the first country in Europe under certain conditions (Federal Ministry of Digitization and Transport 2021). In addition, the public sector can also exert a direct, decisive influence through soft measures. By subsidizing the development of certain technologies and areas of innovation, the state specifically promotes offers that are in line with public interests to increase the chances of success. As an example, three lead projects are currently in progress for the development of green hydrogen, which can be used as fuel. In this way, the state is actively influencing the market (Federal Government 2022a).

Consequently, for a realistic view of possible future developments in the German urban mobility sector, it is important to understand the public sector and its goals in detail. This will be subject for investigation in this part of the dissertation. Furthermore, how the public sector steers the development of efficient, accessible, and sustainable urban mobility in Germany will be analyzed through expert interviews.

3.2 Fundamental overview

“Mobility is one of the foundations of prosperity” is a famous quote of Franz Müntefering, former vice-chancellor of Germany and federal minister of transport, construction and housing

(Schmid 1999). Although Müntefering's position on mobility dates from the end of the last millennium, it still captures the issues at hand today. Even apart from trade and global value creation, urban mobility of people and goods is an indisputable pillar of prosperity and progress. This view remains acknowledged by the current government and is therefore captured in the "German Sustainable Development Strategy" of 2021. The strategy document unveils the overarching aims of the public sector for the overall mobility transformation along three main factors, namely *efficiency*, *sustainability* and *accessibility* (Federal Government 2021).

3.2.1 Efficiency

A Harvard Business School study by L. Lambert found that a country's economy is directly harmed when citizens have to commute more (Lambert 2021). The total opportunity cost of commuting for workers can exceed their hourly wages, amounting to thousands of dollars per average worker per year, and this is before considering potential costs on workers' subjective well-being (Lambert 2021). If this effect is scaled up to the entirety of commuting workers in a region, a state, or even whole Germany, the result is a drastic loss of wealth creation. From an economic point of view, improving the transfer times of workers is therefore indispensable for the public sector of Germany. This area of necessary improvement can be comprised under the factor *efficiency*, that must relentlessly be advanced by the public authorities (Lambert 2021). But also beyond the economic perspective, it is the obligation of the public sector to make future passenger transport and urban mobility more efficient. Reduced waiting times at public transport stops due to frequent departures, seamless traffic flows without congestion, smart connections between train and bus lines, intuitive ticketing processes and delay-free mobility services have a major impact on the quality of life of the city's inhabitants, enabling them to enjoy unhindered daily schedules and to live a life with fewer mobility complications. Ultimately, the goal of the public sector is to provide city residents and commuters with an alternative to the private car which is well competitive or even superior in terms of convenience, transfer time and reliability. Nevertheless, traffic control and efficiency improvements of car

traffic in the city will remain addressed as well (City of Hamburg 2022a). Furthermore, inefficient mobility processes have a direct impact on carbon emissions caused by traffic.

3.2.2 Sustainability

Excessive use of private cars, time-consuming traffic jams and underutilized bus and train journeys have a direct impact on the climate balance (Federal Government 2022b). As such, this leads to the second focus area of the public sector in the development of future mobility: *sustainability*. The Paris Agreement was adopted at the 21st Conference of the Parties to the "United Nations Framework Convention on Climate Change" in Paris in December 2015 and became effective in November 2016. The signatory countries, including Germany, committed to limiting global warming to substantially below 2°C, but preferably to 1.5°C, compared to pre-industrial levels. Despite the strict sustainability goals of the country, the carbon emissions from passenger transport have not decreased since 1995, even though vehicles have become much more energy efficient. This is because almost 60 percent more passenger-kilometers are driven than in the early 1990s, fully canceling out the savings effect. Consequently, especially within the passenger transport sector is a great need for saving carbon emissions (Federal Government 2022b). The most efficient way for the public sector to reduce emissions in urban transport is to implement and subsidize sustainable public transport, while creating adverse framework conditions for individual commuting with private cars, to make it less attractive (Federal Government 2022b).

In recent years, the state has been consistently intervening in economic and social spheres in a regulatory manner and worked towards appropriate "guard rails" for a controlled but free transition to more sustainable actions by individuals and companies. One measure that is already in place is the ban on all new registrations of combustion-powered private cars as of 2035, as well as existing diesel car bans in many of Germany's inner cities (Focus.de 2022). Furthermore, the German government projects to achieve further emission reduction through a combination of increased e-mobility, cycling and rail transport, alternative fuels and carbon

pricing (Federal Government 2022b).

3.2.3 Accessibility

Finally, the *accessibility* factor must be considered. Mobility in climate-friendly and efficient means of transport can only be implemented reasonably as long as adequate demand can be expected, which is largely determined by the price for consumers and the physical access to offerings (Hörcher und Graham 2020). Here, it is important that sustainability and affordability are neither mutually exclusive, nor negatively impacted. It must therefore be the task of the state to subsidize sustainable and efficient mobility offers and innovations if possible. This way, they become an alternative or even a logical preference for consumers. In the course of this, the public sector as a whole must also ensure that the relevant offerings are supported apart from direct financial subsidies, for example by improving regulations that promote change and at the same time pave the way unbureaucratically so that new offerings can gain a foothold in the market (Taylor 2021). Furthermore, the public sector needs to guarantee convenient and flexible physical access to public transport offerings in urban areas, through a full coverage stop network and a comprehensive temporal coverage of the offer on day and night (Stępniaka, et al. 2019).

3.3 Current state of development

The public sector must be measured against the improvement of these three aspects, *efficiency, sustainability* and *accessibility*. Every measure and every project should significantly contribute to at least one of these goals. In this context, it is not enough to continue with established ways and means, because especially in the field of sustainability, wasted time takes its toll, and in the other two areas, it is essential for residents and the economy to continually initiate improvements.

Hamburg is both a city and a state, which makes it an ideal setting for public sector initiatives. The focus of the state government (Senate) is solely on urban mobility and not largely on

mobility in the countryside as in other federal states. Targeted initiatives such as the “Hamburg Mobility Act” make Hamburg a key example of urban mobility development in Germany and therefore, the city will often be used as an illustration in the following (City of Hamburg 2022b).

3.3.1 Efficiency improvement

For each of the three areas, there are numerous smaller or bigger projects ongoing on country-, state- or city-level. In the field of *efficiency* for example, the public bus service in Hamburg is subject for improvement currently. The city has recently initiated a large number of individual projects, some of which are already being applied. A prominent example is the „BiDiMoVe“-project (“Bidirectional, Multimodal, interconnected”). In a few districts of Hamburg, a new type of communications technology is being installed in the buses operating there. Traffic signals along the route will be equipped with the modern technology. The systems in the buses and at the traffic lights can communicate with one another and ensure bus-optimized traffic light control, increasing punctuality and adherence to schedules. The bus drivers receive recommendations on the optimal speeds to be driven. In the spirit of the mobility turnaround and the desired "Hamburg-Takt" (access to public transport every 5 to 10 minutes), a demand-oriented prioritization of local public transport is accordingly being tested for large-scale implementation (City of Hamburg 2021).

3.3.2 Sustainability improvement

As previously described, the public sector in Germany acts in the *sustainability* area mainly through increased e-mobility, cycling and rail transport, alternative fuels and carbon pricing. In the area of electromobility, the state heavily subsidizes the transition in this regard. At least seven to ten million electric vehicles are to be on Germany's roads by 2030. In addition, one million charging points are to be available in the same period. To support this, the German government has adopted various incentive measures. These include purchase premiums, tax breaks and extensive subsidies for expanding the charging infrastructure. Furthermore, the government has adopted a €8 billion initiative that includes charging options for e-bikes and

€200 million for fast-charging stations in urban districts. In 2016, a purchase premium for e-cars, the environmental bonus, in which the federal government and manufacturers participate was introduced as well. Up to 6,000 Euros is granted for electric or fuel cell vehicles and up to 4,500 Euros for rechargeable hybrid electric cars (Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection 2021). Additionally, there are nationwide bans and regulations, such as the ban on new combustion engine registrations. With this measure, the public sector sets a hard end to the unsustainable technology and forces change in the industry to happen (Focus.de 2022).

3.3.3 Accessibility improvement

Accessibility was recently addressed throughout Germany in a prominent initiative. From beginning of June to end of August, the state substituted the so-called "9€ ticket", providing all buyers with a nationwide usable ticket for public transport. In this way, the federal government directly relieved the financial burden on citizens, on the one hand, because of the sharp rise in the cost of electricity, food, heating and mobility. On the other hand, it provided an incentive to switch to climate-friendly public transport and to save fuel and emissions. Since the ticket was introduced as generally valid in the whole of Germany, access and flexibility was drastically increased as well (Federal Government 2022c). Overall, the “9€-ticket” was a clear success in terms of usage and carbon footprint. In total 52 million Germans bought the ticket at least once, around 20 percent of which stated that they had rarely or never used public transport before. A further 27 percent of customers had previously used buses or trains no more than once a month, showcasing the tremendous adoption rate of public transport means through the offering. The trips saved lead to a reduction in emissions of 1.8 million tons of carbon dioxide in just three months (Sueddeutsche 2022). After expiration of the period of the "9€ ticket", the demand for a replacement from the citizenship was responded to, and the "49€ ticket" was announced for 2023. The price increase was economically necessary, however, at least the general validity for the German area as a whole will be maintained (Handelsblatt 2022).

3.4 Research part

The areas *efficiency, sustainability* and *accessibility* are being worked on by the public sector and are a priority in Germany. Nevertheless, developments up to the year of 2040 are difficult to forecast, because ultimately the development depends on all three stakeholder groups: the public sector but also the private sector and consumers. Different interests can be expected, as they will be investigated in more detail in the further course of the dissertation. In addition, the respective development outlooks are fluid, depending on innovations in the private sector, changing values among consumers and politicians, and the public sector's ability and willingness to invest. In this part, the public sector's perspective is addressed in detail.

3.4.1 Methodology

The future urban mobility outlook for Germany in 2040 is a broad field. Especially the perspective on the public sector and its influence on the development remains a white spot so far. Thus, exploratory research must be conducted within a qualitative research approach, as it is the best way to structure, explore and identify insights and relevant information on such topic (Bogner 2009). For this purpose, it makes sense to conduct expert interviews, on the one hand with someone from within the German public sector and on the other hand with industry experts of a variety of topics, that closely work with the public sector. The results were classified into deductively defined sections, which were formed on the basis of theoretical considerations and preliminary explorations with a staff member of a public city authority. These sections represented the full range of relevant categories, and the collected responses were then analyzed anonymously. Five interviews were conducted from November 10th to 22nd and ranged in duration from 27 to 43 minutes (Appendix 1). The interviewees covered the areas of expertise: infrastructure, public sector external, public sector internal, smart mobility and transportation.

The first interview was conducted with a strategy consultant specializing in infrastructure projects in Germany. The second interview was conducted with a project manager, mainly focused on public mobility projects with the German government and public authorities. For

the internal perspective on the public sector, the third interview was conducted with a senior official of the City of Hamburg from the Authority for Transport and Mobility Change (BVM). Furthermore, the fourth interview was conducted with a senior partner and expert in smart mobility of an international consulting firm. Finally, an interview was conducted with a transportation sector expert and strategy consulting principal, with a project focus on strategic projects of public authorities in the transportation sector (Appendix 1).

The different perspectives and backgrounds of the interviews were intended to provide a holistic view of the topic as a whole and to answer the research questions. They were conducted in German and then translated into English. Generally, a semi-standardized approach was chosen, using open-ended questions, to give the experts room for in-depth answers (Appendix 2). The aim was to find out exploratively how the experts perceive the prospects for future urban mobility in Germany from their perspective and ultimately to answer the research questions.

3.4.2 Research questions

RQ1: ***Which developments in future urban mobility are possible and likely in Germany by 2040 from a public sector perspective?***

RQ2: ***How can the public sector promote efficient, sustainable, and accessible future urban mobility and what is the role of the private sector?***

Side RQ1: ***How do the private and public sector interact in mobility development?***

Side RQ2: ***To what extent should the public sector intervene in a regulatory manner?***

3.5 Key findings

In the following, the key findings of the various expert interviews are analyzed in a structured manner. Particular attention will be paid to identifying commonalities of opinions, as well as clear differences. The aim is to provide an overall picture based on the insights of various experts from different areas of urban mobility, in order to be able to make an assessment of how future urban mobility could be shaped from the point of view of the public sector.

First, the German urban mobility sector was examined. The survey focused on the three focus areas *efficiency, sustainability,* and *accessibility*. The current status quo with regard to these three aspects, as well as the experts' assessments of the future, were of particular interest. In the following, the role of the public sector in improving these aspects was queried. This was followed by the section on "technological contribution". Here, the experts were asked to rank technology trends in accordance with their impact on the public sectors goals. Finally, the role of the public sector was compared with the roles of the other two stakeholders, namely consumers and the private sector. In particular, how the various roles are divided up and how cooperation looks like and how it could be improved (Appendix 2).

3.5.1 German urban mobility sector

In the first section, there is a large consensus among the experts that, regarding *efficiency*, *sustainability*, and *accessibility*, carbon emission savings and efficiency improvements in particular must be focused. Here, the public sector has a duty, especially in terms of public transport services, and must find ways to make improvements in both areas (Appendix 3, I2;I4).

> *„I would say carbon emission saving and efficiency improvement are actually the factors that are most important for the public sector (...) but the authorities must act much more strongly in these areas."*
>
> (Appendix 3, I2)

In particular, for experts outside the public sector, public sector measures do not go far enough in terms of carbon emission savings (Appendix 3, I1;I2;I5). While all interviewees see this aspect as the main focus of public sector efforts in mobility development, not all "levers" are being played (Appendix 3, I1;I2). For example, further prohibitions and regulations could be used to encourage more adaptation by the population and private companies (Appendix 3, I2). All experts highlight the expansion and targeted improvement of public transport, along the 3 factors, as essential. The consensus view is that public transport is the future of German urban

mobility and must therefore be consistently promoted and receive a significant amount of funding. It is particularly important, as increased usage of public transport logically decreases private car usage and therefore precisely works towards a carbon emission decrease, as well as towards a more efficient urban mobility (Appendix 3, I1;I2;I3;I4;I5). In this regard, the federal structure of the public sector would not be beneficial across all three areas and would bring more disadvantages than advantages (Appendix 3, I2;I4;I5). In particular, the often-non-existent economies of scale and lost synergy opportunities are criticized, as both would contribute to more efficient progress and cost savings (Appendix 3, I5). The perspective in the public sector itself is contrary to this, and specific reference is made to the large number of projects in each of the three areas. For example, the 9€ ticket introduced throughout Germany, as well as the upcoming 49€ ticket, would especially optimize costs for users and seamless accessibility to mobility throughout Germany (Appendix 3, I3). However, there is agreement that the German target of reducing transport emissions by a further 42% by 2030 is nearly unattainable. Furthermore, revolutions in the area of efficiency of future urban mobility are located in the field of digital through new apps and offers (Appendix 3, I1;I2;I3;I4;I5). Yet, existing infrastructural conditions in German cities would prevent major disruptions with a time horizon of 2040 (Appendix 3, I1;I3;I4;I5).

3.5.2 Technological contribution

In the following, the experts were asked to assess the potential of the four technology trends regarding their respective impact on the public sector's three goals. The queried trends were: autonomous driving, electricity, connectivity, and shared services. In the view of the interview partners, the factors of autonomous driving and connectivity hold the greatest disruptive potential for mobility as it exists today (Appendix 3, I1;I3;I5).

> *„(...) autonomous driving and connectivity will contribute the most (...), I just think you have to be careful with autonomous driving that you don't just relate it to cars."*

(Appendix 3, I5)

From the public's point of view electricity can be seen as replaceable. Climate-friendly mobility can be achieved through hydrogen as fuel or through HVO (hydrotreated vegetable oil) as well (Appendix 3, I2). Moreover, the propulsion problem has already had its disruptive phase of development in the recent past and will come into play generically through the ban on internal combustion engines in 2035. Apart from this, climate-friendly mobility systems are of immense importance for achieving Germany's sustainability goals (Appendix 3, I2).

Shared services as a further factor will continue to grow in the future. However, most experts believe that shared services as such will not contribute to the public sector's goals to the same extend as the other trends. Only in combination with connectivity and autonomous driving, drastic progress would be realized in this field (Appendix 3, I2;I4).

Autonomous driving, in turn, has the greatest disruptive impact on future urban mobility and the public sector's focus areas according to the experts. The technology will most likely have been implemented on a large scale by 2040 and will significantly change the way people commute (Appendix 3, I1;I3;I5). From a public sector perspective, this evolution is already in implementation. On the one hand, fully autonomous subways are increasingly operating in German cities such as Hamburg and Nuremberg, and on the other, strategic partnerships are being entered into with private companies. In Hamburg for example, the city's public transport provider has started a partnership with shared mobility services provider "ioki" (ioki 2022). The company provides digital mobility solutions for cities, including deployment of autonomous vehicles for shared mobility services (Appendix 3, I3;I5). The remaining legal regulations, as well as reliable test runs, are currently the biggest obstacle in Germany regarding the nationwide rollout of the trend (Appendix 3, I4).

Connectivity is, according to the experts, very closely linked to autonomous driving, and is one of the facilitating factors (Appendix 3, I1;I3;I4). In addition, the respondents rated the disruptive

influence of connectivity as the second strongest, after autonomous driving. For example, through optimized traffic light switching, congestion prevention through real-time rerouting, and efficient parking space detection, connectivity holds great potential to significantly improve the factors of *efficiency* and *sustainability*. Hamburg is a model city for many connectivity pilot projects and is already recording initial successes (Appendix 3, I3).

3.5.3 Roles of the stakeholders

> *„The public sector would be the coordinator and implementer. The private sector is the vicarious agent and the consumer is for me (...) a conscious or an insightful participant.“*
>
> (Appendix 3, I5)

The last section addressed the interaction of the three stakeholder groups with regard to the development, support and adaptation of future urban mobility solutions. The experts were first asked to assign a role to each group. Here, it would be the task of the public sector, as "organizer" and "coordinator", to coordinate the development and implementation of future mobility and to set meaningful "guard rails" for the external players (Appendix 3, I4;I5). Also, the public sector is labelled the "shaper", since public transport is an immense component of future urban mobility, and the public sector itself must provide solutions (Appendix 3, I4).

The private sector, however, was considered to play the role of a "vicarious agent" and "enabler". Here, the task would be to find solutions within the established regulatory guard rails and to develop them for the customers (Appendix 3, I4;I5). In this role, a high degree of control by the guard rail system from the public sector is also necessary. Ultimately, the experts assume that private companies have an overwhelming profit motive, potentially leading to “inappropriate” development approaches, which must be restricted and controlled by regulation. Rigorous bans, such as the ban on internal combustion vehicles from 2035, would initiate the necessary change processes in the relevant private companies, to align them on

carbon emission reduction for example (Appendix 3, I2;I4).

The role of the customer is a rather passive one. They would be at the receiving end of the development and would be in the role of the "insightful participant". According to the experts, customers are neither able nor obliged to come up with mobility solutions like the other two stakeholder groups. Instead, it is the customers' contribution to potentially make value-driven consumption decisions and to be willing to accept and support change. The sustainability aspect is politically relevant for the public sector, marketing-wise and regulation-driven for the private sector, but only of secondary importance for customers when making consumption decisions, compared to price or comfort. In view of a much larger necessity to switch to public transport in the future, this value-driven aspect is important (Appendix 3, I3;I4;I5). The smart mobility expert sees this increase in public transport use by customers as difficult, whereas the public sector expert assumes that the shift will proceed well. According to both experts, it is essential that fewer private cars are driven. The smart mobility expert expects problems on an emotional level, since customers do not make purely rational consumption decisions, and even more flexible, environmentally friendly and cheaper public transport offers could not surpass the relationship and convenience of the private car. (Appendix 3, I3;I4).

3.6 Discussion of study findings

3.6.1 Research question 1

> RQ1: ***Which developments in future urban mobility are possible and likely in Germany by 2040 from a public sector perspective?***

Overall, the experts have a consistent opinion on research question 1. From their point of view, it will be very difficult if not impossible to achieve the German emission reduction targets. Nevertheless, the mobility sector must increase its efforts working towards them. They also see a strong need for improvement in terms of increasing efficiency. The current situation is that there is still too much individual mobility by car in the urban mobility mix, making

unnecessarily high levels of emissions per person and per trip a reality still. In the same way, efficiency problems such as lacking parking spaces and inefficient traffic flows due to the high share of individual traffic remain. It is the main task of the public sector to develop an improved public transport. According to the experts, the urban mobility mix must change drastically in the direction of public transport, to achieve strong improvements in all three focus areas.

3.6.2 Research question 2

RQ2: ***How can the public sector promote efficient, sustainable, and accessible future urban mobility and what is the role of the private sector?***

Research question 2 identified the need to expand and improve public transport services in German cities as a priority response to these problems. Here, the public sector is called upon as an "organizer" and "coordinator" to develop efficient, sustainable, and accessible services. Both, the public sector expert and the in-depth research provided insights into several projects that are being tackled by the public sector, such as autonomous suburban trains or electrified bus fleets. The consensus of the interviews is that the role of the private sector is that of a "vicarious agent" and "enabler", and that the private sector must develop and market new mobility solutions within the framework of government-set "regulatory guard rails". In particular road transport with the four technology trends of autonomous driving, connectivity, electricity and shared services must be served in a responsible manner by the private sector.

3.6.3 Side research questions

Side RQ1: ***How do the private and public sector interact in mobility development?***

Side RQ2: ***To what extent should the public sector intervene in a regulatory manner?***

The mode of interaction between the private and public sector is determined by the roles of the two players. The public sector sets guidelines, regulations, bans and incentives, and the private sector acts freely within this framework. Likewise, cooperative ventures, such as the one with shared services provider “ioki”, would be mutually beneficial and represent a form of

collaboration. In addition, the experts believe that the public sector needs to be stricter in setting its framework conditions and implement more restrictions and prohibitions. Hence, they wish for more regulation, especially as previous regulations contributed well to improvements so far.

3.7 Limitations and conclusion

In this part of the dissertation, expert opinions on the development of future urban mobility were obtained using qualitative research methods. In particular, the view of the public sector internally as well as the view on the public sector from external perspectives were explored. Along the three dimensions, various measures for improvement have already been initiated on the part of the public sector. By means of regulations, or through mobility projects or joint ventures, targeted work is being conducted. In the course of this, public transport was identified by the experts as the biggest lever. Achieving more use in this area and significant improvements along the dimensions must be the main task of the public sector in this area.

However, limitations must be considered in the survey part of this section. Five expert interviews were scheduled for the survey, on the basis of which the findings were generated. Particular emphasis was placed on a diversity of expertise and work focus, namely smart mobility, infrastructure, transportation, public sector consulting and public sector internal (from the Hamburg Mobility Authority). This way, the future urban mobility development could be analyzed comprehensively with profound expert knowledge. However, urban mobility is very far-reaching and adequately covering and weighing all relevant facets is difficult. Also, a sample of 5 interviews tends to be small in principle and leads to a high susceptibility to potentially incorrect assessments or subjective biases.

Further added value to this study would be research on political influence on the development of future urban mobility. However, it is hardly possible to realistically "predict" political party influence and therefore, this aspect remained out of scope for this part.

6 Consolidated presentation of main findings and application of a conceptual model (Group part)

6.1 Summary of the main findings

Based on the introductory part of the thesis and the analysis conducted on the various stakeholders, taking into account the respective perspectives and research questions, findings were obtained on the current status quo of urban mobility in Germany, the desired development, and the roles and behavior of the individual stakeholders. The central findings can be summarized under the following key aspects:

- Individual motorized transport with ICE takes up a substantial (depending on the city, the largest) share of the modal split of urban mobility in Germany. Therefore, it has a negative impact on both efficiency and sustainability.
- The public sector has recognized that it is necessary to modify its role and the framework conditions in order to be able to achieve the set objectives.
- Private companies see themselves in a position to contribute positively to urban mobility development, for example, by incorporating new trends and technologies. However, they depend on the framework conditions created by the public sector.
- Consumers take various factors into account when choosing their means of transportation. For many of the most essential factors, consumers see advantages for personal car use over the use of other mobility solutions and a natural shift towards a lower proportion of personal car use can only be expected as soon as alternative mobility options offer an increased perceived value for at least some of the critical factors.

The following can be deduced from the results: Both consumers and private companies see the public sector as primarily responsible for defining the framework conditions needed to drive the urban mobility transformation. The scope of action of private companies depends on the framework conditions created, and a change in consumers' habits towards increased use of alternative mobility options can only be expected with an increasingly compelling offer. The

task of the public sector can thus be differentiated into two essential core points. Firstly, the active provision of an efficient public transport system, in which the public sector represents the supply side and carries full responsibility. On the other hand, in the definition of the framework conditions in the form of the promotion of initiatives or the introduction of restrictive regulations and laws to steer both consumer behavior and the private sector in their respective actions. At the same time, however, the public sector also needs guidelines or indicators against which it can align the tasks mentioned above and serve as a guide. According to the governing parties' party programs and the international treaties to which Germany has committed itself, such as the Paris Climate Agreement, the strong indicators to be considered for the framework conditions are the parameters: *efficiency*, *sustainability*, and *accessibility*.

Consequently, the public sector needs tools or assistance in the decision-making process that adequately take into account the three parameters mentioned or disclose their impact in order to be able to evaluate initiatives. The factor *sustainability* is understood as a positive contribution to reducing carbon emissions, particulate matter pollution, or noise reduction. The efficiency factor is measured by the operational improvement of the urban mobility system, which is reflected, for example, in shorter travel times or higher utilization of the individual means of transport. Accessibility plays a role primarily for consumers and covers easier access to mobility, the degree of coverage of the mobility offer, and affordability in financial terms.

The evaluation of different alternatives is highly complex and requires the inclusion of a wide range of indicators, perspectives, and stakeholders due to the economic scope of the decisions. However, to enable a first evaluation and comparison of different initiatives in the mobility sector, a model was developed by the authors in the context of this work, which enables a purely qualitative comparison in the early concept stage of an initiative in an efficient and fast way using a two-step approach. Based on the described role distribution as well as the perception of the individual stakeholders, this is a tool to be applied in the role or from the perspective of the public sector with a focus on the maximum improvement of the general welfare.

6.2 Scientific justification of the radar chart

Radar charts or network diagrams are often used to compare situations with a similar objective but with different characteristics. Frequent fields of application are the comparison of target/actual deviations or the evaluation of different initiatives based on their contribution to the achievement of the target based on previously defined qualitative or quantitative indicators (Porter & Niksiar, 2018). The equal orientation must apply to all axes of the diagram, i.e., conversely to the selected criteria, which means that the better values recorded in the evaluation are either close to the center or decentralized at the edges.

The network diagram analysis is based on a previously created data table in which the determined values are assigned to each criterion (Porter & Niksiar, 2018). Due to different-sized areas or distances to the central point, strengths and weaknesses can be easily visualized and systematically identified. The network analysis allows a quick graphical comparison of the previously determined criteria (Basu, 2004). Deviations of the underlying bases can be derived directly from the diagram, and the weightings of the individual criteria can be considered.

6.3 Conception and structure of the model

The model design allows the operator, in this case, the public sector, to evaluate possible initiatives based on the defined three factors. Initiatives can be new mobility service solutions, such as extending a subway line by one stop or expanding the offering of car sharing to a new city district. Initiatives can be evaluated using a two-step approach in isolation or as bundles, in which possible combinations of initiatives are reviewed. From here on, the term "initiatives" is used for single initiatives and bundles. When evaluating initiatives, it is assumed that consumers would use the corresponding offer if it targets their use. The factors *efficiency sustainability*, and *accessibility* are rated based on an upstream valuation model, including several subfactors per factor, and are transferred into a score for each possible initiative. Not every initiative must or will contribute to all three factors or all of the defined sub-factors. In both application steps, the results are illustrated with a radar chart.

At the beginning of the two-step approach, the initiative is evaluated along the twelve defined sub-factors. Each factor, *efficiency, sustainability* and *accessibility*, is assigned four sub-factors to ensure comparability. The evaluation is done on a qualitative level, using a scale of 0 to 5, whereby the same assessment principle applies to all factors. That is, the scale ranges from *0= has no positive impact* to *5= has an enormous positive impact*. The categories *efficiency, sustainability* and *accessibility* can achieve a score between a minimum of 0 and a maximum of 20 by evaluating the sub-categories. A score of 0 can occur in the case where the initiative does not contribute to any of the main factors via the sub-factors.

Efficiency is evaluated by the factors of *capacity per vehicle, average utilization per vehicle, space required per vehicle,* and *average travel time*. The *capacity per vehicle* is recorded to show an initiative's decisive impact on transport capacity. The *average utilization rate* refers to the utilization of the vehicle, whereby assumptions are made using utilization rates of comparable means of transport. The *space required* sub-factor is evaluated based on whether the initiative can be easily integrated into existing infrastructure and how it generally fits structurally within the context of the ecosystem, as well as how much space the implementation of an initiative requires in relation to how much mobility is offered in terms of the number of individuals transported and kilometers traveled by them. Finally*, average travel* time will be included to identify and evaluate time savings from deployments of the initiatives examined.

Sustainability is evaluated through the categories of *carbon emission savings, energy consumption, air pollution,* and *noise pollution*. Concerning *carbon emission* savings, the goal is to measure emission savings per person transported to ensure comparability between alternatives. In the context of *energy consumption*, which energy source can be used to implement the initiative in an economically viable way is included. The *air pollution* factor is measured by the contribution to keeping the air clean and a positive or non-negative contribution to air quality. Finally, the factor *noise* is classified by the noise pollution caused by the imitative.

Accessibility is measured by the factors of *price per route per person, average distance* of the mobility alternative to the customer*, the temporal availability* of the offer measured based on a 24-hour day, and the *simplicity of use* or *accessibility to the offer*. The *price per route* factor assesses the service's affordability and assumes the extent to which the population has realistic financial access to the service. *Average distance* measures the proximity and spatial availability of the supply to the consumer. The *coverage period* of the initiative enables conclusions and an assessment of the temporal coverage of the offer within 24 hours per day. *Accessibility* includes the availability of the offer across social classes and the ease of use or booking of the initiative. The following overview of the evaluation sheet is shown for schematic illustration. The illustration shows a pool of sub-factors for the three main factors. These serve as orientation, while further subfactors may exist for different initiatives, which can be designed and substituted by the model user.

Factor	Sub-Factor	Initiative 1	Initiative 2
Efficiency	Capacity per vehicle	3	4
	Average utilization per vehicle	2	4
	Space required per vehicle	4	3
	Average travel time	1	2
Sustainability	Carbon emission savings p.p. transported	4	3
	Energy consumption (cons. energy source)	3	2
	Air pollution	5	4
	Noise pollution	1	3
Accessibility	Price per use/ km traveled per customer	2	0
	Average distance to customers	3	0
	Time coverage of the offer	4	0
	Simplicity of use	1	0

Table 1 - Evaluation sheet of qualitative comparison tool

Based on the evaluation carried out at the sub-factor level, a score in the range from 0 to 20 is obtained by adding up the individual aspects, whereby here, too, it applies, analogously to the evaluation of the sub-factors, that the higher the value, the more significant the positive contribution to the respective main factor. All three main factors have the same weighting, so the overall assessment of the initiative is measured by how large the area is that is spanned between the three main factors. This form of presentation and evaluation enables an equal

comparison of the main factors and illustrates the overall impact on the one hand and the contribution to the result at the level of the main factors.

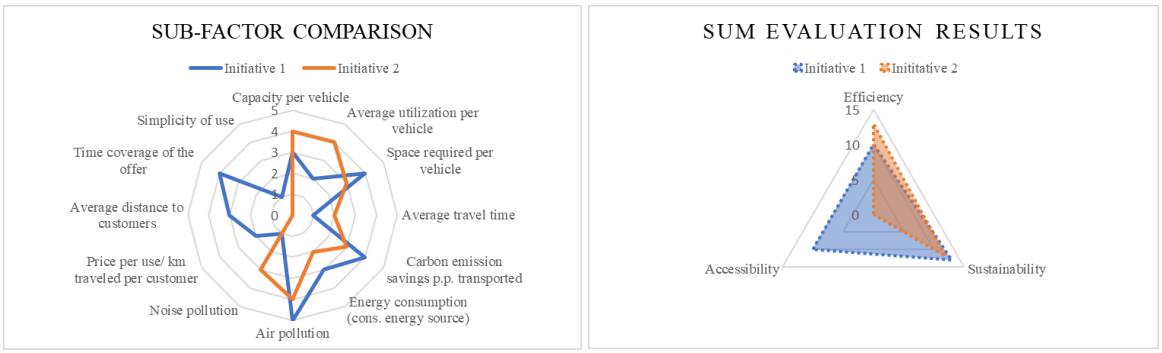

Figure 2 - Exemplary presentation of results of the evaluation steps 1 and 2

In addition, indirect effects, i.e., effects that result from the introduction of an initiative and are not intended but arise as an effect of the initiative, must be considered in the evaluation. While initiatives can be evaluated isolated, they also should be considered and evaluated in comparison with respective alternatives. Here the following aspects should be considered to become a detailed overview of the respective initiatives:

(i) The objective sought to be achieved

(ii) The individuals or groups targeted by an initiative

(iii) Resources used

(iv) Time frame, duration until launch and initiative life cycle

6.4 Exemplary implementation of the model based on the comparison of two initiatives

The model has the potential to add real value to the decision-making process between two initiatives and is very straightforward. Applying the model, initiatives can be compared specifically in terms of the overarching goals of the public sector. To demonstrate the practical use of the model, two concrete initiatives are compared in the following.

One example scenario is that a city would like to connect a small suburb to the public transport network without any gaps. Two initiatives are available for this purpose. One would be to extend the existing subway by one station to the small suburb in order to meet the demand for mobility. The second possible initiative would be regular shuttle buses serving this route.

The first step is to analyze the two initiatives in terms of the sub-factors of the three categories *efficiency, sustainability and accessibility*.

Factor	Sub-Factor	Subway	Bus
Efficiency	Capacity per Vehicle	5	3
	Average utilization per vehicle	3	4
	Space required per vehicle	3	2
	Average travel time	4	2
Sustainability	CO2 Savings per person transported	4	2
	Energy consumption (cons. Energy source)	4	2
	Air pollution	5	3
	Noise pollution	2	1
Accessibility	Price per use/ km traveled per cust.	2	2
	Average Distance to customers	3	4
	Time coverage of the offer	4	3
	Feasibility & simplicity of use	2	1

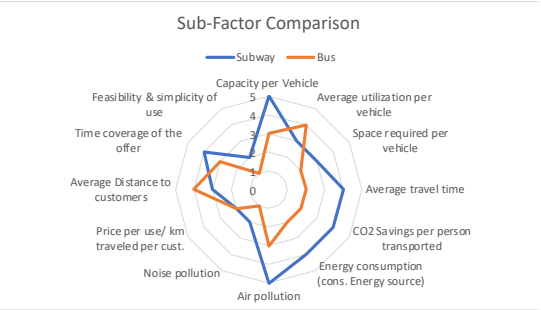

Figure 3 - Presentation of results of evaluation step 1 for the two initiatives

These results can now be summarized in the form of the network diagram, and it quickly becomes clear which of the two initiatives is the more useful in terms of the three goals of *efficiency, sustainability and accessibility*.

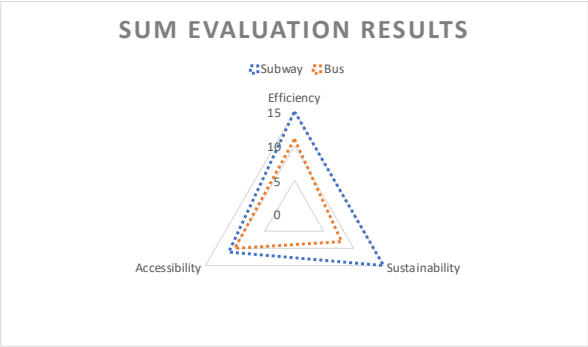

Figure 4 - Presentation of results of evaluation step 2 for the two initiatives

The model clearly shows that the subway is the better choice across all factors. On the sustainability scale, the subway scores almost twice as many points as the bus (15 to 8), it is clearly more efficient and at least marginally more accessible. Of course, the reliability of the model depends on how carefully and accurately the subfactors were evaluated.

Hence, in the next step, decision-makers would know that the subway contributes more to achieving their overall goals and is therefore the preferred option. Now the feasibility has to be checked with regard to other factors. For example, unavailable resources or a too long implementation time of the initiative could still overturn the decision as hard factors.

6.5 Benefits and limitations of the designed model

The developed model allows policymakers to assess initiatives at the individual level and by

comparing different initiatives with each other. However, it is not an all-encompassing tool that allows all indicators to be fully included in the analysis and assessment. Instead, the model offers assistance in making a quick and comprehensive assessment by including key indicators in the context of efficiency, sustainability and accessibility and in evaluating the effectiveness of initiatives on a fundamental level.

The model's advantages include quick and simple handling, which is made possible by the qualitative indication of the individual initiatives or combinations of initiatives. This reveals a broad spectrum of applications, which also allows differentiated weighting about the contribution to efficiency, sustainability or accessibility depending on the focus of the respective initiative.

The limiting factors of the model include that not all indicators can be applied in full range to all potential initiatives, which means that some of the information may be incomplete. At the same time, even with a full scope of application, the informative value is primarily limited to a qualitative assessment of the degree of effectiveness. Imperatively, and to provide a fully comprehensive basis for decision-making, it is necessary to underpin this with quantitative factors and in-depth analyses. Especially for assessing the costs and the derived price-performance ratio, it is necessary to perform an in-depth analysis. Similarly, the time required to implement an initiative, which influences its efficiency, is given too little consideration.

7 Conclusion

This dissertation investigates future urban mobility in German cities and metropolises with the time horizon until 2040. Future urban mobility in Germany has to become more sustainable and efficient while ensuring the highest possible level of accessibility for consumers. The aim of this thesis was to gain a better understanding of the stakeholder groups and factors responsible for the further development of the mobility landscape, the creation of new solutions, and how these groups interact. In turn, these insights can be used to derive how future urban mobility in German cities and metropolises can become more sustainable and efficient. After an

introduction to the topic, the relevance of the three stakeholder groups public sector, private companies, and consumers with regard to future urban mobility in Germany was elaborated and evaluated within three individual parts. Finally, the findings of the individual parts were combined, and a model was developed, which can support public sector officials in the evaluation of new potential projects and the comparison of alternatives in the future.

In the introduction, the relevance of the topic, as well as the selection of the stakeholder groups examined was explained. Furthermore, the status quo of urban mobility in German cities and metropolises was analyzed and the current challenges of Germany regarding urban mobility were outlined.

The first individual part analyzed the role of the public sector in future urban mobility development. More specifically, the overarching goals of the German public sector, to achieve higher efficiency, sustainability and accessibility were examined. Furthermore, it was the target of this part to find out how and where the public sector steers the urban mobility development in German cities. Therefore, qualitative expert interviews were conducted with experts inside and outside the public sector, covering in their expertise various mobility related industries and knowledge areas, such as infrastructure, transportation and smart mobility.

The second individual part of the thesis examined the potential of ACES trends in the context of urban mobility transformation. Through a qualitative survey with representatives of private companies, insights were gained into the market environment, the role of private companies and the anticipated development through the impact of the trends until 2040.

In the third individual part, the factors as well as their relative importance according to which consumers in German cities and metropolises choose their means of transportation were examined. The results of the study provide insights into the conditions under which a natural shift towards a higher proportion in use of alternative means of transportation can be expected.

In the final part of the study, these findings were used to propose and conceptualize a model that can be used by public sector officials as a decision support tool for evaluating and

prioritizing alternatives for new mobility concepts. Here, new mobility concepts are evaluated based on three factors: *efficiency*, *sustainability* and *accessibility*. These factors are composed of several sub-factors, which are evaluated individually and result in an overall score for each category. The results are ultimately presented within a radar chart, providing both visual and quantitative comparability of alternatives. The limitations of the model have been outlined in the corresponding section.

In summary, it can be stated that the model can be used as an initial indication for the evaluation of projects and enables a quick assessment. The model acts as a tool for officials from the public sector, adding much value to educated decision making. In later steps, further factors should be included in the in-depth analyses when evaluating projects in detail.

The transferability of the findings and the application of the presented model is basically given for other markets in which the factors efficiency, sustainability and accessibility also play essential roles in the development of new mobility concepts. In this context it must be mentioned that in this thesis the interaction of the stakeholders in Germany was analyzed and for a possible application of the model for other markets the political and social situation must be considered.

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9 Appendix

Appendix 1: Individual Topic I - Overview conducted interviews

Overview interview partners			
Interview number	**Expertise**	**Role**	**Experience**
Interview 1 (I1) *10.11.2022 – 44 minutes*	Infrastructure	Strategy Consultant	- Various infrastructure projects in Germany, Europe and internationally
Interview 2 (I2) *18.11.2022 – 39 minutes*	Public Sector (External)	Project Manager	- Various strategy consulting projects with the German public sector
Interview 3 (I3) *22.11.2022 – 47 minutes*	Public Sector (Internal)	Public Sector Official	- Digitization of traffic and mobility - Project execution in future mobility topics in Hamburg
Interview 4 (I3) *18.11.2022 – 27 minutes*	Smart Mobility	Senior Expert	- Experience across mobility industries - Special insights into future mobility
Interview 5 (I5) *22.11.2022 – 31 minutes*	Transportation	Principal (Senior project leader)	- Experience across transportation industries - Special insights into public sector collaboration

Appendix 2: Individual Topic I – Semi-structured Interview Guide

Introduction	- Short introduction reviewing experience, sharing of information about the field lab and information procedure - Quick overview of the questionnaire - What do you think urban mobility will look like in German cities in 2040?
Section: German public sector	- How do you evaluate the efforts of the public sector towards improving efficiency, sustainability and accessibility of human urban mobility? - What extend of improvement per factor is realistic? - Do you see an increased responsibility of the public sector to act in these fields? - Will Germany meet their commitment to save further 42% of emissions in the public sector? - Do you wish for more public regulation and intervention or less? - How do you evaluate the German federal system regarding urban mobility development? - Which public interventions do you wish for? - Which cities do you see as future urban mobility leaders in Germany/worldwide?

Section: Contribution of technology trends	- Which of the mobility trends Autonomous Driving, Connectivity, Electrification, Shared Mobility has major impact on the improvement of the three factors? - How would you rank them according to their importance?
Section: Public sector collaboration with private companies and consumers	- In future urban mobility development: What is the role of the public sector? - … What is the role of the private sector? - … What is the role of the consumers? - Do you believe that car drivers will be willing to switch to public transport increasingly? - How can this be reached regarding public intervention (incentivization/regulation) - How can the collaboration with private companies be improved?

Appendix 3: Individual Topic I – Results from interview analysis and inductive coding process

Question	Interview quotes	Outcome/ Finding
What do you think urban mobility will look like in German cities in 2040?	- *"(...) we need to change the system to have fewer cars on the roads."* (I1) - *"I think it is relatively difficult to expand the public transport system. Most large German cities already have a super subway network which of course can be optimized at the expense of tax money and construction delays."* (I1) - *"There will be less car mobility, but public transport will increase in my view, as will pedestrian mobility and mobility by bicycle."* (I3) - *"I would say there can only be limited changes if no applications for approval have already taken place in 2022 to then carry out expansion measures and construction measures accordingly."* (I5)	- German cities already have a fairly good public transport network - Probably less car mobility and more walking, cycling and public transport - Big construction changes by 2040 in mobility planning take a long time and should be known already
How do you evaluate the efforts of the public sector towards improving efficiency, sustainability and accessibility of human urban mobility? **&** **What extend of improvement per factor is realistic?**	- "*(...)almost all measures are focused on carbon savings or have that as their primary goal (...) but the public sector should act more strongly in this area."* (I2) - *"Regarding efficiency, there it comes to infrastructure and it's going to be hard to change that in a big way in the next 18 years, because those are long processes."* (I5) - *"The 49 euro ticket subsidizes public transport. Similarly, there are projects of the city of Hamburg, where we have brought out an app that has calculated*	- Sustainability is the biggest focus area of the public sector - Physical infrastructure will hardly be revolutionized by 2040 - The 49€ ticket showcases the states commitment to accessible mobility - Physical access is also being worked on in city-internal initiatives

	by AI the cheapest route with public transport to get from A to B. Here, all the efforts are made to reduce the number of cars." (I3)	
Do you see an increased responsibility of the public sector to act in these fields? **&** **Will Germany meet their commitment to save further 42% of emissions in the public sector?**	- "*The public sector is responsible. However, I think it's important to focus on one thing at a time and to do it properly rather than trying to do everything a little bit at a time and it not working out well in the end."* (I1) - *"I see this one hundred percent the state's responsibility. I mean, it's a basic need that you have to be able to move around, and that's of course one of the central levers."* (I2) - *"I believe that we are working directly towards this goal. Still, I don't see the goal as realistic, honestly."* (I3)	- The public sector is more responsible than ever to deliver on its goals and commitments such as the paris climate agreement - The fulfillment of the emission reduction goal is unrealistic for Germany - The whole public sector tries to live up to the increased responsibility and to reduce emissions but change remains hard
Do you wish for more public regulation and intervention or less?	- "*I think yes, the state should intervene more (...) otherwise you won't get a grip on the number of cars. I am personally firmly convinced of that."* (I2) - "*I also think that the cities have to proceed how they envision it. That they create regulations that allow private sector business, which can also become more efficient."* (I4) - *"I think for the moment in the direction of carbon it is still too little regulated."* (I5)	- The public sector should regulate more, as this forces real change - Especially in the field of sustainability must be regulated more, as private companies and consumers do not care enough
How do you evaluate the German federal system regarding urban mobility development?	- "*From my point of view, it is a strength being able to implement something quickly and relatively. On the other hand, it makes it more difficult for new measures to be applied across the nation, since each municipality ultimately decides for itself."* (I1) - *"I believe that this is where we lose a great deal of synergy potential, and we have an enormous amount of resources that we have to put into this, because you have to develop your own solutions in 16 federal states. You can bundle much better if it is controlled centrally."* (I2) - *"What I am convinced of is that urban areas or metropolitan regions, which need joint planning, are no longer always located along state or national borders. City-states like Hamburg have a huge advantage as they can fully focus on urban mobility solutions. All in all, federalism does not make too much sense."* (I4) - *"The short answer is that federalism is totally bad in this respect."* (I5)	- The federal system holds the benefit for each state to remain flexible and focussed on the own needs - The federal system holds the disadvantage that resources cannot be bundled - Also, states might have very heterogenous rural to urban mobility conditions to serve

Which public interventions do you wish for? **&** **Which cities do you see as future urban mobility leaders in Germany/worldwide?**	- "*(…) we have to consider whether to nationalize parts of the infrastructure again or subsidize them more or plan them better, across the nation."* (I1) - *"Hamburg is a kind of model city where a lot is being tried out and many pilot projects are being tested for eventual adoption throughout Germany and the entire EU."* (I3)	- The experts generally wish for more restrictive interventions of the public sector to initiate real change - Hamburg is a good model city to run pilot projects and gets much funding from German and EU means
Which of the mobility trends Autonomous Driving, Connectivity, Electrification, Shared Mobility has major impact on the improvement of the three factors? **&** **How would you rank them according to their importance?**	- *"Electrification is a big topic, but other fuels are also needed in parallel. I'm curious to see how, for example, hydrogen or HVO and so on will prevail."* (I2) - *"In itself, I honestly believe that all four aspects are important (…) In my view, autonomous driving will generally bring the most in terms of efficiency and progress."* (I3) - "*In my opinion, only autonomous driving and connectivity will bring relevant change as that's the only way to get all the cars out of the parking lots. I just think you have to be careful with autonomous driving that you don't just relate it to cars.*" (I5)	- In general, all 4 technology trends hold potential to reduce emissions and increase efficiency and accessibility - Autonomous driving is the most promising technology, according to the experts - With electrification, its also important to consider that other clean fuels are serving the same cause and should also be explored and produced
In future urban mobility development: **-What is the role of the public sector?** **-What is the role of the private sector?** **-What is the role of the consumers?**	- *"I think the public sector is the "guide rail provider" (…)the private sector should be the "mastermind", but at the moment, it's not quite like that yet, which means the private sector has a bit of an implementer role." (I2)* - *"(…) the customers are the ones who are moved afterwards. I don't think customers can be expected to think far enough ahead about the complexity of urban mobility to be strong idea generators."* (I4) - *"The public sector would be the "coordinator" and "implementer" for me. The private sector is for me the "vicarious agent" and the consumer is for me (…) a "conscious or an insightful participant"."* (I5)	- The public sector is seen to have the role of an coordinator and guard rail provider - With public transport, the public sector has also the role of implementer - the private sector must be the innovator of new technologies and ideas - The consumers have a receiving role as they simply decide on the usage of mobility options. They should be thoughtful and choose wise and sustainable, but they don't have an obligation
Do you believe that car drivers will be willing to switch to public transport increasingly? **&** **How can this be reached regarding public intervention**	- *"I think the consumer would go along with a lot of things as long as it is not more expensive and significantly more inconvenient than in the car. Then I think a lot of people will switch. Especially for commuters, these factors are rationally important." (I3)* - *"Often the mistake of assuming rational behaviour is made (…) usually, other considerations are involved. People have emotional bonds with their car or value social distance*	- The public sector internal expert believes, that consumers might change their behaviour as soon as a better offer is made - Public sector externally, the switch of consumers is seen as hard to realize as there are other factors than just rational decision making involved, such as emotional bonds with

(incentivization/regulation)	*higher than low cost and flexible transfers with public transport"* (I4) - *"(...) they could somehow impose fines, not penalties, but a hindering tax for example, or decrease parking spaces, make roads more car unfriendly etc."* (I5)	a car or the wish for social distance -The public sector must also actively try to make the personal car less attractive through regulations and make the use less comfortable
How can the collaboration with private companies be improved?	- *"There are many partnerships between state and companies. The state or the administration takes the companies with it and builds new solutions together, such as Moia or Ioki that are only possible through cooperation and not without."* (I3)	- The cooperation between public sector and private sector works quite well - There are a few successful joint ventures between state and Volkswagen for example, when cooperation worked out well - The state must take the companies with it and propose offerings