Scenario Planning

How is big data going to influence the future of smart mobility in Germany?

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Abstract

Smart mobility is the future of transportation services in Germany. The implementation and management of smart mobility is impossible without using big data. At the present time, the analysis of big data in Germany is not fully implemented due to existing challenges. The purpose of this research project is to forecast the impact of big data on smart mobility in Germany with the use of scenario planning. In order to receive the most actual scenarios, the input factors were designed in accordance with extensive literature research, and then ratios between all specifications of input factors were compared and evaluated. Thus four unique scenarios were selected for further detailed interpretation to suggest possible influences of big data on smart mobility in Germany.

Key words: *big data, smart mobility in Germany, INKA 4, scenario planning*

Key findings

- The implementation of smart mobility in Germany depends on governmental regulations and social attitude regarding big data collection and usage.
- The use of scenario planning allowed generating 27 scenarios in total, four of which were chosen to interpret the possible influence of big data on smart mobility development in Germany.
- The scenarios are differentiating in terms of the pace of adoption of smart services and governmental control of the use of obtained data. Two selected scenarios provide progressive development of smart mobility with only few governmental restrictions. Whereas another two scenarios involve governmental control. The major difference between them is the possibility to develop smart mobility products and services using big data.

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ICT	Information and communication technology
ITS	Intelligent transport systems
LTE	Long term evolution
OEM	Original equipment manufacturer

1 Introduction

Within the last few years the concept of a smart city has become the most promising concept to deal with the increasing urbanization and the problems this development brings about. One of the major challenges to be managed within a modern city is the transport sector: Smog, noxious fumes, traffic jams,… these problems will intensify within the next decades if the mobility strategies of the last decades are continued to be followed. To avoid an escalation of the problems linked to current urban transport systems, governments and city planners are developing concepts which aim at a sustainable reorganization of urban mobility – in other words, smart mobility concepts are considered key for the future successful development of cities.

Since urban planning is a critical measure to achieve smart mobility, most of the established concepts focus on the needs of non-modernized road-users, an expansion of the public transport system, and the reduction of the environmental footprint (e.g. through government incentives for environmentally friendly power trains). With quantum leaps in technology and data storage, mobility concepts which are based on big data – as for instance Car-to-Infrastructure Communication, Car-to-Car Communication, or Sharing Platforms – gain more and more attention. Regarding the fact that data storage and the usage of private data is a highly sensitive topic in Germany, this paper will deal with the question:

How is big data going to influence smart mobility in Germany?

In order to answer this research question, this paper will first shed a light on the theoretical aspects of big data, smart cities and smart mobility. Further, the applied methodology (scenario planning) and the team's approach to scenario planning will be outlined before the actual scenarios and results are presented and discussed.

Our findings reveal four potential futures, out of which two show a progressive approach towards big data, smart cities and thus smart mobility, and two which reveal a wait-and-see approach, respectively a restrictive and hampered one.

2 Big Data

Big data indicates the massive amount of data or information produced rapidly by several numbers of diverse sources. Such data can either be created by people or generated by machines, for example: social interactions, mobile devices, R&D reports, physical infrastructure (sensors and surveillance), all contributing to the constant flow of data streaming. Big data may involve personal data: that is any information relating to an individual, and can be anything from a name, a photo, an email address, bank details, posts on social networking websites, medical information, or a computer IP address (European Commission 2016).

According to the study “The digital Universe in 2020” released by EMC Corporation, 4.4 zettabytes of information are created every year worldwide, by 2020 it is estimated that the digital universe will reach 40 zettabytes, or 40 trillion gigabytes, this is equal to 1.7 MB of new information for every human, every second of every day.

Google now processes over 40,000 search queries every second on average, which translates to over 3.5 billion searches per day and 1.2 trillion searches per year worldwide (InternetLiveStats, 2016), moreover in 2016 it is expected to ship over 1.4 billion smart phones (statista, 2016), all packed with sensors capable of collecting all kinds of data, not to mention the data the users create themselves. According to the report “Cisco Visual Networking index” presented in 2016, the number of wirelessly connected devices in 2015 grew to 7.9 billion, up from 7.3 billion in 2014, more than the global population of 7.3 billion in 2015 (United Nations Department of Economic and Social Affairs 2015).

In 2010, enterprises and users stored more than 13 exabytes of new data; this is over 50,000 times the data in the Library of Congress, the potential value of global personal location data is estimated to be $700 billion to end user (Jagadish and Gehrke 2014). According to a report from McKinsey Global Intitute 2011 (McKinsey 2011), big data could have a signigificant effect on employment where 140,000-190,000 workers with data analytical experience will be needed in the US; furthermore, 1.5 million managers will need to become data-literate. Another study “Big Data Analytics: An assessment of demand for labour and skills, 2012-2017" (E-Skills UK 2013) conducted by e-skills uk and SAS predicts that in the UK alone, the number of big data staff specialists working in large firms will increase by more than 240% over the next five years. These global trends in big data hold enormous potential in various fields, ranging from health, food security, climate and resource efficiency to energy, intelligent transport systems and smart cities (Figure 1).

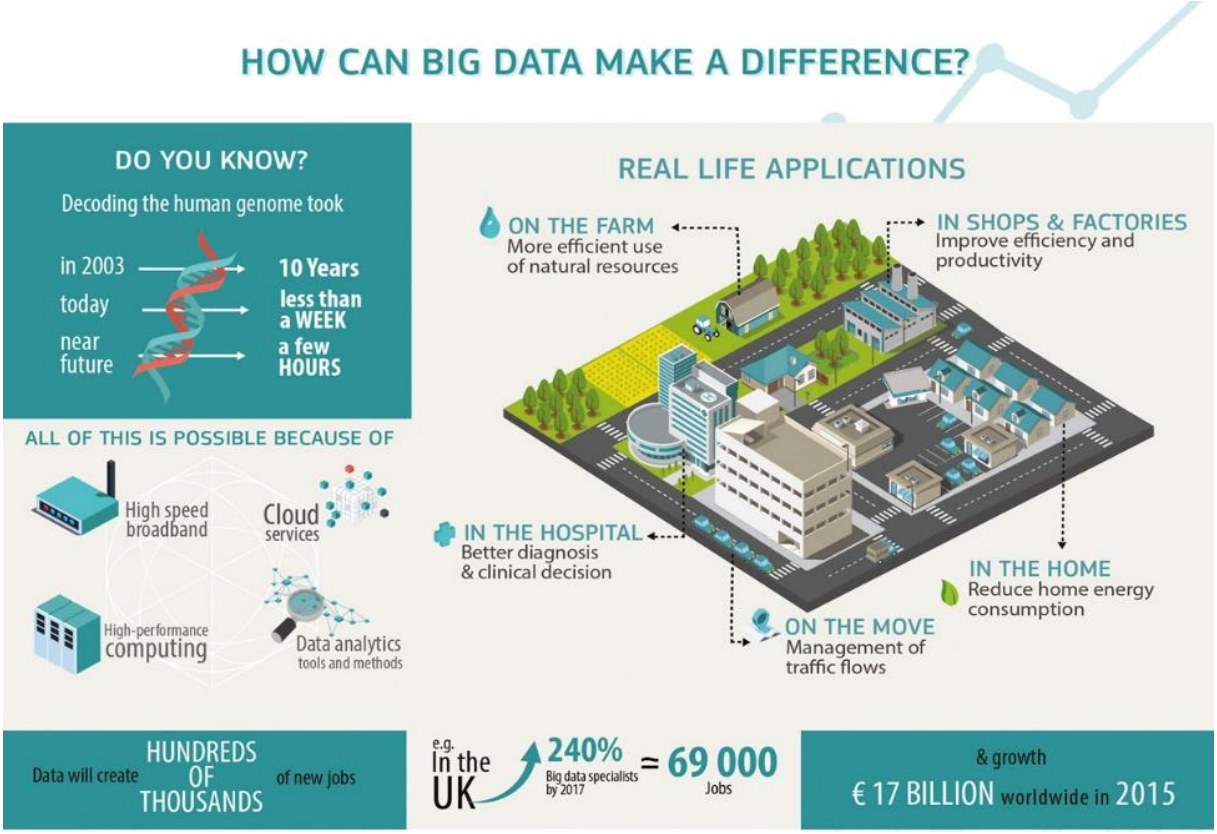

Figure 1: How big data can make a difference. European Commission, 2016. (http://ec.europa.eu/justice/data-protection/files/data-protection-big-data_factsheet_web_en.pdf)

The big data era is at an early stage, as most related technology and analytics applications were first introduced only around 2010, on the other hand almost 80% of the world's data today was generated during the past two years, approximately 90% of it is unstructured with lesser economic value (Kim and Trimi 2014). Still the overwhelming amount of remaining data offers new opportunities for discovery, value creation, and rich business intelligence.

While big data can yield extremely useful information, it also presents new challenges with respect to how much data to store, whether the data can be useful, whether the data will be secure, and how long it must be maintained and so on. Some of the major challenges are discussed below:

Heterogeneity. The data not only comes from multiple channels (such as social networks, the Web, and crowdsourcing) but from different sources (such as countries, institutions, agencies, and departments). Machine analysis algorithms expect homogeneous data, and are poor at understanding nuances. In consequence, data must be carefully structured as a first step in (or prior to) data analysis (Jagadish and Gehrke 2014).

Scale. Managing large and rapidly increasing volumes of data has been a challenging issue when it comes to big data as traditional database approaches don't scale or write data fast enough to keep up with the speed of creation. Additionally, purpose-designed data warehouses are great at handling

structured data, but there's a high cost for the hardware to scale out as volumes grow (Kajal and Somani 2014).

Timeliness. As data grow in volume, we need real-time techniques to summarize and filter what is to be stored, since in many instances it is not economically viable to store the raw data. This gives rise to the acquisition rate challenge described earlier, and a timeliness challenge we describe next. The fundamental challenge is to provide interactive response times to complex queries at scale over high-volume event streams (Jagadish and Gehrke 2014).

Privacy and data ownership. The privacy of data is another huge concern, and one that increases in the context of big data. There is great public fear regarding the inappropriate use of personal data, particularly through linking of data from multiple sources. Managing privacy effectively is both a technical and a sociological problem, which must be addressed jointly from both perspectives to realize the promise of big data (Al-Khouri 2012). Another issue is that many online services today require us to share private information, but beyond record-level access control we do not understand what it means to share data, how the shared data can be linked, and how to give users fine-grained control over this sharing in an intuitive, but effective way. In addition, real data are not static but get larger and change over time; none of the prevailing techniques results in any useful content being released in this scenario.

3 Smart Cities

Nowadays people face significant global trends that will have an impact on lifestyle changes in the future. These main trends are urbanization, economic growth and ecological threats.

The urban population in 2014 was 54% of the total global population and this number is expected to grow to 70% by 2050 (World Urbanization Prospects, 2014). The urban population in Germany is 75.3% of the total population in 2015, that is 1.4% more than in 2011 (The World Bank, 2015).

With the population and productivity expansion, economic growth is expected. Developing countries will overtake developed countries in terms of economic growth. The economic growth in Germany is currently slowing down, nevertheless economic activities have influenced on the ecological environment. Therefore, Germany has the highest level of greenhouse emissions among all European Union members. In 2013, the level of greenhouse gas emissions was equal to 21.17% of the total European Union level (Eurostat, 2015).

With high population density, urban traffic and the need of efficient resource usage, many countries started to implement ambitious projects that aim at the development of modern urban infrastructure based on the use of sophisticated technologies. This concept is called *smart city*.

Beside the smart city concept, the so called *intelligent city* and the c*reative city* concepts exist. The intelligent city is a highly productive city that is specialized in a range of knowledge intensive innovative sectors. The intelligent city is mainly focused on innovative development which is encouraged through learning and technological development. The creative city concept focuses on empowering citizens to improve the city; using their concerns, capacities and creativity (Letaifa 2015, p.1414).

The conceptual component of a smart city is the usage of Information and Communications Technology (ICT), to implement high efficiency and management of the economy as well as a high standard of living and mobility and respect for the environment for long-term sustainable development. Germany's ICT market is the largest in Europe. According to ICT Development Index 2015, Germany was scored 14th in the world rank. Following the ICT Strategy of the German Federal Government, Germany will improve its ICT development that will allow to build smart cities across the regions. (ICT Development Index 2015).

However, it is important to note that the concept of smart cities is not just limited to technological improvement, but rather has the aim to persuade socioeconomic development (Nam and Pardo 2011). Therefore, another key characteristic of the smart city concept is *smart people*. Smart people or *smart citizens* can be characterized by the high level of education and qualification, willingness to participate in public life, creativity and cosmopolitanism (Giffinger et al 2007).

As a result, for the purpose of this research paper, we have selected the definition put forth by Marsal-Llacuna et al. (2014) which states that "Smart Cities initiatives try to improve urban performance by using data, information and information technologies (IT) to provide more efficient services to citizens, to monitor and optimize existing infrastructure, to increase collaboration among different economic actors, and to encourage innovative business models in both the private and public sectors."

The definition of smart cities by Marsal-Llacuna et al. (2014) is connected to the smart city model developed by Giffinger et al. (2007). According to this model, the concept of smart cities is described by six distinct characteristics (see Figure 1). The influential areas are: economy, people, governance, mobility, environment and living. With the aid of this model, a city can examine its current state and identify the missing components which are needed to meet the necessary conditions of becoming a smart city (Giffinger et al. 2007). Furthermore, this model helps cities to establish individual objectives according to their unique circumstances by following the vision outlined by the six characteristics (Giffinger et al. 2007; Steinert et al. 2011).

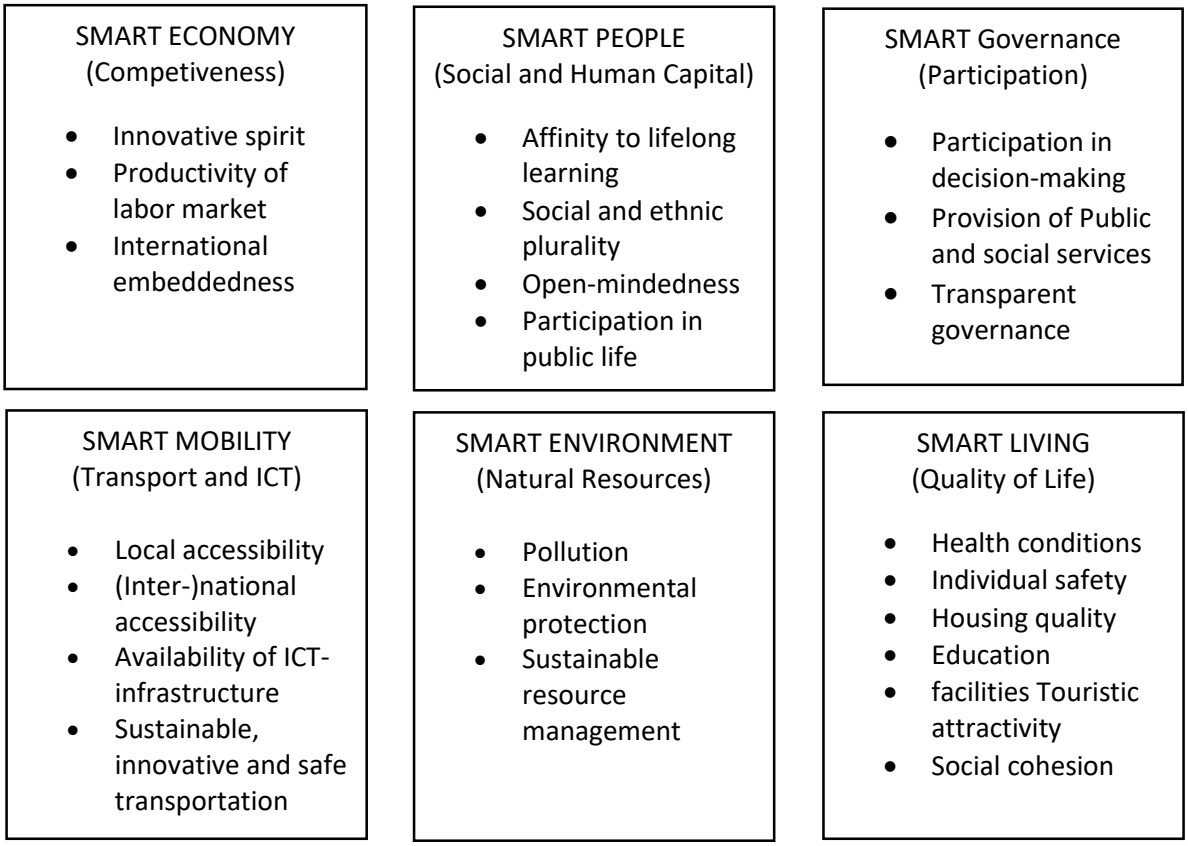

Figure 2: Six characteristics of the smart city model. Giffinger et al., 2007, p.12.

Smart economy describes the overall competitive position of a city, based on its strategy to business, research and development (R&D) expenditures, entrepreneurship, productivity and flexibility of the labor market, and the economical position of the city nationwide as well as in the international field.

Smart people are characterized by a high and consequent level of education, their willingness of participation in public life as well as their cultural awareness and open- mindedness.

Smart governance implements that the smart governance system is transparent and gives the citizens the permission to partake in decision-making. By the help of the ICT infrastructure, people who are living in a smart city have access to information and data connected to the management of their city. As a result, the efficient governance system makes it possible to reduce the barriers in relation to communication and collaboration.

Smart mobility supports more efficient transport systems. In connection to that, citizens should be motivated to change their attitude towards vehicle usage and be able to get easier access to public transport. Key element in this section is the efficient utilization of ICT, which is integrated into the whole transport system. As a result, the aim of smart mobility is an efficient transportation of people, goods and vehicle in an urban and sustainable environment.

Smart environment points out that resource management and sustainable urban planning is needed to enhance the natural beauty of the city. With the help of pollution and emission reduction and measures towards environmental protection, a sustainable development of the city can be guaranteed. Therefore, smart cities put much effort into the promotion of the reduction of energy consumption and into new technological innovation, to shape their environment more sustainable.

Smart living refers to improve the quality of life of citizens, which includes to provide healthy and safe livening conditions. Accordingly, people who are living in a smart city have easy access to health care services, electronic health management, and to diverse social services. (Giffinger et al. 2007).

4 Smart Mobility

Mobility and transportation are two key elements in modern society and a fundamental base for a healthy economy and social welfare. At the same time, urban mobility is influenced by new challenges. The increasing size of our cities requires more road safety, improved traffic flow and environmental sustainability.
The utilization of innovative information and communication technology (ICT) offers the possibility to improve and use the existing traffic infrastructure in an optimal way (Fraunhofer 2016).

Therefore, the aim is to provide an efficient, safe and comfortable transport system, which is linked to ICT infrastructure and open data.

This is also the basis to follow new mobility trends like for example:

- From ownership to sharing (e.g. car sharing)
- Driven by information
- Personification of travel information
- Usage of Electric Cars

In preparation for the mentioned trends, the smart urban mobility is aimed to achieve many significant objectives:

- Ensure the accessibility of transportation services for everybody
- Improve the safety and security for citizens and travelers
- Reduce air and noise pollution, greenhouse gas emissions and energy consumption
- Improve the efficiency and cost-effectiveness of the transportation of persons and goods
- Enhance the attractiveness and quality of the urban environment (European Comission 2012, p. 10)

The smart mobility has a specific structure to provide smart city services. This structure is based on physical infrastructure (e.g. roads, rails, bike paths), operational technology (e.g. sensors, surveillance, controls) and communications technology (e.g. Wi-Fi, 3G, 4G). In Germany, ITS Action Plan for the Roads is aimed at the improvement of existing infrastructure and accelerated introduction of new Intelligent Transport Systems by the year 2020. Operational and communications technology collect the data that is then used by information technology to process, anonymize, analyze and program the data that is then transferred to smart city services for users. The smart mobility benefits are targeted at the main potential user groups: travelers (citizens and businesses), transport operators, urban planners and city governments.

Smart mobility aims at providing efficient movement of people and goods, and in doing so to access the essential facilities, communities and other destinations that are required to support a decent quality of life and a buoyant economy implying ICT that is leveraged to manage city services and improve citizens' quality of life (Smart Cities cornerstone series, 2014).

The smart city concept is impossible without ICT that operate with big data. In the smart mobility concept, big data is obtained from actors that use operational and communications technology. The value chain for sustainable urban mobility starts from data sources that include private and public sectors. Data sources in the smart mobility concept may include public and private transport service providers, citizens, city areas and maps, police, borough, public and other stakeholders. Data sources allow collecting the raw data that is generated by intelligent infrastructure and provides raw material resource, including information about journey time, usage patterns, and service availability.

The raw data analysis derives the information components that have substantial value in managing urban planning, transport system design and service management in real time and for the future. Information services are the final product in the value chain, and can be used by individual travelers and transport operators.

The new concepts of smart mobility require new business models in order to generate revenues that might come from app sales, transaction fees (paid by transport operators and users) and venture capital funding. But while big data can yield extremely useful information for smart mobility, it also presents new challenges like to analyze the huge amount of data and how much this will cost. In addition, big data also presents new ethical challenges, which includes the data security of every individual as well as how long the data must be maintained (Michael, Miller 2013, p.23).

5 Methodology

5.1 Scenario Planning

Scenario planning, also called *scenario-based planning* or *scenario and contingency planning*, has first evolved after World War II as a military planning method and belongs to the *future studies* or *foresight*. The method of scenario planning has been transferred from military usage to business planning in the 1960s and 1970s (Verity, 2003; The Economist, 2008; Research-Technology Management, 2010; Schroeder & Lambert, 2011). After having been introduced by Herman Kahn and associates at Rand Corporation (a US company), the scenario planning technique was further developed by Khan and a think-tank set up by him. In the 1960s and 1970s, scenario planning for business purposes was first applied by General Electric, but the real breakthrough of scenario planning as a strategy tool was made by Pierre Wack at Shell and Peter Schwarz at the Stanford Research Institute of Stanford University. Over time, two styles of scenario planning evolved: the intuitive style and the formal style. The intuitive scenario planning is based on creativity, imagination, as well as subjective and qualitative information, and focuses on storytelling to approach scenarios. The outcome is rather a good understanding of the forces affecting the future development than the exact forecast of future events. Opposite to this is the formal style. This approach is built on the use of computer software and precise analytical processes. A computer based analysis and calculation program has been developed by the US-American consulting group Battelle between the 1970s and 1980s. The INKA 4 software used for this project is an enhanced version of a first program developed at the Battelle Institute (Verity, 2003; Geschka GmbH Unternehemensberatung, 2016).

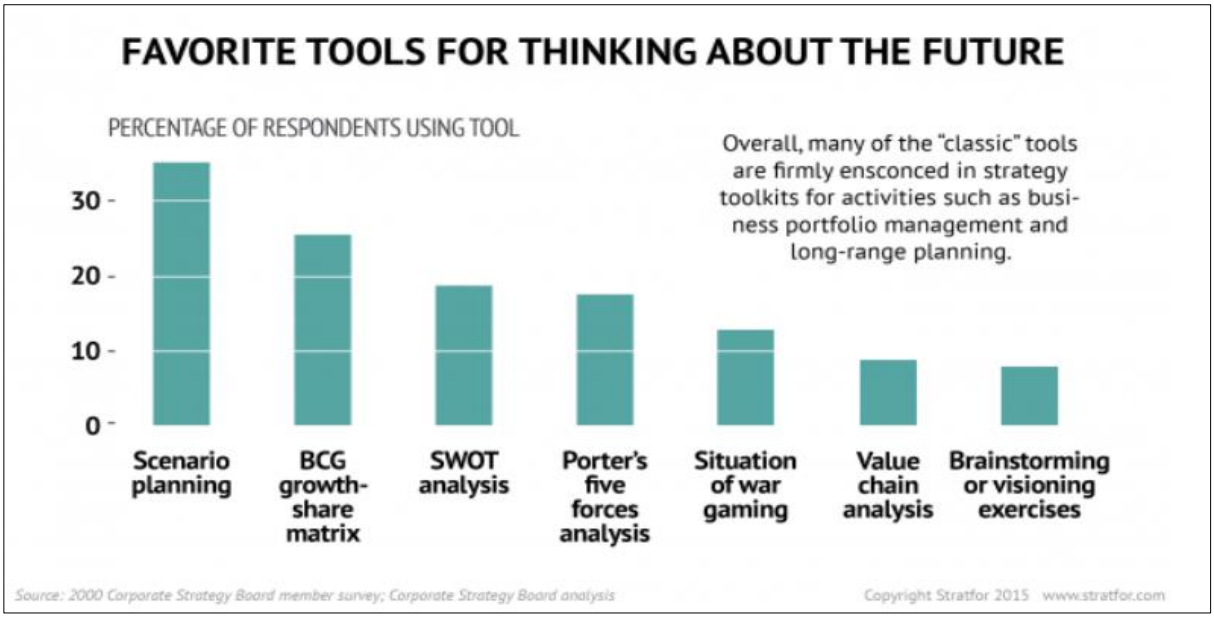

Table 1: Favorite tools for thinking about the future. Ogilvy, 2015. (http://www.forbes.com/sites/stratfor/2015/01/08/scenario-planning-and-strategic-forecasting/#51ed14776b7b)

During the last decades, the use of scenario planning has become more widespread: while less than 40% of companies made use of this technique in 1999, the percentage of firms applying scenario planning had increased to 70% in 2006 (The Economist, 2008). Nowadays, scenario planning is the preferred tool to think about the future.

Scenario planning is a flexible tool which can be applied for a wide range of topics – the targeted issue just needs to contain a certain degree of uncertainty. Main reasons to use scenario planning is to gain insights into the forces shaping future developments such as globalization, demographics, or technological and legal frameworks. Companies usually employ scenario planning as a strategic tool for e.g. budgeting, operational or investment planning (Verity, 2003; Research-Technology Management, 2010; Axson, 2011). However mainly used in a private business context, scenario planning is also used by state/region/local agencies for their planning processes – the US Federal Highway Administration even recommends the usage of scenario planning as an enhancement of the traditional transport planning process (Schroeder & Lambert, 2011; Federal Highway Administration , 2016).

By conducting scenario planning, possible futures are scrutinized. This allows e.g. companies to prepare strategies for different future events or incidents and to quickly adopt to the new circumstances. Scenarios are not only flexible in use, but at different levels of analysis also complementary. Scenario planning can be conducted with long-term, complex, global scope which helps to answer more general questions as outlining future trends and helps to define a strategic focus for the next decades. Another approach is focused and narrow scenarios, which are rather short-term oriented (period of a few years compared to decades at the long-term scope), and focus e.g. on the situation within a single industry. Generally, their purpose is to support management understanding and reflection upon uncertainties to be faced in future. It can also help thinking ‘outside the box’ and identifying first-mover advantages or so far ignored risks (Wright, 2000; Verity, 2003; Axson, 2011; Ogilvy, 2015).

Notwithstanding the advantages scenario planning brings about, there are also some costs which cannot be neglected. Besides the number of different techniques applicable – what can get confusing for beginners – scenario planning is time and resource demanding. It is suggested, for instance, that between five to ten people should form a scenario team. Those people should meet regularly and also conduct workshops to spread their insights. As stated by Verity, this is at least a part-time, or even a full-time job for a manager over a period of several months. For a period of six months, the costs of scenario planning reach about US$600,000 (Verity, 2003). Moreover, the philosophy of scenario planning – the acceptance of an uncertain and unpredictable future – is against human psychology. Evolutionary psychology theory “asserts that accepting uncertainty, recognizing it as inevitable and

living with it, goes against the grain of human nature. It is human instinct to downplay risk“ (Verity, 2003). This is especially true for leading persons which are often biased by “overconfidence in their ability to predict and control” (Verity, 2003). In other words, human instinct makes the application of scenario thinking difficult, especially at the management levels, where scenario planning could actually yield the highest benefits.

The scenario software INKA 4 supports the creation of scenarios from the collection of the input factors, the so called *descriptors*, up to the calculation and evaluation of the different scenarios. Scenarios are alternating narratives of the future; stories how future can develop (Ogilvy, 2015; Geschka GmbH Unternehemensberatung, 2016).

INKA 4 is based on an eight-step procedure:

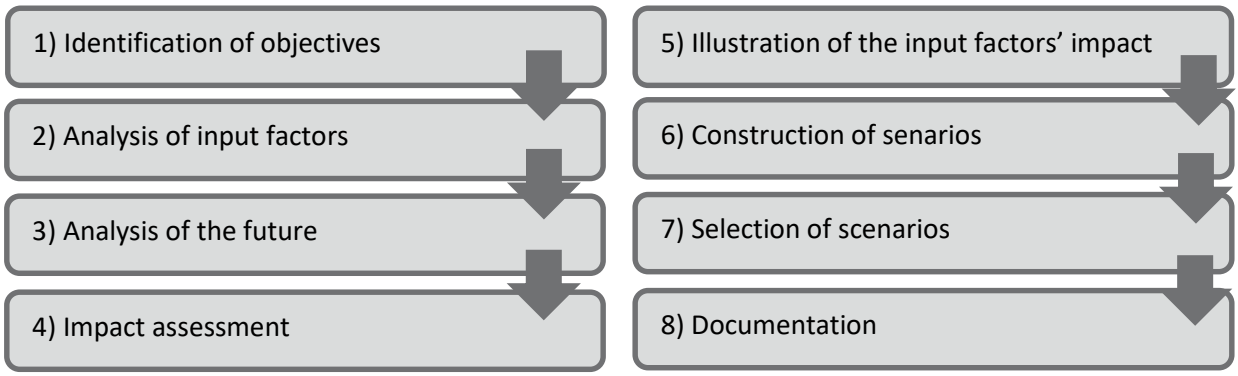

Figure 3: Scenario planning process. According to Geschka GmbH Unternehmensberatung, 2016. (http://szenariotechnik.com/szenariotechnik)

During the first step, the identification of objectives is key. In other words, the framework for the scenario planning is set up: what is the purpose of the scenario planning? What is its scope? Are there problems or strategic issues which need to be identified/taken into consideration?

In a second step, key indicators and input factors, the so called descriptors, are identified and structured. Each descriptor can be ranked according to its importance.

Step three deals with the analysis of the future. For each descriptor up to five projections of the future can be entered. Future projections can also be conducted for interim points of time.

The forth step is the impact assessment of the descriptors. Here the mutual impacts of the single descriptors are highlighted in a matrix scheme and have to be analyzed according to the degree of their linkage.

As a next step, the results of the impact assessment are displayed – on the one hand, driving factors and driven (dependent) factors are differentiated; on the other hand, the degree of the linkage of the descriptors with the system is illustrated.

During the sixth step, the information given to the system is synthesized by the software. A consistency matrix showing the different projections and their consistency is the result. The algorithm behind the

software identifies the most consistent scenario, and proposes further scenarios which are different but consistent.

After having got the different projections, the most probable and plausible scenarios need to be chosen. Finally, all information entered and all the results should be well documented to underpin the overall results (Geschka GmbH Unternehemensberatung, 2016).

Generally, a good set of scenarios contains between three and five different but sufficiently detailed projections/narratives and should be adjusted to the context of the scenario planning's purpose. Most notably in a business context, a strategy – or even several alternative strategies – should be developed from the final scenarios. These strategies should be regularly adjusted to fully exploit the benefits of scenario planning (Ogilvy, 2015).

5.2 Areas of influence for descriptor setup

The quality and accuracy of obtained scenarios in INKA depend on input descriptors. Therefore, descriptors should provide precise information about current situation and future directions of smart mobility and big data development. This section will explain the most significant areas of influence for selected descriptors in accordance with socio-economic trends and state programs in Germany.

Areas of influence are divided into following categories: Society, Urbanization, Innovativeness, Politics, Industry and Infrastructure. Each area has a specific set of descriptors that have the greatest impact on the development of smart mobility through the usage of big data. Areas of influence have from one to five descriptors. The following sections will provide a brief explanation of each area.

5.2.1 Society

Smart mobility is highly dependent on demand, therefore society is a crucial factor in determining the utility of smart mobility and collection of big data. Any changes in society influence the industry as a whole and certain services in particular. For instance, the environmentally friendly lifestyle trend in Germany demands the development of bike paths and electric transportation. Germany is ranked as one of the world's leading producers of electric vehicles alongside Japan and the U.S. (McKinsey, 2014). The success of other countries in launching smart mobility services also helps to encourage its development in Germany. For example, the city government of Amsterdam introduces new mobility solutions through the collaboration of public and private sectors and the usage of open data. Other examples are Vienna and Barcelona which focus on launching electric mobility solutions, parking and bike-sharing systems. All of these examples foster not only German government to develop smart mobility, but also German society to take interest in this industry. However, further smart mobility design and management requires big data collection and analysis. Therefore, indicators as the usage

of mobile devices and fast mobile internet largely determine the future progress of big data analysis for smart mobility. The main concern is the willingness of German society to share data. Studies show that 58% of the German population is concerned that their personal data may be used for a purpose other than that for which it was collected (Statista, 2014). This can be a significant barrier for data collection and thus for smart mobility services.

The descriptors which arose from the area of Politics are as followed:

1) German Smart Services demand

2) Development of Smart Cities around the world

3) Usage of mobile devices

4) Fast mobile internet

5) Acceptance of data collecting through ICT

Interest in and adaption of smart services by the German public are important factors in creating probable future scenarios. Whether the demand for new transportation concepts such like car-sharing will rise or fall will have a huge impact on further developments. Another important descriptor is the *Development of Smart cities around the world* because new concepts and ideas can originate everywhere around the world. The more interest there is in the topic of smart cities around the world the faster innovations and solutions are created and therefore can be applied in German cities as well. The smart part in smart mobility comes from an efficient control of the traffic flows. However for an efficient traffic system an interconnectedness of the travelers is needed. Thus the *Usage of mobile devices* is a critical point for incorporating the routes of ten thousands of individuals every day. Data about the start and end of a trip need not only to be known but also to be transferred quickly which is why *Fast mobile internet* is considered for the scenario building as well. Because privacy rights are a big topic in Germany different developments concerning the *Acceptance of data collecting through ICT* have to be included as influence factors as well. Smart services cannot work in an efficient way if the potential users do not provide information about their travel routes and other habits.

5.2.2 Urbanization

As it was mentioned before, urbanization creates many challenges for cities all around the world. In 2015, the number of urban population in Germany was equal to 75,3% (The World Bank, 2015).

The increasing number of urban citizen is one of the main factors for the need of smart city services and thus one important descriptor is called *Urbanization*.

How smart services will develop in the next couple of years will depend on the urgency with which a solution for the increasing traffic amount is needed. If the growth rate of urban populations accelerates or if less people will move to a city will have a great impact on smart mobility.

5.2.3 Innovativeness

Smart mobility and big data are two highly innovative areas. The automotive industry in Germany is one of the most innovative and competitive ones in the world and number one in Europe (GTAI, 2015). Taking into account that German OEMs are responsible for around one third of international automotive R&D expenditures, the German automotive industry will continue to evolve and provide a variety of products for smart mobility solutions (GTAI, 2015). The automotive industry in Germany will invest 10 to 12 billion euros alone in the next three to four years in alternative engines - that's 40% of all research and development investments (Wissmann, 2014). Another important factor influencing innovativeness is the investment into start-ups. German investments into start-ups in the first half of 2015 exceeded last year's figure (EY, 2015). The private sector supports the development and innovation of the transportation industry and smart mobility services, for example by the planning and delivery of transport services or by developing applications for users. The increasing number of investments into start-ups may encourage the private sector to enter the industry with innovative solutions.

Therefore, the descriptors considered in the area of innovativeness are as followed:

1) Automotive R&D investments rate
2) Venture Capitalism in Technology Industry

The transition to smart cities will require interconnection of transportation vehicles utilizing ICT, such can be driven by innovation. Investments are needed to answer the questions, how future cars will integrate with technology in the user's life and how they will connect to a network of vehicles and the surrounding environment, consequently, depending on the *Automotive R&D investments rate,* it will be possible to generate the solutions needed for interconnection in the urban mobility, referred as one of the pillars of smart cities. On the other hand, Germany's industry strength in electronic technologies and software solutions will be crucial in the advancement of smart cities. This might be possible with the development of technology startups to generate disruptive technologies. *Venture capitalism in Technology Industry* proves to be a necessary funding resource for startups, while massive it can help to evolve the tech culture in Germany and thus, promote the rapid development of smart cities.

5.2.4 Politics

The government is the only institution that can foster smart mobility in Germany. Government programs and plans are determinative for further steps of development and methods of completing challenges. However, the financial situation of German cities may influence on decision of local government to implement intelligent transport solutions. The increasing gap between rich and poor cities affects the ubiquity of smart solutions for transportation and big data analysis, and as a result the collaboration among cities to enhance further development. Other important governmental interventions are automotive and technological programs. Currently, there are several programs aimed at supporting the innovativeness of the private sector, such as “GO-Bio” and “High-Tech Gründerfonds” (GTAI, 2015). With regard to the main challenge of big data usage, data security, state authorities’ efforts focus on creating data collection regulations and protection mechanisms.

Finally, five descriptors were selected in the area of politics:

1) Regulations for data usage
2) Data privacy protection
3) Political collaboration with private sector
4) Government intervention in automotive and technology industry
5) Financial situation of cities

As stated in chapter 2 (Big Data), data will have a critical impact on all major areas of life. Its importance will most notably rise in the technology and industry sector and increase its significance in private lives. Several challenges come along with this development (*heterogeneity, scale, timeliness, privacy and data ownership)*. Depending on the framework set by the government, those challenges will be addressed and solved in favour or against smart mobility. Since data collection and usage represents the basis for its exploitation, the descriptor *Regulations for data usage* has been chosen; more specifically, especially the law regarding the “Störerhaftung” has been considered more closely, since this law exemplifies the general attitude towards data usage (for more details of the descriptor see 8.4). Hand in hand with data usage goes the challenge of privacy and data ownership, or in other words, the question of *data privacy protection*, an extremely sensitive topic in Germany. This descriptor deals with the question of who will own and control the accumulated data and the strictness of regulation (for more details of the descriptor see 8.4). The descriptors *Political collaboration with private sector* and *Government intervention in automotive and technology industry* both foster the development of industry standards (thus addressing the challenges of heterogeneity, scale and timeliness) and spur the development of smart mobility. Depending on the level of collaboration and intervention, the development of smart mobility in Germany will be accelerated or slowed down (for more details of the descriptors see 8.4). However, the possibility of state support for the development of smart mobility

also largely depends on the situation of the public treasuries: financial support of R&D, development of an adequate infrastructure etc. The speed of the realisation of plans mainly depends on the financial resources behind. Therefore, the *Financial situation of cities* has been taken into consideration (for more details of the descriptor see 8.4).

5.2.5 Industry

The Industry area is closely related to innovativeness, because it includes the transportation and private sector industry. Diversification of transportation and private sector industries offer a wide range of services for smart mobility, creating a competitive environment and encouraging service providers to deliver more efficient, environmentally friendly and safer products for users. Another important industrial technology is operational technology that generates raw data for smart solutions. The development of operational technology in Germany is being implemented through supporting small and medium-sized businesses, pressing forward with research and development on new technologies and enhancing security and trust in the digital world (BMWI, 2013).

Thus the following descriptors in the industry area were selected:

1) Diversification of transportation industry
2) Market entry strategies for start-ups
3) Development of operational technologies

Smart mobility embodies new trends (from ownership to sharing, driven by information and usage of electric cars) inevitably influencing and shaping the future of transportation services. The chosen descriptor, *Diversification of transportation industry* is also aimed to solve the existing challenges such as accessibility of transportation services for every citizen, improving the safety and security for citizens and travelers, and increasing the efficiency and cost-effectiveness of transportation of persons and goods. With the huge amount of data, which is equal to 4.4 zettabytes of information, generating by every user every year worldwide, there is a strong need to develop the *Operational technologies*, which collect the data with the purpose to introduce the smart mobility services. The pace of operational technologies development will determine the pace of smart mobility implementation in Germany. The development of operational technologies as well as diversification of transportation industry would not be efficient without start-ups, which together with government might overcome the challenges of big data (*heterogeneity, scale, timeliness, privacy and data ownership).* However, the lack of investments might have an impact on *Market entry strategies for start-ups*. As a result innovative services and products, depending on market strategy, might be different in terms of the innovativeness and efficiency for big data usage and smart mobility development.

5.2.6 Infrastructure

The foundation of smart mobility cities is the physical infrastructure and operational technology. Physical infrastructure such as roads, rails and bike paths are already well developed across Germany. However, in order to collect raw data for further analysis, there is a strong need for devices which monitor daily traffic levels and the most used routes in and out of the city.
Therefore the descriptor Surveillance and sensing infrastructure was selected.

This descriptor takes the development of the German infrastructure for monitoring and analyzing the traffic level and flow into consideration. Its base is the budget allocation proposed in the "Bundesverkehrswegeplan", the state program for maintaining and improving the German transport routes (BMVI 2016).

5.3 Proceeding

The first step for this project was to develop a suitable research question. Because the project was introduced with the title "Scenario Planning - The future of Big data", it was clear that the project was about forecasting possible future developments in the area of data collecting and analysis. However, the topic alone was too broad, thus we gathered information to focus on a more specific use of big data. We found the use of big data for the development of a smart city quite intriguing but still too wide, which is way we decided to concentrate our research on smart mobility. Our final research question was formulated as "How is big data going to influence smart mobility in Germany?"

The process of answering this question through creating the final scenarios can be seen in Figure 4 below and is described in the following section of this paper.

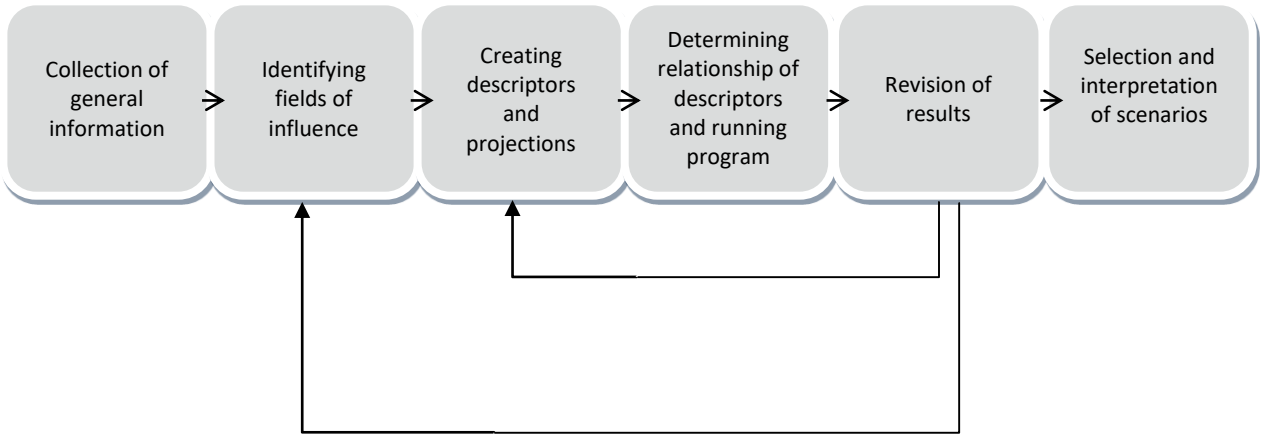

Figure 4: Process of scenario creation.

After deciding on the research question the next step was to identify the most influential fields for smart mobility. At the end of the literature review we concluded that social changes, security issues, legislation and politics, technological advancements and the German infrastructure include points which all together would determine the future of smart mobility. In the next step we assigned a team member to each of the fields of influence for further research. Although everyone was still looking for descriptors in every area of influence it was important to have someone for each area who looked deeply into the subject matter and could act as an expert. After we researched the fields of influence and found our first set of descriptors we gathered to evaluate them together.

During this examination we came to realize that we had to be careful not to confuse results of future developments with descriptors, since descriptors are only “descriptive parameters” (Schwarz-Geschka 2014, p.8). Future trends or alternative developments of the descriptors are described with up to three different so called projections. Those projections have to be plausible and probable which means that they have to be derived from facts and data stated by reliable sources (Schwarz-Geschka 2014, p. 8). It is necessary to set for each projection a), b) and c) a probability of occurrence. The probabilities of the projection for each descriptor combined cannot exceed a 100%.

While examining the descriptors we jointly revised the projections of the descriptors and the probabilities for them to happen with the help of the researched literature. One advantage we had through the new cloud-based INKA 4 version was that everybody had already entered their descriptors and projections into the program. We saved a lot of important group time because we did not have to type in all the information while meeting but instead just had to edit and delete. After the elimination and rewriting of unsuitable descriptors and projections we had 16 descriptors with 34 projections.

The next step was to fill out the consistency matrix. In order to create reasonable, conclusive predictions about future scenarios the software needs information about the relationships between the single projections. This information is entered via the consistency matrix. Figure 5 shows a screenshot of a single consistency matrix for two predictions with three projections each.

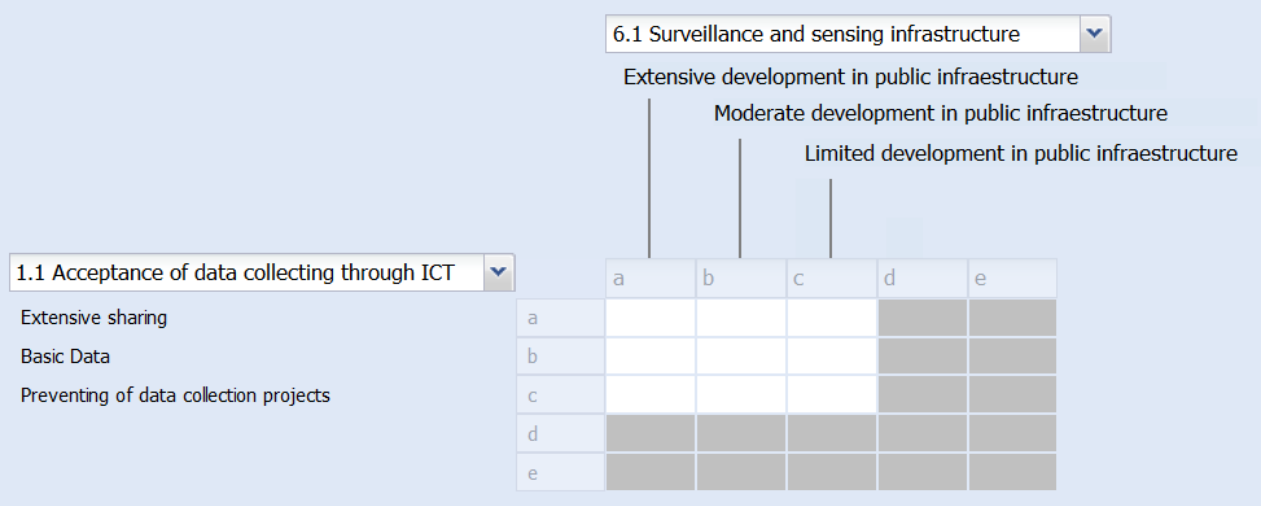

Figure 5: Example of consistency matrix.

Each projection is assed against one another. The question to ask is: Suppose, descriptor 1.1a and descriptor 6.1a occur at the same time. Do the projections fit together? Do they support each other? Or are they contradictory to each other? (Schwarz-Geschka 2014, p. 12). Filling out the consistency matrix is one of the most important but at the same time most difficult task. The software creates and appraises the scenarios to great parts according to the information given in the matrix but assessing the relations is very difficult. Since the matrix is treated as symmetrical only half of it is processed. That means that there cannot be a direction of effect in assessing the relationship of two projections. If projection 3a supports projection 4b, then projection 4b has to support projection 3a as well. Otherwise the relation is not properly assessed. At the same time the kind of relationship has to be estimated correctly as well. The options for describing the nature of the relation between two projections are shown in the following.

Entering value	Meaning
+3	Belong necessarily together, mutually dependent
+2	Supporting each other
+1	Fitting into the same promotional climate
0	No relationship (unrelated) (coexistence possible)
-1	Fits badly together
-2	Contradictory
-3	Mutually exclusive

Table 2: Values and meanings for consistency matrix.

The assessment of the relationships was a very time consuming task because in order to enter the right value we often had to go back to the explanations of the descriptors and the projections. The name

given to the descriptors was no enough to judge the kind of relation properly. After entering the values for all the relationships, we run the software and obtained our first set of scenarios.

Unfortunately, the first scenarios were not different enough from one another. In the course of examining each scenario we saw that some descriptors moved in blocks, that means that for example every time descriptor 3a was chosen 4a and 5a were chosen as well and when descriptor 3b was chosen the other descriptors changed for example to 4b and 5b as well. Such patterns can mean that there are so-called meta-descriptors. Meta-descriptors are descriptors which include all aspects of the single descriptors which move together and can replace those if it is appropriate content-wise (Schwarz-Geschka 2014, p. 16). During the revision of our descriptors we found meta-descriptors which gave us reason to rework our descriptors. After a second time filling out the consistency matrix we received better result but we still were not completely satisfied. Although there was variety among the created scenarios they were lacking differences in important descriptors. Because we did not feel able to interpret these scenarios into disguisable and probable future developments we went even further back and reconsidered even our choice of fields of influence. We checked again if we had included all important influences on the topic and revised the assignment of the descriptors to the fields of influence. After we improved our work and filled out the consistency matrix again we received 27 scenarios. Among these results we identified four in themselves consistent and distinguishable scenarios. The consistency of a scenario is reflected by its consistency sum according to with the scenarios are ranked from highest consistency sum to lowest. The consistency sum is calculated by adding all the consistencies of the chosen scenario together. It is a relative measurement of quality depending on the number of descriptors used in the project. The more descriptors are used the higher the consistency sums. The scenario with the highest consistency sum is the most conclusive scenario. The four final scenarios which were chosen for interpretation are described in the following chapter.

6 Results

In this section the above mentioned final four scenarios which were created with the help of INKA 4 are going to be interpreted and evaluated. After the final overhaul, we arrived at 17 descriptors from six different fields of influence to describe the future of smart mobility in Germany. For creating the scenarios three descriptors were not used in the consistency matrix. Two descriptors were unambiguous with only one projection. Unambiguous descriptors are not taken into account in the consistency matrix because they have only one possible outcome and therefore do not bring variation for the scenarios. One other descriptor was not considered neither because although not unambiguous it still did not improve the quality of the scenarios.

For calculating scenarios INKA 4 selects the two to four most consistent descriptors and then combines the projections which fit together the best. In our case the three descriptors: “Government intervention in Automotive and Technology industries”, “Political collaboration with private sector” and “Surveillance and sensing infrastructure” were the determined descriptors for the bundling process. Despite the descriptors being fixed all of their different projections were used to create scenarios.

The criteria for choosing the scenarios for interpretation were the value of the consistency sum and the difference between the individual projections of each scenario. Chosen were scenario S-6 further referred to as #1, scenario S-1 (#2), scenario S-10 (#3) and scenario S-12 (#4). A list with the complete information about the chosen projections for every individual scenario can be found in the Annex (List of final descriptors). None of the descriptors has the same projection for every one of the four chosen scenarios. That means that the four scenarios differ from one another significantly. : : Differences between scenarios gives an overview about how distinctive the scenarios are.

Scenario		#1	#2	#3	#4
Consistency sum		66	54	47	44
Consistency average		1,40	1,35	1,07	1,02
Probability		44	48	45	46
Differences					
	#1	-	7	10	11
	#2	7	-	9	11
	#3	10	9	-	6
	#4	11	11	6	-

Table 3: Differences between scenarios.

The interpretation of the scenarios depends on their chosen descriptor projections. The selected projection has to be considered as well as what that selection means in relation to the other projections selected in that scenario. The full interpretations of the four final scenarios are presented in the following sub-chapters.

6.1 Scenario (S-6) #1: „Big brother is watching you and everybody likes it"

A strong urbanization rate leads to an exponential growth of the cities populations. The resulting increase in traffic volume needs to be addressed with a smart way of transportation management which is why the government highly collaborates with the private sector in the use of big data for innovation.

Besides setting the course for the automotive and ICT-industry through easier regulation processes and incentives, the government itself uses its financially sound situation to promote and implement smart solutions. Extensive investment in the German infrastructure does not just include the maintains and expansion of transport routes but the implementation of improved surveillance and sensing devices in order to monitor and control mayor transport interchanges more efficiently. A change in the liabilities for public Wi-Fi-signals leads to the use of Germany's high potential for free hotspots in cities. Those hotspots are used heavily by the German public who shares the information to plan routes and maneuver through the cities via and increasing number of mobile devices like smartphones or tablets extensively. The amount of the data gather is controlled by a central private hub which provides the data to companies and organizations in accordance with German law.

The high demand for smart mobility services together with the increased need for intelligent transportation solution arouses international interest in the German market. The positive climate which is reinforced by government incentives in the automotive and technology industries not only entices new Start-ups to enter the market on their own but leads to an increase in investments rates in research and development activities from automotive companies. Thus the advancements of operational technologies accelerate, resulting in more precise and faster sensing and surveillance devices which are implemented in the city infrastructure making public transportation more and more efficient.

6.2 Scenario (S-1) #2: „Old Uncle Sam lets the kids play"

Smart mobility profits from an exponential growth of demand for smart services as well as high interest in the development of smart cities in Germany from around the world. As the population of cities is slowly but continuously increasing, automotive companies increase their efforts in researching and

developing new products and services which are efficient enough to cope with the challenge of an increasing transportation demand.

The government limits its involvement due to a lack of financial resources of the city administrations to backing the private sector with supporting legislation enabling them to use the gathered information about the transportation patterns of citizens. Additionally, the government creates incentives for the technology and automotive industry in order to support intelligent transportation solutions such as the connection of transportation vehicles like busses, subways and cars with different information networks for real time traffic management and congestion avoidance. This Laissez-faire environment enables new Start-ups to enter the market on their own which leads to more innovation and further development of operational technologies as well as powerful analyzation algorithms which can deal with the processing of incoming big data.

Because of a lack of mobile hotspots in Germany, common carriers provide fast mobile internet through LTE technologies. Citizens tolerate the for smart services necessary data collection on a basic level which together with a steadily increasing number of mobile device users results in a vast accumulation of movement patterns. The data gathered through the networks is the main source for the development of smart services since the expansion of the surveillance and sensing infrastructure is hampered by the aforementioned lack of financial resources of the public authorities.

6.3 Scenario (S-10) #3: "The tight grip of the federal data kraken"

Although the vast majority of the German population uses mobile devices such as smartphones and tablets and accepts the collection of basic data through ICTs as well the government restricts the processing of this information through the private sector. By controlling the citizens' information on its own and increasing the complexity of the regulatory process for the data usage the governments wants to protect the privacy of its citizens but hampers the development for smart mobility at the same time. Severely underfunded city administrations prevent the government from implementing smart transportation solutions necessary surveillance and sensing infrastructure.

A steady number of people move from rural areas to Germany´s cities, but without exponential growth and the support of the government, smart service demand never reaches a critical level to tip of mayor developments. As a result, foreign interest in German cities stays on a moderate level. Since the cities treasuries are empty, mobile hotspots are rare and the main providers for mobile internet are the common carriers which developed their long term evolution (LTE) networks. At the same time the government structures the regulation process for the use of data more complex and increases the restrictions for the industries.

Although the government cooperates with the companies to a certain level, the tougher restrictions imposed on the firms severely hamper innovations and fruitful collaboration between the public and the private sectors. Therefore, automotive and technology firms work on implementing ICTs into their vehicles by their own but because of the difficult situation with the data usage the growth rate of investments in R&D activities increase only minor. Thus developing sensing devices and other operational technologies takes more time. Instead they buy Start-ups which provide ready to use solutions or possess interesting new concepts

6.4 Scenario (S-12) #4: "Better safe than sorry"

A healthy financial situation of the cities enables the government to focus on long term goals. Although growth rate of German cities remained on a moderate level for the last couple of years increasing traffic volume and fume exhaustion are problems which have to be solved.

Through high collaboration with the private sector as well as the support of Start-ups the government initiates the creation of new smart solutions. With a change in the liabilities for public Wi-Fi-signals the high potential for hotspots can be used to provide nearly ubiquitous free internet access in German cities for the increasing number of mobile device users. Those users are fine with the collection of their basic data in order to improve smart services for which the demand has been continuously growing over the past.

While on the one side the government encourages the private sector to innovate, it holds all the strings in its hand on the other side. Through controlling the private data, the government decides which companies and organizations it grants access to that information. In combination with increasing restrictions for the automotive and technology industry the government slows down the ability of those industries to achieve results in a short time because they restrict investments in research and development. The development of operational technology is hampered by these conditions as well. By improving its surveillance and sensing infrastructure only gradually Germany literally follows the motto "better safe than sorry" thus falling behind in the development of smart cities around the world and failing to attract high foreign interest in its projects.

6.5 Discussion of results

The interpretations of the selected final scenarios describe four unique possibilities in which way the utilization of big data can influence smart mobility in Germany. The direction of the development of the four chosen scenarios differ by the pace of adoption of smart services and the control the government takes over the use of the gathered data. The for the year 2030 forecasted scenarios can be described as progressive, stagnating or observant. Scenario #1 and #2 are both progressive where

only a few government restrictions for the use of big data exist. In scenario #3 the development of smart mobility is stagnating because the government has a tight control over the data usage. In #4 the government holds control over the data as well but allows the use in order to invent new products and services to have them ready when needed.

Nobody can predict the future and it is not the purpose of scenario planning to do so neither. Scenario planning intends to reveal the relations between different influences and show a spectrum for future developments which are substantiated in facts. The scenarios created reflect very different developments. This was intended by use and can be seen in our number of approaches to create such results. We base our predictions on at the moment available information and literature. In that sense we believe our results are valid estimation for future developments.

7 Conclusion

With the beginning of the big data era, the amount as well as the importance of collected data racketed. Successfully dealing with the mass of data comprises enormous challenges but also a huge potential. Big data can help to solve problems arising from urbanization and the emergence of mega-cities – especially problems in the transportation sector. However, it is not clear how big data is going to develop and how it will influence the development of smart mobility in Germany in the future.

This paper discusses the methodology of scenario planning for the development of smart mobility using big data in Germany. An overview of smart mobility and smart cities was presented, with the focus on the main players, trends, development and influencers. As a team we aimed to answer the main research question: “How is big data going to influence smart mobility in Germany?” After intensive work, we were able to identify six different fields of influence with a total of 17 important descriptors. In the end 27 scenarios were created from which four scenarios where chosen for interpretation.

However, having a limited knowledge on smart cities, smart mobility or scenario planning, the project caused some difficulties through different stages. Normally the formulation of possible future scenarios is carried out throughout half a year by a fulltime employee who has expert knowledge about both scenario planning as well as the field the research is conducted in. As we are neither experts in smart city concepts nor on scenario planning, we first of all had to establish some basic knowledge in both of those areas. The literature as well as multiple current reports got us the information to generate the fields of influence as well as the descriptors and specifications for smart mobility in Germany. However, the literature available often presented some clear trends and bias into the input data. In order to counter these effects multiple sources were consulted. Further, the creation of the descriptors constituted a massive challenge because many descriptors moved in the same direction due to similarities within them. Therefore, it was required to restart the process over and over again to obtain the desired data quality and satisfying scenarios.

At the end, four scenarios were selected according to their consistency rating and the differences between them. Each scenario was interpreted into a possible future reality. The four unique possibilities describe in which way the utilization of big data can influence smart mobility in Germany. The difference lies mainly in the pace of adoption of smart cities and the control the government takes over the use of the gathered data. Two of the scenarios are of a progressive type, one can be seen as hampered by governmental restrictions and in one the government acts reluctant and observant.

But what does this mean for businesses? Which of the four is the way to go? The need of smart mobility is becoming more important caused by an increasing urban population as well as environmental

aspects which urge to make transportation less energy consuming and overall efficient in the future. At this point, it is important to mention that the aim of scenario planning is not to predict the future. It is rather a possibility to take current information and literature into consideration to make proposals for the future. The four scenarios show opportunities and drawbacks of possible developments. By analyzing the four scenarios, businesses – but also state institutions – are able to develop appropriate strategies to be able to quickly adjust to upcoming realities concerning the implementation of smart mobility in Germany.

However, since especially the technological and the legal situations[1] are continuously changing. Expert knowledge in both those fields would help to improve the scenarios by quite a bit since legal implications and technological details can lead to major developments. Constant further research is therefore required but can build up on the generated results and focus more in-depth on specific areas of influence. Adjusting the input factors for the latest developments and adding new arising influences as descriptors refines the predictions made. The results of this paper should therefore be seen as guideposts which show in the right direction and not as perfect maps. During the journey to the future you have to continuously incorporate new information to ensure that you are still on course.

[1] For instance: while writing this research paper, already one legal aspect changed - the so called *Störerhaftung* has been announced to be abolished in the course of a new law regulating the usage of free WiFi (spiegel, 2016)

8 Annex

8.1 Differences within the Scenarios -1st trial (14 April 2016)

Anzahl unterschiedlicher Projektionen

Szenario	S-6	S-4	S-5	S-2	S-3	S-1
Rang	**1**	**2**	**3**	**4**	**5**	**6**
KS	175	134	134	129	129	93
KD	1,70	1,43	1,37	1,34	1,29	1,01
WM	59	65	63	58	56	61
S-6		2	1	2	1	3
S-4	2		1	2	3	1
S-5	1	1		3	2	2
S-2	2	2	3		1	1
S-3	1	3	2	1		2
S-1	3	1	2	1	2	

KS:	Konsistenzsumme
KD	Konsistenzdurchschnitt
WM	Wahrscheinlichkeitsmaß

Die Einträge in der Matrix geben die Anzahl der Deskriptoren an, in denen sich die Szenarien unterscheiden.

8.2 Differences within the Scenarios – 2nd trial (22 April 2016)

Anzahl unterschiedlicher Projektionen

Szenario	S-18	S-14	S-17	S-16	S-13	S-10	S-12	S-15	S-11	S-9	S-8	S-7
Rang	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
KS	70	64	54	49	48	46	45	39	35	33	30	27
KD	1,43	1,33	1,13	1,17	1,02	0,92	1,13	0,95	0,90	0,66	0,70	1,08
WM	60	65	56	67	61	60	72	60	65	56	67	32
S-18		1	1	2	2	1	3	4	5	2	3	13
S-14	1		2	3	1	1	2	5	4	2	3	13
S-17	1	2		3	1	2	4	3	4	1	4	12
S-16	2	3	3		4	3	1	2	3	4	1	11
S-13	2	1	1	4		2	3	4	3	1	4	12
S-10	1	1	2	3	2		3	5	5	1	2	12
S-12	3	2	4	1	3	3		3	2	4	1	11
S-15	4	5	3	2	4	5	3		1	4	3	9
S-11	5	4	4	3	3	5	2	1		4	3	9
S-9	2	2	1	4	1	1	4	4	4		3	11
S-8	3	3	4	1	4	2	1	3	3	3		10
S-7	13	13	12	11	12	12	11	9	9	11	10	

KS:	Konsistenzsumme
KD	Konsistenzdurchschnitt
WM	Wahrscheinlichkeitsmaß

Die Einträge in der Matrix geben die Anzahl der Deskriptoren an, in denen sich die Szenarien unterscheiden.

8.3 Differences within the Scenarios – final (30 May 2016)

Anzahl unterschiedlicher Projektionen

Szenario	S-6	S-4	S-8	S-7	S-9	S-1	S-3	S-5	S-11	S-10	S-2	S-25	S-27	S-24	S-26	S-15	S-17	S-13	S-14	S-16	S-12	S-19	S-18	S-21	S-23	S-20	S-22
Rang	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
KS	66	59	57	57	57	54	52	51	48	47	45	45	45	45	45	44	44	44	44	44	44	44	44	34	34	34	34
KD	1,40	1,48	1,24	1,24	1,21	1,35	1,21	1,16	1,23	1,07	1,10	0,98	0,98	0,96	0,96	1,05	1,05	1,05	1,02	1,02	1,02	1,00	0,98	0,83	0,81	0,81	0,79
WM	44	50	47	49	49	48	41	46	43	45	44	44	46	41	44	46	48	49	43	45	46	49	46	45	46	42	44
S-6		3	13	14	14	7	1	3	11	14	7	2	3	2	3	11	13	11	11	13	11	12	12	6	8	6	8
S-4	3		10	11	11	4	4	1	14	12	5	5	6	5	6	8	10	12	8	10	12	9	9	4	6	4	6
S-8	13	10		2	1	8	12	11	5	3	9	11	12	12	13	2	2	4	3	3	5	1	2	8	8	9	9
S-7	14	11	2		1	8	13	12	3	1	9	12	11	13	12	4	3	4	5	4	5	3	4	9	8	10	9
S-9	14	11	1	1		8	13	12	4	2	9	12	11	13	12	3	2	3	4	3	4	2	3	9	8	10	9
S-1	7	4	8	8	8		6	5	11	9	1	9	9	9	9	10	8	11	10	8	11	9	9	6	4	6	4
S-3	1	4	12	13	13	6		4	10	13	6	3	4	3	4	12	14	12	12	14	12	13	13	7	9	7	9
S-5	3	1	11	12	12	5	4		14	11	4	5	6	5	6	9	11	13	9	11	13	10	10	3	5	3	5
S-11	11	14	5	3	4	11	10	14		3	11	9	8	10	9	7	6	3	8	7	4	6	7	11	10	12	11
S-10	14	12	3	1	2	9	13	11	3		8	12	11	13	12	5	4	5	6	5	6	4	5	8	7	9	8
S-2	7	5	9	9	9	1	6	4	11	8		9	9	9	9	11	9	12	11	9	12	10	10	5	3	5	3
S-25	2	5	11	12	12	9	3	5	9	12	9		1	1	2	9	11	9	10	12	10	10	11	4	6	5	7
S-27	3	6	12	11	11	9	4	6	8	11	9	1		2	1	10	11	8	11	12	9	11	12	5	6	6	7
S-24	2	5	12	13	13	9	3	5	10	13	9	1	2		1	10	12	10	9	11	9	11	10	5	7	4	6
S-26	3	6	13	12	12	9	4	6	9	12	9	2	1	1		11	12	9	10	11	8	12	11	6	7	5	6
S-15	11	8	2	4	3	10	12	9	7	5	11	9	10	10	11		2	4	1	3	5	1	2	6	8	7	9
S-17	13	10	2	3	2	8	14	11	6	4	9	11	11	12	12	2		3	3	1	4	1	2	8	6	9	7
S-13	11	12	4	4	3	11	12	13	3	5	12	9	8	10	9	4	3		5	4	1	3	4	10	9	11	10
S-14	11	8	3	5	4	10	12	9	8	6	11	10	11	9	10	1	3	5		2	4	2	1	7	9	6	8
S-16	13	10	3	4	3	8	14	11	7	5	9	12	12	11	11	3	1	4	2		3	2	1	9	7	8	6
S-12	11	12	5	5	4	11	12	13	4	6	12	10	9	9	8	5	4	1	4	3		4	3	11	10	10	9
S-19	12	9	1	3	2	9	13	10	6	4	10	10	11	11	12	1	1	3	2	2	4		1	7	7	8	8
S-18	12	9	2	4	3	9	13	10	7	5	10	11	12	10	11	2	2	4	1	1	3	1		8	8	7	7
S-21	6	4	8	9	9	6	7	3	11	8	5	4	5	5	6	6	8	10	7	9	11	7	8		2	1	3
S-23	8	6	8	8	8	4	9	5	10	7	3	6	6	7	7	8	6	9	9	7	10	7	8	2		3	1
S-20	6	4	9	10	10	6	7	3	12	9	5	5	6	4	5	7	9	11	6	8	10	8	7	1	3		2
S-22	8	6	9	9	9	4	9	5	11	8	3	7	7	6	6	9	7	10	8	6	9	8	7	3	1	2	

KS:	Konsistenzsumme
KD	Konsistenzdurchschnitt
WM	Wahrscheinlichkeitsmaß

Die Einträge in der Matrix geben die Anzahl der Deskriptoren an, in denen sich die Szenarien unterscheiden.

8.4 List of final descriptors

Descriptor name: Acceptance of data collecting through ICT

Area of influence: Society

Current situation: Data security once again is a hot button issue in Germany. The result of a representative study showed that around 70% of the German population worries about their personal data and privacy protection. Especially bank and paying information are affected.

Specification A

- **Name:** Extensive sharing
- **Description:** Great changes in the attitude towards data collection which is a systematic approach to gathering information from a variety of sources to improve smart mobility.
- **Reason:** Users understand and appreciate the benefits of sharing such as the convenient and inexpensive access to information, goods and services.
- **Probability:** 20%

Specification B

- **Name:** Basic Data sharing
- **Description:** Consumers are more apprehensive about sharing data and are doing it with a more discerning attitude
- **Reason:** Users are willing to share personal information in exchange for tangible benefits, with the understanding of ICT technologies they are often cautious about disclosing their information.
- **Probability:** 65**%**

Specification C

- **Name:** Preventing on data collection projects
- **Description:** Due to a feeling of wariness or mistrust users neglect sharing their information
- **Reason**: Attitude is one of the main components argued to affect the intention to share data and based on the perceived negative outcomes of sharing information, users can neglect to do so.
- **Probability:** 15%

Sources:

- Handelsblatt (2015), Viele Deutsche haben Angst vor Datenklau. available at: http://www.handelsblatt.com/technik/it-internet/mobiles-bezahlen-viele-deutsche-haben-angst-vor-datenklau/11895076.html

Descriptor name: German Smart Services demand

Area of influence: Society

Current situation: Interest of the German population in smart services**.** Most of the German population has a high level of environmental consciousness, according to the result of a survey made by the Umweltbundesamt. In connection to smart services, the demand for car-sharing institution increased enormously during the last years but in contrast to that the sale of electric cars runs slow.

Specification A

- **Name:** Linear growth
- **Description:** Smart services will be developed in no sensitive areas.
- **Reason:** There are some examples of development of smart services. The German city of Wiesbaden provides an ingenious way to ensure that bike paths are built where they're most needed using data of bike rides to determine important bike routes.
- **Probability:** 55%

Specification B

- **Name:** Exponential growth
- **Description:** The innovative use of data helps to provide better and more inventive services to increase the demand of smart services in
- **Reason**: Due to connectivity offer by big data users can increase the awareness of the urban environment and to enhance the interaction with its inhabitants**.**
- **Probability:** 45**%**

Sources:

- Bundesumweltministerium (2014). Umweltbewusstsein in Deutschland. Available at: http://www.umweltbundesamt.de/publikationen/umweltbewusstsein-in-deutschland-2014;
- Anzahl der Carsharing-Fahrberechtigen in Deutschland nach Varianten (Stand: 1. Januar 2016). Available at: http://de.statista.com/statistik/daten/studie/202416/umfrage/entwicklung-dercarsharing-nutzer-in-deutschland/

Descriptor name: Usage of mobile devices

Area of influence: Society

Current situation: Development of the usage of mobile device that allow people to access data and information form where ever they are. This includes cell phones and mobile devices.

Specification A

- **Name:** Extensive usage
- **Description:** In the case of smartphones, such devices also generate log data via the use of mobile applications, financial transaction data associated with mobile banking and shopping, and social media data from updates to Facebook, Twitter and other social networks.

- **Reason:** From 2014 to 2016, statistics show that the number of smartphone users increased during the last years. The forecast estimates that the smartphone penetration rate will reach about 84% by 2019. The volume of mobile data and the speed at which it is created is only going to increase as both the global population and mobile device penetration rates rise, and the use of social media increases.
- **Probability:** 100**%**

Sources:

- Share of mobile phone users that use a smartphone in Germany from 2014 to 2019. Available at: http://www.statista.com/statistics/257056/smartphone-user-penetration-in-germany/
- Bitkom Study (2015). 44 Millionen Deutsche nutzen ein Smartphone. available at: https://www.bitkom.org/Presse/Presseinformation/44-Millionen-Deutsche-nutzen-ein-Smartphone.html

Descriptor name: Fast Mobile Internet

Area of influence: Society

Current situation: With 1.87 Wifi-Hotspots per 10.000 inhabitants, Germany is lacking behind in international comparisons but the number of Wifi-capable devices is double of the worldwide average. Legal issues like the "Störerhaftung" prevent the exploitation of this potential in Germany. On the other hand, Germany is in the leading group in case of LTE coverage.

Specification A

- **Name: Free hot spots available in cities**
- **Description:** Providing areas with wide fast mobile internet to secure viability of mobile devices.
- **Reason:** Germany is making an effort to catch up in terms of providing public networks. Part of this push is commercially motivated, since Internet access via hotspots is becoming a competitive advantage, as well as an attractive business model for many providers.
- **Probability**: 40%

Specification B

- **Name:** Private mobile internet
- **Description:** Spread of LTE or wireless communication of high-speed data for mobile phones and data terminals.
- **Reason:** Limited development of wifi-hotspots as result of unchanged restrictive legal frameworks such as Störerhaftung will spread the use of private mobile internet to solve connectivity issues.
- **Probability:** 60%

Sources:

- Bundesministerium für Wirtschaft und Energie. (2016). Mehr Rechtssicherheit bei WLAN. Available at: http://www.bmwi.de/DE/Themen/Digitale-Welt/Netzpolitik/rechtssicherheit-wlan.html
- Dörner, S. (2015). Deutsche zahlen gewaltig für winziges Datenvolumen. Die Welt. Available at: http://www.welt.de/wirtschaft/webwelt/article141320502/Deutsche-zahlen-gewaltig-fuer-winziges-Datenvolumen.html

Descriptor name: Development of Smart Cities around the world

Area of influence: Society

Current situation: Germany recognizes the crucial importance of cities in safeguarding a sustainable and more prosperous future. The country is active in a number of projects. Nevertheless, other European countries like f. ex. Spain Sweden and the Netherlands payed much more attention of becoming a lead provider of complete smart technology solutions in their cities.

Specification A

- **Name: Exponential interest in development in Germany**
- **Description:** The interest of Germany in developing smart cities increases as a result of development in other countries
- **Reason**: Today's top-five smart cities around the globe are: Singapore, Barcelona, London, San Francisco and Oslo, showing a significant growth in activities for areas such as smart parking, traffic management, lighting, security, waste control, and many others.
- **Probability: 40%**

Specification B

- **Name: Moderate Interest in development in Germany**
- **Description:** Existing initiatives such as Smart City Berlin Strategy
- **Reason:** Germany have identified urban development as a key political issue for the future and order to promote development of smart cities, it has lunched several smart grid projects currently underway, in total they are 131 projects up to date.
- **Probability: 40%**

Specification C

- **Name: Low interest in development in Germany**
- **Description:** Activities are focused in other areas. Furthermore development of smart mobility in smart cities is not a priority.

- **Reason:** Development of smart cites in Germany is more related to energy provision and energy awareness instead of smart mobility as part of the Energiewende plan for 2020
- **Probability: 20%**

Sources:

- Barcelona world's smartest city (2015). Available at: https://eusmartcities.eu/content/barcelona-world's-smartest-city-2015
- Germany Trade & Invest. Smart Cities. Available at: https://www.gtai.de/GTAI/Navigation/EN/Invest/Industries/Smarter-business/Smart-living/smart-cities.html
- Peeples, D. (2016) Europe is demanding a common smart city platform. Should you be doing the same? Available at: http://smartcitiescouncil.com/article/europe-demanding-common-smart-city-platform-should-you-be-doing-same
- Bundesministerium für Bildung und Forschung (2015) Zukunftsstadt, Strategische Forschungs- und Innovationsagenda. http://www.nationale-plattform-zukunftsstadt.de/BMBF_NPZ-FINA_Ansicht.pdf

Descriptor name: Urbanization

Area of influence: Urbanization

Current situation: In 2014, 75% of the German population lived in cities, ascending trend. In the last years, there was a movement from the rural areas to the cities because of following factors: demographic change, higher energy prices, fiscal interventions and a lot of traffic on the streets. In total there is a decrease in the German population, nevertheless there is an increase in the population of medium-sized cities

Specification A

- **Name:** Strong Urbanization rate
- **Description:** An expected increase in the population in cities and towns versus rural areas.
- **Reason:** Approximately half the population of Germany lives in the 30 major urban German agglomerations, such as Berlin, Hamburg, Munich (München), and Cologne (Köln) but also in smaller cities including Münster, Freiburg, Leipzig, and Dresden. This tendency seems to increase in the future as part of the demographic process and economic development.
- **Probability: 55%**

Specification B

- **Name:** Moderate Urbanization rate
- **Description:** Urbanization increases however not as expected.

- **Reason:** Even with the high rates of re-urbanization, the suburban areas often have stagnating or even declining populations as a result of aging in German population.
- **Probability:** 30%

Specification C

- **Name:** Exodus from the city
- **Description:** Switching from big cities to small cities and rural areas
- **Reason:** With the development of cities pollution will increase citizens and families will look forward to countryside.
- **Probability:** 15%

Sources:

- Europäische Union: Urbanisierungsgrad in den Mitgliedsstaaten im Jahr 2014. Available at: http://de.statista.com/statistik/daten/studie/249029/umfrage/urbanisierung-in-den-eu-laendern/
- Worldbank Data on Urban population. Available at: http://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS
- Hennig, B., and Kaup, S. (2015). The Growth and Decline of Urban Agglomerations in Germany Available at: http://www.viewsoftheworld.net/?p=4625

Descriptor name: Automotive R&D investments rate

Area of influence: Innovativeness

Current situation: Investment in research and development to maintain the competitiveness worldwide in automotive industry German OEMs are responsible for around one third of international automotive R&D expenditure, with R&D investments amounting to EUR 17.6 billion in 2014. Germany is considered the most innovative automotive hub in international comparison.

Specification A

- **Name: Strong continuous growth**
- **Description:** Germany's Automotive R&D infrastructure enables companies to develop cutting- edge technologies
- **Reason:** The automotive industry is the largest industry sector in Germany. In 2015, the auto sector listed a turnover of EUR 404 billion, around 20 percent of total German industry revenue. In 2015, domestic internal automotive industry R&D expenditure reached EUR 20.6 billion, equivalent to 40 percent of Germany's total R&D expenditure.
- **Probability: 70%**

Specification B

- **Name: Moderate growth**
- **Description:** The worldwide automotive growth is slowing Down
- **Reason:** Over the next five years the global automotive industry faces a reduced market growth, down from an annual 3.1% (between 2007 and 2014) to an annual 2.6% (between 2015 and 2021), such situation might be due to political and economic instability.
- **Probability: 30%**

Sources:

- Industry overview the Automotive Industry in Germany (2015). Available at: https://www.gtai.de/GTAI/Content/EN/Invest/_SharedDocs/Downloads/GTAI/Industry-overviews/industry-overviewautomotive-industry-en.pdf?v=9

Descriptor name: Venture Capitalism in Technology Industry

Area of influence: Innovativeness

Current situation: In the first half of 2015 Investment into start-ups reach 1,638 USD million in Germany alone surpassing the previous year. This momentum is driven by the key regional tech hubs in Berlin, Hamburg and Munich.

Specification A

- **Name:** Strong continuous growth
- **Description:** A change on the country's approach to innovation will provide support to startups.
- **Reason:** An increasing number of firms are forming partnerships with startups in an effort to step away from conservative business approaches and embrace a rapidly evolving tech culture.
- **Probability: 40**

Specification B

- **Name:** Moderate growth
- **Description:** Culture of investing in start-ups is not as widely spread as investing in stablished companies.
- **Reason:** Germany has been trying to become the next big European tech hub, Berlin continues to dominate the German venture capital scene, accounting for over 40% of all investments to German Venture capitalism-backed companies since 2012 and over 55% of all funding. However, compared to other regions is still laying behind.
- **Probability: 60**

Sources:

- L Ernst & Young GmbH Wirtschaftsprüfungsgesellschaft. (2015). Liquidity meets perspective: Venture Capital and Start-ups in Germany 2015. Available at: http://www.ey.com/Publication/vwLUAssets/ey-venture-capital-and-start-ups-in-germany-2015/$FILE/ey-venture-capital-and-start-ups-in-germany-2015.pdf

Descriptor name: Government intervention in Automotive and Technology Industry

Area of influence: Politics

Current situation: Subsidized loan programs in Germany to boost the economy and to maintain competiveness. There is a subsidized program addressed to electric cars, moreover the programmes "EXIST", "GO-Bio", "IKT Innovativ", "INVEST" and "High-Tech Gründerfonds" are helping to increase the numbers of start-ups – and doing so especially in the early phases of new technological developments.

Specification A

- **Name: Increase government incentives**
- **Description:** The government will give more incentives for automotive industry and Technology industry development in terms of resources allocation to increase new technology development.
- **Reason:** The German federal government promotes research through the so-called High-Tech Strategy. This initiative defines areas of particular significance due to their contribution to solving global challenges. Support is also granted to key technologies that act as innovation drivers. Moreover, there are also subsidy programs in place for all types of technology that are primarily targeted at small and medium-sized enterprises (SMEs). The "Central Innovation Program for SMEs" (ZIM) is the best known of these programs; its aim is to promote innovation and competitiveness at SMEs.
- **Probability: 50**

Specification B

- **Name: Increase of governmental restrictions**
- **Description:** The government will issue new restrictive laws and procedures
- **Reason:** The lack of financing in the technology industry and the possible crisis events in EU, based on the current financial and political situation in many countries, can cause more restrictions for grating subsides and allocation different resources within both sectors.
- **Probability: 50**

Sources:

- Germany Trade and Invest (2015). Industry overview the Automotive Industry in Germany 2015-2016. Available at: https://www.gtai.de/GTAI/Content/EN/Invest/_SharedDocs/Downloads/GTAI/Industry-overviews/industry-overview-automotive-industry-en.pdf?v=9
- Bundesministerium für Bildung und Forschung (2014). The new High-Tech Strategy Innovations for Germany. Available at: https://www.bmbf.de/pub/HTS_Broschuere_engl_bf.pdf

Descriptor name: Regulations for Data Usage

Area of influence: Politics

Current situation: providers of public Wifi may be held legally responsible for any (illegal) misuse of the offered data connection. March 2016: the advocate general of the ECJ claims that public Wifi providers cannot be held legally responsible for a third party's misuse of the provided data connection. German government intends to revise the law regarding 'Störerhaftung'.

Specification A

- **Name:** Regulatory processes become more complex
- **Description:** In order to supervise the use of data new regulatory frameworks are developed
- **Reason:** The German Federal Government acknowledged in the Coalition Contract, and highlighted in the Digital Agenda, their intention to exploit local wireless networks as Internet access in public spaces however according to the Federal Government, a new legal security framework is urgently required for Wi-Fi operators to prevent any misbehavior
- **Probability: 40**

Specification B

- **Name:** Regulatory processes stay the same
- **Description:** Störerhaftung is not changed
- **Reason:** For years, organizations and individuals have been calling for Germany to abolish or at least curtail this so-called "liability of duty" (Störerhaftung), but some parties of the government refuses due to such a move is neither appropriate nor necessary
- **Probability:40**

Specification C

- **Name:** Regulatory processes will become easier
- **Description:** Changement/ Abolishment of Störerhaftung partly due to social and economic pressure allows expansion of public Wifi/freely accessible Hotspots and a simultaneous reduction of legal risks for the providers.

- **Reason:** The goal of the Federal Government is to improve the spread and availability of the mobile Internet using Wi-Fi.
- **Probability: 20**

Sources:

- Anon., (2015). Electronic Frontier Foundation. available at: closedwifiasanobstacletolegitimatetrade-4.pdf
- Bohsem,G., (2016). Süddeutsche Zeitung. available at: http://www.sueddeutsche.de/digital/stoererhaftung-eugh-anwaltoffene-wlans-muessen-nicht-verschluesselt-werden-1.2910059
- Reinbold, F. (2015). Spiegel Online. available at: http://www.spiegel.de/netzwelt/netzpolitik/bundeslaender-wollenhuerden-fuer-freie-wlan-netze-abschaffen-a-1060936.html

Descriptor name: Political collaboration with private sector

Area of influence: Politics

Current situation: Collaboration, including financial support for R&D, to spur development and implementation of smart and sustainable mobility as well as the necessary infrastructure. Cooperation of government and industry (e.g. field projects, statutory promotion ...)

Specification A

- **Name: Moderate collaboration**
- **Description:** German state has a limited role in industrial development
- **Reason:** German government operates in an ‘enabling’, rather than strategic, capacity in industry by supporting key institutions, such as the training system and underwriting company loans.
- **Probability: 35**

Specification B

- **Name: High Collaboration**
- **Description**: The German government makes grants and incentives available to certain target groups and for certain projects.
- **Reason:** The German government is actively encouraging certain new technologies that might contribute in the achievement of long term governmental plans, the latest example is linked to the Energiewende 2020, in which Germany's government and the auto industry have agreed on introducing an incentive of 4,000 euros for electric car buyers and 3,000 euros for those purchasing a plug-in hybrid vehicle.

- **Probability: 65**

Sources:

- Bundesministerium für Bildung und Forschung (2016). Die Bundesregierung. Available at: http://www.hightechstrategie.de/de/Zukunftsprojekte-der-Bundesregierung-972.php
- Presse und Informationsamt der Bundesregierung, (2016). Die Bundesregierung. Available at: https://www.bundesregierung.de/Webs/Breg/DE/Themen/Energiewende/Mobilitaet/ramsauer/_node.html
- Forum ElektroMobilität e.V. (2016). Forum Elektromobilität. Available at: http://www.forumelektromobilitaet.de/flycms/de/web/43/-/Foerderdatenbank.html#h3_1

Descriptor name: Data privacy protection

Area of influence: Politics

Current situation: With the application of smart mobility comes a constant observation and data collection on people's transportation patterns as well as their behaviors. Consumers concern over organizations' data collection methods, especially the use of tracking technologies. Yet, some companies have been engaged in questionable data collection and sharing practices such as Nissan, Apple and Google. So far there are no concrete laws or agencies set up to deal with the mass collection of data and the compliance of legal surveillance.

Specification A

- **Name:** Service providers control data
- **Description:** Companies offering smart mobility services own the data.
- **Reason:** According to Federal Data Protection Act that companies are allowed to process personal data only if it is permitted by the user, however it doesn't state abut ownership.
- **Probability: 10**

Specification B

- **Name:** Government controls data
- **Description:** A governmental dependency is created to control mobility data
- **Reason:** Data privacy regulations in the Germany is among the strictest in the world. Companies opting to implement cloud application services in Germany must navigate a layered and complex web of regulations, therefore governmental agencies are more plausible to own the data.
- **Probability: 60**

Specification C

- **Name:** Private central hub controls data
- **Description:** A separate private company administrates the mobility data

- **Reason:** No new governmental dependency is created furthermore, a private company controlled by complex privacy protection laws administrates mobility data.
- **Probability: 30**

Sources:

- Source: Kshetri, Nir (2013). Big Data's impact on privacy, security and consumer welfare

Descriptor name: Financial situation of cities

Area of influence: Politics

Current situation:

Situation of household budgets of German cities. The gap between rich and poor cities in Germany has been rising over the past years. Although a number of cities like Wolfsburg or Dresden could reduce their debt, a lot of cities face an increasing amount of liabilities. Four out of five cities and communities want to increase taxes and fees and decreases services in order to tackle their household deficits.

Specification A

- **Name:** Healthy financial situation
- **Description:** Clear reduction in debt levels in the coming years
- **Reason:** The increase in taxes and fees will generate enough revenues for developing programs and benefits.
- **Probability: 30**

Specification B

- **Name:** Empty public treasuries
- **Description**: Given the current economic situation of many German cities, public treasuries might suffer a budget deficit
- **Reason:** By 2014, 79% of the North Rhine-Westphalian municipalities presented budget deficit, additionally due to the current refugees' crisis the German government will have to spend 50 billion euros on refugees during the following years, such disparity will cause slowness in the development of other projects.
- **Probability: 70**

Sources:

- Ernst & Young GmbH Wirtschaftsprüfungsgesellschaft. (2015). Kommunen in der Finanzkrise: Status quo und Handlungsoptionen. Available at: http://www.ey.com/Publication/vwLUAssets/EY-Kommunenstudie-2015/$FILE/EYKommunenstudie-2015.pdf.

- Deutscher Städtetag. (2015). Kommunale Finanzlage und föderale Finanzbeziehungen. Available at: http://www.staedtetag.de/dst/inter/schwerpunkte/057866/index.html.

Descriptor name: Diversification of Transportation Industry

Area of influence: Industry

Current situation: In 2015, around 15 billion products around the world are connected to the Internet. By 2020, this figure is expected to rise to 30 billion. Automakers are increasingly seeing themselves as both product manufacturers and mobility services companies. Nowadays leading automakers are developing cars that park themselves, brake at the sign of danger and stay in lanes without driver assistance.

Specification A

- **Name:** Telecommunications and IT systems
- **Description:** Technological improvements in computers, smartphones, wireless communications and the cloud have converged to advance safety for connected consumers. The percentage of new passenger cars globally shipping with factory-installed telematics (IT Technologies) will increase from nearly 10 percent in 2010 to 62 percent in 2016,
- **Reason:** In addition to developing next-generation connected and autonomous vehicles that will improve traffic flows and safety, automakers worldwide are investing in a wide swath of new mobility services everything from carsharing and rental services to multimodal trip-planning apps.
- **Probability: 95**

Sources:

- Viechnicki, P., Khuperkar, A., (2015). Smart mobility: Reducing congestion and fostering faster, greener, and cheaper transportation options. Available at: http://dupress.com/articles/smart-mobility-trends/
- Edit: Kagermann, H., Riemensperger, F., (2015) Smart Service Welt 2015. Available at: https://www.eitdigital.eu/fileadmin/files/2015/publications/acatech_report_SmartServiceWelt2015_short_en.pdf

Descriptor name: Market entry strategies for start ups

Area of influence: Industry

Current situation: Opportunities for start-ups and SMEs through efficient market access and rapid scalability due to innovation cycles of new market players from digital niche markets are significantly

shorter than the development cycles of product manufacturers. However, the difficulty to get financial resources can prevent entrepreneurs from entering the market.

Specification A

- **Name:** Start-ups successfully enter market on their own
- **Description:** Start-ups are able to overcome difficulties and therefore can enter to the market by their own
- **Reason:** With the development of smart cities initiatives it is possible to target niche markets benefiting from the revenues.
- **Probability: 40**

Specification B

- **Name:** Start-ups innovate to be acquired by large firms
- **Description:** Due to economic and managerial barriers Start-ups are unable to take off however one company's failure can be another company's win; they sell the innovation to large firms.
- **Reason:** Innovation is an intensive process that requires expertise, while many start-ups may produce an "invention" it is very difficult for them to transform it into a new service.
- **Probability: 50**

Specification C

- **Name:** Start-ups partner with government and enter market
- **Description:** Start-ups rely on cooperation with the government to enter the market.
- **Reason:** with the Public Private Partnerships in Germany companies are invited to propose joint projects that meet specified criteria. However, such due to the partnerships such projects are not fully independent and the accompaniment is limited.
- **Probability: 10**

Sources:

- Edit: Kagermann, H., Riemensperger, F., (2015) Smart Service Welt 2015. Available at https://www.eitdigital.eu/fileadmin/files/2015/publications/acatech_report_SmartServiceWelt2015_short_en.pdf

Descriptor name: Development of operational technologies

Area of influence: Industry

Current situation: Operational technologies (sensors, surveillance, controls) generate raw data material required for smart solutions: the data. ICT Strategy of the German Federal Government: Digital Germany and IST Action Plan for Roads form the framework for further development of technologies, including operational technology, to achieve a more efficient management of the

transport network for passengers and business, pressing forward with research and development on new technologies and enhancing security and trust in the digital world.

Specification A

- **Name:** Further development
- **Description**: With the implementation of the ICT strategy, the Federal Government is seeking to contribute to promoting sustainable economic growth, help create new jobs and bring about social benefits.
- **Reason:** The Federal Government's ICT strategy is aligned with the goals of the Digital Agenda for Europe and will further enhance Germany's international competitiveness as a business location.
- **Probability: 65**

Specification B

- **Name:** Moderate development
- **Description:** Small and medium-sized enterprises are the mainly drivers of the ICT industry
- **Reason:** There is a disproportionally large number of small size companies and only a few medium-sized suppliers in the German software industry in particular, which do not invest large amount of resources in research and development triggering a moderate growth rate.
- **Probability: 35**

Sources:

- Federal Ministry of Economics and Technology (BMWi) (2012). ICT Strategy of the German Federal Government: Digital Germany. Available at: https://www.bmwi.de/English/Redaktion/Pdf/ict-strategy-digital-germany-2015,property=pdf,bereich=bmwi2012,sprache=en,rwb=true.pdf
- Federal Ministry of Transport, Building and Urban Development. ITS Action Plan for the Roads. Available at: http://www.bmvi.de//cae/servlet/contentblob/103328/publicationFile/70494/its-action-plan-roads.pdf

Descriptor name: Surveillance and sensing infrastructure

Area of influence: Infrastructure

Current situation: The first draft of the Bundesverkehrswegeplan 2030 plans most of the budget for maintenance and improvement of existing and important transport routes and traffic knots. Only a minuscule amount is devised to sensoring and surveillance infrastructure.

Specification A

- **Name: Extensive development in public infrastructure**

- **Description:** Development and expansion of controlling devices for traffic surveillance and management.
- **Reason:** In order to meet the challenges of the 21st century in the field of road transport, transport policy employing of intelligent transport systems (ITS) will be accelerated in Germany as part of the Bundesverkehrswegeplan 2030 plans
- **Probability: 20**

Specification B

- **Name: Moderate development in public infrastructure**
- **Description:** German government focuses on development of certain infrastructure
- **Reason:** For the required infrastructure it is needed stable digital data transmission for the entire country. There are gaps in the supply, particularly in rural areas, which need to be bridged. However, the budget for this activity is limited.
- **Probability: 70**

Specification C

- **Name: Limited development in public infrastructure**
- **Description:** Other projects remain more important for the government
- **Reason:** Without a clear national strategy. Germany will not be able to constructively improve public infrastructure and effectively employ sensoring and surveillance technologies
- **Probability: 10**

Sources:

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