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Smart City Vienna: System Dynamics Modelling as a Tool for Understanding Feedbacks and Supporting Smart City Strategies

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Abstract

Urban areas are a major driver of climate change. Cities need to promote sustainable development for improving the overall quality of life of its citizens. In order to do so cities started developing smart city strategies. Smart city strategies translate visions which mainly have been working as a label instead of a policy. For turning a label into a successful policy it is crucial to understand the dynamics behind it. For making the entire system more transparent the author used qualitative and quantitative system dynamics modelling. As part of a case study in Vienna, expert interviews, qualitative data analysis and a quantitative simulation model were conducted. The resulting baseline simulations replicate possible negative consequences which could arise if stakeholders do not understand basic dynamics in a given urban area and do not take into account feedbacks and delays.

The author expects this new approach of system dynamics modelling to work as a basis for future policy implementations, to underline how important it is to understand the dynamics of a city and as an incentive for everyone to use the smart city strategy for promoting sustainability instead for marketing purposes.

This master thesis is dedicated to my mum and to my dad.
They made it possible for me to not only aim for the sky, but to reach for the stars.

Danke Mama.
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1. Introduction

1.1. Background and relevance

Urbanization is one of the main drivers of climate change and one of the most plausible indicators of increasing CO_2 emissions (Grimm, 2008). Cities need to combat the effects of climate change by promoting sustainable development for improving the overall quality of life of its citizens (Martos, 2016). In order to do so, cities started using smart city strategies (Marsal-Llacuna, 2015).

This research project is focusing on the development of smart city strategies as possible solutions for urbanization on the basis of the system dynamics modelling method, adopting the Vienna experience as a case study.

The European Union (2011) associates the concept of smart city with the idea of environmental sustainability, which aims to reduce greenhouse gas emissions in urban areas by developing and deploying innovative technologies. However, the fact that cities are very complex systems makes it very difficult to identify shared definitions and common current trends at a global scale. Consequently, the diffusion process of smart city initiatives in different countries is still very hard and very slow (Neirotti, 2014). To overcome related challenges not many concrete tools were proposed yet and research on the topic is still scarce. The author proposes an innovative approach to apply qualitative and quantitative system dynamics modelling as tools for supporting the understanding of feedbacks and strategy development for implementing the smart city concept.

In the case of Vienna, for example, no empirical data yet is able to prove or disprove how, to what extent and if related with positive or negative effects the city of Vienna is smart or not (Hollands, 2008). One opportunity to go about this lack of data challenge is, as suggested by Forrester, 1992, who stated that no other store of information is as extensive as the one in peoples mind and conducted interviews with stakeholders.

Qualitative system dynamics modelling presents itself as a relevant approach in the initial conceptualization phase. It supports the organization of a tremendous amount of information (Forrester, 1994) gathered in relation to a dynamic issue and helps to explain causal links in real-world interventions, which are highly complex, like urbanization.

On the other hand, quantitative system dynamics modelling is a powerful tool due to its constant iterative process of analyzing problems, where time is an important factor and setting boundaries is crucial (Sterman, 2000; Luna- Reyes, Andersen, 2003).

Based on the case study of the smart city strategy of Vienna, which is aiming to be the most populated, most attractive, emission free capital by 2050 within the highest quality of life for its citizens, the opportunity arises of building on the Urban Dynamics work of Forrester to explain the dynamics underlying smart city strategies. Urban Dynamics already in 1969 replicates main principles of a city, which explain that the moment land is gradually developed, the speed of growth of the city increases and the belief of a wealthy future fuels even more growth, which will increase prices by opposing a slowed down process for further constructions.

The author will explore the same main principles by taking into account that constructions not only will slow down, but new constructions will lead to a demolition of historical buildings. Historical buildings in Vienna generate the whole atmosphere and attraction of the city. This kind of dynamic in a city is a textbook example of the bathtub principle, explained by Sterman, 2002.

Vienna's understanding of fulfilling its meta goal strongly underestimates the inertia of systems, by not taking into account that in complex dynamic systems cause and effect are often distant in time and space. This may lead to possible unintended consequences, such as the smart city strategy in Vienna besides being the solution for urban problems, is also able to be the cause of a new wave of environmental, social and economic problems.

1.2. Research objectives and contribution

This research project is highly relevant for present and future developments of urban planning. So far no research has applied the method of system dynamics to the concept of smart cities.

This motivated the author to formulate the following research objectives:

1. Use a qualitative system dynamics modelling approach to unwrap the *label* smart city in order to understand what smart city means and how it could help to diminish urban problems.
2. Develop a system dynamics modelling approach with the aim to emphasize that system dynamics is a suitable method for simulating which possible problems arise in a growing urban area. The example of Vienna will be used as a case study for illustrating this purpose.
3. Analyze the advantages and disadvantages of the smart city strategy related to Vienna based on the system dynamics modelling approach.

The pursuit of these research objectives is the application of the powerful tool of system dynamics. As part of the case study Smart City Vienna was used as an instrument for demonstrating the impact of system dynamics on smart city strategies and to provide a basis for further research on this field.

The author used the qualitative and quantitative system dynamics modelling approach to unwrap the strengths and the weaknesses of the smart city strategy of Vienna. A qualitative step unfolded the strategy as a whole and tried to explain its main dynamics. By simulating the main principles of an average city the author emphasized basic issues which arise in urban areas and could be even strengthened due to smart city strategies.

This research project highly contributes to further research in order to tackle current and upcoming urban problems in Vienna, but also in other parts of this world.

1.3. Setup of the research process and the dissertation

This research is conducted as part of the case study of the city of Vienna, in Austria. Vienna is a good practice example of a European capital with an incredible high quality of life. The city is not only trying to keep this status quo but also to fulfil a meta goal by 2050. The meta goal of reaching the best quality of life for all inhabitants of Vienna, while minimizing the consumption of resources based on comprehensive innovation, is aimed to be achieved within Vienna's smart city strategy (Stadt Wien, accessed 09.05.17).

In order to critically questioning the smart city strategy of Vienna a line over the history of sustainable urban planning was drawn. In chapter 2 of the literature review the author described in detail the sustainable city concept, the eco-city concept, *Urban Dynamics* by Forrester and of course the smart city concept. By studying the existing literature it was possible to emphasize common features and differences of all four concepts. The literature review also helped to outline how system dynamics, as a tool, is related to smart city strategies in general. The literature review formed a good starting point for conducting expert interviews and for the upcoming research process.

In chapter 3 the author reasoned about the methodological choices made and described the approaches which have been used during this research process. The following chapter 4 discusses and describes the smart city strategy and its main pillars in detail.

In chapter 5 the author presents its main results. The results derive from a comprehensive qualitative data analysis from the conducted expert interviews. The qualitative data analysis was highly relevant for the following construction of the simulation model. Given that the smart city strategy still is a vision data is scarce the author incorporated the main insights gained from the interviews in the model. This way it was possible to highlight the importance of the system dynamics modelling tool in relation to the smart city strategy Vienna. In chapter 6 of conclusion, limitations and further research the author discusses the main insights gained, emphasizes her main limitations and proposes pathways for further research.

2. Literature Review

2.1. Urban Dynamics

In 1969 Jay W. Forrester published *Urban Dynamics*, the most insightful system dynamics application ever developed (Alfeld, 1995). The developed model is a selection from numerous alternatives and relates to pertinent topics such as urban growth, urban aging and urban revival (Forrester, 1969). This scientific work has not been treated kindly in the past and experienced a lot of disbelief.

However, *Urban Dynamics* only waits for the change of its revival and for some inspiration for its reinterpretation (Alfeld, 1995). The book analyses an urban area by looking at its life cycles and by using the methods of industrial dynamics, which have been developed at the M.I.T. (Massachusetts Institute of Technology) in Cambridge Massachusetts, since 1956 (Forrester, 1969). *Urban Dynamics* emphasizes limited land availability in a city as a resource constraint which is growing but then is hindered by a lack of buildings and infrastructures. It explains that, the moment land is gradually developed, the speed of growth increases and the belief of a wealthy future fuels more growth, which increases prices and slows down further constructions. The consequence is the demolition of existing structures in order to build new houses. *Urban Dynamics* highlights the need of making the most out of every single job producing land. As jobs were growing and land was decreasing, the mismatch between housing and commercial structures developed towards an increasing gap. *Urban Dynamics* looks into how persistent unemployment increased as a natural consequence of urban aging.

Almost 50 years have passed since *Urban Dynamics* was published, nevertheless this work still has an important role to play in the future of urban planning, because it extends our capacity to see and shape our future. Global population, pollution and resource usage are dangerous trends in a city. That is why it is important to uncover feedback, nonlinearities and hidden delays to successfully implement policies (Alfeld, 1995).

In the meantime, many concepts evolved in the field of urban planning, all with the same goal of making cities more sustainable. One of those main concepts is the *sustainable city* concept, which is described in the next section.

2.2. The sustainable city concept

According to the widely-used definition of the Brundtland report, sustainable development is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs (Waas, 2010).

Definitions in the literature diverge when it comes to determine of what a sustainable city should be or should look like (Bibri, 2017).

A city, for instance, can be defined as sustainable if the conditions of production do not destroy the conditions of its reproduction over time (Castells, 2000). A resource-efficient, sustainable city is a city that is decoupled from resource exploitation and ecological impacts (Martos, 2016).

Sustainable cities encompass a set of tools, which apply the gathered knowledge of urban sustainability and respective technology for planning and designing the built environment (Bibri, 2017). In the long-term this concept is meant to be socio-economically and ecologically sustainable. In order to promote a better quality of life for its citizens and to satisfy their needs in a sustainable way a city must not only integrate methods to mitigate their negative side-effects, but also become a space which promotes active participation in the development of the means (Martos, 2016). The adoption of sustainable urban development strategies by constantly improving the efficiency gains should foster innovation in urban infrastructure, urban management, ecosystem service provision and public service delivery (Bibri, 2017). However, it is crucial to understand cities as urban ecosystems that consist of interactions between social, biological and physical elements (Nilon, 2003).

Deriving from the idea of an urban ecosystem, the main aims of sustainable cities can therefore be summarized as follows: maximization of energy and material resources, creation of a zero-waste system, support of renewable energy production and consumption, promotion of carbon neutrality and reduction of pollution, decrease of the need to individual transportation by encouraging walking, cycling and the provision of efficient public transportation, preservation of ecosystems and promotion of liveability and sustainable community (Bibri, 2017).

2.2.1. Urban sustainability dimensions

In order to achieve their highly diverse urban sustainability goals and to promote a better quality of life for their citizens, cities are divided into different dimensions, spatial levels and key sectors. In the following paragraphs the mentioned subdivisions are described in order to give the reader a holistic overview what the concept of sustainable city implies.

Urban sustainability requires linkages between technological innovation, scientific and social research, institutionalized practices and policy design and planning in order to develop and achieve long-term success. Based on these linkages urban sustainability can be divided into four dimensions:

1. Form
2. Environment
3. Economy
4. Equity

These physical, environmental, economic and social dimensions should obtain a balance to overcome constraints and achieve goals (Bibri, 2017). According to the definition of Richardson (1989), sustainable urban development is a process of change, which starts in the built environment with the effect of fostering economic development, while conserving resources and promoting the health of the individual, the community and the ecosystem. However, urban planning pursues different goals, which are in deep-seated conflict with each other. To dispel these conflicts, an appeal to images of a community in harmony with nature is not sufficient. It requires cooperative effort, collaborative work and concerted action from diverse urban stakeholders to obtain a holistic view of the chances and pressures of the contemporary city. Obtaining a balance between the four dimensions also means going back to the historic core of urban planning and developing a strategic process for reaching a sustainable city (Bibri, 2017).

2.2.2. Urban sustainability spatial levels

Scholars, planners, local and international NGOs, civil societies and governments worked on new frameworks in order to redesign and restructure urban places for achieving urban sustainability. Therefore approaches have been addressed on four different spatial levels:

1. The regional and metropolitan level
2. The city level
3. The community level
4. The building level

Similar to the four urban sustainability dimensions, the approaches of urban sustainability spatial levels do not agree on one common goal. However, the analysis of these four spatial levels has identified seven concepts, which are significant, detailed and repeated themes in urban spatial levels.

For a better understanding of sustainable urban forms it is important to analyse and know more about the seven concepts identified by the four spatial levels (Jabareen, 2006).

Compactness

With the increased compactness of the built environment in a city, sustainability might increase as well (Jabareen, 2006). Connectivity implies that future urban buildings should be built next to existing urban structures (Wheeler, 2002). The advantage of a compact city is the reduction of transportation of energy, water, materials, products and people. In order to achieve compactness, the intensification of built environment is necessary. This includes the development of so far undeveloped urban land, the redevelopment of existing buildings or previously developed sites, subdivision and conversion, additions and extensions. Therefore, by increasing the density of city development and city activity, land gets used more efficiently. An urban form that is compact is also easily walkable, small enough to eliminate the desire of possessing a private automobile but large enough to provide a variety of opportunities and services that constitute a rich urban life. Liveability of a city is partly the consequence of compactness, which reduces commuting and pollution (Jabareen, 2006).

Transportation

Transportation is arguably one of the main issues relating to the environmental debate of urban forms (Jenks, 1996). Transport technologies, which were dominant at different stages of their development, are reflected in the design of a city (Jabareen, 2006). As argued by Elkin, McLaren and Hillman (1991) a sustainable urban form must be shaped in such a way that walking, cycling and efficient public transportation reach a compactness, which encourages social interaction. It needs to provide access to the facilities and services of a city while minimizing external costs. At the same time it should be financially affordable, it should operate at maximum efficiency and support the vibrant economy of a city. A successful restructuring of the urban and metropolitan transportation system supports the conservation of energy in several ways but can only be effective if an urban form is dense enough (Jabareen, 2006).

Density

Sustainable cities are a matter of density (Carl, 2000). Density is the ratio of people to land area. It plays a significant role, because to make urban functions and activities viable a certain number of people, who generate interactions in a given area, are necessary.

Transit use is highly related to the density of a city. A higher density will decrease the automobile ownership and therefore also the gasoline consumption. Lower city densities, especially low and disconnected densities of suburbs encourage car use and increase CO_2 emissions (Jabareen, 2006).

Mixed Land Use

Mixed land use plays a key role when it comes to achieve a sustainable urban form due to its aim of decreasing the need of travel. The reason is that heterogeneous zoning allows compatible land uses. That is why it is possible to locate activities close to each other and decrease the travel distances (Parker, 1994). Mixed land use differs between functional land use such as residential, commercial, industrial, institutional use, and use related to transportation. It renews life in many parts of the city, because it ensures that many services are within a reasonable distance and therefore only require walking or cycling. That is also why urban planners should support mixed land use instead of homogenous zoning (Jabareen, 2006).

Diversity

The sustainability of cities depends on diversity of activities (Jabareen, 2006). Thanks to Jane Jacobs (1961), who popularized the dimension of diversity, it became widely accepted by many planning approaches, such as new urbanism, smart growth and sustainable development. The multidimensional phenomenon encourages further desirable urban features by including a great variety of housing types, building densities, household sizes, ages, cultures and incomes. Hence, diversity is the social and cultural context of an urban form (Jacobs, 1961).

Passive solar design

Passive solar design aims to reduce the demand of energy and to provide the best use of passive energy in sustainable ways. Thus, it is central for achieving a sustainable urban form. The urban area, also called urban microclimate, differs with its climate from the countryside.

Built urban sites have larger areas of exposed surface per unit area of ground cover. Therefore, more solar radiation can be collected on a built site than on a flat terrain. That is also why sustainable urban forms play a crucial role in reducing energy usage (Jabareen, 2006).

Greening

Green space has the ability to contribute positively to the key agenda of sustainability (Swanwick, 2003). Due to greening of the city, urban and suburban places become more appealing and pleasant and therefore more sustainable (Jabareen, 2006). However, there are many other benefits of greening a city:

- Contributing to maintain biodiversity
- Reducing pollution, moderating the extremes of urban climate and contributing to cost- effective urban drainage systems
- Improving the image of the urban area and the quality of life
- Increasing economic attractiveness and encouraging community pride
- Greening stands as a symbol of nature and plays an educational role

Green urban forms shape more sustainable places, communities and lifestyles, while at the same time incorporating ecologically responsible forms of living and settlement (Jabareen, 2006).

2.2.3. Urban sustainability key sectors

A sustainable city does not only depend on its urban shape but needs to become a space which promotes a better quality of life for its citizens. Thus, six key sectors were identified in order to reduce the effect of cities on the environment and further develop means to satisfy the needs of citizens in a sustainable way (Martos, 2016).

The six key sectors partially overlap with the urban spatial levels as well as with the urban sustainability dimensions. Nevertheless, no common framework combines the goals of the mentioned strategies. However, the elaboration of these key sectors will once more emphasize what an urban area should focus on in order to achieve long-term sustainability.

Sustainable urban transport

Due to urban expansion and the development of low-density residential areas private transportation rises as well (Shakouri, 2010). Urban transportation is the crossroad between human development and the environment. These are two factors, which need to evolve together in order to achieve an enduring balance and therefore decrease CO_2 emissions. Urban policies need to become more sustainable to decrease the dominant use of private motor vehicles in the cities. That is also why transport planning is one of the most important tools to reinvent cities. Sectors, groups and jurisdictions need to be coordinated for a sustainable planning of the transport network. The sustainable planning contributes to a short-term decision-making process with long-term strategic objectives. Long-term objectives constitute the development of a multi-modal transport system, where installations promoting the use of bicycles, play an important role. Low carbon technology in transport has become a priority in international politics as well. Low carbon means of transportation are designed to run without petrol or diesel, but instead with bio fuel, natural gas or electricity. The limitations of these new technologies are the related uncertainties to electricity prices and growth rates of vehicles (Martos, 2016).

Buildings energy consumption

The residential sector is responsible for high electric energy consumption in urban areas and emits 32% of the total CO_2 emissions in the European Union (European Commission, 2008). It is therefore crucial for decision-making to model the energy consumption related to buildings in the city or district scale. The prediction of energy consumption for a whole city has been proven to be one of the greatest investigated challenges (Martos, 2016).

Next to predicting energy consumption several options exist to reduce energy consumption in an urban area.

Shadings influence the building energy use for lighting, heating and cooling. Its negative effects can be recognized by the loss of natural light for passive or active solar energy applications and the loss of warming, which increase the heating requirement during the cold season. By efficiently control the design of shading devices energy savings can be achieved (Martos, 2016).

Furthermore, the energy demand should be covered by renewable energy (Cucchiella, 2012). Ongoing exploitation of biomass increases toxic gas emissions, which contributes to the deterioration of the urban environment. The development of new materials, which are able to store heat and offer low-cost thermal stability, are required (Martos, 2016). Besides the composition of materials, the study of Masoso and Grobler (2010) emphasized that 50% of the energy consumption in commercial buildings takes place during non-working hours. Workers tend to leave electronical equipment and lightening systems on.

The restoration of over 50 years old buildings is considered as one of the greatest opportunities to reduce the impact of cities on its environment. New urban developments on new land would be reduced as well as the construction industry would be recovered. However, this option requires normative and economic support from authorities (Martos, 2016).

Urban green areas

The quality of life in an urban area increases due to implantation of urban parks and open green areas (Chiesura, 2004). The green lungs of a city absorb contaminants and release oxygen. This causes environmental but also psychological, cognitive and social benefits due to social integration and citizen interaction coming from different socio-economic backgrounds (Martos, 2016). Planning green infrastructure should be one of the first steps when developing new urban areas (Chang, 2012). The existence of green zones in urban areas can contribute to the mitigation of the urban heat island effect (Maimaitiyiming, 2014). The urban heat island effect is one of the most evident environmental problems coming from urbanization and industrialization and needs to be solved (Fernández, 2014).

Municipal solid waste management

The decomposition of the organic matter contributes to 5% of greenhouse gas emissions internationally (UNEP, 2011). By improving urban solid waste management, waste gets eliminated in many parts of the world and the risk of contaminating the surroundings decreases as well. Reasons for not doing so are mainly high treatment costs and lack of alternatives, which developing countries experience in a very intensive manner (Martos, 2016).

Programs, such as recycling glass, plastic, biomass and dangerous mass, face the challenge posed by urban solid waste and reduces its impact on the environment (UNEP, 2012). Whether these programs are successful or not strongly depends on the acceptance by its citizens. Research convincingly shows, that their economic situation determines the willingness and behaviour of citizens towards recycling (Wang, 2011). Other recommendations to achieve a successful solid waste management are communication channels with residents, transparent systems and local authority implications to make sure recycling obligations are met (Martos, 2016).

Water supply

Predictions by the year 2050 say that 70% of world's population will live in urban areas, which will lead to an international crisis of water supply and treatment (Martos, 2016). In order to assure long-term access to water, cities must be involved in the catchment scale management (UNEP, 2012). Urban water management faces challenges regarding natural resources, which due to its exploitation have reached their limit (Martos, 2016).

The formulation and implementation of comprehensive water plans, which concentrate on managing the supply and controlling the demand, are crucial for the future (Singh, 2010). As a consequence of lacking water plans, low quality water could create health problems, especially for weaker members of the society such as elderly people, children and people in developing countries (Gondhalekar, 2013). Findings also showed that water shortages were more frequent in low-income suburban areas than in high-income suburban areas (Macedonio, 2012).

Social variables

Social issues often get dismissed when sharing knowledge on sustainability (Martos, 2016).

Present and future generations need to be prepared through education in order to be able to address environmental issues and sustainable development (Andreasen Lysgaard, 2015). The global framework for sustainable development, which is laid out in the Sustainable Development Goals, highlights its ambition to put people at the centre of sustainable development (Martos, 2016). The participation of citizens in this framework is still problematic though. Public participation on sustainable development needs to go beyond policy makers, planners or academics. That is why citizens' participation should be included in official city development projects (Cohen, 2015). The results of city development projects clearly emphasize the suitable applicability of sustainability concepts and consequently the better understanding by citizens (Martos, 2016).

Culture also plays an important role when it comes to sustainable development in cities (Cultural Sustainability, accessed 17.03.17). The perceptions of wellbeing in houses have an effect on consumption patterns and urban development models, i.e. special characteristics of the buildings themselves are able to promote cultural sustainability (Martos, 2016). Therefore, involving citizens in development projects and taking cultural aspects into account supports public acceptance of sustainable development actions and fosters a great impact in the long run.

Urban sustainability dimensions, spatial levels and key sectors emphasize the key role cities are playing in fighting against climate change and the deployment of new intelligent technologies in order to decrease CO_2 emissions and improve the energy efficiency of cities. Thus, new technologies need to be smart, integrated, cost-efficient and resource-efficient. Besides having an impact on environmental sustainability, they should improve citizens' wellbeing and financial sustainability (Ahvenniemi, 2017). In recent years, in order to achieve this goal, cities have shifted their end-goals from sustainability goals towards smart city targets (Marsal-Llacuna, 2015).

2.3. The smart city concept

The high number of smart city initiatives, city implementation projects and jointly-funded public research projects indicate the growing interest in the smart city concept and the need of solving the challenges related to urbanization (Ahvenniemi, 2017).

The smart city concept was introduced the first time in 1994 (Dameri, 2013). Starting in 2010 the European Union supported smart city projects and initiated a recognisable increase in publications regarding this topic (Jucevicius, 2014). Although this concept is widely used and very popular, a clear and consistent understanding of its meaning is still missing (Angelidou, 2015). The European Commission, for instance, defines smart city as a matter of diverse technologies, which promotes the achievement of sustainability. Furthermore they focus on the node between energy, transport and ICT (European Commission, 2012). There is wide agreement on the objective, that the use of information and communication technologies in various urban domains helps cities making better use of their resources. However, cities, which are more equipped with ICT systems, are not necessarily better cities. Crucial for cities is to not identify the deployment of ICT with the overall concept of smart city, since smart initiatives do not only entail technological changes, but also investments in human capital and changes in urban living practices and conditions (Neirotti, 2014).

Marsal-Llacuna et al. (2015) defined the smart city concept slightly different. To their understanding, the smart city concept builds on experiences in the past, which measures environmentally friendly and liveable cities within the comprehensive idea of sustainability and quality of life but with the addition of technological and informational elements. Data and information technologies make it possible to provide efficient services to citizens by monitoring their behaviour, to optimize existing infrastructure, to increase cooperation amongst different economic actors and to support innovative business models in private and public sectors (Marsal-Llacuna, 2015). However, Neirotti et al (2014) highlight the importance of human capital. Human capital is necessary for developing smart cities with enhanced economic, social and environmental sustainability, hence improving the liveability of cities. Human capital investments also aim fostering a city’s capacity of learning and innovating. In doing so, the local population improves its own life through education and innovation, and attracts other valuable inputs from outside.

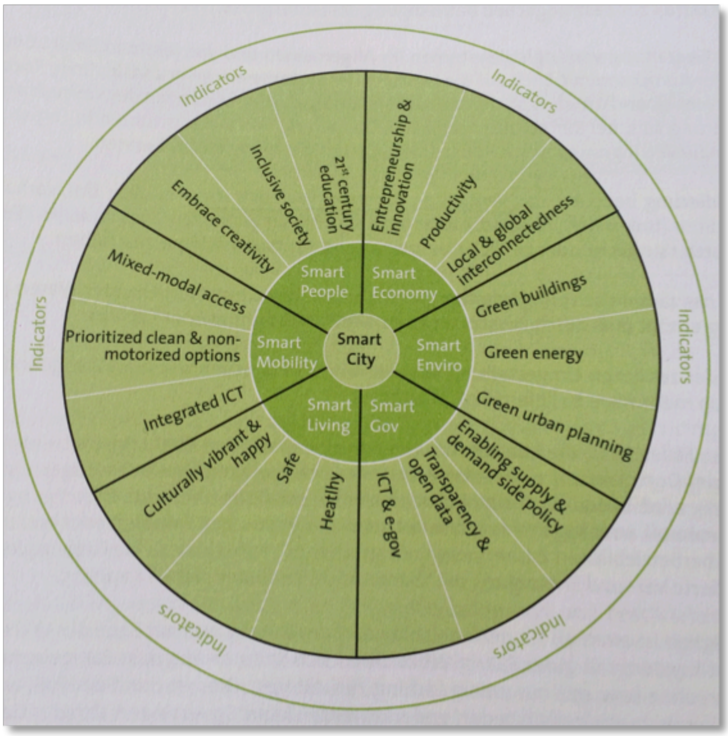
Caragliu et al. (2011) supports Neirotti´s statement by stating that a smart city is smart when investments in human and social capital and traditional and modern communication infrastructures, known as ICTsystems, trigger sustainable economic growth and an improved quality of life for its citizens by still wisely managing natural resources through participatory governance (Ahvenniemi, 2017).

2.3.1. The smart city wheel

The holistic model of Boyd Cohen called *Smart City Wheel* combines and transforms the different definitions of the smart city concept into a more tangible and unified framework (Bundesvereinigung Logistik Österreich, 2014).

Figure 2-1 illustrates the six characteristic sectors, which are proposed by the *Smart City Wheel*, in order to describe the features a smart city is composed of.

Figure 2-1: The Smart City Wheel



Source: Grünbuch der Bundesvereinigung, Logistik, Österreich

Smart People- Refers to distinct creativity in an inclusive society with contemporary education in order to satisfy requirements of the 21st century.

Smart Mobility- Refers to intermodal transport systems with prioritization of non-motorised options and a more comprehensive use of information and communication technology.

Smart Living- Refers to a lifestyle with the main focus on cultural dynamic, happiness, safety and health.

Smart Environment- Refers to environmentally friendly constructions, energies and urban planning.

Smart Economy- Refers to entrepreneurship and innovation, productivity and local, but also global networking.

Smart Government- Refers to supply-side and demand-side politics, transparency and open access to datasets, ICT and e-government.

All sectors have the term *smart* in common. It stands for multiple adjectives, which are describing the framework of the *Smart City Wheel*:

- Smart implies ***intelligence***. It stands for innovative approaches, which will apply new information and communication technologies.

- Smart is ***integrative***, highly connected and serves across systems. System integration and networking in-between these six sectors cause synergies, which support interactions in a transparent and efficient way; for instance the cooperation between a city and its surrounding area.
- Smart is ***efficient***. Energies are used in a very efficient way, which means the overall energy consumption decreases and within the least possible input of resources, the greatest output of energy is possible.
- Smart is ***effective.*** Thanks to the highly integrated approach of these six sectors the resulting effects on indicators are stronger and affect the future-oriented urban society in a more significant way.
- Smart is ***adaptive***. It means that systems adapt to changing conditions by keeping their fundamental functionality.
- Smart is ***attractive.*** Attractiveness plays an important role for citizens and investors in order to increase their quality of life. Long-term strategies for urban planning and logistics create promising perspectives for investments in the future (Bundesvereinigung Logistik Österreich, 2014).

2.3.2. The smart city dimensions

The *Smart City Wheel* introduces the two leading theories in the discussion of smart cities, namely:

1. An approach that is highly related to Information and Communication Technologies (ICT)
2. An approach that is highly related to people (Ahvenniemi, 2017)

Angelidou (2014) defines these two leading theories as the main dimensions of smart cities. On one hand they pursue strategies with the target of efficiency and technological improvement of cities hard infrastructure, and on the other hand they concentrate on soft infrastructure and people, i.e. social and human capital, knowledge, inclusion, participation, social innovation and equity. Deriving from the ICT-oriented and the people-oriented approach, a variety of factors affect the way cities choose to develop their own smart city initiatives (Neirotti, 2014):

Size and demographic density

Large cities attract more human capital. Hence, they rely on a greater implementation of infrastructural resources for electricity, water and telecommunication infrastructures (Elvery, 2010). Large cities, due to a high number of citizens, consequently also have a reasonable mass of ICT users. This supports a rapid scaling up and breaking-even for new digital services, which mainly attracts research and businesses in an urban area. Despite these advantages of larger cities, the increased size of a city can also be associated with barriers for smart city initiatives. Pilot projects do not run ideally, because of a longer installation time and the requirement of investments in distributed infrastructures. Technology vendors are less willing to undertake the experimentation of new technologies due to high costs in large cities (Neirotti, 2014). However, large cities also consist of a high demographic density, which makes it easier to facilitate social interactions and the exchange of knowledge and ideas by putting a greater number of people in contact (Glaeser, 2006). In order to engage all in a smart city, it is necessary to construct social relations and networks which are built on trust and reciprocity (Carley, 2001). In addition, cities with a high demographic density make more efforts to develop their local public transportation system, in order to make the city accessible for all citizens (Jun, 2013). Therefore, highly dense cities depart from a situation in which they are less smart, but at the same time offer more potential to introduce smart and ICT initiatives for mitigating congestion problems (Neirotti, 2014). However, technology needs to be utilizable and understandable by the community in order to serve citizens (Hollands, 2008).

Economic development

Local economic conditions and development rates influence the development of smart city initiatives (Neirotti, 2014). Given the large amounts of money necessary to meet the growing demand for smart growth development, it is indispensable for a city to be business-friendly in order to attract private investors (Hollands, 2008). Therefore, a high GDP and growth rate increase the economic expansion, which influences the financial resources that are available for investments in new transportation, utility and telecommunication infrastructures and education in urban areas (Neirotti, 2014). Overall, cities with a greater economic development are more attractive to people, who want to increase their standard of life, because it puts them into a better position for developing their human capital (Cheshire, 2006). Processing human capital is crucial for imposing smart initiatives. Citizens with more human capital are more likely to be end-users of new software tools, whose aim is to improve the quality of urban life (Neirotti, 2014). However, in order to develop more human capital and to increase the quality of urban life, it is necessary to find an effective balance between the needs of the community, the local government and of business, particularly in form of cooperation's (Monbiot, 2000). Therefore, it must be taken into account that cities are also a space, in which a great amount of resources is consumed and a great amount of environmental waste is created (Low, 2000; Satterthwaite, 1999).

Technology development

Cities which invested earlier in technology trajectories, for instance in ICT that characterises the actual trends of smart city initiatives, are assuming a leading role, compared to other cities, when it comes to further development or adoption of technologies belonging to the same trajectory (Neirotti, 2014).

Especially internet access and the use of internet-based services in an urban area support the development of an information society and thus the promotion of smart city initiatives in areas of soft governance, particularly in the field of government and economy in urban settings (Beniger, 1986). This emphasizes the importance of telecommunication and human capital infrastructures in promoting e-government and e-democracy initiatives, which are based on increased transparency and the empowerment of citizens.

Nonetheless a gap in digitalization strongly inhibits the achievement of a critical mass of users and therefore hinders the development of a variety of smart city initiatives. Cities within a digital divide become less favourable settings for economic sustainability at the local level and restrain economic and societal values even more (Neirotti, 2014).

Environmental-friendly policies

The quality of urban living is fundamentally influenced by environmental sustainability. Green spaces represent an important dimension of smartness due to the many types of socio-economic benefits they create (Jim, 2013). It shall be assumed that smart cities with green spaces rely on a more developed infrastructure than polluted cities. Therefore, they are facing lower marginal costs for further development of smart city initiatives related to infrastructure and green spaces, which aim to improve the environmental sustainability (Neirotti, 2014).

However, even if in comparison it is more costly for polluted cities to adopt smart initiatives in transport, energy and urban planning, the overall advantage of cities which adopt these initiatives shows the evident positive output in case of adoption (Glaeser, 2011). Nevertheless, highly polluted cities show less intention of changing patterns by investing in smart initiatives. This applies especially to the domain of transport and mobility. An explanation could be that most of the highly polluted cities are located in developing countries, where the awareness for smart initiatives is not fully developed yet, as well as capabilities and financial resources for investments in new physical and ICT infrastructures are still limited (Neirotti, 2014).

Consequently, it is easier to adopt smart initiatives in cities that already have green spaces. The positive output of smart initiatives is more evident in polluted urban area (Glaeser, 2011).

Other country-specific factors

Country-specific variables influence the way in which a city increase its level of smartness These go beyond an economic, technological and environmental development rate and instead include a range of variables, such as political leadership, strategic guidelines in the current political agenda, cultural variables, morphological and climate conditions. These variables determine the needs and approaches to develop a successful smart city policy. The capability of implementing smart city projects also depends on the degree of centralization in decision-making power on a political level, as well as the political risk and the level of corruption (Mahizhnan, 1999). Therefore, a fundamental point when it comes to raise the smartness of a city relates to policies fostering human capital, education and entrepreneurship (Neirotti, 2014).

2.3.3. Critical aspects of smart initiatives

The country-specific factors accurately described how municipalities approach smart initiatives. Current cities are still highly complex systems. They are characterized by different needs and contextual conditions, deriving from interconnected citizens, businesses, and diverse modes of transport, communication networks, services and utilities. Therefore, the diffusion of smart city initiatives in different countries makes it still very hard to identify shared definitions and common current trends at a global scale (Neirotti, 2014).

Especially the definitional impreciseness causes numerous unspoken assumptions, contradictions and a tendency of not being critical, which rhetorically labels cities as smart and ranks them into a high-tech variation of urban entrepreneurialism (Hollands, 2008).

This tendency of not being critical downplays negative effects of the development of new technological and networked infrastructures in cities (Graham, 2001). Information technology deepens social division in cities. More and more, smart cities are facing the problem of increasing inequality and social polarization given to the migration of highly educated, mobile, middle class professionals and IT workers, who create gentrified neighbourhoods and thereby exclude and displace traditional communities and poorer residents (Hollands, 2008).

Urban labelling runs the risk of being used exclusively for marketing purposes instead of referring to actual infrastructural change or effective IT policies (Begg, 2002). Therefore, the disjuncture between image and reality is the real difference between a city actually being smart and a city labelling itself smart (Hollands, 2008). As argued by Paquet (2001), the critical factor in a successful community is its people. Information technology does not automatically create smart communities, but it can be used socially, to empower and educate people in order to get them involved into political debates about their own lives as well as the urban environment where they are living in. Thus, the emphasis should be put on people's knowledge's and skills, not on technology in itself. A real shift in the balance of power between the use of information technology by business, government, communities and citizens should take place (Hollands, 2008). Otherwise, in-between image and reality, assumptions and ideological contradictions will hide, which assume that a transition from a non-intelligent city into a smart city is inherently positive. How, to what extent and if related with positive or negative effects a city is smart or not, is not proven yet by any empirical data.

Therefore, the main focus should be placed on unwrapping the label of *smart city* and moving away from believing that information technology equals urban regeneration (Hollands, 2008).

Hence, there is no general consensus on the meaning of the term *smart city* or its attributes. For instance, the intermediate output of smart city strategies reflects the efforts made to improve the quality of life of citizens. The consequence of a lacking shared vision and the large variety of indicators on smart city concepts is its slow diffusion process (Neirotti, 2014; Ahvenniemi, 2017). Each initiative has to overcome various obstacles that are related to the better understanding of the characteristics and future trends of smart city concepts in order to develop a political, economic and cultural context and shape the cities in such a way that they become smarter and more sustainable (The Economist, accessed 21.03.17; Ahvenniemi, 2017).

Ultimately, a city that is not sustainable does not have the potential to become a city that is smart (Ahvenniemi, 2017). With regards to this, concepts and definitions which evolved and developed over years should be combined in order to unwrap labels and make the overall concept of a sustainable city more tangible.

2.4. The eco-city concept

In 1975, the philosopher Richard Register founded a non-profit organization called *Urban Ecology* which introduced the eco-city concept (Roseland, 1997). Richard Register defined an eco-city, as a city that ensures the wellbeing of its population due to a holistic urban planning and management approach with the main goals of eliminating waste and emissions. However, an eco-city consists of complex subsystems that need to be adjusted and coordinated in order to achieve the desired outcomes (Tsolakis, 2015).

Ecological cities, therefore should take into account 10 principles when they are planned and created (Roseland, 1997):

1. *Land use*: Creation of compact, diverse, green, safe, pleasant and vital mixed-use communities close to transit hubs and transportation facilities.
2. *Transportation*: Support of foot, bicycle, cart and transit by emphasizing access by proximity.
3. *Urban environments*: Restoration of creeks, shorelines, ridgelines and wetlands.
4. *Housing*: Creation of decent, affordable, safe, convenient and racially and economically mixed housing.
5. *Social justice*: Creation of improved opportunities for women, people of colour and disabled people. Social ecology insists that it is not enough to simply protect nature, but rather create an ecological society in harmony with nature.
6. *Agriculture*: Support of local agriculture, urban greening projects and community gardening,
7. *Recycling*: Reduction of pollution and hazardous wastes as well as conservation of resources within innovative and appropriate technology.

   Technology should be designed in order to be compatible with its local settings and to increase the self-reliance of people on a local level.
8. *Economic activity*: Businesses should support ecologically sound economic activities by also decreasing pollution, waste and the use and production of dangerous materials.
9. *Simplicity*: Support of voluntary simplicity, while discouraging excessive consumption of material goods.
10. *Awareness*: Creation of awareness of the local environment and bioregion within activism and educational projects. Bioregionalism considers people as being part of a life- place and being dependent on natural systems the same way as plants or animals. The *ecological footprint* analysis is an example of a bioregional tool, which considers the impact of cities on natural resources and ecosystems and furthermore raises awareness in urban areas.

Besides these 10 guiding principles, the planning and designing of an eco-city should also be able to cope with specific and critical components such as sustainable urban growth dynamics related to population, economic growth. The dynamics of population and economic growth are accompanied by the appropriate life-style and education development efforts; urban transportation, greenhouse gas emissions (GHG) and solid waste management and energy consumption related to efficiency and clean energy provision against local demands (Khanna, 2014).

When it comes to eco-cities, sustainable urban growth dynamics play a significant role due the relationship between energy consumption in transportation and the physical characteristics of the urban arrangements such as the city size and the population density (Banister, 1997). Transportation, in general, is a major cause of global warming and a huge energy consumer. That is why it is also necessary to reduce car use in order to achieve urban sustainable settlements (Choguill, 2008). Tsolakis (2015) concluded that density, land diversity and employment influence the distances to reach facilities in an urban area; that is, how the ability to walk can be fostered and the usage of cars as well as fossil fuels can be reduced. The reduction of fossil fuels is crucial, given that cities occupy 1% of the earth surface but emit about 80% of the global GHG emissions (Feng, 2015). However, even prototypes of eco-cities employ energy and materials in a wasteful manner (Tsolakis, 2015). Zaman and Lehmann, 2011 defined waste as the most important challenge, when designing sustainable cities. Therefore, urban public- private alliances in urban, solid waste management are required in order to achieve sustainable development (Tsolakis, 2015).

Nevertheless, similar to the sustainable city and smart city concept, the eco-city concept also lacks of a holistic approach when it comes to applying theory in practice (Anthopoulos, 2013).

To sum up the major points of chapter 2 table 2-1 gives the reader an overview of all four urban planning concepts by listing the main objectives and main dimensions of each strategy. Consequently, it is easier to recognize similarities and differences amongst their dimensions. Regarding their objectives, it is particularly interesting that all four concepts are aiming to improve the quality of life of its citizens, which means that over time the approaches of urban planning changed but the main goal remained the same.

Table 2-1: Comparison of urban planning concepts

Urban planning concepts	Dimensions	Objectives
Urban Dynamics	• Decrease of land availability • Lack of buildings and infrastructures • Growth of jobs	• To solve rising unemployment as a natural consequence of urban aging and lack of land availability
Sustainable City Concept	• Increase of compactness of the built environment • Improvement of transportation • Increase of density of people to land • Mixed land use decreases need of travelling • Diversity of activities for citizens • Reduction of energy demand due to passive solar design • Creation of green spaces in urban area • Reduction of waste due to municipal solid waste management • Supply of water for all citizens • Education about sustainability	• To promote a better quality of life for its citizens • To satisfy the needs of its citizens in a sustainable way
Smart City Concept	• Establishment of intermodal transport systems • Better usage of resources due to ICT • Change in urban living practices • Provision of efficient services to citizens due to data and information technologies • Optimization of infrastructures	• To reduce greenhouse gas emissions by the development and deployment of innovative technologies

	• Support of innovative business models • Increase cooperation between economic actors • Improvement of life of its citizens	
Eco City Concept	• Creation of compact, diverse, green and safe communities • Improvement of transportation • Restoration of urban environment • Creation of affordable, safe and convenient mixed housing • Creation of improved opportunities for women, people of colour and disabled people • Support of local agriculture, urban greening projects and community gardening • Reduction of pollution and waste • Conservation of resources • Support of ecology and decrease of pollution by economic activities • Creation of awareness of the local environment by activism and educational projects • Discourage of excessive consumption of material goods	• To ensure the wellbeing of its citizens • To eliminate waste and emissions

Source: Compiled and summarized by the author

2.5. Challenges for implementing smart city strategies

Given the complexity of smart cities challenges arise, which hinder them to be designed and deployed (Khatoun, 2016). Many existing frameworks already describe the architecture of smart cities, yet, as stated before, the main focus should be placed on unwrapping the label of *smart city* and on empirical data, to prove or disprove to which extent and in which way a city is smart or not. This way the identified challenges might be overcome (Hollands, 2008).

Despite the scarce literature on smart city strategies, however, the White Paper 2013 of the European Union highlights the specific challenges which underline the reasons a framework in the field of policy and regulations is necessary in order to become smart:

- ***EU-wide complexity:*** Change requires considerable due diligence processes, because policy and regulations need to be implemented on the EU-, national and the municipal level.
- ***Silo Thinking:*** Collaboration across thematic borders is necessary. Cities often focus on smart cities projects on their own or involve only specific parts of the municipal administration.

- ***Regulations that inhibit smart city roll-out:*** The implementation of smart city strategies can be impeded by local regulations, which are in conflict with national standards.
- ***Uncertainty:*** Policy uncertainty and limited technology integration prevent private companies from investing in new technologies and infrastructures. Hence, these differences in technical standards between countries often hinder the deployment of smart city concepts on a large scale, i.e. Europe-wide.
- ***Multiple players:*** A major change needs to be done in capabilities. Processes need to become more inclusive and involving and built upon a greater collaboration within and across traditional administrative and industrial boundaries. Therefore an early, dynamic and comprehensive involvement of multiple governmental and non-governmental actors, private sectors and citizens is required.
- ***Citizens:*** Citizens need to be the heart of the solution, given that they also form the heart of the challenges cities are facing through on-going urbanisation, demographic mix, consumption habits and increasing expectations regarding quality of life.
- ***Long-term planning:*** Implementing smart cities strategies in a successful manner will demand a long-term planning perspective by involving short-term actions. In order to achieve political and professional ambitions it is necessary to set new levels of integration and address diverse domains.

2.6. Tools for implementing smart city strategies

Smart city strategies are, in practice, an attempt to formalise visions. That is why it matters to take into account the fact that there are not many concrete tools proposed yet in order to overcome emerging challenges.

However, the Whitepaper 2013 of the European Union and the Strategic Implementation Plan 2013 of the European Innovation Partnership on Smart Cities and Communities propose *Lighthouse Initiatives* in order to cope with the mentioned issues and make cities smart again.

Lighthouse Initiatives are characterized by city groupings composed of industries and other stakeholders, which are committed to develop solutions based on integrated technologies across ICT, energy and the sector of mobility in order to address the needs of citizens. The aim of such groupings is to deliver common frameworks and designs.

The Strategic Implementation Plan 2013 of the European Innovation Partnership on Smart Cities and Communities lists a number of implementation tools, which are supporting the ambitions of the European Union.

2.6.1. Implementation Tools

1. Cross-Cutting Content Management

   This tool consists of a matrix scheme which deals with the interdependencies of smart city concepts. The matrix approach will support city authorities to not lose sight of interlinkages and interdependencies of actions. It makes it easier to approach city planning and management in a systematic way by articulating logical synergies and inter-dependencies between city systems.

2. Stakeholder coordination

   The successful implementation of smart cities strategies requires the involvement of multiple stakeholders.

   In order to assure an effective action, a platform at European level is necessary. The European Commission needs to take over the important role of hosting such a platform and support stakeholder engagement. This platform will provide the right space to manage coordination and communication activities.

3. Country Smart City Landscaping and Bench-learning

   Given that each member state of the European Union is approaching the topic of smart city from a different perspective and within varying instruments, but still aiming for the same goal, it is important to develop a robust comparison framework in order to exchange accurate data. Consequently, experience sharing is promoted and insights will be implemented into EU policy and regulatory processes on a national and a city-level.

4. "Kitemark" recognition

   "Kitemark" recognition is proposed for creating greater confidence from all stakeholders, including citizens. This initiative should be linked to ongoing knowledge management and dissemination plans, meaning that it should include new urban networks, city conferences and relevant events.

5. Events and Marketing

   City conferences and events with multiple sources and different quality are already taking place. Although these events raise awareness they also compete against each other and stretch resources. The goal of this tool is to maximise the means in order to exploit existing events and to establish new key ones. This tool receives support by multi-media, which allows enhancing communications and dissemination.

6. Progress Monitoring

   The scale of complexity about what smart city strategies are seeking to accomplish, requires very clear and ambitious goals, an easy to communicate roadmap, principles that will underpin programme success and a mechanism and resources that will demonstrate that.

7. Funding

   Resource input is necessary and crucial in order to apply the above-mentioned tools.

2.6.2. System Dynamics as a tool

Apart from the tools proposed by the European Union, a literature review was conducted which emphasizes the appropriateness of the tool of system dynamics in order to deal with the challenges in the field of urban planning.

System Dynamics is a methodological, well-developed systematic simulation tool. It analyses, comprehends and manages the development of systems within causal loop and stock and flow diagrams (Tsolakis, 2015). More precisely, it quantifies complex, system-based feedbacks, which are characterized by endogenous, non-linear and dynamic behaviour in system interactions, many of which are also uncertain.

System Dynamics is designed similarly to system thinking, although it works with computer software, which makes it possible to analyse, visualize and explore problems (Forrester, 1961, 1968, Sterman, 2000).

The feedback control characteristics prove it to be an appropriate tool for decision-making on a strategic level. The strategic level regards a wide range of problems starting with managerial, socioeconomic to organizational ones (Tsolakis, 2015). Therefore, besides arranging and describing connections between each element on different levels, it is also able to predict the complex system change under a variety of "what-if" scenarios, which is crucial when it comes to examining and recommending policy decisions (Mohapatra, 1994). System dynamics is an adequate method to analyse problems, where time is an important factor and setting boundaries is crucial (Sterman, 2000).

When it comes to urban planning models, it takes into consideration the existing interdependencies among social, ecological, economic and other subsystems that are relevant for the development of urban sustainability policies and emphasize possible divergences with regard to initial planning (Pretorius, 2015).

Table 2-2 and table 2-3 furthermore emphasize that there has not been any scientific research so far that looked at the dynamics of a smart city strategy. This once more highlights the importance of this research project.

Table 2-2: Literature review with search on SCOPUS database with the terms 'system dynamics' & 'city'

Title	*Author*	*Description*	*Location*	*Modelling approach*
Evaluation of sustainable policy in urban transportation using system dynamics and world cities data: A case study in Isfahan	Hossein Haghshenas Manouchehr Vaziri Ashkan Gholamialam (2014)	Analyzing environmental, economic and social impacts of various transportation policies by using system dynamics in order to identify successful policies for sustainable transportation for cities worldwide.	Isfahan (Iran)	System Dynamics Model

System Dynamics Model of Shanghai Passenger Transportation Structure Evolution	Yang Chao Miao Zishan (2013)	Analyzing the evolution of urban passenger transportation structure using system dynamics as approach.	Shanghai (China)	System Dynamics Model
Applying system thinking to city logistics: a qualitative (and quantitative) approach to model interdependencies of decisions by various stakeholders and their impact on city logistics	Oliver Kunze Gebhard Wulfhorst Stefan Minner (2015)	A system thinking approach is applied in order to model the interdependencies of the different factors influenced by different stakeholder decisions.	Germany	Systems Map Partial System Dynamic Models of Scenarios
Modeling of urban solid waste management system: The case of Dhaka city	M.A. Sufian B.K. Bala (2006)	Prediction of solid waste generation, collection capacity and electricity generation within a system dynamics model.	Dhaka city (Bangladesh)	System Dynamics Model
System dynamics modelling for urban energy consumption and CO_2 emissions: A case study of Beijing, China.	Y.Y. Feng S.Q. Chen L.X. Zhang (2013)	A system dynamics model, which provides essential information for Beijing's future energy and carbon emission profiles.	Beijing (China)	System Dynamics Model
Eco- cities: An integrated system dynamics framework and a concise research taxonomy	Naoum Tsolakis Leonidas Anthopoulos (2015)	A system dynamics framework is proposed for assisting decision-makers, local governments and managers.	Greece	System Dynamics Model

Source: Compiled and summarised by the author

Table 2-3: Literature review with search on SCOPUS database with the terms 'system dynamics' & 'city' & 'sustainability'

Title	*Author*	*Description*	*Location*	*Modelling approach*
Combining system dynamics model, GIS and 3D visualization in sustainability assessment of urban residential development	Zhao Xu Volker Coors (2011)	GIS, SD modelling and 3D visualization explains the interaction and the variation of sustainability indicators for residential development.	Stuttgart (Germany)	System Dynamics Model

Modelling a policy making framework for urban sustainability: Incorporating system dynamics into the ecological footprint	Wei Jin Linyu Xu ZhifengYang (2009)	Attempt to incorporate system dynamics into the ecological footprint in order to develop a forecast framework and to support policy makers.	China	System Dynamics Model

Source: Compiled and summarised by the author

3. System Dynamics modelling approach and research methods

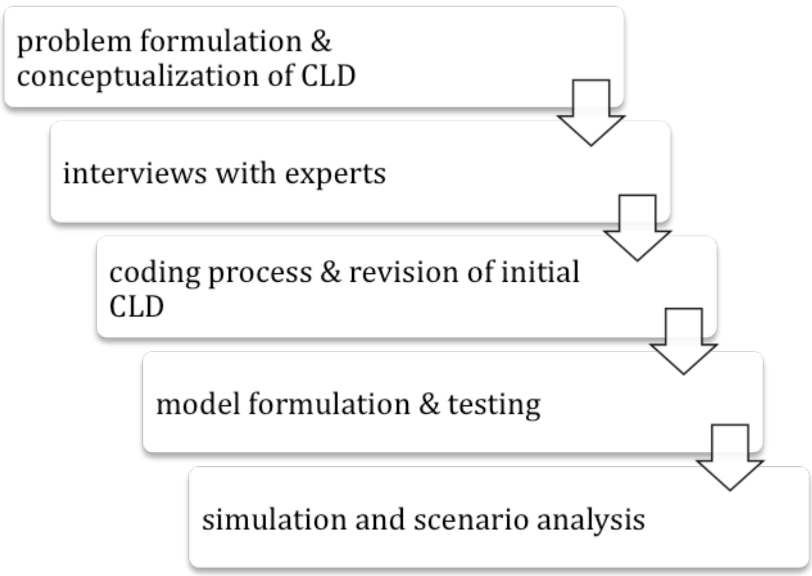
3.1. The case study approach

A case study approach was deployed in order to investigate the contemporary phenomenon of urbanization in its real-world context. Case studies support the understanding of complex, social phenomenon like the increased growth of urban areas. They are furthermore aiming to illuminate a decision or a set of decisions in order understand why decisions were taken, how decisions were implemented and what the result of those decisions is. Consequently, case studies not only want to contribute to abstract theory building, but are analysing concrete situations for expanding and generalizing theories i.e. in this research by looking at the smart city strategy of Vienna as solution for dealing with an increased growth of the city (Yin, 2013).

3.2. Overview of the research process

This chapter will give an overview of the overall research process, by describing in detail each research step. Figure 3-2 visualizes the performed research process of this project.

Figure 3-2: Overview of the research process



Source: Compiled by the author with adaptation from Sterman (2000)

Firstly, the author started by meeting Dominic Weiss, the CEO of the smart city agency *TINA Vienna.* He helped her to get in contact with relevant stakeholders of the smart city strategy Vienna in order to set up, the initially planned, group model building sessions.

Group model building sessions were planned, because of a salient lack of participatory approaches in the literature of smart city strategies; especially when it comes to the implementation part of the strategies.

This is why the author contacted 12 stakeholders, which the reader can gather from table 3-4. Given the short timeframe, none of the contacted stakeholders could attend and therefore the group model building sessions did not take place.

Table 3-4: Stakeholders contacted in Vienna

Name	Organization/ Institution
Angelika Winkler	Wien GV (The city of Vienna)
Harald Semela	Wien GV (The city of Vienna)
Mueller Rainer	TINA Vienna (Smart City Agency Vienna)
Verena Eder	Wirtschaftsagentur (The Vienna Business Agency)
Gerrit Hell	Wien GV (The city of Vienna)
Georg Hauger	TU Wien (Technical University of Vienna)
Matthias Prandtstetter	Austrian Institute of Technology
Andrea Faast	Wirtschaftskammer Wien (Chamber of commerce Vienna)
Rojko Peter	Hafen Wien (A company of Vienna Holding)
Jürgen Schrampf	e consult (Logistic consultancy)
Ilse Stockinger	Wiener Stadtwerke (Municipal Utility Vienna)
Patrick Hirsch	University of Natural Resources and Life Sciences, Vienna

Source: Compiled by the author

However, four out of twelve stakeholders offered their expert knowledge in the context of an interview. The stakeholder, who were interviewed are listed in table 3-5. That is how the actual empirical process of this research project started.

Table 3-5: Stakeholders interviewed in Vienna

Name	Organization/ Institution
Harald Semela	Wien GV (The city of Vienna)
Verena Eder	Wirtschaftsagentur (The Vienna Business Agency)
Georg Hauger	TU Wien (Technical University of Vienna)
Jürgen Schrampf	e consult (Logistic consultancy)

Source: Compiled by the author

3.3. The research methods applied in each step regarding the case study

In this section it will be explained in detail which research methods were used in each step of this research project in order to make the whole process transparent with regards to its research objectives.

3.3.1. Problem formulation and conceptualization

To unwrap and explain causal links in real-world interventions, which are too complex for experimental methods, like urbanization is, the author decided on conceptualizing a causal loop diagram (CLD). As a first step the literature on smart and sustainable city strategies were studied by especially focusing on Vienna in order to grasp the main dynamics of the field.

Based on Kim and Andersen (2012) qualitative data was used for conducting a qualitative system dynamics model. CLDs are able to represent relationships by plus and minuses. Thus, if the relationship is represented by a plus it means it has a reinforcing character. A reinforcing character means that a positive/ negative change will lead to a consequence with the same character. Consequently, positive change will lead to even more positive change and negative to even more negative. A relationship represented by a minus has a balancing character. A balancing character is seeking for a goal. It emphasizes that a positive/negative influence will lead to the exact opposite character in its consequence. Therefore, a positive influence will cause a negative consequence and a negative influence will lead to a positive consequence (Sterman, 2000).

CLDs are very helpful when it comes to guiding consultation and group processes. Such is the case in this case study, when system dynamics directly interfaces with people in actual systems. System thinking goes along with case studies and the initial conceptualization phase of system dynamics. It especially supports the organization of the tremendous amount of information deriving from the mental database of participants (Forrester, 1994).

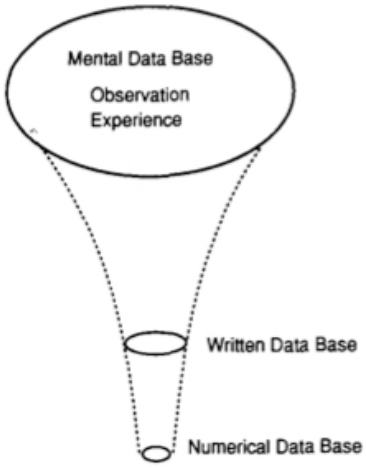
Furthermore, by building the CLD the main dynamics of smart city emerged and produced new insights regarding the smart city strategy. The author finalized the CLD by classifying it into 13 sectors. The result of the CLD can be found in chapter 5.

3.3.2. Interviews with experts

Case studies are using two sources of evidence, namely direct observation of events being studied or, like in this research project, interviews of people involved in the observed events (Yin, 2013). That is why the author conducted interviews with experts who are involved in the smart city strategy Vienna.

Information can be gathered from many sources. Forrester (1992) suggests mental, written and numerical databases. Figure 3-3 visualizes how the amount of available information declines, starting within mental until numerical information. The movement also implies a shrinking proportion of information about structures and policies. However, as also shown in figure 3-3, information in people’s mind is more extensive than in other stores of information (Forrester, 1992). This was one of the main reasons for conducting expert interviews.

Figure 3-3: Mental data base



Source: Forrester, 1992

The author decided to hold semi-structured, "disconfirmatory" interviews to especially build more confidence in the structure of the preliminary qualitative model, which was built based on existing literature. As stated by Andersen et al, (2012) the goal of such interviews is not to be superior to the use of quantitative methods but to offer a complementary tool. They furthermore emphasized that interviews become more important in system dynamics research projects when data series are missing on the side of the modeller and also on the side of the client. Given that the smart city strategy Vienna is a vision and lies ahead in the future and no data is available yet, interviews become an important method to collect data or detect behavioural trends. They allow data gathering, which in a further step will be analysed, and generates or creates theory, inductively (Babbie, 1992; McCracken, 1998).

Semi-structured interviews can be defined as a verbal interchange, which means that the interviewer tries to elicit information from another person by asking questions. Nevertheless, the author beforehand prepared a list of questions. Semi-structured interviews aim to unfold, in a conversational and informal manner, issues that feel important to the interview partners. Consequently, semi-structured interviews are about talking but also about listening (Clifford et al. 2016).

The guideline of the interviews, which can be found in annex A, included as a first step showing and explaining the CLD to the participants, which was built beforehand.

The author initially challenged each stakeholder in order to let him or her start thinking in dynamic complexity. This mostly did not happen intuitively, but still contributed in finding out if they are agreeing with literature or not. The main goal of these interviews was to get knowledge about the main dynamics of the smart city vision in Vienna. Since it is a vision, data only exists in the mind of experts and consequently makes interviews crucial.

The information provided was recorded, given its importance for the subsequent modelling process but also to provide a comfortable atmosphere while talking to the stakeholders. The final results are presented in chapter 5.

3.3.3. Coding process and revision of initial Causal Loop Diagram

The steps described in this section were undertaken in order to build grounded theory from qualitative data. Given that the author shares the stakeholders' mother tongue, the interviews were hold and transcribed in German but then translated into English. All interviews were transcribed and translated by the author. The transcribed and translated interviews can be found in annex B.

The transcriptions were the basis for coding to obtain qualitative data.

Coding was based on the research of Kim and Andersen (2012). However, the author decided on making slight adjustments. The red, crossed out lines in figure 3-4 illustrate which steps where not accomplished by the author. After discovering themes and identifying causal relationships the author decided to replace step three by identifying factors of influence amongst the variables. The author was inspired to process the data this way because of the research of Martinuzzi et al (2014).

Figure 3-4: Coding process

Description of the process	Main tool	Input	Output
1. Discovering themes in the data	Open coding	Raw text data	Definition of problem and system boundary; selection of relevant data segments
2. Identifying variables and their causal relationships	Open coding; causal links	Data segments (each Segment = one argument + supporting rationales)	Coding charts (e.g. Table 2)
~~3. Transforming text into words-and-arrow diagrams~~	~~Causal links; causal maps~~	~~Coding charts~~	~~Simple words-and-arrow diagrams (e.g. Figure 1)~~
4. Generalizing structural representations	Axial coding; causal maps	Simple words-and-arrow diagrams	Final causal map (e.g. Figures 2 and 3)
~~5. Linking maps to the data source~~	~~Map/data ID numbers~~	~~Coding charts and final causal map~~	~~Data source reference table~~

Source: Kim & Andersen, 2012; adjusted by the author

Factors of influence replicate the cause of a variable and its consequence and support the establishment of causal pathways. Therefore, they were taken as intermediate step before constructing CLDs. The factors of influence are represented as conceptual models and have plusses and minuses in order to show the coherent relationship. The relationship is reinforcing or balancing, same as when building CLDs. However, the author would like to emphasize that these are still conceptual models and not CLDs, also because they are missing feedback.

The author also took into account the frequency of naming of the influencing factors during the interviews. Thereby, by the thickness of the arrows it was already possible to get a first insight on what stakeholders consider highly influencing or highly influenced.

Based on the steps undertaken in the coding process, the data gathered in the interviews and the information of the smart city strategy Vienna were assigned to the corresponding strategy pillar. The initial CLD was used as a basis for each strategy pillar and enriched by additional and integrated inputs, which always corresponded to the given pillar. This made it possible to show the dynamics of each strategy pillar, separately.

The resulting CLDs consist of three colours in order to understand which information was given during the interviews of the stakeholders (red), which information derives from smart city literature (black) and which connections were made by the author based on her system dynamics modelling expert knowledge (blue).

3.3.4. The system dynamics modelling approach

This research step aims to explain the development of a system dynamics simulation model in order to better understand the dynamics of the pillar of quality of life of the smart city strategy Vienna.

Figure 3-5: A pictorial representation of the process of transforming qualitative data into a simulation model

Source: Luna- Reyes, Andersen, 2003

As section 3.2.3. has shown and as Luna-Reyes and Andersen (2003) emphasized, qualitative data and their analysis play a central role at all levels of the modelling process.

Although, models are mathematical representations of problems and policy alternatives, it is acknowledged that most of the information available for the modeller is qualitative instead of quantitative (Luna-Reyes, Andersen, 2003). Forrester, 1992 recognized, that the most significant source for the modeller is the mental database. Figure 3-5 represents the uncertainty that is associated with the quantification of qualitative variables. It is not always easy to understand the translation of the observation of reality and the assumptions made when formulating the model. This gap is evident, especially when the model includes soft variables (Luna- Reyes, Andersen, 2003). This uncertainty has caused experts to believe that corresponding simulations could be misleading or could be very fragile (Coyle, 2000).

Nevertheless, system dynamics modelling is a powerful tool due to its constant iterative process and especially in the creation of feedback theories (Luna-Reyes, Andersen, 2003). That is also the reason why this approach was chosen.

Guidelines for the model building process

The founders of the system dynamics field have developed a series of guidelines for the model building process as well as tests to build confidence in the models (Luna- Reyes, Andersen, 2003). Figure 3-6 gives an overview of the suggested guidelines according to the authors.

Figure 3-6: Overview of the classical system dynamics modelling process across the classical literature

Randers (1980)	Richardson and Pugh (1981)	Roberts *et al.* (1983)	Wolstenholme (1990)	Sterman (2000)
Conceptualization	Problem definition	Problem definition	Diagram construction and analysis	Problem articulation
	System conceptualization	System conceptualization		Dynamic hypothesis
Formulation	Model formulation	Model representation	Simulation phase (stage 1)	Formulation
Testing	Analysis of model behavior	Model behavior		Testing
	Model evaluation	Model evaluation		
Implementation	Policy analysis	Policy analysis and model use	Simulation phase (stage 2)	Policy formulation and evaluation
	Model use			

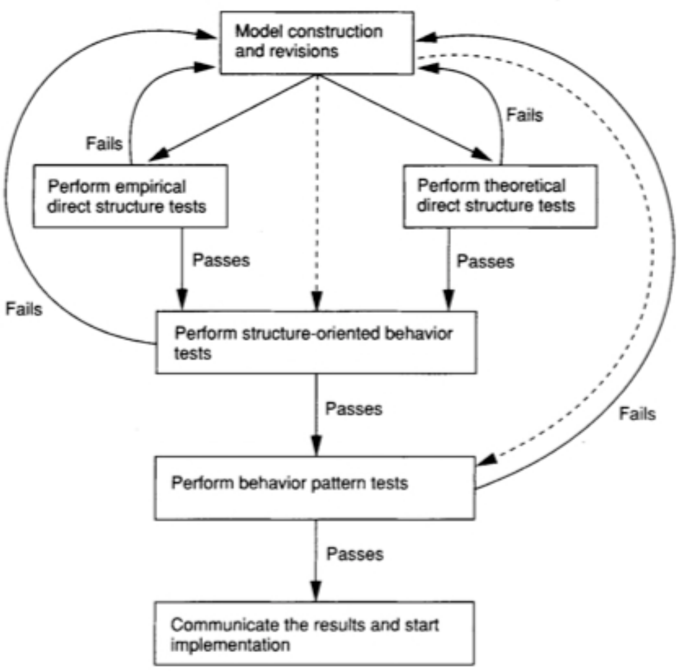
Source: Luna- Reyes, Andersen, 2003

As depicted in figure 3-6 the ways of grouping the activities varies among the different authors. However, the activities along the stages remain rather constant (Luna- Reyes, Andersen, 2003). Consequently, the formulation of model behaviour goes through four main stages.

Stages of modelling behaviour

The four main stages of the formulation of model behaviour namely are: conceptualization, formulation, testing and implementation. These four stages are also represented in figure 3-7.

Figure 3-7: Formal steps of model validation



Source: Barlas, 1996

Problem definition and system conceptualization

This step is still a very qualitative part of the model development. Interviews with stakeholders and written data made it possible to develop a qualitative model. The feedback loops within the qualitative model are assumed to cause the reference mode and therefore represent the problem.

The qualitative models can be found in chapter 5.

Formulation

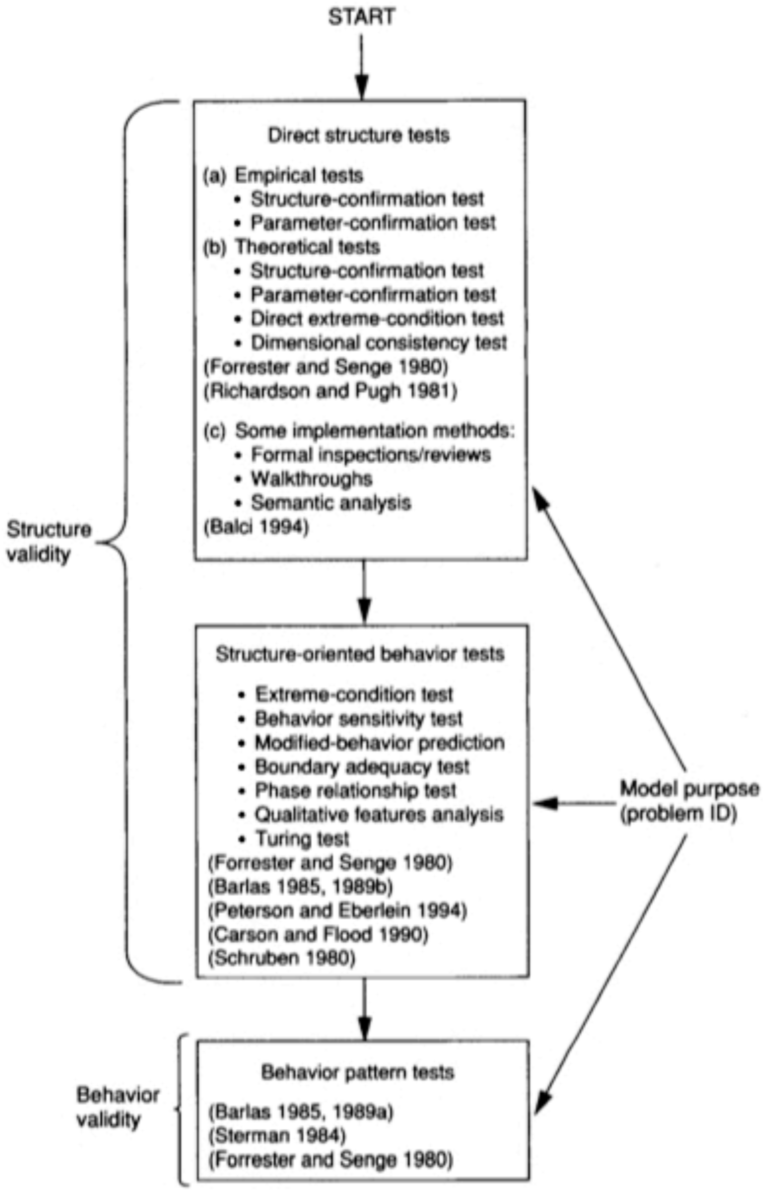
This step contains the building of a detailed structure and the selection of parameter values. Values with a qualitative construct where no quantitative data was available yet were included as well. Doing so is especially supported by Sterman, 2000 who emphasizes that leaving out structures or variables, because numerical data is not available is less accurate than using its own judgement to estimate values. However, given that the smart city strategy Vienna is a vision it is important to mention that several data is currently unavailable. Nevertheless, by interviewing experts it was possible to estimate important parameters and values.

Model behaviour and model evaluation

This step of validation is crucial, given that system dynamics modelling is an effective tool for policy analysis. However, in order to be effective it is necessary to build confidence in the structure as well as in the behaviour of the model so that it is possible to also build confidence in its output (Sterman, 2000).

Consequently, the logical order of validation is to first test the validity of the structure and as a second step to test the accuracy of the behaviour, but only after the structure of the model is perceived adequate (Barlas, 1996). This validation sequence is represented in figure 3-8.

Figure 3-8: Sequence of validation process



Source: Barlas, 1996

Direct structure tests:

The direct structure tests evaluate the model structure, by comparing the model to the real system structure. This involves taking each relationship on its own and comparing it to the real system. This step does not involve any simulations (Barlas, 1996). As shown in figure 3-8, direct structure tests can be classified into **empirical** or **theoretical tests**. The difference between them is, that empirical structure tests involve the comparison of the model structure with the real system, which has been modelled, while theoretical structure tests involve comparing the model with generalized knowledge, which exists in the literature.

Structure confirmation tests are most likely the most difficult to formalize and quantify, given the direct comparison of the form of the equation of the model with the form of the relationship that exists in the real system. This information is highly qualitative in nature. As shown in figure 3-8, **parameter confirmation test** can be applied as an empirical, but also as a theoretical test. These tests aim to estimate the numerical value of the corresponding parameter with enough accuracy (Barlas, 1996).

Direct extreme-condition test is another important direct structure test and involves the evaluation of model equations under extreme conditions by assessing the knowledge of what would happen under similar conditions in real life (Forrester, Senge, 1980).

In order to check the right-hand side and the left-hand side of each equation for the dimensional consistency it is necessary to perform a **dimensional consistency test.** The test to be meaningful requires that the model has no parameters, which have no meaning in real life (Barlas, 1996).

Structure-oriented behaviour tests

Structure-oriented behaviour tests aim to uncover potential structural flaws. They are based on simulations, which can either be applied to the entire model or sub-models of it.

Extreme-condition test is about assigning extreme values to selected parameters and comparing the generated behaviour to the behaviour of the real system under the same extreme conditions.

The **behaviour sensitivity test** determines parameters in the model, which are highly sensitive and asks if the real system would replicate the same high sensitivity to the corresponding parameters. Data about the behaviour of a modified version of the real system makes a **modified-behaviour prediction** possible as well. The test is passed, when the model with its structural modifications replicates the same behaviour as the "modified" real system.

Qualitative Features Analysis is a test, which consists of the specification of qualitative features of the estimated behaviour under certain conditions and compares it to the actual results of the simulation.

The **turing test** compares real and simulated output behaviour patterns. If these patterns are indistinguishable then the test is passed (Barlas, 1996).

Behaviour pattern test.

System dynamics models are long-term oriented and that is why the emphasis is placed on pattern prediction rather than point prediction.

As shown in figure 3-8, all three stages of the model validation process are depending on the model purpose, which has been determined during the problem formulation process. Consequently, no validity test can be carried out without referring to the modelling purpose (Barlas, 1996).

Given that system dynamics modelling is an iterative process, it makes only sense to move to the next step of the validation process, if the author was able to establish sufficient confidence in the current step.

Base simulations and Dynamic Story Line

After building confidence into the structure and behaviour of the model base simulations can be done for better understanding how the dynamics of the system connect and interplay with each other.

Implementation

The last step of the modelling process is the implementation. This includes the explanation of the model to individuals, who necessarily are not modellers themselves. The implementation part is a qualitative process, which requires discussion, interpretation of results and the determination of the use of the output of the model.

4. The case study

4.1. Vienna- A good practice example

Vienna is the capital of Austria and located in the centre of Europe. With a population of 1.840.226 it is the largest city and the political centre of the Republic of Austria (Stadt Wien, accessed 09.05.17).

Figure 4-9: Map of Austria and its capital Vienna

Source: Maps from Google. Complemented and adjusted by the author.

Vienna is a good example for a city, which is able to improve its overall quality of life due to multiple initiatives. This positive development is illustrated by its multiple high-ranking positions in an international context.

The internationally known consulting firm *Mercer* put Vienna, among 231 major cities, for the 8th time in subsequence on the first place for its overall quality of life (Mercer, accessed 09.05.17). Furthermore Vienna was ranked first place in the international ranking of "smart city index 2017", before 86 major cities. The ranking was conducted by the globally active consultancy *Roland Berger* (Stadt Wien, accessed 09.05.17).

While *Mercer* evaluates the quality of living in a city, *Roland Berger* looks at systematic strategies for developing smart solutions in major cities. Given that systematic strategies are a very comprehensive field, the consultancy *Roland Berger* decided to restrict its index to three key areas: fields of application, strategic planning and IT-infrastructure by focusing on interlacing fields of application such as public administration, health, education, energy and environment, buildings and mobility (Stadt Wien, accessed 09.05.17). A comparison between these two rankings confirms the lack of consensus on the meaning of smart city or its defining attributes. However, Vienna's smart city strategy strongly relates to the before-mentioned interlacing fields of smart city strategies, which also explains its leading position in the international context.

4.2. Vienna and Smart City Strategies

Experts coming from the city administration and external partners developed the smart city framework strategy in Vienna. Additionally, civil society, research institutions and the private sector came together in order to draft a successful long-term strategy. The strategy is directed to all target groups of the city, which includes Vienna's citizens, enterprises, non-profit institutions and the public sector. The city council adopted the strategy on June 25th, 2014 (Stadt Wien, accessed 09.05.17).

4.3. Vienna's goal and its main objectives

The framework strategy of the *Smart City Wien* defines its meta goal for 2050 as following:

"The best quality of life for all inhabitants of Vienna, while minimizing the consumption of resources. This will be realized through comprehensive innovation." (Stadt Wien, accessed 09.05.17).

By setting the three main objectives, the smart city strategy, pushes forward the fulfilment of its meta goal.

The three objectives are the following:

1. **Highest possible resource preservation**
2. **Innovation leader through cutting-edge research, a strong economy and education**
3. **Ensuring top- level quality of life**

Resource preservation:

Resource preservation is one of the major goals of the smart city strategy and it is highly interlinked with the two other key goals: quality of life and innovation. The approach primarily and foremost wants to reduce CO_2 emissions and dependencies connected to sparse and finite resources, especially in the sectors of energy, mobility, infrastructure and building management. Additionally, many people in Vienna actively implement resource conservation into their everyday life as part of their lifestyle. That is why the municipality should try to foster and anchor these trends by means of strong incentives in the future. Further conservation of resources is done by improving building shells, providing energy-efficient technical services for buildings or intensified urban condensation, local shopping options and measurements in order to promote cycling and walking. All buildings will need to fulfil the mandatory requirements of zero-energy standards and older buildings will receive a paid building rehabilitation.

In order to improve the energy system of Vienna, the main emphasis is put on the usage of local renewable sources and waste heat for heat and electricity generation. Renewable resources will be produced in rural areas, which will generate added value to those areas.

In the field of mobility, attention must be paid to sufficiency and efficiency. The growth in population will also lead to a rising number of car trips, which will be followed by an increase in energy demand and pollutant emissions due to traffic, as well as intensified use of scarce urban space. Therefore, it is necessary to promote a shift towards walking and cycling by strengthened urban structures, which is defined by resource-saving mobility and short distances. The city will also introduce electromobility in order to optimise the flow of traffic and goods. The view on traffic should be extended across municipal boundaries within multimodality and mobility hubs for integrating mobility in and outside an urban area. All of this will be combined within ICT, which will be the *nervous system* and the driver for innovation of Vienna. In order to make this happen, the city is committed to an open government principle, which is defined by participation, transparency but also data security. Innovations will be created for the benefit of citizens in the areas of energy, health, culture, environment, transport and housing (Stadt Wien, accessed 09.05.17).

Innovation:

Innovation is the key to create a link between resource preservation and high quality of life for the population of Vienna. A dynamic development in a city can be achieved by high diversity. Nevertheless, the city needs to provide frame conditions, institutions and supporting services, starting with education, by focusing on gender equitable education, from kindergarten to universities up until innovative economy. Consequently, new solutions and competencies for Vienna across the world will be developed. The city will function as a launching pad to conquer global markets and will represent support for future-oriented enterprises, especially in their start-up phase.

Education, research and a dynamic economy are crucial aspects for the future evolution of the city as a smart city. In fact education defines the very core of each smart city, because it represents the possibility to change something either as an individual or as a group. That is why Vienna as a smart city is highly interested in assuring that as many young people and children as possible complete their education. However, it is a declared as an objective of the city to overcome educational disadvantages of certain social groups in order to achieve prosperity, quality of life and innovation. This will generate added value and ensure high-quality workplaces, which will protect its quality of life. People with special needs will be integrated in the primary labour market and there will not be any salary or wage gaps, because women and men will be treated equally.

Particular emphasis is placed on social innovation and the contribution of women to future-oriented sectors.

Even if the service sector in general predominates so far, Vienna nevertheless disposes of an excellent industrial basis, which applies resource conserving production methods, good productivity and a strong export orientation. This will play a strategic role for the development of Vienna in the future (Stadt Wien, accessed 09.05.17).

Quality of life:

Vienna already shows a high degree of quality of life and a high degree of participation, which are prerequisites for urban development. To insure quality of life in the long-run it is crucial for the future to ensure a high degree of social inclusion with the participation of all citizens. An open society and solidarity, good neighbourly relations, mutual respect and acceptance define social inclusion. This also relates to migrants, especially youngsters from families with migration background.

It is necessary to constantly and systematic monitor the gender equality process in order to eliminate existing gender gaps in all fields. Always with regard to equality, all residents of the city should enjoy the maximum quality of life, irrespective of their sex, background and age. That is why diseases should be prevented by equal access to medical services based on solidarity-based funding for the public healthcare sector. Proper medical service should be provided at any time, in the right place and by qualified medical professionals.

However, a growing and aging population will also raise the demand of nursing care for elderly people in geriatric centres and nursing homes. Consequently, the city will need to favour structures but also promote outpatient care and assistance in order help people to stay in their homes as long as possible.

The high degree of quality of life in Vienna also derives from its extensive green spaces and its biodiversity. Nevertheless, these spaces need to be carefully safeguarded, especially due to its growing population but also to keep the inner-city temperatures stable. They must be kept publicly accessible, reachable by eco-friendly means and barrier-free. This requires preservation and networking on a large scale. Trees need to be planted in the city roof gardens and greened flat roofs should be created, as well as neighbourhood gardens organized. The gardening culture will furthermore foster social encounters and create intensified commitment on behalf of the neighbourhood, in Viennese called *"Grätzl".*

The close cooperation with the Federal Republic of Austria and the European Union is a crucial pillar towards achieving this goal (Stadt Wien, accessed 09.05.17).

4.3.1. Links between the individual objectives

Given that Vienna is already a highly liveable city it is obvious that all stakeholders are trying to maintain or improve this status quo. Enterprises and companies of the city already cover many areas of life of citizens' life: housing, water management, healthcare, public utilities, such as mobility, and energy services etc. and thus contribute to the attainment of the major objectives.

Nevertheless, Vienna, as many other cities, is confronted with specific challenges that arise from urban growth and from upcoming processes of change.

As already emphasized, one particular challenge is urban traffic. Traffic is the main cause of noise and air pollution. Smart urban planning should motivate the population to voluntarily change their habits and switch to climate-friendly mobility.

In Vienna the mobility sector already shows changing demands, which is characterised by a steep increase in the shares for walking and cycling. Therefore, fossil fuels will be largely abandoned on the long-run. More sustainable forms of energy, conversion technologies and services are expected to substitute them.

The Vienna model region focuses on a gradual switch towards an integrated, comprehensive transport system. The intention is to embody this development by mobility partnerships and transnational mobility management. If walking, cycling and public transport use is not possible, e-cars are supposed to substitute fossil-powered trips and thus ensure mobility for all.

Hence, the sectors of mobility, infrastructure and logistic will need to work more efficiently for decreasing CO_2 emissions by 2050.

Vienna's objectives to become a smart city cannot be approached through individual activities or competencies but require superordinate thematic management, which forms part of governance (Stadt Wien, accessed 09.05.17).

4.4. Governance

The smart city strategy Vienna consists of two levels of implementation. Firstly, it is concerned with the political level. That is, setting of political priorities and defining policies in view of increasing complexity, coupled with scarce resources. The smart city concept is constituted of challenges regarding the operative level. Many tasks can only be approached by cutting across individual organisation units, which calls for a tighter collaboration inside and outside the municipal administration. One of the most essential tasks for the smart city framework lies in the additional assistance for the abundant specialised strategies in Vienna. The City of Vienna already planned on taking several steps in the future in order to achieve its objectives.

One of its first steps will be the coordination and cooperation with lighthouse projects, which were also proposed in the White Paper 2013 of the European Union. Lighthouse projects will aim to go beyond of narrow departmental confines and create interdepartmental, organisational models. Secondly, Vienna's smart city framework aims to strengthen the participatory possibilities of citizens and experts. This step intends to create a wider scope of action for all Viennese based on direct, interpersonal contact and via the Internet.

The novelty of the smart city strategy represents an opportunity of human resource development, training and recruitment. It offers a possibility for employees of the Vienna City Administration to learn about new techniques and test novel forms of cooperation. Strong and broadband communication strategy is supposed to give a vibrant life to this concept and to allow the Vienna City Administration a constant exchange and dialogue with the population and numerous other partners. Cooperation can create a platform for cities to give more weight to their concerns and to safeguard their public services, services of general interest or eligibility for subsidies in important areas (Stadt Wien, accessed 11.05.17).

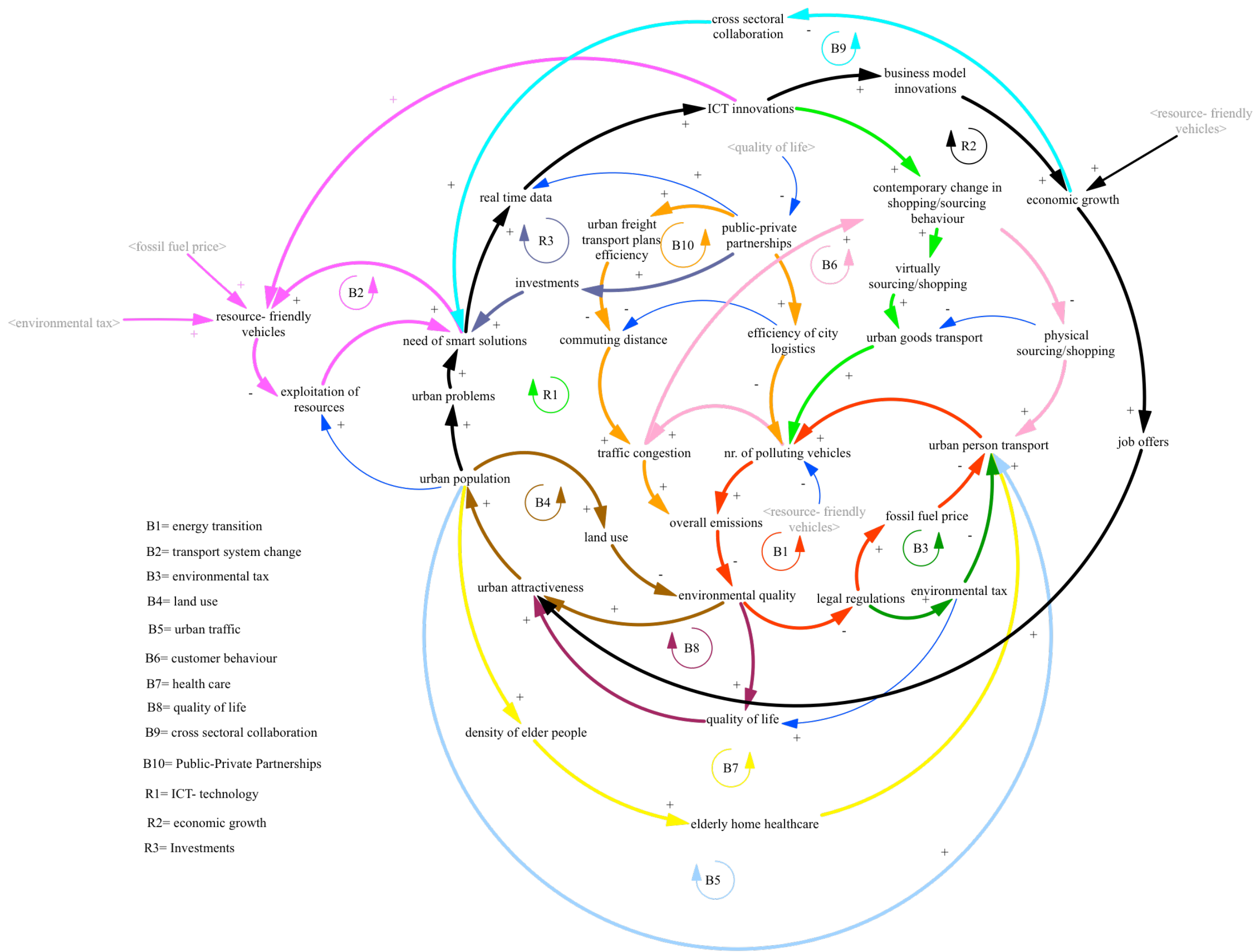
5. Results and Discussion

Chapter 5 will present and discuss the results of the applied and developed research methods. The reader will find the results and the analysis of the stakeholder interviews, as well as the resulting qualitative models. Furthermore, this chapter will show and explain the different steps of the development of the simulation model, including the model validation process and the simulation model itself. The developed baseline simulations are outlined and their outcomes presented. Each section synthesises the main insights gained from the respective analysis.

5.1. Preliminary Causal Loop Diagram

Smart City, as already stated in Chapter 2, is a highly interdisciplinary research topic. A preliminary causal loop diagram (CLD) was constructed (Figure 5-10) to illustrate and explain the main dynamic hypothesis of a smart city in general. During the interviews, this CLD, based on common smart city literature, was shown to the stakeholders in order to initiate a discussion and make it easier to relate the corresponding questions to the corresponding feedback loops.

Figure 5-10: Generic causal loop diagram, based on smart cities literature review



Source: Developed by the author with the Vensim software

The CLD presented in figure 5-10 consists of 13 feedback loops, which were considered as 13 different sectors that replicate the main dynamics of the smart city literature.

Loop **B1** describes the **energy transition** which in some cities is already underway or will happen in the near future. The reason of energy transition is the number of polluting vehicles, which increases given the constant growth of the urban area. That is why the overall emissions increase as well and, consequently, environmental quality decreases. The decrease of environmental quality will force the public domain to introduce legal regulations, which include environmental taxes and the increase of fossil fuel prices in order to lower urban personal transport and therefore the number of polluting vehicles. The number of polluting vehicles can also be reduced through the increase of resource-friendly vehicles. Consequently, there will be a **transport system change,** as shown by loop **B2**. Due to increasing population numbers the exploitation of resources enhances the need of smart solution, which will increase the spread of resource-friendly vehicles and therefore slow down the exploitation of resources. The increase in fossil fuel prices and environmental tax will support this development of resource friendly vehicles as well as ICT. Through the increase of resource-friendly vehicles and the decrease of exploitation of resources, the need of smart solutions will decrease as well. This development results in decreasing ICT and decreasing virtual shopping/sourcing behaviour. Urban goods transport will decrease and the number of polluting vehicles as well. Overall emissions will decrease and environmental quality will increase, which will lead to less legal regulations.

However, a decrease in environmental quality could cause the establishment of an environmental tax, which would be further supported by the implementation of legal regulations to decrease urban person transport and therefore also polluting vehicles, thereby lowering overall emissions and increasing environmental quality. An increase in environmental quality will lead to less legal regulations and therefore also to a decrease of environmental tax. These dynamics are explained by **B3,** the feedback loop of **environmental tax.**

Loop **B4** relates to **land use** and the growth of urban population, which will also increase the use of land and cause a decrease in environmental quality, leading to less urban attractiveness and therefore to a slower increase of urban population, given that the city might will lose popularity. **Urban traffic**, represented in loop **B5,** explains how the growth of urban population will automatically increase urban personal transport, assuming that in the near future individuals will still prefer to own their own car. This behaviour will contribute to the increase of overall emissions and consequently to the decrease of environmental quality and urban attractiveness, which will lead to a decrease in urban population. Also related to mobility and logistics is **B6,** the **customer behaviour**. A change in shopping/ sourcing behaviour will lead to less physical shopping and therefore decrease urban personal transport, since most goods will be delivered. Less polluting vehicles will circulate in the city centre and cause less traffic congestion. Traffic congestion will favour the change in shopping/ sourcing behaviour given that citizens prefer to order online instead of taking into account traffic and long travel time.

Loop **B7** replicates the dynamics of **health care.** The increase in urban population means, relatively higher density of elderly people as well. The high density of elderly people will require a shift in healthcare, which means elderly home healthcare automatically increases and, consequently, urban person transport too. This will increase overall emissions and decrease urban attractiveness, which will lead to a slower increase of urban population.

Quality of life, which is shown by loop **B8,** relates to the decrease of environmental quality, which will lead to a decrease of quality of life, thereby negatively influencing urban attractiveness and decreasing urban population. With a lower number of citizens, urban problems will decrease and therefore also the development of ICT innovations. Due to a decrease in contemporary change in shopping/sourcing behaviour, as well as less virtual sourcing/shopping and a decreasing urban good transport, the number of polluting vehicles will decrease and lead to less emissions. A low amount of emissions will increase environmental and quality of life and consequently increase urban attractiveness and urban population.

Cross-sectoral collaboration, loop **B9,** is pushing forward the development of ICT innovations and the innovation of new business models. Both will foster economic growth. It shall be assumed that the collaboration of various sectors, also called cross-sectoral collaboration, decreases the moment that economic growth is raising, given that each company involved tries to be successful on their own. The drop in collaboration will therefore partially also hinder the further development of ICT. The literature on smart cities and smart city mobility also refers to **public private partnerships.** The corresponding dynamics are visible in loop **B10.** Public private partnerships increase the urban freight transport plans' efficiency, which will lead to a decrease in commuting distance and traffic congestion. Commuting distance also decreases due to efficiency of city logistics, which is directly linked to the decline of number of polluting vehicles. However, both effects decrease the overall emissions in an urban area and increase the environmental quality. Therefore, quality of life will increase and (the need for new) public private partnerships will decline.

ICT relate to many feedback loops of the CLD, are represented in loop **R1.** The growth in population will cause and increase urban problems and will foster the need of smart solutions. Smart solutions require real-time data in order to be transformed into ICT-innovations, which will support the contemporary change in shopping/ sourcing behaviour. Virtual sourcing/ shopping will increase as well as urban good transport. The number of polluting vehicles will rise in order to deliver goods. Overall emissions will increase and will contribute to an increase of urban problems, which in turn will push forward the development of ICT-innovations. The developments of ICT-innovations due to business model innovations will foster **economic growth,** shown in **R2,** as well as the increase of resource friendly vehicles, which will create more job offers and increase urban attractiveness. A popular urban area will attract even more people and consequently also cause more environmental problems, which will again support the development of ICT-innovations and economic growth.

However, mainly the collaboration through public private partnerships supports investments and makes it possible to realize ICT-innovations, which is visualized by loop **R3 investments.**

ICT-innovations will bring a change in current shopping/ sourcing behaviour and decrease overall emissions, which will lead to an increased environmental quality and therefore quality of life, which again will foster a decline in public private partnerships.

5.2. Results from stakeholder interviews

The smart city strategy Vienna, as stated in chapter 4.2. and chapter 4.3. can be divided into four main pillars, namely: resource preservation, innovation, quality of life and governance. All four pillars are aiming to achieve the three main objectives and the meta goal of the smart city strategy.

Figure 5-11: Four strategy pillars of smart city strategy Vienna

Source: Conducted by the author

The aim of the interviews was to gain insights of experts and to thereby bring additional value to the model conceptualization of the four visionary pillars.

In each interview, the author first introduced the CLD and its main dynamics to each expert. Starting the process with the explanation of the CLD was useful to the interviewee and the author to initiate the interview from a common point of view. Furthermore, this made it helpful for both parties to always have the possibility of referring back to the CLD.

Over time each interview developed into a very interesting and insightful talk instead of a strictly held question-answer session. That is why stakeholders referred to topics straight through. However, most of the 11 questions asked (annex A) referred to the presented CLD or a theme in it.

The next section describes interview results and how expert knowledge gave insights to the understanding of the four main pillars of the smart city strategy in Vienna. Answers which did not provide enough information or went beyond the scope of this case study, were excluded from this analysis (and can be found in the transcripts in annex B).

5.2.1. Pillar of Quality of Life

Economy

As stated in chapter 4.2. one of Vienna's smart city key elements in order to ensure quality of life is comprehensive equality of the economy. That means that the city needs to safeguard economic participation and a minimum living wage in order to cover all basic needs of its citizens.

Respondent 1, 2 and 3 enriched this key element by various statements.

As the reader can infer from table 5-6, respondent 1 emphasized the importance of the support of young companies in order to assist their long-term establishment in the city, as well as the generation of jobs, which will become essential given an increasing population. Respondent 2 focused more on the importance of economic wealth, which will allow the setting of legal regulations and make Vienna more sustainable. Furthermore, respondent 2 stated that economic growth will become more intelligent, which means that economic wealth will arise, but without causing emissions. Respondent 3, same as respondent 1, underlined that upcoming generations will not aim for property anymore, which means they will not own a car, a flat or a bicycle anymore. Economy will be directed towards different directions than the ones known so far.

Table 5-6: Insights from Interviews - Quality of Life Pillar- Theme Economy

Respondents	Theme: Economy
Respondent 1	• Support of young companies in order to assure their establishment • Generation of jobs, which is important with an increasing population • Upcoming generation is not aiming for property, which means economy moves into different directions
Respondent 2	• If there is enough economic welfare then public interest becomes more important than economic growth • Economic growth is the most important feedback loop in order to make Vienna more sustainable • Setting legal regulations requires economic power • Economic growth does not have power, but it will become more intelligent • Transfers via applications will create economic growth, without creating emissions, therefore intelligent economic growth will rise
Respondent 3	• Upcoming generation is not aiming for property, which means economy moves into different directions

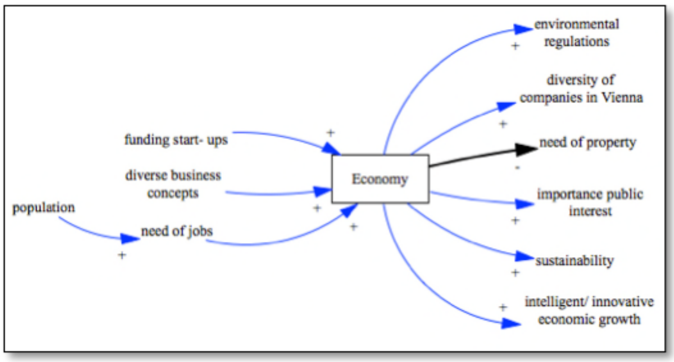
Source: Interviews with stakeholders; Compiled by the author

Table 5-6 gives a first impression of where the common interest of the stakeholders is concerning the city's economy. However, this table does not yet allow for visualizing inter-relational connections nor evaluating common or divergent perspectives of respondents' in relation to the theme.

Therefore, the author created conceptual models which show how the statements of stakeholders are related to each other.

The thickness and the colour of the arrows have their own meaning, that is, they signal how often stakeholders named a certain variable. A black arrow means that a variable was named twice. The more often a stakeholder named that variable, the thicker the black arrow is replicated. The author will furthermore take this intermediate step as a chance to explain the mentioned relationships in order to make it easier to understand the revised CLD in the final step. The conceptual model within its explanation can be found in figure 5-12.

Figure 5-12: Theme Economy



Source: Conducted by the author

Figure 5-12 shows how the increase in urban population will lead to an increased need of jobs, which will stimulate the economy. Diverse business concepts, as well as the funding of start-ups will support the growth in economy. Economic growth will lead to more legal regulations and will make it possible to further support sustainability and to increase the importance of the overall public interest. Economy will increase but in an intelligent, innovative manner, which consequently will decrease the individual need of property.

Healthcare

Another key element in the strategy of smart city Vienna, which belongs to the pillar of quality of life, is healthcare**.** According to the smart city strategy Vienna, physical health is an essential factor for the wellbeing and satisfaction of individuals. That is why health-promoting conditions of life need to be further strengthened, also in order to prevent diseases and mental disorders (Stadt Wien, accessed 11.05.17).

Respondent 1 and 3 emphasized that healthcare is not a focus of their organization (Table 5-7). Respondent 3 surprisingly stated it would not be so important for urban planning, even if it is a key element in the smart city strategy in Vienna. Respondent 4 referred to local supply structures, which will thin out over time and thus create a challenge for elderly people, who are depending on such structures in order to remain in healthy, as they also adapt more slowly to new systems.

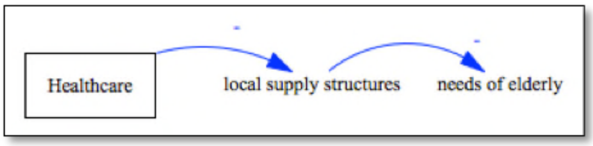
The conceptual model once more emphasizes how stakeholders are dealing with the theme of healthcare in their organization and can be found in figure 5-13.

Table 5-7: Insights from Interviews - Quality of Life Pillar - Theme Healthcare

Respondents	**Theme: Healthcare**
Respondent 1	• Not the focus, but if there are start-ups with this topic, then they have good chances to get funding from the agency
Respondent 3	• It is not so relevant for urban planning
Respondent 4	• Local supply structures thin out, which will turn into a challenge with older people who are depending on these structures and adapt slowlier/with more difficulty to new systems

Source: Interviews with stakeholders; Compiled by the author

Figure 5-13: Theme Healthcare



The change in healthcare will lead to a decrease in local supply structures. The needs of elderly will increase, given a shrinking number of local supply structures.

Source: Conducted by the author

Green Space

Green space makes up half of Vienna's municipal territory. The "green lungs" highly contribute to Vienna's high quality of life. That is also the reason why the municipal territory must be safeguarded even in a growing city (Stadt Wien, accessed 11.05.17).

Both respondent 2 and 3 supported this part of the smart city strategy by stating that the growth of population will not inhibit a city to be the greenest city, even if an expanding city is related to an increasing demand of green spaces as well (Table 5-8).

The relationship highlighted by the stakeholders is replicated in figure 5-14.

Table 5-8: Insights from Interviews - Quality of Life Pillar- Green Space

Respondents	**Theme: Green Space**
Respondent 2	• The growth of population does not inhibit a city to be the greenest city
Respondent 3	• An increasing population will also increase the demand of green spaces

Source: Interviews with stakeholders; Compiled by the author

Figure 5-14: Theme Green Space

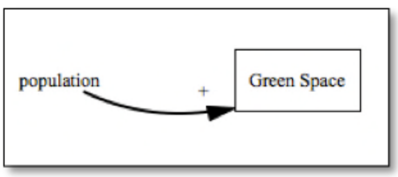


Figure 5-14 shows how an increasing population will lead to an increasing use and/or need of green space.

Source: Conducted by the author

City Participation

Vienna already has a particularly high quality of life, also due to social participation, which plays a central role for urban development and was mentioned by stakeholders during the interviews (Stadt Wien, accessed 11.05.17).

Respondent 1 supports this key element of the smart city strategy by stating how important the incorporation of citizens is in order to optimize existing neighbourhoods, mobility, living, energy supply and traffic. However, respondent 1 emphasizes that citizens so far are not very well-informed about city initiatives, which leads to a minor participation (Table 5-9).

Respondent 3 mainly focused on the getting-together of stakeholders in order to develop the smart city strategy and create commitment towards it. Additionally, respondent 4 highlighted the importance of participation by emphasizing how participation will move the city and its citizens towards more negotiation and discussion.

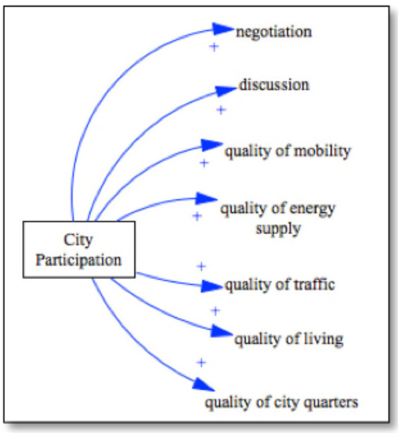
The conceptual model mainly replicates possible consequences of city participation. This is because no respondent mentioned what would cause or enable city participation or how city participation could be implemented. The conceptual model can be found in figure 5-15.

Table 5-9: Insights from Interviews - Quality of Life Pillar- City Participation

Respondents	**Theme: City Participation**
Respondent 1	• Incorporating citizens in order to optimize existing neighbourhoods, mobility, living, energy supply, traffic but citizens are not well informed about these initiatives
Respondent 3	• Developments of smart city strategy happened with all stakeholders together in order to create a strong identification with the strategy
Respondent 4	• Participation plays an important role and moves towards negotiation and discussion

Source: Interviews with stakeholders; Compiled by the author

Figure 5-15: Theme City Participation



City Participation is causing an increase in negotiation, discussion, quality of mobility, quality of energy supply, quality of traffic, quality of living and an increase in quality of city neighbourhoods.

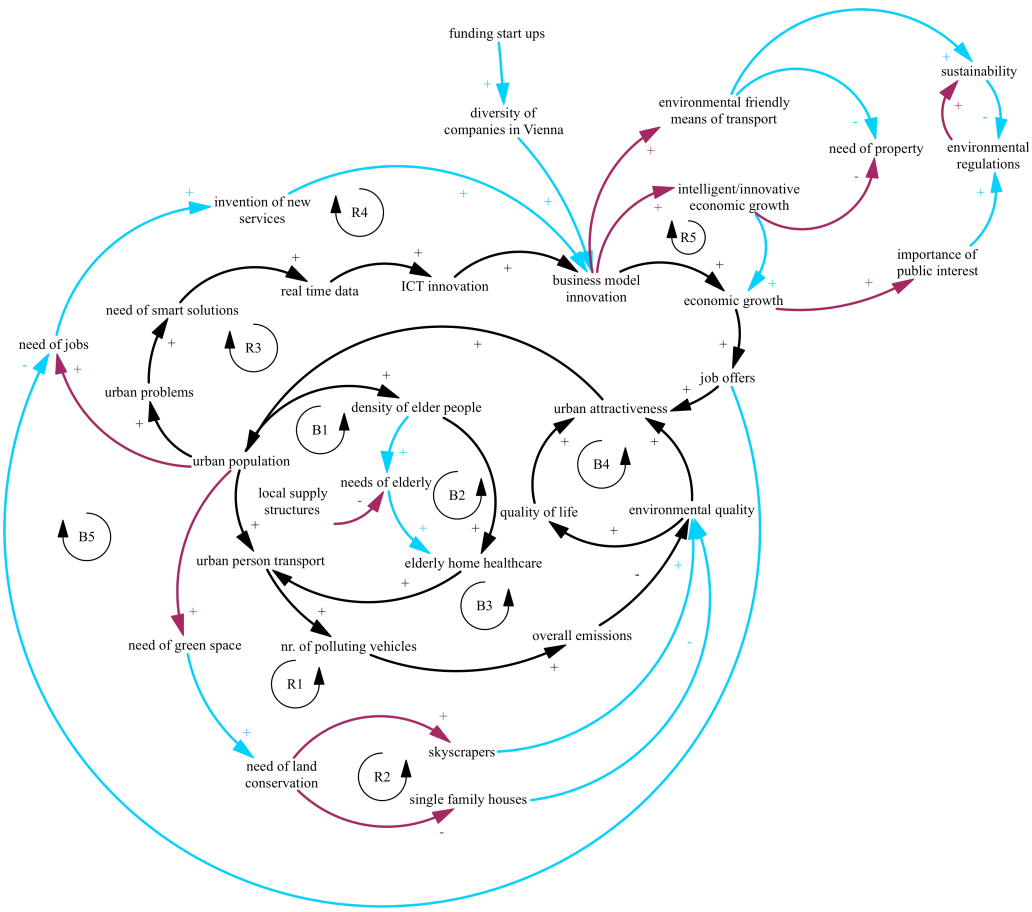
Source: Conducted by the author

The pillar of quality of life of Vienna's smart city strategy has the vision of Vienna as an environmental city (Stadt Wien, accessed 11.05.17). However, at the moment urban traffic is the main cause of noise and air pollution. Smart development should take over the task of motivating the population to voluntarily switch to eco- and climate friendly mobility types. Despite this, no stakeholder mentioned urban traffic

A qualitative system dynamics model will replicate the integration of the relationships mentioned by the four respondents, the existing literature and the smart city strategy, in regard to the pillar of quality of life.

The CLD can be found in figure 5-16, followed by an explanation of the identified feedback loops.

Figure 5-16: Causal loop diagram for the Quality of Life pillar



Source: Developed by the author with the Vensim software

The CLD of figure 5-16 replicates the many dynamics, which are either balancing or reinforcing.

Some of these feedback loops were not present in the original CLD in figure 5-10. For example, in **R1**, a growing population leads to an increased need of green space and an increased need of land conservation, leading to the construction of more of skyscrapers, which will have positive effects on the environmental quality, because skyscrapers can provide more accommodations on the same amount of construction land than single-family houses. The construction of skyscrapers will support the conservation of land and thus also increase the quality of life and the urban attractiveness.

In loop **R2**, which constitutes an example of a feedback loop added after the stakeholder interviews, it is shown that growing urban population leads to an increased need of green space and an increased need of land conservation, which minimizes single-family houses. A higher number of single-family houses equals less environmental quality. A bad environmental quality leads to a lower quality of life and a decreasing urban attractiveness, which in turn attracts less people to the city and decreases urban population.

Loop **R3** remained unchanged after having conducted interviews with experts. It does not replicate any new insights. Therefore, the continuous growth of urban population will cause urban problems and will increase the need of smart solutions, which will increase real-time data in order to develop ICT innovations and business model innovation. An increase in business model innovation will lead to economic growth and more job offers, which will attract people to the city and increase the urban population.

Experts emphasized in loop **R4** the relationship of a growing urban population, which will lead to an increased need of jobs. The author linked this insight with an increasing invention of new services, which will lead to business model innovation. Interrelationships based on smart city literature finalized the loop by underlining that an increase in business model innovation once more will lead to economic growth and more job offers, which will attract people to the city and increase the urban population.

Loops **R5/B5** are able to draw multiple links. Consequently, business model innovations increase intelligent/innovative economic growth, which will increase total economic growth, job offers and the city' attractiveness, which will in turn attract people and cause urban problems. Urban problems increase the need of smart solutions, which will lead to an increase in real-time data, ICT innovation and therefore business model innovations.

An increased amount of job offers simultaneously decreases the need of jobs and the invention of new services and business model innovations.

B1 and **B4** don not replicate any new insights gained through the interviews, while **B2** does. **B2** underlines that with an increase in urban population, consequently also an increase of the density of elderly people and their needs will occur. Their needs decrease if local supply structures exist, because elderly people are having greater difficulties to adapt to new structures, which might be online. However, due to the increase of elderly people, also elderly home healthcare will increase, which leads to an increased urban person transport and a higher number of polluting vehicles. Therefore, overall emissions are increasing, environmental quality and quality of life is decreasing, which lowers urban attractiveness as well as urban population.

B3, similar to **B1** and **B4,** replicates a feedback loop, which derives from smart city literature and emphasizes that the increase in urban population leads to an increased urban person transport and a higher number of polluting vehicles, which will increase overall emissions and decrease environmental quality and consequently also quality of life. Therefore, urban attractiveness will shrink and attract less people to the city.

City Participation is not integrated into the CLD, although stakeholders did mention it during their interviews. However, they talked about the positive consequences city participation would bring, but left out where and how to start implementing city participation. That is why city participation is not depicted. The smart city strategy Vienna approached it similarly and mainly mentioned the positive effects city participation would cause. Smart city literature did not mention city participation at all.

5.2.2. Pillar of Resource Preservation

Energy Transition

Cities play a key role in regard to energy transition. That is why municipalities need to take over the responsibility in order to achieve their ambitious goals.

Smart city strategy Vienna's meta goal is an emission free city by 2050. CO_2 reduction will mainly be achieved by increased energy efficiency and the transition towards renewable energies (Stadt Wien, accessed 11.05.17).

As stated in section 4.2. the main emphasis in Vienna will be placed on energy transition in order to shift the main use of energy towards local renewable sources and waste heat for both, the generation of heat and the generation of electricity.

All four respondents enriched these insights with their expert knowledge (Table 5-10).

Respondent 1 mentioned the need of solar and geothermic energy, which will rise due to energy transition, while respondent 2 elaborated that electricity, will derive from hydropower, district heating plants, waste incineration plants and caloric power plants. Respondent 2 highlighted the long-time delay until effects of the energy transition will take place. As stated by respondent 3, even if energy efficiency will happen, fossil fuels so far are still too cheap than citizens would fully shift to environmentally friendly transportation and like respondent 1 emphasized, nobody knows if due to energy transition the actual amount of vehicles circulating in the urban area will decrease. Respondent 3 mentioned the import of wind power and the usage of solar power and took construction business as a good practice example, since it is more advanced regarding energy transition. Respondent 4 noted the effect of electrification in the future and its impact on certain vehicles and certain businesses.

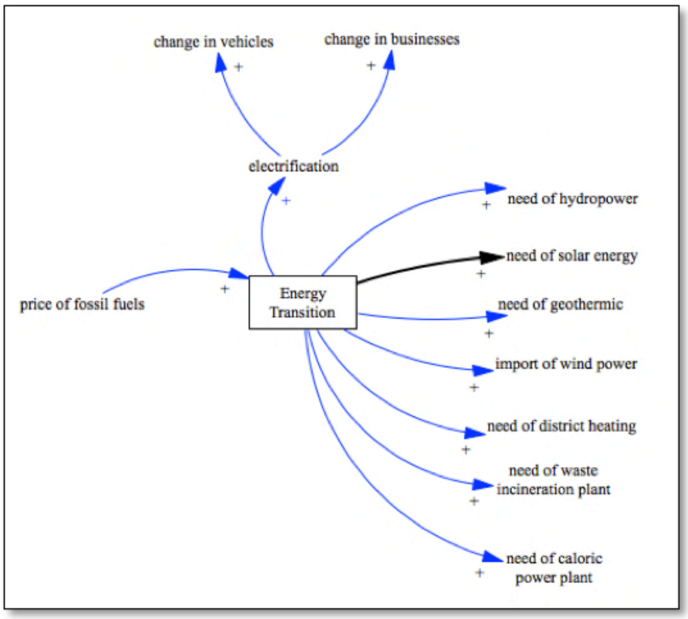
The conceptual model, which was conducted by the author, visualizes the insights gained throughout the interviews and can be find in figure 5-17.

Table 5-10: Insights from Interviews - Resource Preservation Pillar- Energy transition

Respondents	Theme: Energy transition
Respondent 1	• Energy transition will require a lot of solar energy and geothermic • The question pops up if I have really fewer vehicles in the urban area?
Respondent 2	• Electricity will derive from hydropower, district heating plant, waste incineration plant, caloric power plant • Long-time delay until effect of energy transition will be visible
Respondent 3	• Energy transition loop is applicable to Vienna • Fossil fuels are still too cheap to fully shift to environmentally friendly transportation • Energy efficiency will take place • Wind power will be imported otherwise solar power will be used • Construction business shows it is more advanced
Respondent 4	• Electrification will take place in the future and will affect certain vehicles and certain businesses

Source: Interviews with stakeholders; Compiled by the author

Figure 5-17: Theme Energy Transition



Source: Conducted by the author

Figure 5-17 shows how the increase in fossil fuel prices will promote energy transition. Energy transition will cause an increased need of hydropower, solar energy, geothermic, the import of wind power, need of district heating, need of waste incineration plants and the need of caloric power plants. Through energy transition electrification will take place, which will bring a change in vehicles and businesses.

Mobility holds an important place in the city, since urban population is increasing, also the number of trips taken by the citizens will increase. Resource-conserving mobility represents an option, which is able to combine the claim of high quality of life with short distances. Electricity and renewable energies substitute fossil fuels. This optimization will also take place in the sector of logistics and improve the flow of goods by using electromobility (Stadt Wien, accessed 11.05.17). Hence and with regard to this key element of the smart city strategy Vienna, stakeholders talked about emissions, public transport system and electromobility.

Emissions

Emissions were highly relevant for respondent 1, 2 and 3 (Table 5-11).

Respondent 1 took emissions into consideration even if they are produced abroad, and highlighted the importance of the lifecycle of products. Respondent 2 emphasized how important it is to decrease the number of polluting emission vehicles and to further promote cycling and walking by the environmental alliance. Respondent 2 furthermore mentioned that Vienna so far does not have to deal with emission problems and that certain emissions require specific regulations. However, emission values are also depending on weather conditions. Respondent 2 expressed her concern that only a small amount, a range of mill of kilometres, will be completed by shared drive or e-mobility.

Respondent 3 highlighted once more the main aim of the smart city strategy Vienna, which is the improvement of quality of life by decreasing CO_2 emissions, as underlined that traffic and a growing population are the main causes for not achieving environmental quality. However, rising innovation will support the shift of distribution of goods to environmentally friendly means of transport.

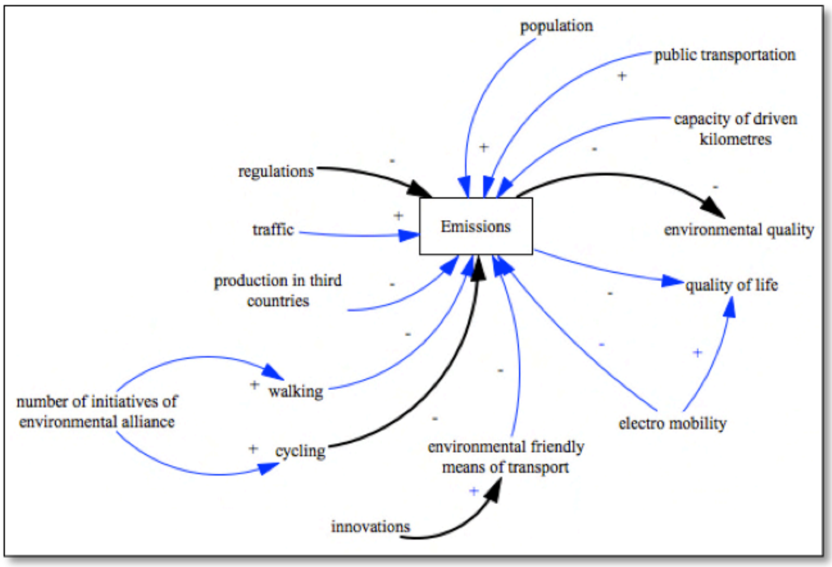
The conceptual model in figure 5-18 replicates the above-mentioned insights.

Table 5-11: Insights from Interviews - Resource Preservation Pillar- Emissions

Respondents	Theme: Emissions
Respondent 1	• Important to look at lifecycle of products and taking into account emissions created abroad
Respondent 2	• Vienna wants to decrease number of polluting emission vehicles or motorised individuals; initiatives by the environmental alliance exist in order to increase walking and cycling • Bicycles already increase and emissions decrease; public transportation also causes emissions • Vienna has a certain attractiveness and its population is growing but due to limits to growth problems will arise • Vienna so far does not have emission problems • The number of vehicles matter, but it is a question of capacity • Certain emissions need certain regulations • Emissions also depend on weather conditions • Only a small amount of kilometres will be driven by individual cars
Respondent 3	• Decreasing CO_2 emissions in order to improve quality of life, which is the main aim of the smart city strategy • Traffic is the main cause of not achieving environmental quality • A growing population will also increase negative impacts on the environmental quality • Innovation will shift distribution of goods to environmentally friendly means of transport

Source: Interviews with stakeholders; Compiled by the author

Figure 5-18: Theme Emissions



Source: Conducted by the author

As previously stated by the three stakeholders, emissions mainly increase due to traffic, the urban population and public transportation. Thanks to regulations, electromobility, extended capacity of driven kilometres and environmentally friendly means of transport, emissions are decreasing.

A high number of initiatives of the environmental alliance promote walking and cycling, which will decrease emissions as well. A shift of production into developing countries does decrease emissions in Vienna, however stakeholders do not consider it as something positive. Emissions affect quality of life and environmental quality in a negative way and decrease both of them. In connection with emissions, stakeholder, as well as the Smart City Strategy Vienna mentioned the public transport system, which thanks to its optimization can contribute to reduced emissions and an improved quality of life.

Public Transportation System

According to respondent 1, the public transportation system needs to integrate more distant districts of the city in order to support a shift from individual towards public transportation. Respondent 1 also took into consideration that a negative side effect of this field was the fact that men still strongly dominate the sector of public transportation. Respondent 2 thinks park and ride stations at the city border might be possible solutions. These are supporting the canalization throughout the city with public transportation.

Same as respondent 1, respondent 3 mentions the accessibility of places in order to integrate them into the public transportation system. It is further highlighted that urban traffic plans need to be aligned with surrounding areas in order to work, which mainly requires cooperation. Public transportation works more efficiently thanks to constant intervals, but also decreases the number of injured or killed people and has a traffic calming effect. Respondent 3, by looking towards the future, mentions autonomous driving, taking into account the research already undertaken in that field.

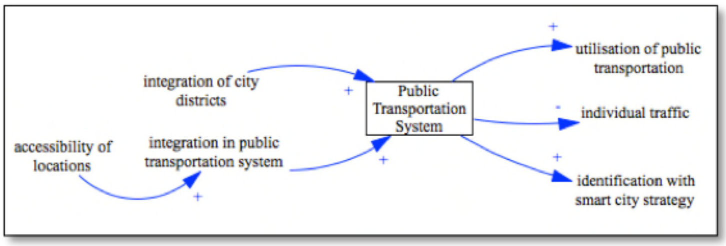
These insights are recapped in the conceptual model in figure 5-19, which is conceived by the author.

Table 5-12: Insights from Interviews - Resource Preservation Pillar- Public Transportation System

Respondents	Theme: Public Transportation System
Respondent 1	• Integration of more distant districts of the city and therefore support a shift from individual towards public transportation • Male dominated sector (negative side effect)
Respondent 2	• Park and Ride stops commuters at the city border and within public transportation they get canalized through the city
Respondent 3	• Transport System Change loop is applicable to Vienna • Autonomous driving will happen in the future since there is already research being undertaken • Urban traffic plans need to be aligned with surrounding areas, this requires cooperation • Traffic calming regulations decreased killed or injured people because an increasing amount of people are using public transportation • Efficiency increased over time due to consonant intervals • Plans between different means of transport are aligned very well • Accessibility of places are in favour for integrating in the public transportation system

Source: Interviews with stakeholders; Compiled by the author

Figure 5-19: Theme Public Transportation System



Source: Conducted by the author

The easier urban districts are accessible, the higher is their chance of integration into the public transportation system. The integration of city districts into the urban area, as well as the integration in public transportation system, will increase the overall public transportation system and will cause a more widespread use of public transportation and a stronger identification with the smart city strategy. Individual traffic will decrease with the expansion of the public transportation system.

Electromobility

Electromobility will be the result of too high emissions, a new public transportation system but especially the innovative approach of the smart city strategy Vienna. With regard to this field, respondent 2 and 3 expressed their opinion.

Respondent 2 considers e-mobility as solution for congestion and emissions in the future. Respondent 3 thinks its strongest effect will be the shift from fleet to e-mobility. Furthermore, respondent 3 recognizes a lot of potential for e-mobility in the surroundings of a city. It will decrease energy consumption and improve the overall quality of life. E-mobility most probably will celebrate its biggest success when peak oil is reached and e-vehicles become cheaper. However, the city should not support funding for individual e-cars because individual traffic needs to be reduced, even if it is e-mobility.

In order to get an impression of how the statements of the various stakeholders are related to each other, a conceptual model was made, which can be found in figure 5-20.

Table 5-13: Insights from Interviews - Resource Preservation Pillar- Electromobility

Respondents	**Theme: Electromobility**
Respondent 2	• E-mobility would solve congestion and emissions
Respondent 3	• E-mobility will decrease energy consumption (also shorter routes) and improve quality of life • Strongest effect if shift from fleet to e-mobility • No funding from the city for individual e-cars because of reduction of overall individual traffic, especially in the city centre • E-mobility has a lot of potential in the surroundings of a city • E-mobility will be successful the moment vehicles become cheaper and peak oil is reached

Source: Interviews with stakeholders; Compiled by the author

Figure 5-20: Theme Electromobility

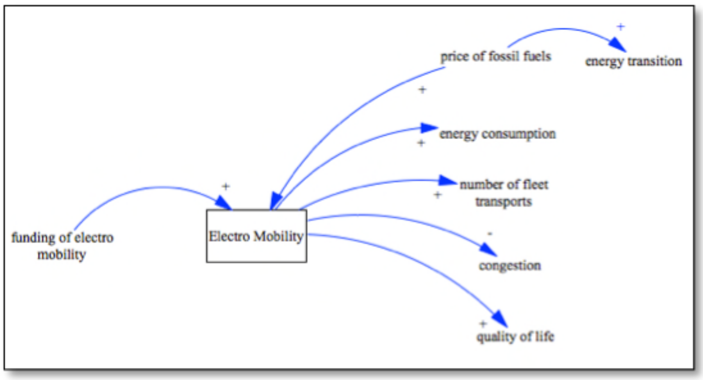


Figure 5-20 shows how funding of electromobility will increase the overall shift towards electromobility. However, the price of fossil fuels will promote this development as well. Electromobility will lead to an increased number of fleet transports and less congestion, but also to higher energy consumption.

Source: Conducted by the author

Information Communication Technology (ICT)

The smart city strategy Vienna is highly dependent on innovation. The central driver of innovation is ICT. The city views itself as an advanced client, provider and enabler of digital services. That is also the reason why the city and the stakeholders assign a high priority to this sector (Stadt Wien, accessed 11.05.17). Related to ICT, stakeholders also named data and city participation.

ICT was relevant and named by all four stakeholders (Table 5-14).

Respondent 1 stated that ICT is supporting the developments of technologies connected to the smart city strategy Vienna. It mainly works as an enabler and for this reason it is able to transform ideas into IT solutions. Respondent 2 framed his answer slightly different, however the message was that ICT is the basis for smart solutions and will improve systems in order to improve energy. Respondent 3 mentioned the optimization of transport of goods and the pool of flows of good. Furthermore, the improvement of order picking would be an effect of ICT. Additionally, respondent 4 considers ICT as an enabler, whose importance will increase over time. Nevertheless, respondent 4 sees this development far in the future and also mainly in the sector of logistics.

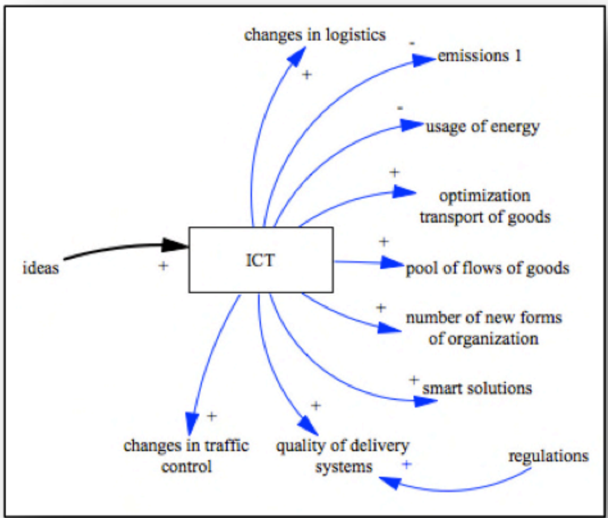
The conceptual model in figure 5-21 informs once more about the statements given by the four respondents.

Table 5-14: Insights from Interviews - Resource Preservation Pillar- ICT

Respondents	Theme: ICT
Respondent 1	• ICT is supporting the development of technologies and works as an enabler, which means it transform ideas into IT solutions
Respondent 2	• ICT technologies are the basis for smart solutions • ICT will improve systems, save energy and leave out emissions which are unnecessary
Respondent 3	• ICT plays an important role • Optimization of transport of goods and implicate to pool flows of goods and support development of new forms of organization • Improve order picking
Respondent 4	• ICT technologies play an increasing role, they are an enabler, but more in the future because nowadays not enough offers exist yet • Offers will develop especially in the sector of logistics and traffic control

Source: Interviews with stakeholders; Compiled by the author

Figure 5-21: Theme ICT



Source: Conducted by the author

ICT primary arises because of ideas. ICT causes an increasing change in logistics and in traffic control, and overall optimize the transport of goods and increase the pooling of flows of goods. Quality of delivery systems will improve with a rising number of ICT, but also accordingly with some regulations. Emissions and the usage of energy will decrease. ICT will increase the number of new forms of organization and will lead to an increasing number of smart solutions.

Data

In this context, the city of Vienna is highly committed to the concepts of participation and data security. Big data initiatives represent important challenges for future-oriented cities like Vienna (Stadt Wien, accessed 11.05.17).

However, as stated by respondent 2, private individuals are in need of public data in order to offer products, but if data is private then data will also stay private. Respondent 3 considers Vienna very open towards data, which will also support the development of mobile applications. Respondent 1 clearly stated that open data would bring a benefit for all parties, but so far personal rights make this development very difficult. A business concept should regulate benefits or constraints, which will be created by sharing data throughout sectors, according to respondent 4. Nevertheless, as respondent 1 mentions, public offices are also in need of statistical data.

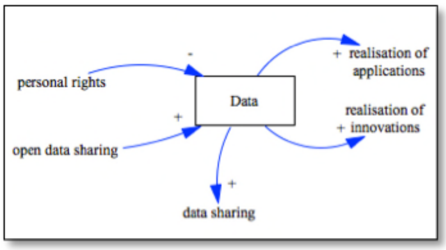
The explanation and the conceptualisation of the outlined statements of the four stakeholders is represented in the conceptual model in figure 5-22.

Table 5-15: Insights from Interviews - Resource Preservation Pillar- Data

Respondents	Theme: Data
Respondent 1	• Open data would create benefits for all involved parties but personal rights makes this development still difficult • Public offices also require statistical data in order to develop smart city strategy
Respondent 2	• If data is private, it will stay private and in order to offer products, private individual need public data
Respondent 3	• Vienna has a very open approach towards data, which will support the development of mobile applications
Respondent 4	• A business concept should regulate additional benefit or constrain, which is created by sharing data through sectors

Source: Interviews with stakeholders; Compiled by the author

Figure 5-22: Theme Data



Data will increase the moment personal rights will decrease with open data sharing. The higher the amount of available data, the more data sharing will occur. Data is necessary in order to increasingly realise mobile applications and innovations.

Source: Conducted by the author

To connect with the previously discussed paragraph of resource-conserving mobility, a shift in traffic will occur in order to combine the claim of high quality of life with short distances. A shift in traffic favours walking and cycling and will strengthen urban structures with shopping and leisure attractions (Stadt Wien, accessed 11.05.17). That is why consumption behaviour plays a significant role and was discussed by the stakeholders.

Consumption Behaviour

Consumption behaviour increasingly develops towards online shopping. Respondent 1 stated that online shopping could be combined with stationary trading by pick-up stations. If these pick-up stations were accessible and open 24/7, online shopping would evolve even more. Additionally, respondent 3 considers e-commerce as a dominant topic, which will increase and present challenges for the sector of logistics. Respondent 4 similarly stated that new businesses, concepts and digitalization will arise due to online shopping. The availability of products will play a main role and according to respondent 4, supplier and client will not meet anymore, because delivery will happen at boxes, micro hubs and transfer systems. Online platforms will become the starting point for this new evolving shopping behaviour and logisticians will need to adapt in order to satisfy customers. Respondent 2 concurred with it and emphasized that smart concepts are necessary in order to make sure that purchase power remains in the city and logistic services will not be abandoned. However, respondent 2 also highlighted that the city needs to support logistic service providers, otherwise they will not deliver anymore and shift their market to another urban area.

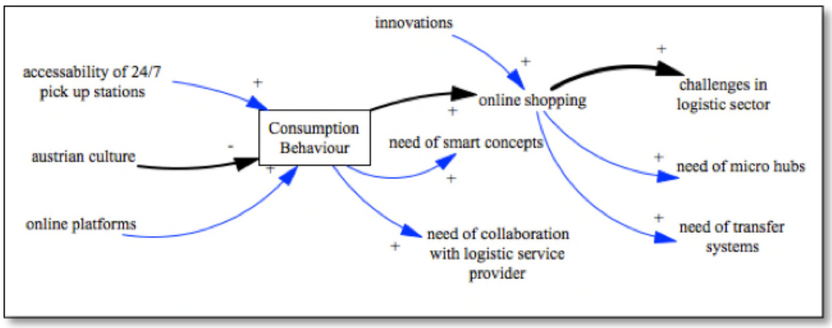
These statements supported the development of the conceptual model in figure 5-23.

Table 5-16: Insights from Interviews - Resource Preservation Pillar- Consumption Behaviour

Respondents	Theme: Consumption Behaviour
Respondent 1	• Online shopping can be combined with stationary trading through pick up stations • Stations which are accessible and open 24/7 would support online shopping
Respondent 2	• Is Amazon satisfying a need of customers or is Amazon creating new needs? If the city is not supporting logistic service providers then they will stop delivering in that place and shift their market • Smart concepts are necessary to make sure that purchase power remains in the city, without abandoning logistic services
Respondent 3	• E-commerce is a dominant topic and will increase and create challenges for logistic sector
Respondent 4	• New business and concepts will support and increase online shopping • Digitalization will take place and the availability of products will become the main focus • Supplier and client will not meet anymore because the delivery will happen at boxes, micro hubs and transfer systems • Online platforms are the starting point for new shopping behaviour and logisticians have to adapt in order to make this work and satisfy the customers

Source: Interviews with stakeholders; Compiled by the author

Figure 5-23: Theme Consumption Behaviour



Consumption behaviour will change due to an increasing amount of online platforms and an increased accessibility of

24/7 pick up stations in the city.

Source: Conducted by the author

However, Austrian culture is very traditional, which will partially inhibit the increase of change in consumption behaviour. The overall change in consumption behaviour will however lead to an increased need of smart concepts and an increased need of collaboration with logistic service providers. Consequently, online shopping will rise, also due to innovations, and will increase challenges in the logistic sector as well as the need for micro hubs and transfer systems.

Land Use

The pillar of resource preservation also includes land use. Given population growth and demographic change, new dwellings will be constructed, under the condition of keeping Vienna green and energy-efficient (Stadt Wien, accessed 11.05.17).

Respondent 4 prioritized land use in his interview under the circumstances that Vienna makes part of medieval cities. Respondent 3 mentioned that land use needs to shift towards area and resource conservation, which was elaborated in more details by respondent 2, who sees the future in skyscrapers rather than single-family houses.

The topic of land use is represented in the conceptual model in figure 5-24.

Table 5-17: Insights from Interviews - Resource Preservation Pillar- Land Use

Respondents	Theme: Land Use
Respondent 2	• Buildings need to shift away from single family houses and move towards skyscrapers
Respondent 3	• Land use in the future will shift towards area conservation, resource conservation
Respondent 4	• Land use is prioritized, since Vienna makes part of medieval cities

Source: Interviews with stakeholders; Compiled by the author.

Figure 5-24: Theme Land Use

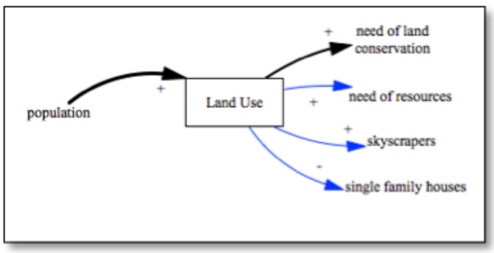
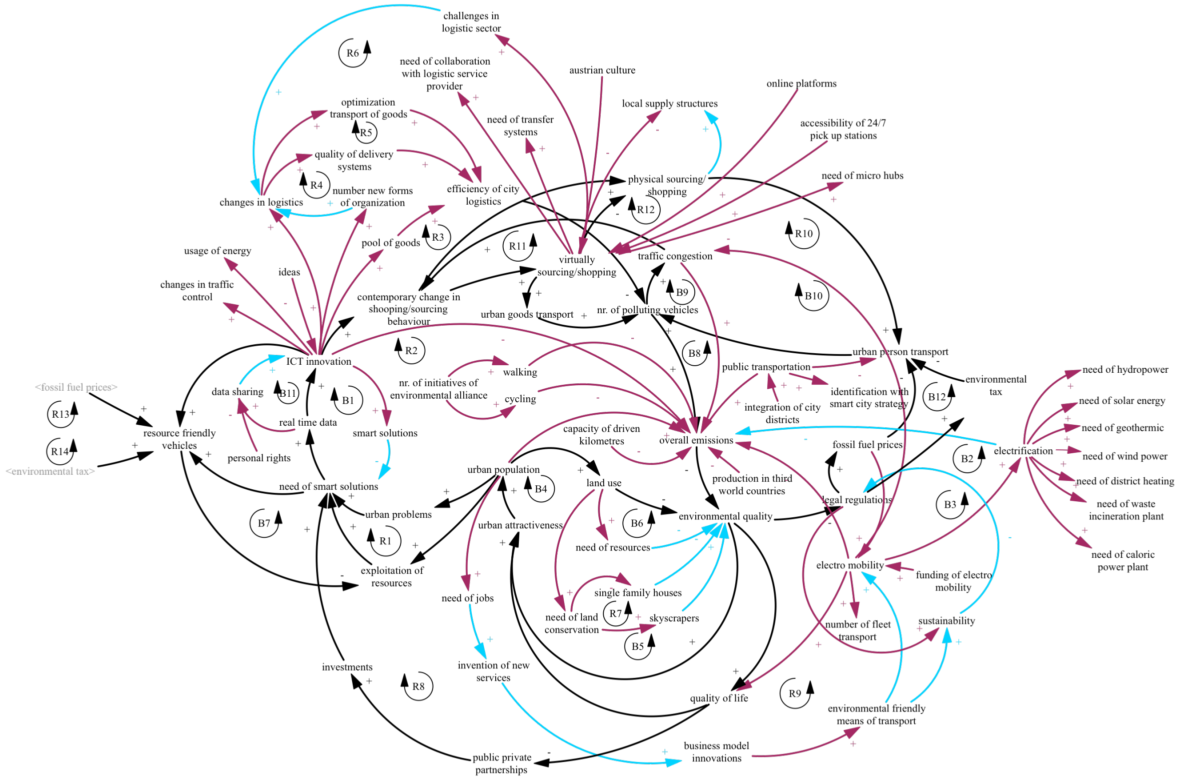


Figure 5-24 shows how the growing population of an urban area will also increase land use. Land use leads to an increased need of land conservation and need of resources. With declining land, more skyscrapers will be built and the construction of single-family houses will decrease.

Source: Conducted by the author

A qualitative system dynamics model in figure 5-25 will once more replicate the integration of the relationships mentioned by the four respondents, the existing literature and the smart city strategy, in relation to the pillar of resource preservation.

Figure 5-25: Causal loop diagram for the Resource Preservation Pillar



Source: Developed by the author with the Vensim software

The CLD replicating resource preservation counts 26 feedback loops in total. Most of the feedback loops displayed were enriched through the contribution of expert knowledge; i.e. **R1** and **R2. R1** and **R2** are explaining the mechanism of an increasing urban population, which will lead to an exploitation of resources (***R1***) and/or urban problems (***R2***). Urban problems and exploitation of resources will increase the need of smart solutions and consequently real-time data will increase as well. Based on real-time data, ICT-innovations will increase and will lead to a decrease of overall emissions.

Similarly, loop **R3,** which got enlarged thanks to the contribution by the experts in the interviews. It explains that ICT-innovations will increase the pool of goods and therefore contribute to the efficiency of city logistics, which will decrease the number of polluting vehicles and the overall emissions. A decrease in overall emissions will increase environmental quality, as well as quality of life; this will attract people, increase urban population and consequently create urban problems and exploit resources, which will increase the need of smart solutions, in other words ICT-innovations.

Loop **R4** and **R5** emphasize how the interviews enriched the CLD with new variables such as *efficiency of city logistics* or *optimization of transport of goods,* which were not mentioned at all by the smart city strategy Vienna or the literature of smart city.

However, **R4** and **R5** explain how ICT-innovations will increase the number of new forms of organization and increase changes in the sector of logistics, by also increasing the quality of delivery systems (***R4***). Thanks to ICT-innovations and changes in the field of logistics the transport of goods will be optimized (***R5***). Optimization of transport of goods, as well as an increasing quality of delivery systems, will lead to an increased efficiency of city logistics, which will decrease the number of polluting vehicles and overall emissions. A decrease in overall emissions will increase environmental quality, as well as quality of life, which will attract people and increase urban population. In turn this will create urban problems and exploit resources, thus increasing the need of smart solutions and therefore ICT-innovations.

Loop **R6** combined the knowledge of experts, the literature of smart city and the smart city strategy Vienna. As a result of this a new loop emerged, which is able to explain that ICT-innovations will lead to a contemporary change in shopping/sourcing behaviour, which will support virtual shopping/sourcing and increasingly create challenges in the sector of logistics. Challenges in the sector of logistics will automatically lead to changes in logistics. The optimization of transport of goods, as well as an increasing quality of delivery systems, will lead to an increased efficiency of city logistics, which will decrease the number of polluting vehicles and overall emissions. A decrease in overall emissions will increase environmental quality, as well as quality of life, which will attract people, increase urban population and consequently create urban problems and exploit resources, which will increase the need of smart solutions, in other words ICT-innovations.

R7, B5 and **B6** are loops which were not identified originally. **B4** is a loop that derives from smart city literature and did not change after some interviews with experts. However, the four feedback loops describe the following mechanism: with an increase in urban population, land use will increase too (***B4***) and will lead to an increased need of resources (***B6***) and an increased need of land conservation. Consequently, single-family houses will decrease (***R7***) and skyscrapers will increase (***B5***). Single-family houses as well as the increased need of resources will decrease environmental quality. Therefore, quality of life changes too and leads to urban attractiveness and an increase in urban population, which will decrease or increase depending on a high or low environmental quality. With an increase in urban population, land use will increase as well.

Loop **R8** is linked to two other reinforcing feedback loops, namely **R4** and **R3**. Quality of life increases and will lead to a decrease in public private partnerships and in investments. It leads to ICT-innovations, which will also decrease the need of smart solutions, real-time data and ICT-innovations. Decreasing ICT-innovations will decrease changes in logistics (***R4***) and the quality of delivery systems, as well as the pool of goods (***R3***), which will lead to an increasing number of polluting vehicles but especially to an increase of overall emissions. Overall emissions will decrease environmental quality and quality of life, which will increase public private partnerships.

R9 partly is similar to the feedback loop R4 in the pillar of quality of life due to an increasing urban population which consequently also increases the need of jobs. The need of jobs will foster the invention of new services and business model innovations. However, new variables are added, i.e. the increase of environmental friendly means of transport and consequently also the increase of electro-mobility due to business model innovations. By an increase in electro-mobility, quality of life increases as well and will attract people to an urban area and consequently increase urban population.

R10 and **R12** are loops deriving from the smart city literature and do not t replicate any new insights gained by the interviews.

ICT- innovations will lead to a contemporary change in shopping/sourcing behaviour, which will increase virtual shopping/sourcing (***R12***) and physical sourcing/shopping and urban person transport. With an increase in urban person transport the number of polluting vehicles will increase and lead to an increase in overall emissions. Therefore, environmental quality and quality of life will decrease as well and attract less people to the city, which will decrease urban population and due to urban problems and the exploitation of resources require more ICT-innovations.

Loop **R11** derives from the smart city literature as well. It explains how the contemporary change in shopping/sourcing behaviour will lead to an increase in virtual sourcing/shopping and an increase in urban goods transport, which will lead to a higher number of polluting vehicles, more traffic congestion and which will again foster the contemporary change in shopping/sourcing behaviour.

However, the linked loops **B9** and **B8** are enriched with variables mentioned by the stakeholders and emphasize how the increasing number of polluting vehicles can also lead to an increase in traffic congestion (***B9***) and in emissions (***B8***). Therefore, environmental quality and quality of life will decrease and attract less people to the city, which will decrease urban population and due to urban problems and the exploitation of resources require more ICT-innovations, which will promote a contemporary change in shopping/sourcing behaviour.

The loops **R13** and **R14** are again an integration of expert knowledge, insights of the smart city strategy and literature regarding smart city. They explain how the increase in legal regulations leads to an increase in fossil fuels and environmental taxes. That is why resource-friendly vehicles will increase as well, thereby decreasing the exploitation of resources and the need of smart solutions as well as real-time data and ICT innovation. A decrease in ICT innovation will increase overall emissions, decrease environmental quality and increase legal regulations.

B1 and **B11** are minor feedback loops, which emphasize the dynamic of ICT-innovations, which will increase smart solutions and which will decrease the need of smart solutions, by decreasing real-time data as well. Consequently, ICT-innovations will decrease. However, real time-data will increase with data sharing (***B11***).

B2 for the first time includes electrification and explains how electrification will be increased by electro-mobility. Overall emissions will decrease and will lead to an increase in environmental quality and a decrease in legal regulations. With a decrease of legal regulations, fossil fuel prices will decrease and lead to a decrease of electromobility.

The loop **B3** is completely new and has not been mentioned before. Legal regulations will lead to an increase in sustainability and an increase in sustainability will decrease legal regulations.

B7 is a loop which derives from smart city literature and shows how ICT-innovations lead to resource-friendly vehicles, which will decrease the exploitation of resources. Therefore, the need of smart solutions will decrease, same as real-time data and ICT-innovations.

The balancing loops **B8** and **B9** include topics which were already mentioned in the CLD. They draw a link between the increasing number of polluting vehicles and the increasing traffic congestion (***B9***), which leads to an increase in overall emissions (***B8***) and consequently a decrease in environmental quality. A decreased environmental quality will foster legal regulations, thereby increasing fossil fuel prices as well. This implies a decrease in urban person transport and therefore a decreasing number of polluting vehicles.

B10 starts by explaining how electro-mobility will decrease traffic congestion and emissions. Environmental quality will increase and legal regulations will decrease, which will lead to a decrease in fossil fuels and electro-mobility, which again, will increase traffic congestion.

The loop of **B12** once more derives from smart city literature and emphasizes how the increase of legal regulations will lead to an increase of environmental tax and consequently decrease urban person transport, the number of polluting vehicles and overall emissions, which will increase environmental quality and decrease legal regulations.

City Participation same as in the pillar of quality of life in 5.2.1. was not integrated in the CLD due to its missing dynamic.

5.2.3. Pillar of Innovation

Innovation in the smart city strategy of Vienna is the key pillar for linking pillar 1: quality of life and pillar 2: resource preservation. Innovation is understood as intelligence, creativity and critical analysis. The more diverse Vienna becomes, the more potential for dynamic development evolves. As stated in the smart city strategy Vienna, economy, society and administration must be ready in order to absorb innovations. Education, research and a dynamic economy are decisive factors for the future development of Vienna to become a truly smart city.

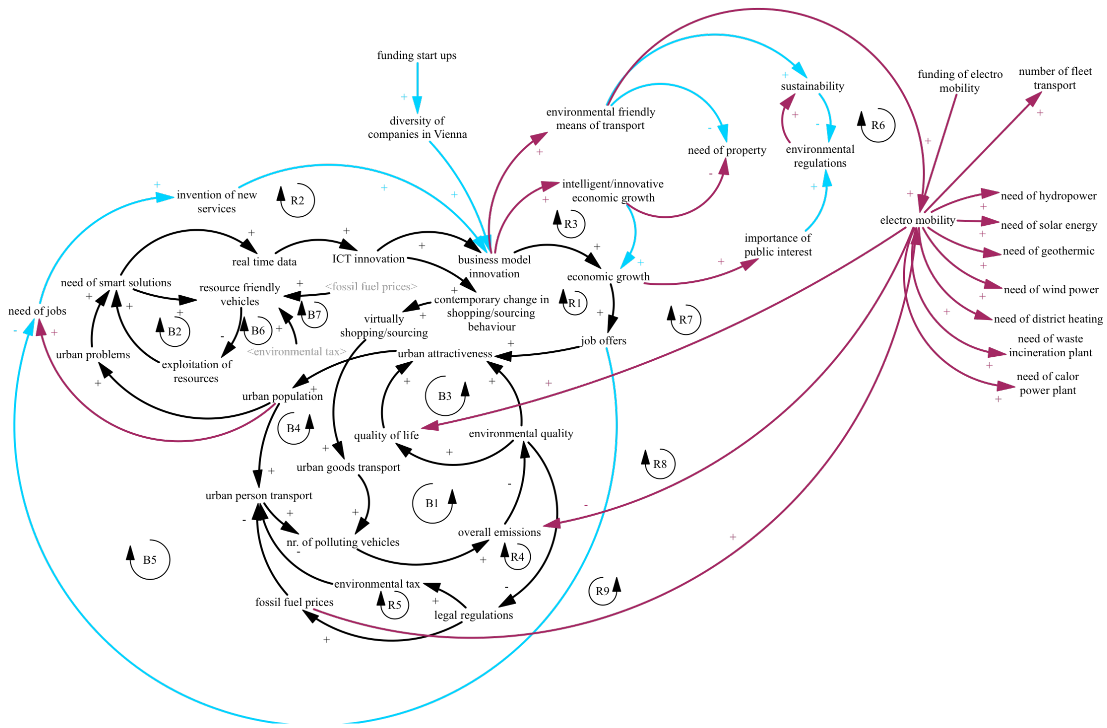
Consequently, cities are ideal breeding grounds for a strong economy. As the reader could already gather in 5.2.1. a key element in Vienna´s smart city strategy, is comprehensive equality of **economy.**

Innovation also calls for openness to science and research at all levels in a manner that is dynamic, reflective and possibly participatory. That is why **city participation** plays an important role for all stakeholders involved in the development of the smart city strategy Vienna.

Research efforts are undertaken mainly in field of energy, mobility, climate and sustainability, which are particularly relevant. **Electromobility** and **energy transition** hold an important positioning in the pillar of innovation and are elaborated in 5.2.2. (Stadt Wien, accessed 11.05.17).

The relationships mentioned by the four respondents, the existing literature as well as the smart city strategy, in regard to the pillar of innovation were combined and replicated in figure 5-26.

Figure 5-26: Causal loop diagram for the Innovation Pillar



Source: Developed by the author with the Vensim software

Figure 5-26 replicates the CLD of innovation, which is richer than the original CLD, deriving from literature. Especially electromobility added many variables to the CLD and enriched it with new feedback loops.

However, loop **R1** shows a feedback loop, which derives from the smart city literature and explains how the growth in population leads to urban problems, which require smart solutions. The need of smart solutions will increase real-time data and ICT-innovations, which consequently will create new business model innovations and increase economic growth. Economic growth leads to job offers, an increased urban attractiveness and growth in population.

The loops **R2** and **R3** are feedback loops, which contain added variables, such as invention of new services. Once more, the dynamic of the loop starts with the growth of population, which will increase the need for jobs, in turn leading to the invention of new services and new business model innovation, as well as to economic growth. Economic growth leads to job offers, an increased urban attractiveness and growth in population.

R4 and **R5** are again loops based on smart city literature and which explain the decrease of environmental quality, the increase of legal regulations, which leads to higher fossil fuel prices (***R5***) and to higher environmental taxes (***R4***). These regulations will lead to a decrease in urban person transport and to a decrease in the number of polluting vehicles. Overall emissions will decrease and environmental quality will increase.

Causes and effects related to electromobility are shown by loop **R6, R7** and **R8.** These inputs derive from the interviews with experts and emphasize the increase in urban population, which leads to urban problems and to an increased need of smart solutions, which requires real-time data. Real-time data is the basis for ICT-innovations and increasingly supports business model innovations, which will foster environmentally friendly means of transport and consequently electromobility (***R6***). Electromobility leads to an increase in quality of life (***R7***) and a decrease in overall emissions (***R8***). A decrease in overall emissions leads to an increase in environmental quality, which also increases quality of life and urban attractiveness and therefore increases urban population.

B1 and **B3** replicate the dynamics related to the increase in urban population, leading to urban problems and to an increased need of smart solutions, which requires real-time data. Real-time data is the basis for ICT-innovations, which will foster a contemporary change in shopping/sourcing behaviour and increase virtual shopping/sourcing. Urban goods transport, the number of polluting vehicles and overall emissions will increase. Environmental quality as well as quality of life (***B3***) will decrease and consequently also decrease urban attractiveness and urban population.

Smart city literature also introduced the loop of **B2. B2** relates to the increase in smart solutions, which will also support the increase of resource friendly vehicles and decrease the exploitation of resources. Therefore, the need of smart solutions will decrease as well.

Loop **B4** shows that by an increase of urban attractiveness, the urban population will increase too, as well as urban person transport. Due to an increase in urban person transport the number of polluting vehicles increases as well as the overall emissions. Environmental quality and quality of life will decrease and so will urban attractiveness as a consequence

B5 is a feedback loop, which contains the variable of *job offers* deriving from smart city literature with *need of jobs*, which is a new insight deriving from the interviews. The following cause and relationship is explained by the CLD: The increase of job offers will lead to a decreased need of job offers. Consequently, the invention of new services and business model innovations will decrease. Therefore, economic growth will decrease as well as job offers.

The loops **B6** and **B7** relate to the interrelationship of an increase in environmental tax (***B6***) and fossil fuel prices (***B7***), leading to an increase in resource friendly vehicles, which will decrease the exploitation of resources and increase the need of smart solutions. Consequently, more real-time data will be available, ICT-innovations will develop which will lead to a contemporary change in shopping/sourcing behaviour. Virtual shopping/sourcing as well as urban goods transport and overall emissions will increase. Environmental quality will decrease and will lead to more legal regulations.

City Participation is also not integrated into this pillar due to its missing dynamics.

5.2.4. Pillar of Governance

Challenges cannot be overcome by individuals, but require a superordinate thematic management. That is why Vienna´s smart city strategy established its pillar of governance. Vienna aims to go through constant exchange and dialogue with its population as well as its numerous partners.

Consequently, **city participation** and **cross-sectoral collaboration** play a significant role in Vienna's smart city strategy (Stadt Wien, accessed 11.05.17).

City participation takes place also in pillar 1, 2 and 3, whereby **cross-sectoral collaboration** appears for the first time.

Respondent 2 emphasized that cross-sectoral collaboration in combination with public private partnerships will form part of a fundamental solution, because the public domain has the power to enforce certain politics. Respondent 2 underlined the resulting benefits for all participating parties in case of a combination of cross-sectoral collaboration and public private partnerships. Respondent 3 mentioned that collaboration would support the pooling of goods and the creation of an alternative means of transport. Respondent 3 furthermore emphasized the importance of this collaboration with the surrounding areas, since the demand of green space is increasing. For respondent 4 its main importance lies in the collaboration/coordination with actors for the simultaneous growth with the developments of society, the market and the creation of new services, models and infrastructures. Respondent 1 confirmed the loop shown by the CLD based on literature.

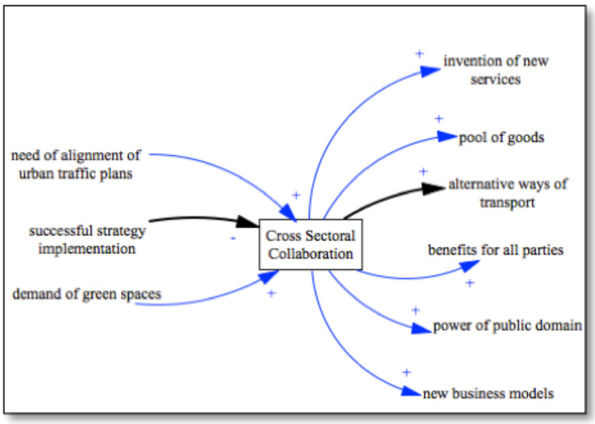
These answers were summarized and and a conceptual model was conducted, which can be found in figure 5-27.

Table 5-18: Insights from Interviews - Governance Pillar- Cross-sectoral Collaboration

Respondents	Theme: Cross-sectoral Collaboration
Respondent 1	• Cross-sectoral collaboration loop is applicable to Vienna
Respondent 2	• Cross-sectoral collaboration in relation with public private partnership makes part of the solution, because the public domain has the power to enforce certain politics • Collaboration creates a benefit for all participating parties
Respondent 3	• Cross-sectoral collaboration loop is applicable to Vienna • Collaboration of partners would support to pool goods and create an alternative mean of transport (to pool products is very important) • Cooperation becomes important with the surrounding areas, since the demand of green spaces is increasing
Respondent 4	• Coordination/Collaboration of actors is mandatory in order to grow with the developments of society, the market and to create new services, models, infrastructures etc.

Source: Interviews with stakeholders; Compiled by the author.

Figure 5-27: Theme Cross-sectoral collaboration



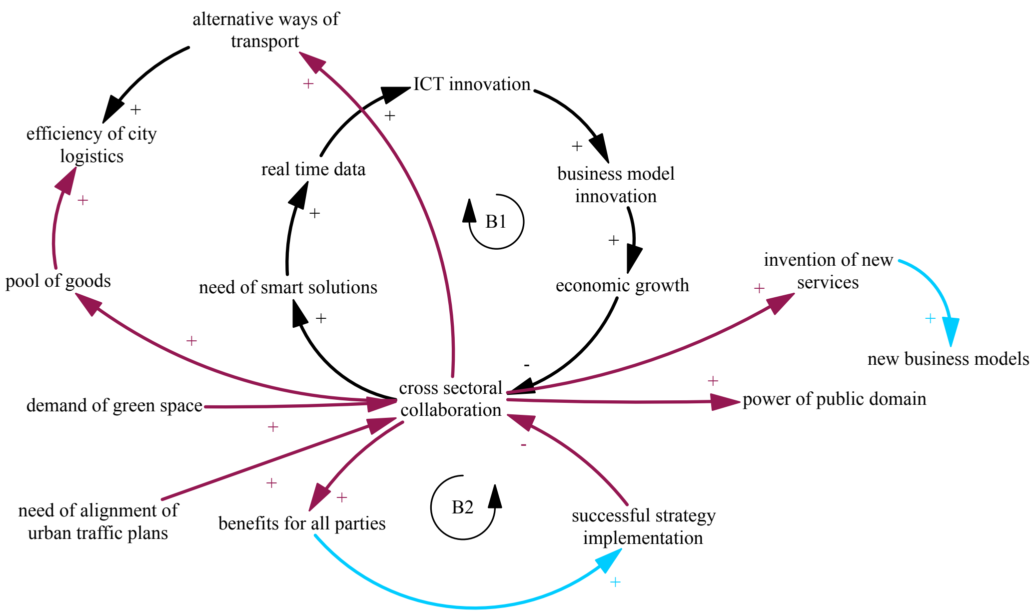
Cross-sectoral collaboration will take place after urban traffic plans are aligned. Cross-sectoral collaboration is especially necessary when it comes to a growing population, because then the demand of green space will grow as well. In the moment of a successful implementation of cross-sectoral collaboration, this kind of collaboration will decrease, because the involved parties will not see the need of collaboration anymore.

Source: Conducted by the author

However, cross-sectoral collaboration causes consequences, such as an increase in invention of new services. It will further support the pool of goods, alternative ways of transport as well as new business models. The power of the public domain will increase and many benefits for all parties will arise.

The relationships mentioned by the stakeholders, the existing literature as well as the information gathered from the smart city strategy with regards to the pillar of governance were combined and replicated in figure 5-28.

Figure 5-28: Causal loop diagram for the Governance Pillar



Source: Developed by the author with the Vensim software

The CLD in figure 5-28 is minor compared to the ones shown before. However, it is one of the most important ones, according to the smart city strategy Vienna.

It is clearly visible which variables derive from experts, which links are drawn by the author and which causal relationships are based on smart city literature; i.e. **B1.**

B1 shows how cross-sectoral collaboration increases the need of smart solutions and consequently of real time data. ICT innovations evolve and new business model innovations increase as well. Economy in the city will grow and cross-sectoral collaboration will decrease, given that the involved parties do not want to share their success.

On the contrary, **B2** is a feedback loop, which links variables with the system dynamics knowledge of the author, which derive from literature and the interviews with experts. Cross-sectoral collaboration implies benefits for all parties and successfully increases the strategy implementation, which will lead to decreased cross-sectoral collaboration, because the involved parties want to earn their own success.

As in every other pillar, the pillar of governance also mentions **city participation.** However, it is not integrated into the CLD, like in all other pillars as well.

5.3. Synthesis of relevant themes highlighted in stakeholder interviews

During the interviews stakeholder also talked about **regulations**, the organization of **target groups** and **taxes**. However, these themes are neither included in the smart city strategy Vienna nor in the literature on smart cities. That is why they are outside the boundary with regards to this master thesis.

However, the author in table 5-19 gives an overview of themes mentioned by the experts during the interviews and the themes of the smart city literature, and how she assigned the several themes to the corresponding pillar of the smart city strategy Vienna.

This way it was possible to construct the CLDs, which are shown in sections 5.2.1 to 5.2.4. Table 5-19 gives an additional idea where the focus of literature as well as the focus of the local experts is placed.

Table 5-19: Themes highlighted by stakeholders *versus* those covered in the literature review

Pillars of smart city strategy	*Themes from Interviews*	*Themes from smart city literature*
QUALITY OF LIFE	- Economy - City Participation - Health Care - Green Space	- Urban Traffic - Health Care - Quality of Life - Economic Growth
INNOVATION	- Economy - City Participation - Electromobility - Energy Transition	- Economy - Participation - Quality of Life
RESOURCE PRESERVATION	- ICT - Energy Transition - Consumption Behaviour - Austrian Culture - City Participation - Data - Emissions	- Energy Transition - Transport System Change - Land use - Consumption Behaviour - Healthcare - ICT

	- Public Transport System - Electromobility - Land use	
GOVERNANCE	- Cross-sectoral Collaboration	- City Participation - Cross-sectoral Collaboration

Source: Compiled by the author.

5.4. The simulation model

The contemporary city has been recognized as a major source of environmental problems (Jabareen, 2006). It is a major, centralized and tightly sealed settlement (Bundesvereinigung Logistik Österreich, 2014). That is also the reason why it is crucial to take into consideration existing interdependencies among social, ecological, economic and other subsystems (Pretorius, 2015). As stated in section 3.3.4. system dynamics modelling might constitute a powerful tool, because of its constant iterative process and its ability to create feedback theories.

This section describes the system dynamic model built to improve understanding on dynamics of smart cities. The main mechanisms of the model will be explained, as well as the resulting baseline simulations and how the system dynamics modelling approach is able to connect the previously described highly qualitative vision of the smart city within a quantitative simulation.

5.4.1. The focus on the Pillar of Quality of Life

The smart city strategy Vienna, as stated in section 4.2., defines "*the best quality of life for all inhabitants of Vienna*" as its meta goal for 2050. The qualitative CLD of the pillar of quality of life was translated into a quantitative system dynamics simulation model.

As already explained in chapter 2 the main goal of all four urban planning concepts has always been the improvement of the living quality of citizens in a certain urban area. This research project sticks to this meta goal and chose this pillar of the smart city strategy Vienna for illustrating the testing of the proposed system dynamics modelling approach.

The starting point for the development of the system dynamics simulation model was the CLD for the Quality of Life Pillar presented previously in figure 5-16.

The smart city strategy for Vienna is a vision and consequently it is still not operational and detailed. Having this as a starting point increases the amount of assumptions, which were made during the entire research project. This research project is particularly constraint by data, given that many smart city concepts are still being developed and will only materialize in the future. That is also why the system conceptualization is partly based on the insightful Urban Dynamics application by Jay W. Forrester in 1969.

Given that in recent years the number of smart city initiatives strongly increased (Ahvenniemi, 2017), a model was developed, which would also represent a typical sized European capital city, in order to make the model applicable for future policy development in other cities, not only Vienna. Thus, the model can contribute as a common thread in the field of smart cities in Europe.

Inspiration for the model conceptualization was also gathered from Dr.-Ing. Christian Walloth from *Walloth Urban Advisors*, who was a keynote speaker for the topic of *Eco-*

Systems from living in Smart Cities to Sustainable Agriculture and Environmental Ecology at the International society for System Sciences in Vienna, 2017. He emphasized the capacity problem Vienna will face in its future due to its policy aims of becoming the most populated city in Europe by 2050, while at the same time running emission free and offering the highest quality of life for its citizens. This input was kept in mind during the modelling process and that is also the reason why the model focuses on capacities in an urban area and how those influence the total smart city attractiveness.

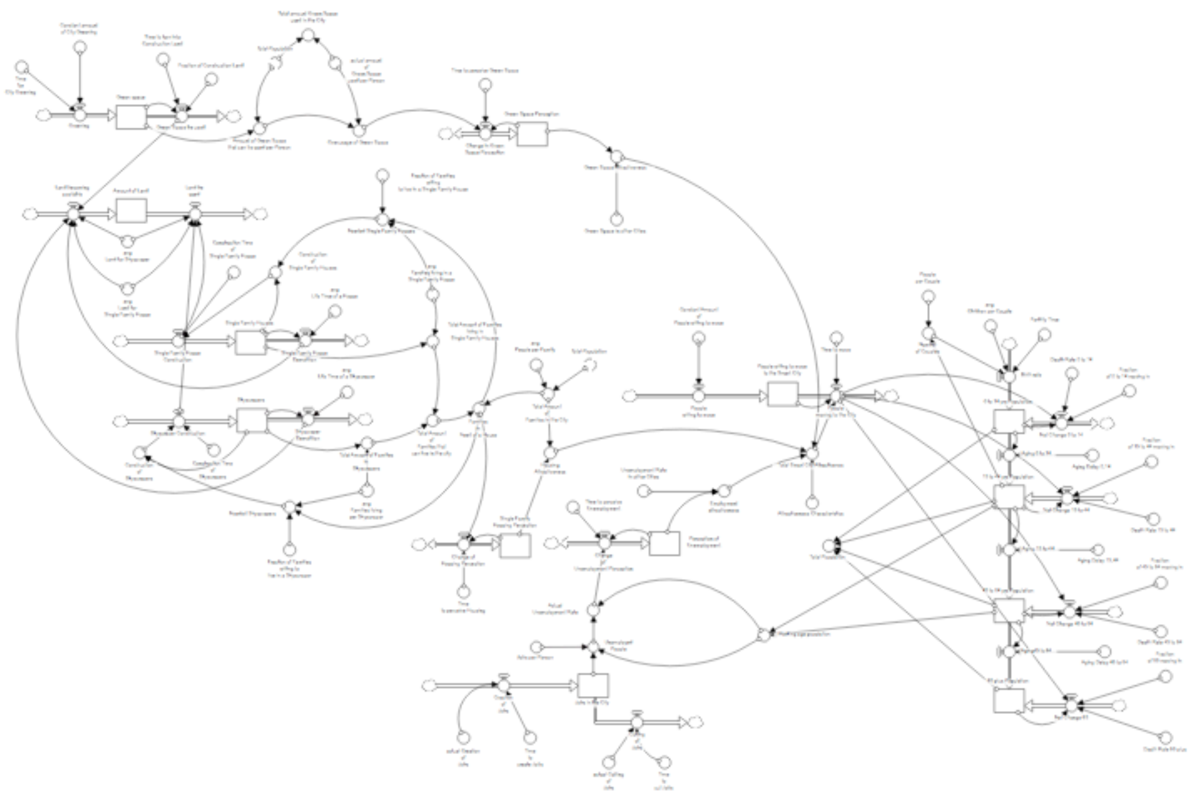
5.4.2. The sectors of the simulation model of the pillar of quality of life

The simulation model includes four main sectors representing the quality of life pillar. At the same time these sectors represent the main mechanisms of the model and the capacity restrictions, which the city will face in the nearby future.

Figure 5-29 aims to show the whole model to give an idea of the complexity and the size of the entire model. The model consists of 13 stocks, 19 flows and 62 parameter values.

Despite not being readable, however, this is shown to emphasize the size of the model and how all four sectors are connected to each other.

Figure 5-29: Overview of the stock-and-flow structure of the simulation model, for the pillar of Quality of Life



Source: Constructed by the author with the software Stella Architect

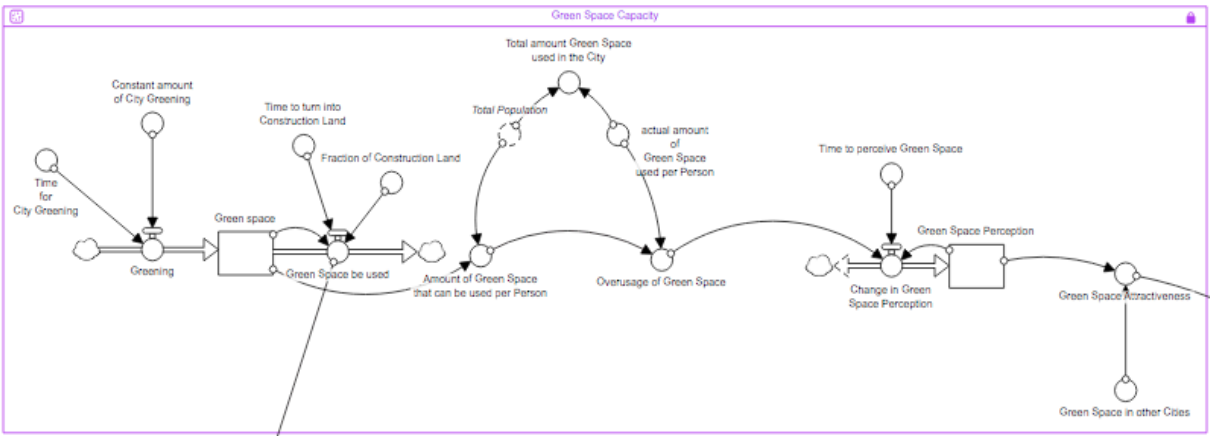
Sector of Green Space Capacity

Half of Vienna's municipal territory is covered by green space. The "green lung" of the city strongly contributes to Vienna's high quality of life (Stadt Wien, accessed 11.05.17). As stated by the smart city strategy Vienna, even in a growing city the spacious and attractive green and open space needs to be safeguarded. That is why the key element of *green space capacity* is included in the model, in order to demonstrate how fast a growing city can lose control over its environment and overuse green space for obtaining more construction land.

Respondent 3 confirmed in his interview (see annex B) how important it is for Vienna to keep its green space. The demand of green space will increase relatively to the increasing number of people. Respondent 3 defined this development as an upcoming challenge for the city. Given that Vienna has narrow borders it is impossible to expand the urban area for obtaining more green space.

Figure 5-30 shows the structure of green space capacity and the connected green space attractiveness which so far is a crucial factor for Vienna for attracting people. In chapter 5.4.3. the model will be simulated and the resulting baseline simulations will be explained. The interplay of all four sectors will highlight the important role of the sector of green space.

Figure 5-30: Sector of Green Space Capacity



Source: Constructed by the author with the software Stella Architect

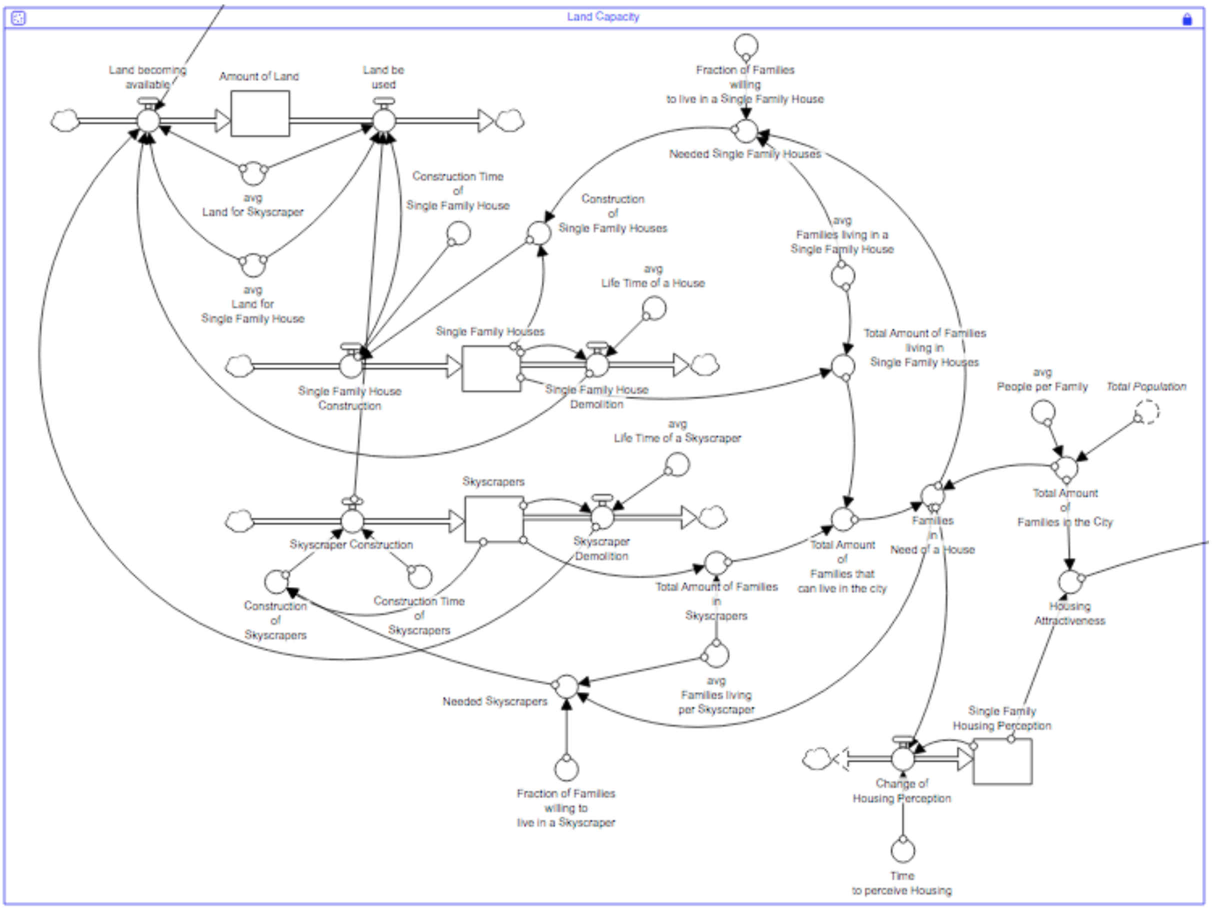
Sector of Land & Housing Capacity

Figure 5-31 represents the sector of land and housing capacities with its main stocks and flows.

According to respondent 3, Vienna consists of an amount of urban land which is set and which boundaries are not possible to shift (see annex B). However, the smart city strategy expects Vienna to be the most populated city in Europe by 2050. The increase of citizens requires housing. The housing availability determines the housing attractiveness of the city which contributes to the total smart city attractiveness. Therefore, land will be used in order to build either skyscrapers or single-family houses. As stated by respondent 2 during his interview (see annex B), it is not a contradiction that Vienna aims to become the most populated city in Europe, while at the same time be the greenest city. Respondent 2 compared Vienna to cities in Asia. In Asia constructions started to be horizontally instead of vertically, which makes it possible to offer people accommodation, but in skyscrapers instead of single-family houses. Given, that this would significantly change the image of the city of Vienna, respondent 2 emphasized that right now this kind of city development is happening exclusively in the so-called area districts. An increase of people increases the possibility of a reversal in the construction field as well.

The sector of land and housing capacity represents the mechanism in a city, where land is used to either construct skyscrapers or single-family houses. In this model it was decided to add the function that in case of land scarcity, which means a higher outflow (*Land be used*) than inflow (*Land becoming available*), the city will be forced to build more skyscrapers than single-family houses. This represents the development in constructions mentioned by respondent 2 during his interview.

Figure 5-31: Sector of Land Capacity



Source: Constructed by the author with the software Stella Architect

Sector of Job Capacity

The sector of job capacity, which is represented in figure 5-32, demonstrates an important part of the model, albeit simplified for the purposes of this research, given the time constraints.

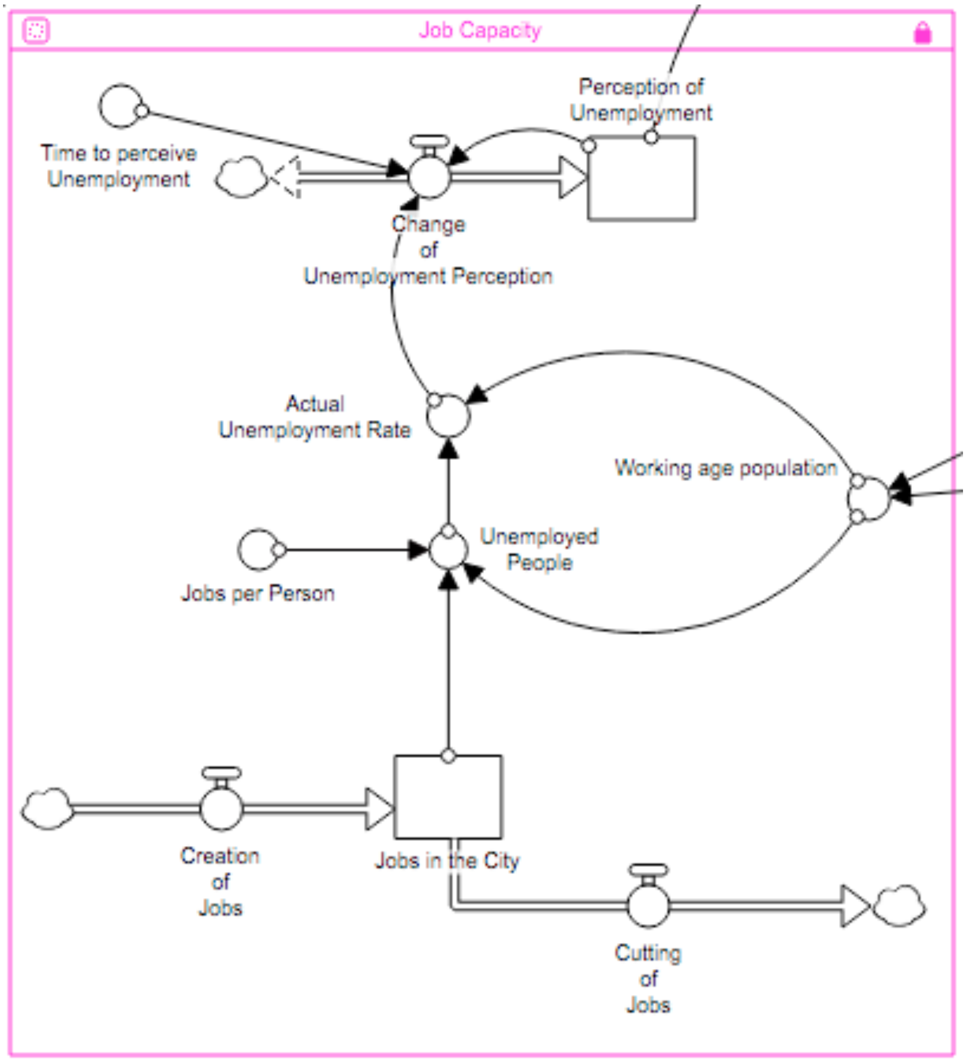
This sector is highly relevant because it represents a main driver for people migrating to Vienna. Vienna's job market is very attractive due to Vienna's strategy of keeping the access to its labour market low-threshold and equitable, especially for less advantaged people in the society (Stadt Wien, accessed 11.05.17).

The dynamic of city attractiveness is represented as follows: the *Creation of jobs* by lowering the number of unemployed people strongly increases the attractiveness of the city, while the *Cutting of jobs* decreases it. The number of *Unemployed People* results by the division of the variable *Working age population,* which includes all citizens who are able to work between age 15 to 64, by *Jobs in the City.*

This mechanism got confirmed and underpinned in the interview with respondent 1, which can be found in annex B. Respondent 1 stated that the business agency in Vienna plays a significant role when it comes to population growth, because it is responsible for the generation of jobs. It supports the establishments of national and international companies on a long-run. The establishment of national and international companies makes Vienna highly diverse and attractive on the national and international market. This statement goes hand in hand with what respondent 2 mentioned in his interview. Respondent 2 explained that a smart city could only be smart and sustainable if there is economic welfare. As stated in the smart city strategy handbook of Vienna, one of the city's main objectives by 2050 is to be the innovative leader due to top-end research, to a strong economy and to research. Innovation is the key for linking resource preservation to quality of life and consequently merges all pillars of the smart city strategy together (Stadt Wien, accessed 11.05.17).

However, this model is dynamic and consequently the sector of job capacity is not cut off from the sector of housing. This means, that the smart city strategy of Vienna should be aware of that population size will constantly change and that this constant change will require an adaption in supply structures and housing availability.

Figure 5-32: Sector of Job Capacity



Source: Constructed by the author with the software Stella Architect

Sector of Population

The meta goal of the smart city strategy Vienna is the best quality of life for all inhabitants of Vienna. That is why *Population* is the main focus of the smart city strategy and the principal driver for the three other sectors. In this model *Population* is represented by an aging chain and a stock of migrating *People willing to move to the Smart City*.

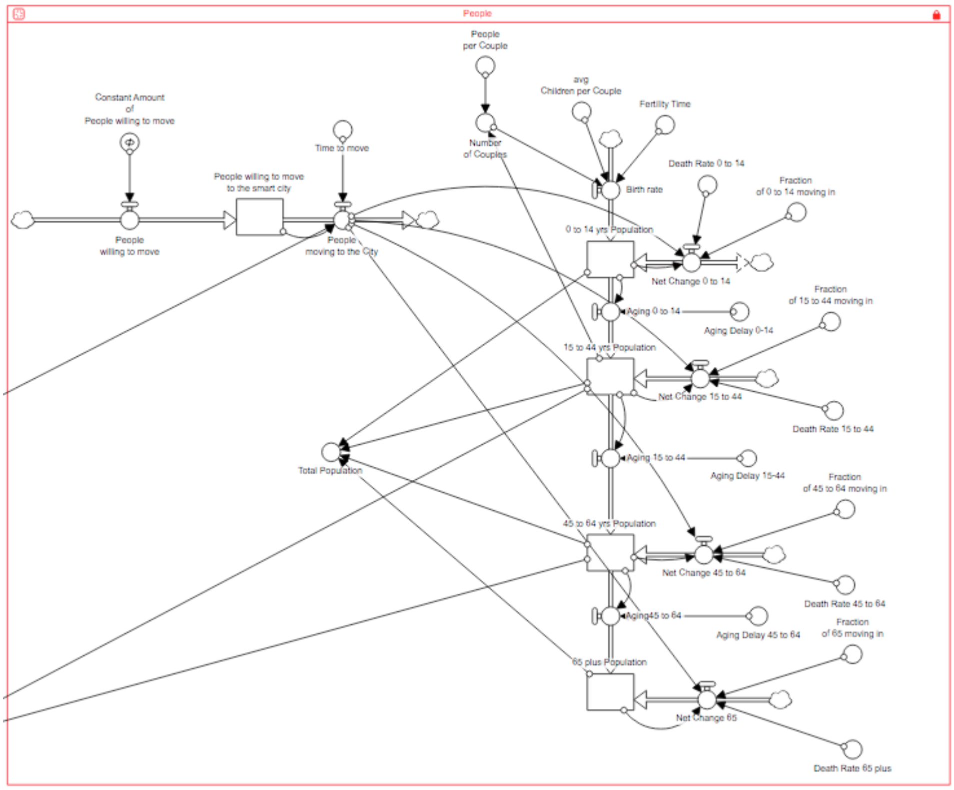
This sector is highly relevant. As respondent 2 explained in his interview (see annex B), jobs, green space and housing attract people to migrate to a city. However, at a certain point population growth will create problems due to limits of growth.

People are the main force to make a city attractive. At the same time urban attractiveness is the main driver for people to migrate to a city; in this case due to jobs, green space and housing attractiveness. Urban attractiveness creates economic wealth and due to its workforce also economic stability, by at the same time consuming all kind of resources.

Consequently, by pushing the capacities of Vienna to a certain level, urban problems will emerge. These problems could either be manageable or not.

Hence, all sectors are depending on each other and make this simulation model highly dynamic. In the following subsections the aim is to study these dynamics more in depth and to underpin it with corresponding baseline simulations.

Figure 5-33: Sector of Population



Source: Constructed by the author with the software Stella Architect

5.4.3. Model simulation – dynamic story of the smart city strategy Vienna

Given the meta goal of the smart city strategy Vienna, this chapter aims to show and describe various baseline simulations in order to demonstrate how the system dynamics modelling approach can be a helpful tool for understanding better the dynamics of the pillar of quality of life of the smart city strategy Vienna.

The four sectors in chapter 5.4.2. were considered to represent basic needs which are necessary to be fulfilled in every city worldwide in order to attract people and to guarantee quality of life. Given that Vienna wants to become the most populated city in Europe by 2050 but with the highest quality of life, it is crucial to understand basic dynamics of an urban area. If a city is not capable to understand its basic dynamics it cannot estimate consequences of future policies. That is why the baseline simulations aimed to replicate possible negative consequences in case the above mentioned basic needs are not covered anymore.

Consequently, these simulations are a call to the city of Vienna, but to every other city in the world as well, to change mindset, to start taking into consideration feedbacks and delays and to combine strategies in order to prevent negative long-term effects.

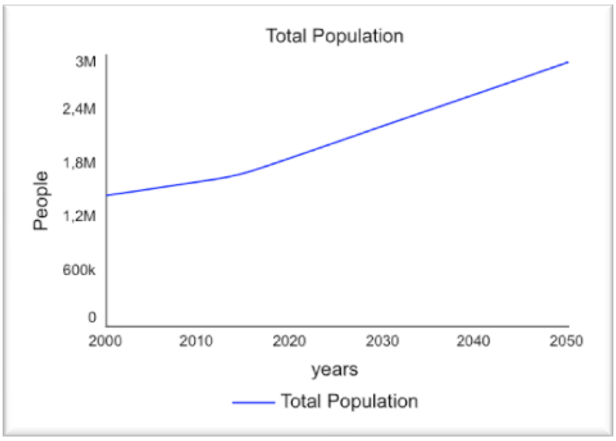
The model is exploratory and tells a dynamic story. Dynamic stories are mainly used in fields where real data is hard to get. However, even if data is scarce, dynamic stories, due to their rich feedback structures, are able to improve mental models upon which decisions are based. Consequently, the culture in companies and organizations can improve by learning (Dutta, 2008).

The following paragraphs discuss on the basis of baseline simulations, the insights gathered by interviewing experts, by studying the smart city strategy handbook of Vienna and after having done an extended literature review.

Individuals are migrating to Vienna for various reasons. These reasons are, but do increase the total population. However, as stated by the smart city strategy Vienna the city enjoys a very good starting point of city attractiveness. Housing, public transport and other infrastructural services, universities, education, as well as urban green spaces are performing really well. This strongly contributes to the high quality of life in Vienna (Stadt Wien, accessed 11.05.17).

Figure 5-34 demonstrates the continuous, strong increase of total population in Vienna. Starting with 2015 the increase of people is slightly stronger than between year 2000 and 2050. Based on the simulation run in figure 34 Vienna expects 2.910.000 people by 2050.

Figure 5-34: Total Population



Source: Constructed by the author with the software Stella Architect

Vienna is currently hosting 1.741.000 people. Consequently 2.910.000 people will create challenges for the overall system. As stated by respondent 3 in his interview (see annex B) it is important to have the whole set of measures for preventing negative impacts which will arise with an increasing number of people. Respondent 3 also suggested a shift in living and working style for consuming less resources and less land area. Such a shift would support an increase in density where it is possible and where it makes sense. The importance of density was discussed by the sustainable city concept in chapter 2.2., the smart city concept in chapter 2.3. and the eco-city concept in chapter 2.4. All three concepts concluded that density matters in order to turn into a sustainable urban area. The sustainable city and the eco-city concept promote density as significant, because it influences the distances to reach facilities in an urban area. Thus, walking and cycling get promoted while cars and fossil fuels will be reduced. The smart city concept considers density important, because it makes it easier to put people in contact and consequently to facilitate social interactions and to exchange knowledge and ideas.

Relating back to the answer given by respondent 3, he also mentioned the topics of working and housing. Jobs and housing often are connected when living or migrating to a city.

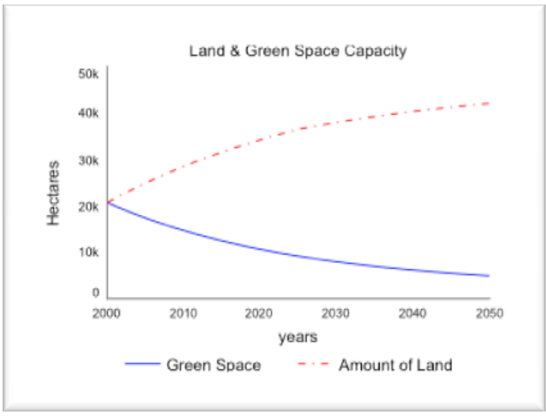
In this model the construction of houses was given priority, because it was assumed that each employee is also in need of a house. Thus, commuters were left outside the boundary.

For building houses construction land is necessary which derives from green spaces inside the city boundaries. Figure 5-35 demonstrates how the amount of construction land is increasing while green space is decreasing. Given that construction land is depending on green space the graph replicates an inverse. By 2050 green space will be decreased from initially 20.700hectares to 5.000hectares, while the amount of land will be increased from initially 20.700hectares to 42.100hectares. These developments affect the attractiveness of the city.

Figure 5-36 shows how the attractiveness of green space and the attractiveness of housing changes, due to increasing constructions in Vienna.

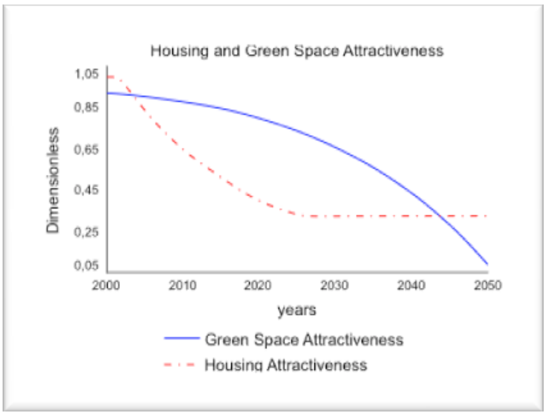
Housing attractiveness stagnates in year 2024, while green space attractiveness constantly decreases. The stagnation in housing attractiveness can be attributed to the low point of *total amount of families that can live in the city* in 2024, which is shown by figure 5-37. *Total* *amount of families that can live in the city* is the actual amount of people who can live in the city due to housing capacity.

Figure 5-35: Land and Green Space Capacity



Source: Constructed by the author with the software Stella Architect

Figure 5-36: Land and Green Space Attractiveness

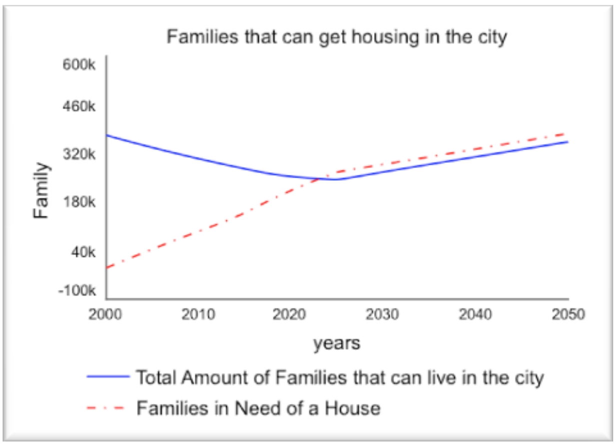


Source: Constructed by the author with the software Stella Architect

Housing capacity includes skyscrapers and single-family houses, whereby it was assumed that an average Viennese family prefers to live in a single-family house. However, that preference requires more construction land and less people can live in a single-family house.

In figure 5-37 in year 24 the lowest number of families can live in the city and the highest number of *families are in need of housing*. This can be attributed to the strong increase of people in the city, but also to the fact that population is getting older and consequently occupies housing for a longer period. The constant increase of people, which is one of the main goals of the smart city strategy Vienna, forces the construction business to build more houses. Although, the construction of single family houses and skyscrapers takes time, creates a delay and that is why in year 2024 the city is faced with the highest number of families in need of a house.

Figure 5-37: Families that can get housing in the city & Families which are in the need of housing



Source: Constructed by the author with the software Stella Architect

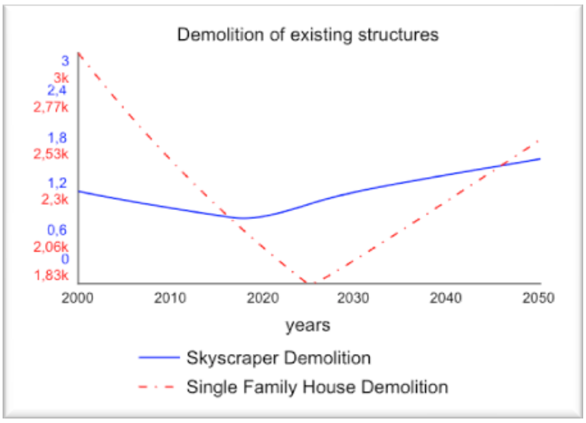
The challenge of limited land availability has already been discussed by Forrester (1969) in Urban Dynamics and has been mentioned by the author in chapter 2.1.

Limited land availability, as shown by simulating model, is a resource constraint, which helps a city growing but then is hindered by a lack of buildings and infrastructures. Forrester (1969) explained how the growth of an urban area leads to the demolition of existing structures in order to build new houses.

Figure 5-38 replicates the demolition of skyscrapers and single-family houses. The demolition of single-family houses decreases over time until it reaches the turning point in 2024, where the city experiences the strongest need of housing. In year 2025 the demolition strongly increases. Skyscrapers slightly decrease their demolition until 2018, but then increase it again. Firstly, this pattern of demolition can be attributed to the fact that Vienna consists of a high capacity of housing and can deal with the migration of people, consequently does not need to demolish existing structures. Figure 5-37 refers to this development really well, because it demonstrates the cutting point of *families in need of a house* and *total amount of families that can live in the city* and emphasizes the year of housing shortage.

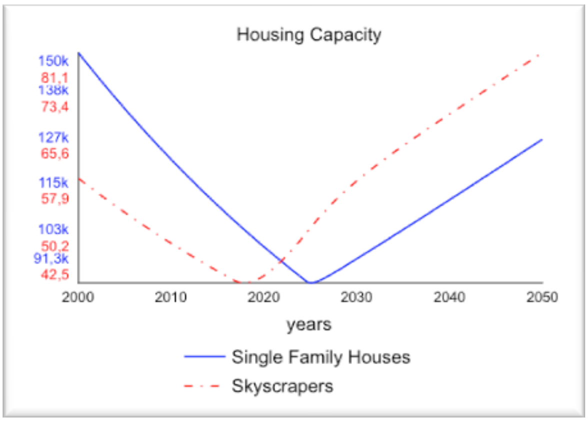
Furthermore, average families in Vienna prefer to live in a single-family house instead of a skyscraper. Thus, more families are occupying single-family houses and consequently a smaller amount of single-family houses are "available" to demolish. The amount of single-family houses strongly decreases due to the increase of total population (figure 5-34), but the demolition of them only starts increasing the moment Vienna experiences an evident lack of housing.

Figure 5-38: Housing Demolition



Source: Constructed by the author with the software Stella Architect

Figure 5-39: Amount of Single Family Houses & Skyscrapers



Source: Constructed by the author with the software Stella Architect

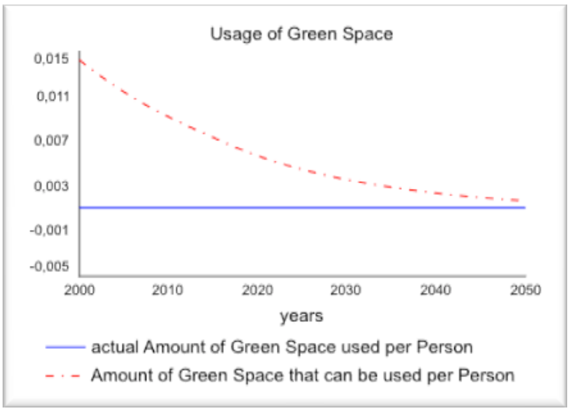
Figure 5-39 shows how the capacity of skyscrapers and single-family houses decreases until the city lacks in housing capacity. In 2050 the city consists of 81 skyscrapers, which in total are able to host 97.200 families, while the 128.000 single-family houses are able to host 256.000 families.

In 2050 it is still assumed that families prefer to live in single-family houses. Considering the answer of respondent 2 in his interview (see annex B) it would be possible to increase the number of citizens even further than the simulation model is running. Respondent 2 takes Asian cities as example and suggests skyscrapers in order to handle a highly populated city, but by still being green.

Despite, the comment of respondent 2, in figure 5-40 it is demonstrated how the amount of green space, which can be used per person, is decreasing. At the moment and based on real data, the city of Vienna counts 0,0011 hectares per citizen. Nevertheless the city is trying to keep the city green, i.e. by constant greening. Figure 5-40 demonstrates how the *amount of green space that can be used per person* overcomes the *actual amount of green space used per person* and consequently create an over usage of green space.

As the smart city strategy of Vienna states, Vienna consists of 50% green space. It is the "green lung" of the city and it contributes to the high quality of life. Consequently, it is necessary to take care of it, also because it plays a significant role regarding Vienna's city attractiveness (Stadt Wien, accessed 11.05.17).

Figure 5-40: Usage of Green Space run- Vienna



Source: Constructed by the author with the software Stella Architect

Green space does not only make an urban area more attractive, but it positively contributes to the key agenda of sustainability, as stated by the sustainable city concept in chapter 2.2. The sustainable city concept supports the statement of the smart city strategy Vienna, by emphasizing how important the implantation of urban parks and open green areas is, for increasing the overall quality of life. The green lungs absorb contaminants and release oxygen, thus create environmental, but also psychological, cognitive and social benefits for its citizens.

The smart city concept, presented in chapter 2.3. defines green spaces as an important dimension of smartness and assumes that smart cities within green spaces rely on more developed infrastructure than polluted cities. Vienna should keep track of these inputs for not losing it status as smart and sustainable city.

Another very important attribute of the smart city concept is its economic development. In chapter 2.3. and 2.4. the smart city and eco-city dimension of economic development were described in detail.

Smart cities are in need of large amounts of money in order to attract private investors and to support the growing demand for smart growth development. Financial resources are necessary to make investments in new transportation, education, utility and telecommunication infrastructures. Cities with a greater economic development are also more attractive to people, who are aiming to increase their standard of quality of life, which is the defined meta goal of the smart city strategy Vienna.

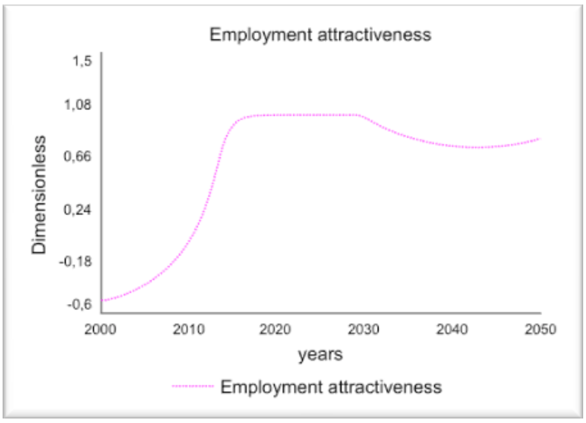
Respondent 2 (see annex B) related to this topic by emphasizing the importance of economic welfare in cities. According to respondent 2 sustainability and the satisfaction of needs of citizens is exclusively possible if a city is economically wealthy. Economic welfare is mainly generated by jobs, which attract people as employees or as investors.

Respondent 1 in her interview (see annex B) described the relationship of the smart city Vienna and the business agency Vienna. The focus of the business agency Vienna is not one single area, but almost all areas in a city. It supports national and international companies in Vienna for establishing better on a long run.

Even though this sector by definition is significant for smart cities, this research project, due to time and data constraints, was forced to keep this part of the model simple and leave economic development outside the boundary. The model is also constrained by its low diversity of job types. The smart city strategy Vienna considers Vienna highly innovative and diverse in terms of research, education and jobs.

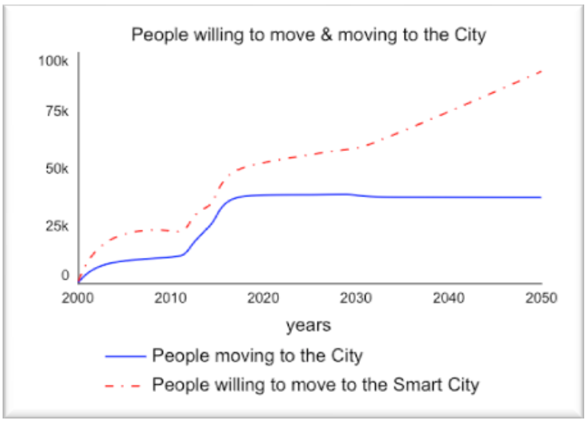
However, the simulations of the sector of jobs can relate to the comments of respondent 1 and 2.

Figure 5-41: Employment Attractiveness



Source: Constructed by the author with the software Stella Architect

Figure 5-42: People willing to move & moving to the city



Source: Constructed by the author with the software Stella Architect

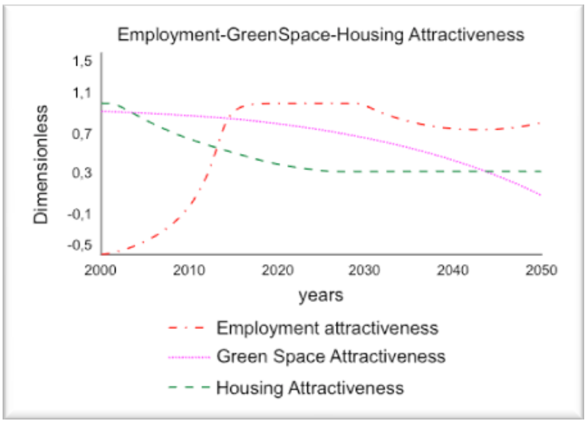
Figure 5-41 demonstrates how the employment attractiveness starts with a negative value and how it increases until year 2020. It stays constant until 2029 and then decreases again. By year 2043 it increases again. This means, that Vienna until 2010 was not attractive to people due to its job market. However, figure 5-42 replicates a decreasingly increasing behaviour until 2010, which then changes and increases the moment Vienna's employment attractiveness starts to be positive. Figure 5-42 also shows how people were constantly willing to move to Vienna. This development results in the highest number of citizens, who would like to migrate in year 2050. The smart city strategy Vienna anticipates this trend already in its handbook. That is why it is possible to conclude that people until 2010 where moving to Vienna for other reasons i.e. housing or green space attractiveness.

Cities are places, where a great amount of resources get consumed and a great amount of environmental waste is created (Low, 2000; Satterthwaite, 1999). However, they attract people for various and individual reasons.

In this research project 3 attributes were chosen, which attract people to come to Vienna. In figure 5-43 a comparison of employment, green space and housing attractiveness is demonstrated.

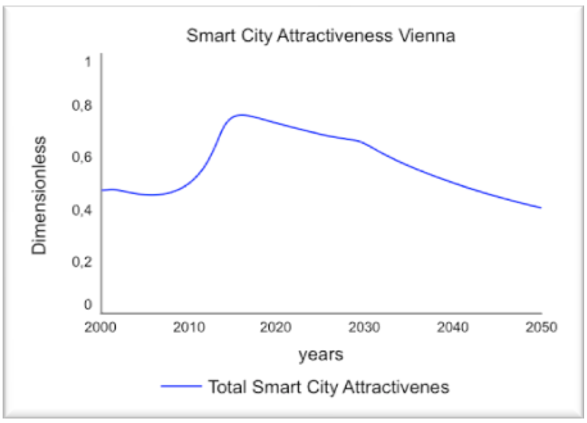
In figure 5-43, in year 2013, employment is equally attractive as housing. However, the overall housing attractiveness is constantly decreasing, while employment is increasing until year 2020. In 2020 employment attractiveness starts to decrease again for 9 years, where it shifts to an increase. Green space attractiveness is constantly decreasing given to the transformation of green space into construction land.

Figure 5-43: Smart City Attractiveness Comparison



Source: Constructed by the author with the software Stella Architect

Figure 5-44: Total Smart City Attractiveness



Source: Constructed by the author with the software Stella Architect

The graph in figure 5-44 the total smart city attractiveness of Vienna is shown. The total smart city attractiveness combines all three attributes of attractiveness. As demonstrated in figure 5-44, the smart city attractiveness reaches its peak in year 2015 and decreases afterwards.

The total smart city attractiveness of Vienna in this model emphasizes that urban labelling runs the risk to be used exclusively for marketing purposes instead of referring to actual policies. The disjuncture between image and reality is the real difference between a city actually being smart and a city labelling itself smart (Hollands, 2008). This is stated in chapter 2.3.3.

5.5. Validation of the simulation model

In this chapter are reported several tests, which were performed to address the validation of the model. As also stated in chapter 3, validation is defined as a gradual process of building confidence in the simulation model. Especially external validity is addressed when testing the robustness of the model. External validity includes direct structure tests, structure-oriented behaviour tests and behaviour pattern tests.

5.5.1. Direct structure tests

With regard to the structure of the model one of the tests is concerned with how adequate the boundary of the model is. The guiding question is whether the model includes all relevant structure needed for the purpose of the model. In this research project the purpose of the model is to show the dynamics of the pillar of quality of life and to emphasize the negative consequences which could evolve in case of a constant increase of population. Four basic capacities, which make part of the pillar of quality of life of Vienna’s smart city strategy and which are present in every major city of the world, were chosen. These four capacities highly contribute to improve the quality of life of its citizens.

Without data constraints the model could have been enriched with more detail. However, the primary purpose of the model is achieved.

Another test for assessing the structure of the model is to check dimensional consistency of equations. The author carefully checked and this validation test has been fully satisfied.

A third test as structure check is the response of the model to extreme conditions of parameters. Table 5-20 presents an overview of three parameters with extreme conditions together with analysis if an error occurred. The parameters were randomly chosen.

Table 5-20: Extreme Condition Tests

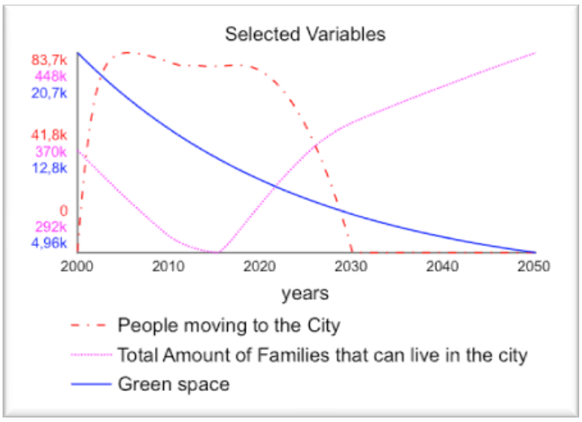
Parameter	*Normal value*	*Extreme value*	*Analysis*
Construction Time of Skyscrapers	5	0	Floating point error computing - Skyscraper Construction - at time = 0.000000. Division by '0' is not possible.
		1	No error
		1.000	No error
Fraction willing to live in a Single Family House	0,7	0	No error
		1	No error
Time to turn into Construction Land	2,5	0	Floating point error computing - Green space be used - at time = 0.000000. Division by '0' is not possible.
		1	No error
		100	No error

Source: Compiled by the author.

5.5.2. Structure-oriented behaviour tests

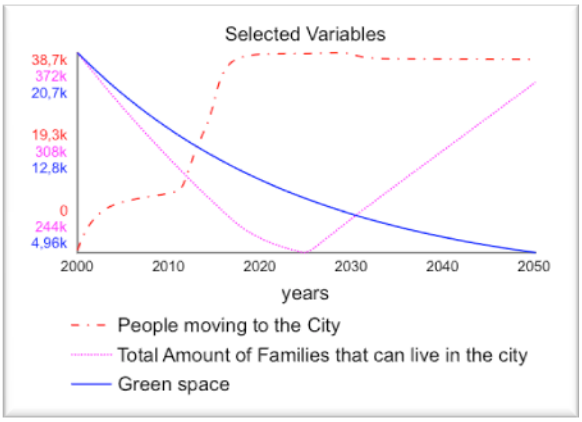
One of the tests regarding the structure-oriented behaviour of the model is concerned with the different generated behaviours when assigning extreme values to selected parameters. The existence of modes of behaviour indicates the presence of dissimilar structures for each sector of the urban area, which reflects the differences between the modes. Figure 5-45 depicts the behaviour over time of the people for different sectors of the model. Results suggest that there are indeed differences among the sectors of the model.

Figure 5-45: Run with step increase of people willing to move to the city



Source: Constructed by the author with the software Stella Architect

Figure 5-46: Baseline run

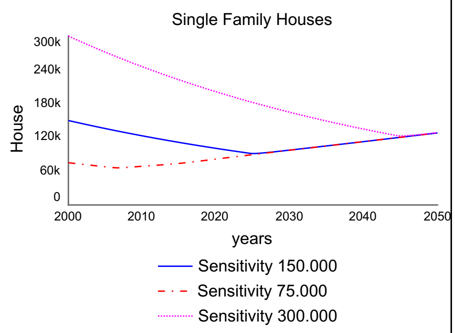
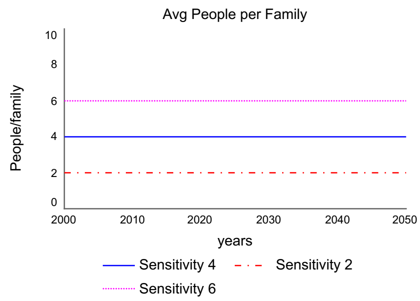
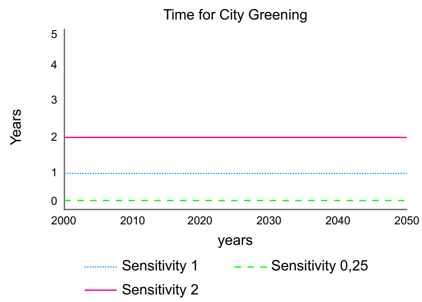


Source: Constructed by the author with the software Stella Architect

In the run with a step increase of 100.000 people willing to move to the city in 2000 a change in behaviour is replicated. The number of people willing to move to the city decreases in year 2020 and capacity of families that can live in a city is earlier reached than in the baseline rune. However, the capacity of families that can live in a city also increases faster and has a change in behaviour in year 2030 shown by a weaker increase than until 2030.

Another test for assessing the structure-oriented behaviour of the model is to check if the model behaves as expected under different conditions of parameter values. Table 5-21 shows three parameters with different combinations of parameter values with documentation of the behavioural output. These parameters were randomly chosen. All graphs show behaviour over time which is to be expected based on the structure of the model.

Table 5-21: Sensitivity Analysis for Different Parameter Values

Parameter	*Normal value*	*Sensitivity value*	*Analysis*
Single Family Houses	150.000	300.000 and 75.000	
Average People per Family	4	2 and 6	
Time for City Greening	1	0,25 and 2	

Source: Compiled by the author.

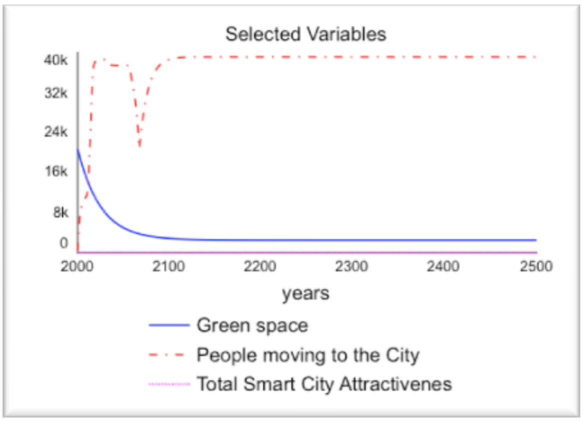
5.5.3. Behaviour pattern tests

In the category of behaviour pattern many tests require detailed information about the past and present behaviour of the simulation model. Given that the smart city strategy Vienna is a vision, no data from the past is available. That is also the reason why these tests are not possible to undertake. Nevertheless, one of the tests regarding the behaviour pattern produced by the model is concerned with the stability of the simulation. For this purpose, the simulation time is extended from 50 years to 500 years.

The results can be found in figure 5-47. It can be concluded that stability is largely present as most dynamics even out after a period of.

The selected variables are chosen randomly.

Figure 5-47: Stability of the simulation



Source: Constructed by the author with the software Stella Architect

The results of the model validation, which are demonstrated in chapter 5.5.1. to 5.5.3, allow us to affirm that this is a robust model. The assessment regarding external validity tests shows that the model behaves logically which allows further and more detailed research with it.

5.6. Policy Scenarios

The baseline simulations supported to study the dynamics of the pillar of quality of life more in depth and the validation tests confirmed the robustness of the model. At this point the model could or rather should be used for testing and formulating policy scenarios. Under the given circumstances of this research project no policy scenarios were tested. However, in chapter 6.2. suggestions will be given for further research inter alia for the ve´

6. Conclusion, Limitations and Further Research

This chapter aims to emphasize the importance of this research project by recapitulating the initially set research objectives, commenting on the obtained results, and highlighting the limitations of this research project leading up to the recommendations for further research.

6.1. Main Lessons Learned

"The best quality of life for all inhabitants of Vienna, while minimizing the consumption of resources. This will be realized through comprehensive innovation." Meta goal of the smart city strategy Vienna by 2050 (Stadt Wien, accessed 09.05.17).

Urbanization, one of the most plausible drivers of increasing CO_2 emissions is one of the main drivers of climate change (Grimm, 2008). For combating the increase of CO_2 emissions and the development of climate change, cities started using smart city strategies (Marsal-Llacuna, 2015).

This research project analysed the smart city strategy of Vienna under the perspective of qualitative and quantitative system dynamics modelling.

So far no author used system dynamics as a method for understanding the dynamics of the smart city strategy. This has also been the motivation of the author to formulate the following research objectives:

- Use a qualitative system dynamics modelling approach to unwrap the *label* smart city in order to understand what smart city means and how it could help to diminish urban problems.
- Develop a system dynamics modelling approach with the aim to emphasize that system dynamics is a suitable method for simulating which possible problems arise in a growing urban area. The example of Vienna will be used as a case study for illustrating this purpose.
- Analyze the advantages and disadvantages of the smart city strategy related to Vienna based on the system dynamics modelling approach.

The smart city concept is a rather new movement and was introduced for the first time in 1994 (Dameri, 2013). Due to the strong support of the European Union in 2010 smart city projects experienced a recognisable increase in publications (Jucevicius, 2014). The concept of smart cities is widely used, nevertheless it is missing a clear and consistent understanding of its meaning (Angelidou, 2015). Especially the identification of shared definitions and common current trends at a global scale is difficult (Neirotti, 2014). The risk of urban labelling arises which is mainly used for marketing purposes (Begg, 2002). Cities can actually be smart or only label itself smart (Holland, 2008).

Initially the author planned to hold group model building sessions. Firstly, to understand and to unwrap the label smart city and secondly because smart city approaches are lacking of a participatory approach. However, due to limited time of the contacted stakeholders, the group model building sessions did not take place. Nevertheless, four experts offered their expertise in form of semi-structured interviews. All four experts were involved in the development of the smart city strategy Vienna and all four are deriving from different sectors. This way the author gathered information's from four different perspectives which partly were concordant and partly contradictory.

Qualitative system dynamics modelling helped the author to organize the huge amount of information gathered. On the basis of causal loop diagrams it was possible to draw interdependencies among social, ecological, economic and other subsystems of the strategy. The author analysed each pillar of the smart city strategy by combining the information gathered during the interviews, with that of the smart city strategy Vienna and the smart city literature. This way it was possible to improve understanding on what is hidden behind the label of smart city and which are the main dynamics of each strategy pillar.

The qualitative data analysis particularly emphasized that *city participation* plays an important cross-cutting role to the smart city strategy. Consequently, it appears to be highly important although it is lacking of implementation. This insight highlighted the importance of the initially planned group model building sessions.

Although the group model building sessions did not take place the qualitative data analysis was used as a basis for developing a quantitative system dynamics model. The focus was placed on the pillar of quality of life, because improving the overall living quality of Vienna's citizens defines Vienna's meta goal.

As stated in chapter 2 of the literature review, a city that is not sustainable does not have the potential to become a city that is smart (Ahvenniemi, 2017). According to the widely-used definition of the Brundtland report, sustainable development is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs (Waas, 2010). Consequently, it is all about the handling of resource capacities in order to preserve them. That is why an exploratory model was built and a dynamic story was developed. The dynamic story explains what attracts people to come to Vienna and how this attractiveness varies depending on the exploitation of essential resources. The author wanted to emphasize that Vienna needs to understand and to control its basic resource capacities before it starts implementing a strategy which aims to attract even more people. By building the system dynamics model it was shown that basic needs such as housing, jobs and green space per person ought to be satisfied before individual needs can be approached.

The smart city strategy Vienna incorporates themes such as housing and green space. However, it mainly discusses the increase of attractiveness of those city sectors by leaving out negative side effects, delays or feedbacks of the increased growth of population. This is actually in conflict with the overall goal of the strategy which aims to minimize resources by being the most populated city in Europe by 2050. That is why for the author the following critical question arises: *Is the urban label smart city Vienna exclusively used for marketing purposes?*

The increase of urban areas is a complex, social phenomenon and therefore hardly to understand (Yin, 2013). Smart city strategies are visions which are lacking of a commonly defined guideline and tools to overcome emerging challenges.

This research project aimed to unwrap the label *smart city* by analysing it with a critical eye, by comparing information gathered through various sources and by simulating it main dynamics. It presents the basis for further research, for challenging the concept of smart city strategies and for improving mental models for the successful implementation of the smart city policy.

6.2. Limitations and Further Research

The major limitations of this research project were related time and data constraints.

As stated through the entire research project, smart city strategies are visions. Smart city strategies are fuzzy and they are lacking of a common definition, goal and tool for overcoming emerging challenges, whereby those challenges are unknown as well. Consequently, they are highly uncertain. Experts who are involved in the development of smart city strategies are most able to give concrete information on the operationalisation and details for implementation.

Therefore, a larger time frame would have given the author the possibility to talk to more experts and to study the subject more in depth. This would have given the possibility to gather more data, which would have enriched the simulation model.

The mentioned constraints point to the need for further research.

Given that this research partly took place in Vienna it leads to the suggestion to continue with it in Vienna. Therefore, it would be advisable to get into contact again with all four stakeholders in order to organize a follow up group model building session.

Firstly, the follow up group model session would make the stakeholders familiar with the tool of quantitative system dynamics modelling. Secondly, it would foster a discussion about what has been the starting point, the process and the output of this research project. A group model building session would also deliver more data and would support the further construction of the model by aiming to develop scenarios. Thirdly, it would discuss the topic from different perspectives, since all four stakeholders have another background and another profession.

Under the circumstance that a major limitation of smart city strategies is the lack of a common definition, group model building could be an appropriate method for overcoming this challenge. It could support the creation of a common language amongst the stakeholders and help to unwrap the label *smart city*. The author already experienced great enthusiasm when talking about group model building with each stakeholder and consequently assumes that it would meet the approval of the expert group.

Next to the work with stakeholders it is suggested to extend the data research and to compare multiple smart city strategies of European capitals. This should support the understanding of similarities and differences in order to be able to capture a common thread throughout smart city strategies. The goal would be to unwrap the label smart city, to find a common definition and to turn it into a successful policy, which is applicable in European urban areas.

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Annex A: The interview scripts

Interview- Leitfaden

Zu Beginn möchte ich Sie kurz über den Hintergrund dieses Gesprächs aufklären. Meine Masterarbeit ist eine Fallstudie und beschäftigt sich damit, inwiefern partizipative Ansätze einen Beitrag dazu leisten können, um Nachhaltigkeit bzw. smart city strategien langfristig und erfolgreich zu implementieren, insbesondere im Bereich smart city logistics. Dabei werden als Vergleich zwei europäische Hauptstädte herangezogen, nämlich Wien und Lissabon. Wien ist eine zentraleuropäische Stadt mit vielen Traditionen, viel Grünfläche und einer außerordentlich gut funktionierenden Infrastruktur. Aus wirtschaftlicher und touristischer Sicht ist Wien auch sehr wettbewerbsfähig.
Lissabon ist eine südeuropäische Stadt, mit einer schwachen Wirtschaft, einer außerordentlich schwachen Infrastruktur aber genauso wie Wien gezeichnet durch einen historischen Stadtkern, einen konkurrenzfähigen Tourismus und vielen Traditionen.

Zur Methode System Dynamics, die ich anwende.
System Dynamics ist eine am Computer simulierte Technik, die sich mit komplexen und auf Systemen basierenden Problemen befasst. Auf Systemen basierende Probleme sind charakterisiert durch endogenes, nicht lineares und dynamisches Verhalten, das Rückkopplungsschleifen (feedback loops) verursacht. Mithilfe von Modellen, die am Computer simuliert werden ist es möglich Probleme zu veranschaulichen, zu analysieren und zu erforschen. Zusätzlich können Strategien entwickelt und getestet werden, bevor ihre Umsetzung in der realen Welt beginnt.

Auf Basis von Literatur über smart city hab ich dieses Model erstellt und möchte dieses nun anhand von Fragen und Ihres Expertenwissens verifizieren.
Ich möchte Sie noch um Ihr Einverständnis bitten, dieses Gespräch aufzuzeichnen?!
Ich möchte Sie auch noch darüber informieren, dass Sie das Gespräch jederzeit unterbrechen bzw. abbrechen können, sollten Sie sich beim Beantworten einer Frage unwohl fühlen.
Das Ergebnis dieses Gesprächs wird ausschließlich zum Zweck meiner Masterarbeit dienen.
Haben Sie noch weitere Fragen oder ist etwas unklar? Sollten Fragen während des Gesprächs aufkommen, bitte ich Sie mich jederzeit zu unterbrechen, um diese zu beantworten bzw. zu klären.

1.) Was ist das Interesse Ihrer Organisation an der Entwicklung und Umsetzung von smart city logistics Wien?

2.) Repräsentiert das erklärte, systemwissenschaftliche Model die wesentlichen Bereiche der smart city logistics Wien?

- Welche Bereiche sind Ihnen neu? Welche würden Sie eliminieren, welche hinzufügen?

Ich bitte Sie jetzt unter den 11 repräsentierten Kreisläufe jene rauszupicken, mit denen sich Ihre Organisation am meisten beschäftigt.

3.) Welche Rolle spielt ICT bei den smart city logistics Wien?

- Inwiefern agiert ICT mit anderen Bereichen der smart city logistics Wien?
- Welche stakeholder sind involviert, die an ICT und smart city logistics Wien arbeiten?

4.) Wie hat sich die Energiewende auf die smart city logistics bisher ausgewirkt?

- Was würden Sie zu aktuellen und zukünftigen Trends sagen?

5.) Im Laufe der Zeit hat sich das Verhalten von Konsumenten und Produzenten verändert. Inwiefern spielen smart city logistics darin in eine Rolle?

- Wie würden Sie diese Entwicklung begründen?
- Was werden die Konsequenzen dieser Entwicklung sein?

6.) Spielt Zusammenarbeit im Bereich der smart city logistics Wien eine Rolle?

- Könnten partizipative Methoden potentielle Methoden für die Zukunft sein?

7.) Wie hängen smart city logistics Wien und die Privatisierung von Daten zusammen?

- Wie werden Daten in Wien gesammelt?
- Wie könnten mögliche Probleme, die in der Zukunft aufkommen, gelöst werden?

8.) Ist Ihre Organisation abhängig von Datenaustausch?

- Wie würden Sie die Entwicklung von Datenaustausch für die Zukunft prognostizieren?

9.) Welche Rolle spielt der Menschenfokus in Ihrer Organisation im Bereich smart city logistics Wien?

- Am Beispiel Pflegebedürftige Menschen

10.) Welche positiven und negativen Entwicklung der smart city logistics Wien prognostizieren Sie für die Zukunft?

- Welche potentiellen Strategien diese (positiven oder negativen Entwicklungen) zu unterstützen oder zu verhindern gibt es bereits?

Annex B: The interview transcripts

The author mentioned in parenthesis emotions of the stakeholders or herself as well as if someone did not finish a sentence. The author in parenthesis also explains Austrian colloquial expressions which has been used during the interviews.
The order of how the transcripts are presented in annex B are in alphabetical order.

Interview: Verena Eder Business Agency Vienna 24th April 2017

Interviewer: Monika Pichler (P)

Interviewe: Verena Eder (E)

Date the interview was conducted: 24th April 2017 in Vienna

Person, who is transcribing the interview: Monika Pichler

Date of transcription: 16th May 2017 in Lisbon

P: Also die erste Frage wäre ob Sie können die Kreisläufe mit welchen beschäftigt sich die Wirtschaftsagentur am meisten? Oder allen oder gar keinen? Also, ich hab sie auf diesen Karteikarten aufgeschrieben mit einer kurzen Erklärung nochmal was jeder Kreislauf darstellt.

E: Also im Großen und Ganzen beschäftigt sich die Wirtschaftsagentur als Gesamtunternehmen vermutlich mit allen oder fast allen.

P: Ok.

E: Weil wir im Prinzip uns ja nicht auf ein bestimmtes Themengebiet fokussieren, sondern wir sind einfach dazu da Wiener Unternehmer zu stärken und in ihrem Fortkommen beizutragen.

P: Ok.

E: Also wir haben Abteilungen, die sich mit Immobilien befassen. Also wir haben selbst Immobilien für Start-ups, für weiter fortgeschrittene Firmen. Wir haben auch Gewerbeflächen Seestadt Aspach, ist vielleicht auch ein Begriff, da hängen wir auch mit drin.

P: Ok.

E: Was ja mit diesem ganzen Bevölkerungswachstum, Arbeitsplatzgenerierung doch sehr stark eine große Rolle spielt. Und sonst, wir richten uns an alle möglichen Formen von Unternehmen, von Start-up bis zum internationalen Unternehmen, das sich überlegt, ob es sich in Österreich oder halt insbesondere in Wien ansiedeln soll.

P: Ok.

E: Und im kleinteiligeren Bereich betreuen wir eben diese Unternehmen bisschen nach Themengebiet. Also mein Themengebiet ist generell Mobilität.

P: Ok.

E: Wo Logistik reinfällt, wo Telematik reinfällt, wo Fahrradverkehr reinfällt, also quer durch Elektromobilität.

P: Ok. Ok.

E: Ja. Und wir haben solche Personen wie mich für sämtliche Themengebiete. ICT-Themen im Detail, Produktion in der Stadt bis hin zu "*awareness*" für Schulkinder.

P: Ok. Ok. Super. Und was ist das genaue Interesse sich mit der smart city Strategie zu befassen? Also was ist das Interesse von der Wirtschaftsagentur sich daran zu beteiligen?

E: Eines der Hauptinteressen ist sicher eben diesen international doch recht hohen Standard von Wien, also Wien ist immer so ein Beispiel für die smart city. Auch international nach wie vor weil eben. Es gibt ja diesen, wie nennt sich das, diesen, es gibt eine Publikation, die ist ein paar Jahre alt zum Thema smart city mit eben Zielsetzungen was bis wann passieren soll und Maßnahmenvorschlägen. Das kennen Sie sicher?

P: ja das kenn ich *(durcheinander reden)*

E: Mir fällt leider grad nicht ein wie´s heißt. *(lachen)*

P: Es ist sicher so eine Rangliste oder so, hab ich im Kopf.

E: Smart City Rahmenstrategie.

(lachen)

E: Genau. Genau da waren wir auch ein bisschen mitbeteiligt mit der Erstellung. Natürlich ist alles was da drinsteht, alle Unternehmen, die da dazu beitragen können, ist natürlich für uns noch interessanter bzw. es ist auch bisschen ein Ziel die Unternehmen dahin zu bringen.

P: Ok.

E: Diesen Strategievorgaben, diesen Rahmenideen zu folgen.

P: Ok. Also im Großen und Ganzen diese, also diese Strategie oder die Ziele von der Strategie zu erreichen, das ist ihr Hauptinteresse?

E: Genau.

P: Ok. In allen Bereichen oder so viel wie möglich?

E: Genau.

P: Ok. Und dann. Dann gehe ich auch davon aus, dass dieses Model schon reflektiert was Sie machen zum Großteil?

E: Zum großen Teil, ja. Es gibt natürlich Randbereiche, wo wir jetzt nicht viel Einfluss haben, natürlich.

P: Ok. Ok. Können Sie ungefähr sagen inwiefern ICT mit anderen Bereichen von smart city logistics zusammenwirken?

E: Also in meinem Empfinden. Also ICT ist ja überall mit drin.

P: Ja. Mhm.

E: Also das ist ein Themenbereich, den kann man inzwischen eigentlich gar nicht mehr außer Acht lassen, weil´s doch alle diese Lösungen oder alles was sich entwickelt im Logistikbereich hat immer eben mit einer App oder einem Programm oder mit irgendeiner Telematiklösung zu tun, was ja im Grunde einfach nur ICT ist.

P: Würden Sie dem jetzt einen besonderen Stellenwert geben oder ist es gleich wichtig wie andere Bereiche? Bezogen auf den Bereich Logistik?

E: Ich glaub schon, dass das ein bisschen eine stärkere Bedeutung hat, als manch anderer.

P: Ok. Ok.

E: Also es ist jetzt im Gegensatz zu den Themen wie diese Steuern. Steuern ist natürlich ein Grund etwas zu machen, aber ICT ist halt das Tool zur Umsetzung.

P: Ok. Ok. Und die Stakeholder, die involviert sind, um diese Technologien umzusetzen in Wien bei die logistics. Können Sie das irgendwie eingrenzen? Oder ist es breitgefächert?

E: Stakeholder im Sinne von solchen die Logistik betreiben oder solche die quasi Vorgaben geben wie´s ausschauen soll in Zukunft?

P: Die sich praktisch mit ICT und smart city logistics beschäftigen. Oder würden Sie sagen es sind rein IT-Experten, die sich damit beschäftigen?

E: Sicher nicht rein IT-Spezialisten. Es sind dann eher die IT-Spezialisten, die irgendwann hinzugezogen werden, weil´s halt ohne die dann nicht mehr geht.

P: Ok. Ok. Und können Sie sagen inwiefern sich die Energiewende auf die smart city logistics bisher ausgewirkt hat?

E: Also ich denke, dass das wahrscheinlich auch in Zukunft noch stärker wird, weil es gibt ja die Vorgaben seitens der EU mit der emissionsfreien Logistik in der Stadt bis 2030. Und das fängt, also es sind jetzt grad die Firmen dabei und auch die Unternehmer sich da was zu überlegen, weil die Zeit vergeht sehr schnell. Ja und, es werden momentan, es wird sehr viel überlegt.

P: Ok.

E: Aber ich glaub in der Umsetzung "*happerts*" (österreichischer Ausdruck für nicht funktionieren) noch.

P: Ok. Ok. Und glauben Sie das ist wichtig, dass, also die Zielgruppen später für diese Technologien, weil momentan sind die Technologien auch für z.B. meine Generation nicht wirklich erschwinglich, als Studentin, aber meine Generation wäre vielleicht die stärkste Zielgruppe, die des benutzen würde weil wir das, mit dem Bewusstsein mehr aufgewachsen sind. Also inwiefern ist das relevant glauben Sie? Inwiefern wird das miteinbezogen gerade?

E: Es spielt sicher eine große Rolle, weil man muss schon auch bedenken in dieser, grad diese Logistikthematik, generell Mobilität ist, wenn man's jetzt blöd ausdrückt auch noch sehr männerdominiert und jetzt auch nicht gerade, dass das jetzt alles 25jährige Männer sind, sondern jeder schon bisschen weiter fortgeschritten und da ist sicher nicht immer dieses Bewusstsein oder auch der Wille vielleicht nicht immer ganz so stark wie er vielleicht sein sollte.

P: Ok.

E: Um das möglichst schnell voranzutreiben, weil es ist natürlich wenn man jetzt nimmt, keine Ahnung den Hafen oder irgendein großen Spediteur, die arbeiten ja seit 100 Jahren in diesem Gewerbe und es hat immer irgendwie funktioniert.

P: Ja das stimmt.

E: Da reinzukommen mit der Idee jetzt ändern wir alles. Sobald dann irgendwas kurz mal nicht funktioniert ist natürlich "Ich hab's euch doch gesagt und früher war alles besser".

(lachen von beiden Seiten)

P: Ok. Ja die Frage war deswegen, weil die smart city Strategie ja Wien auch, also das Handbuch, was sie rausgebracht hat, auch wirklich klar definiert, dass sie wollen so junge und innovative Menschen wie möglich anziehen. Daher kommt der Gedanke eigentlich.
Inwiefern glauben Sie, was sind die zukünftigen Trends bei dieser E-Mobility? Für Wien jetzt immer?

E: Also ein Haupttrend ist sicher weg vom Besitz. Also das wirklich das Privatpersonen Fahrzeuge besitzen, jetzt nicht nur Autos, sondern generell auch Fahrräder. Es gibt sehr viel Initiativen, da ein sinnvollen Verleihsystem, das dann auch möglichst unkompliziert, wo man sich jetzt nicht Wochen vorher anmelden muss "Ich möchte gerne an diesem Tag für eine halbe Stunde Fahrzeug X benutzen", sondern dass das wirklich von jetzt auf gleich funktioniert. Die Herausforderung ist natürlich, weil das Ziel ist ja immer Fahrzeuge, also es sollen weniger Fahrzeuge unterwegs sein.

P: Genau, genau!

E: Aber natürlich wenn ich verspreche jeder kann jederzeit alles verwenden.

P: Ja

E: Ist die Frage ob, dass dann wirklich weniger Fahrzeuge sind.

P: Das stimmt, ja. Ok. Also das ist praktisch so ein negativer Effekt, der sich ergeben könnte.

E: Genau. Und natürlich im Speziellen im Zusammenhang mit der Logistik eben mit dieser Vorgabe mit der Emissionsfreiheit.

P: Ja.

E: Ist das natürlich auch eine sehr große Überlegung, dass man zumindest im Innerstädtischen Bereich, da kleinere LKWs oder anders geartete Fahrzeuge verwendet, die halt dann elektronisch betrieben sind. Also es gibt da auch momentan einige Pilotversuche am Hafen Wien. Die haben sich jetzt einen Elektro-LKW angeschafft mit dem sie so Testfahrten machen. Ich glaub der wird noch nicht jetzt wirklich für Auslieferungen verwendet, aber sie probieren mal wie das alles funktioniert.

P: Ok. Ok. Und wo glauben Sie kommt dann der Strom her, oder die Energie irgendwann, wenn sich diese Wende, also ja, momentan sind wir gerade in der Wende, dass sich das ändert. Wenn die Wende dann da ist, woher will Wien die ganzen Energien nehmen?

E: Also es funktioniert ja sehr viel über solar.

P: Ok.

E: Es ist momentan, es gibt wieder Projekte mit Geothermie. Soll auch dann, ich weiß nicht genau was sie da genau vorhaben, ob sie das rein zum Heizen verwenden wollen oder ob sie da irgendwie andere Transformatorenprozesse in die Wege leiten wollen. Ja.

P: Aber bis jetzt hauptsächlich solar?

E: Sehr viel ja. Grad im kleinteiligeren Bereich, eben dass größere Unternehmen über große Dachflächen generell verfügen. Da kann man eigentlich relativ problemlos was installieren.

P: Ok. Ja und im Laufe der Zeit hat sich auch das Verhalten von Konsument und Produzent verändert eigentlich. Also ich nehme wieder mich selbst, als Beispiel: ich bestelle sehr viel auch im Internet und die Entwicklung geht jetzt auch hin zu Drohnen oder was *Amazon* vorhat. Und wie glauben Sie ist da Wien oder was erwartet sich Wien in der Zukunft für seine Logistik?

E: Jetzt ist es ja generell ein Recht interessantes Thema, weil man glaubt immer es geht immer mehr weg vom stationären Handel immer mehr hin zu online Handel, was aber gleichzeitig immer mehr ein Thema wird ist das ich mir zwar meine Produkte im Internet aussuche oder mir vorbestelle, dass ich sie aber dann im stationären Handel abhole.

P: aha. Ok.

E: Da war grad letztens ein Vortrag zu dem Thema wo´s eben gesagt wurde, dass es gar nicht so sehr stimmt, dass dieser Onlinehandel wirklich im Sinne von "ich bekomme es nach Hause geliefert"

P: Ok.

E: Dass das so ein gewaltiger Anteil ist, sondern, das die Leute schon das auch gern haben, dass ich sag ich geh in das Geschäft wo ich weiß wie lange es offen hat, wo ich mir die Dinge, wenn´s jetzt irgendwas ist, wo ich mir nicht 100% sicher bin auch einfach anschauen kann und dann direkt dort lassen kann wenns *(führt den Satz nicht zu Ende).*

P: Glauben Sie vielleicht es hängt auch mit der österreichischen Kultur zusammen, dass man das...

E: Sicher. Sicher auch. Und es ist sicher auch ein urbanes Thema.

P: Also im Sinn von wie schnell man zu dem Punkt gelangt, wo man´s abholt.

E: Genau. Weil was natürlich auch...was da eine Änderung bringen könnte: es ist momentan doch hauptsächlich, dass es bei der Post dann liegt oder in einem von diesen Abholstellen, die natürlich auch z.B. am Sonntag zu haben oder am Samstag meistens auch und unter der Woche auch nur bis 18. Das ist halt für manche auch schwierig, dass man dann an seine Waren kommt...

(lachen)

P: Das stimmt, ja.

E: Wenn sich da jetzt mehr tun wurde in Richtung rund um die Uhr betretbare Verteilräumlichkeiten, wo es ja auch einiges schon gibt *(wird von P unterbrochen).*

P: Bei der Post z.B.

E: Bei der Post gibt's es. Es gibt auch ein paar kleinere Firmen, die da Ideen haben mit diesen Erdgeschosszonen, quasi bevor das leer steht machen wir da Schränke rein, wo man sich mit einem Code seine Pakete abholen kann. Wenn sich in die Richtung mehr tut, was geplant ist, aber was natürlich auch dann wieder schwierig wird Zutrittsberechtigungen und wie komm ich da rein und wie komm ich da wieder raus.

P: Ok. Ok.

E: Aber ich glaub dann würd´s vielleicht ein bisschen mehr werden, dass sie die Leute Dinge einfach bestellen.

P: Ok. Sagt Ihnen Joint Delivery Systems irgendwas?

E: Ich hab's gehört, aber ich bin mir jetzt nicht 100% sicher.

P: Das wurde in ein paar Städte ausprobiert. In Frankreich oder auch in China. Es sind praktisch so Abholstellen. Es ist als Strategie eingeführt worden, um den Verkehr zu minimieren und das Paket so nahe wie möglich an mein Haus kommt, aber nicht in mein Haus geliefert wurde. Aber dann wäre das auch eine mögliche Idee für Wien?

E: Da gibt's in Wien eine Idee, das nennt sich "*Grätzlbox*".

P: Hab ich mal gehört, hab ich das Gefühl. Ok.

E: Genau. Aber soweit ich weiß, noch quasi Forschungsidee. Also es gibt da noch keine Umsetzung, soweit ich weiß. Da wäre eben die Idee dahinter, dass man eben in Wohngegenden eben so leerstehende Geschäftslokale oder so, einfach so Räumlichkeiten da anbietet, wo man sagt, die im Umkreis von 300m wohnen, die können dort ihr Postfach quasi opfern.

P: Ok. Ja. Die Zusammenarbeit, also smart city involviert ja wie wir gesehen haben viele Bereiche. Arbeiten diese Bereiche auch zusammen, Ihrer Meinung nach? Oder inwiefern spielt die Zusammenarbeit eine Rolle?

E: Zusammenarbeit spielt eine sehr große Rolle. Wurde wahrscheinlich in der Vergangenheit ein bisschen stiefmütterlich behandelt, aber es wird mehr. Also diese Erkenntnis, dass einfach die meisten Dinge nicht nur eine Branche oder einen Teilbereich betreffen, die ist da. Es ist natürlich in diesen gewachsenen Strukturen ein bisschen schwierig das zu ändern.

P: Also irgendwie verfolgt, dann doch jeder seine eigenen Ziele?

E: Genau.

P: Ok. Also würden Sie sagen, dass Partizipation, also so partizipative Methoden, wie es eigentlich der ursprüngliche Plan war von den Workshops, die leider nicht zu Stande gekommen sind, wäre das eine Idee für die Zukunft?

E: Auf jeden Fall.

P: Ok. Ok.

E: Genau, es wird auch sehr viel inzwischen verwendet für so Sub-Prozesse. Also jetzt nicht nur zwischen den Stakeholdern, die wirklich einen Einfluss haben, sondern auch mit diesen ganzen Bürgerbeteiligungsansätze.

P: ah. ok. Hat Wien schon etwas gemacht in dieser Richtung?

E: Es gibt da einige Projekte. Es gibt z.B. ahh wie heißt denn das, in Simmering gibt es ein Projekt das nennt sich "*smarter together*". Da geht es drum, dass die meisten, ein bestehendes Stadtviertel zu optimieren. Also was Mobilität betrifft, was wohnen betrifft, ich glaube auch mit Energieversorgung. Weil normalerweise diese Stadtteilprojekte das wird meistens in Neubaugebieten gemacht. So was wie Aspach oder so, wo man halt wirklich von Beginn an mitdenkt, wie man das optimal machen könnte mit dem Verkehr und mit der Verfügbarkeit von eben Leihfahrrädern und so weiter und sofort. Und im Simmering gibt es diese Idee das nachträglich in einem bestehenden Wohngebiet zu optimieren und da werden eben sehr viel die Anwohner einfach miteinbezogen weil es oft auch einfach nur darum geht die Leute zu informieren. Wenn dann solche Ideen scheitern, liegt das oft einfach daran, dass keiner wusste, dass es da was gibt.

P: Aber Interesse besteht?

E: Interesse besteht ja. Es gibt natürlich immer Leute, die sagen, das brauchen wir nicht und sinnlos, aber Interesse ist da und im Grunde sobald man zumindest zwei oder drei erreicht hat, hat man ja schon *(führt Satz nicht zu Ende).*

P: Ja das stimmt und die anderen ziehen mit.

E: Genau. Hoffentlich.

(lachen)

P: Das führt eigentlich über zum nächsten Thema. Wie hängen die smart city logistics Wien und die Privatisierung von Daten zusammen? Sie haben ja selber gesagt, Zusammenarbeit spielt eine wichtige Rolle und es entwickelt sich mehr in das *sharing* aber ICT, so viel ich darüber weiß, basiert viel auf die Datensammlung und das Daten teilen und das Daten analysieren. Aber, ja, wie werden diese Daten gesammelt und wem gehören sie dann später?

E: Daten, ist sowieso ein schwieriges Thema, weil natürlich große, grad große Firmen oder große Stakeholder meistens nicht wollen, dass die Daten, die sie erheben oder verwenden frei zugänglich sind für andere. Natürlich kleinere Unternehmen sind da sehr interessiert, auch die Forschung ist da auch sehr interessiert, dass man da nicht 100.000€ ausgeben muss. Ja es ist ein komplexes Thema. Wird aber derzeit auch angegangen. Es gibt da ein Projekt, das ist glaub ich vor kurzem gestartet, das nennt sich *datamarketaustria.*

P: Ok.

E: Da ist, also ich bin da nur am Rande, habe das mitbekommen. Es soll eben drum gehen, dass *open data* für viele Bereiche sinnvoll ist, dass man eben als Unternehmer oft was Daten nicht direkt mit dem eigenen Tätigkeitsbereich zu tun haben, dass es da sehr tolle Ansätze geben könnte, was für sich selbst und andere einen Mehrwert generiert. In dem man eben andere Daten nutzen kann und im Gegenzug vielleicht von sich etwas weitergibt. Natürlich ist immer diese Persönlichkeitsrechtgeschichte, immer ein bisschen schwierig.

P: Ja genau. Ok. Glauben Sie, dass z.B. so wie im Model jetzt war, dass Regelungen von oben herab nötig sind oder dass, das alleine bei den Unternehmen passieren wird, dass sie das irgendwie regeln mit die Daten jetzt?

E: Ich mein es braucht sicher einen gewissen Rahmen von oben.

P: Ok.

E: Was erlaubt ist, was nicht erlaubt ist. Aber wirklich diese, was für die Benutzung sinnvoll ist, muss natürlich von unten kommen.

P: Ok. Und glauben Sie hängt das auch zusammen mit, immer bezogen auf die Daten und Wien, das hängt auch zusammen mit der *cross sectoral collaboration*, dass man sagt ok, zuerst wir wollen irgendwas entwickeln und da schaut für uns alle was raus aber in dem Moment wo was rausschaut, will jeder sich da abzweigen und sagen "nein ich will den Erfolg jetzt allein einfahren als Unternehmen"?

E: Hängt definitiv damit zusammen.

P: Ok. Aber hat man sich da schon Lösungen überlegt für die Zukunft oder eher weniger?

E: Ich glaub teils, teils.

P: Ok. Ok. Und ist die Wirtschaftsagentur Wien abhängig von dem Datenaustausch?

E: Jetzt sicher nicht so sehr wie andere, weil wir selbst jetzt nicht irgendetwas entwickeln. Was natürlich für uns schon interessant ist, sind gewisse statistische Daten, die z.T. frei verfügbar sind, die man aber z.T. auch zukaufen muss.

P: aha. Ok.

E: Beziehungsweise generell ist es halt natürlich grad statistische Daten dauert ja. Es braucht ja eine gewisse Zeit bis das aufbereitet ist für Dritte. Es ist eben das Problem frei verfügbar sind z.B. jetzt haben wir 2017, die aktuellsten frei verfügbaren, statistischen Daten zum Standard sind von 2014. Da hat sich halt ein bisschen was getan wahrscheinlich.

(lachen)

P: Hoffentlich. Oder ich weiß nicht, ja. Ok. Und welche Rolle spielt der Menschfokus für die Wirtschaftsagentur? Sie haben gesagt, Sie unterstützen Jungunternehmer z.T. aber jetzt im Sinn von wie der Kreislauf von Altenbetreuung im Model ist. Spielt das irgendwie eine Rolle, wird das miteinbezogen bei den ganzen neuen Ideen, die was man sammelt?

E: Es ist jetzt sicher kein Fokusbereich, wo es immer wieder Unterstützung gibt. Wir haben natürlich...wir verwalten ja die Unternehmensfördergelder der Stadt Wien. Und, wir haben da alle möglichen Förderprogramme, wo man eben zu verschiedensten Themen einreichen kann und da gibt's schon immer wieder Projekte aus dem Pflegebereich, die da gefördert werden und die da *(führt Satz nicht zu Ende).*

P: ah Ok. also spielt das definitiv eine Rolle.

E: Es ist jetzt kein Thema, das man jetzt wirklich bei uns auf der Homepage finden wird als Fokusthema aber wenn Firmen kommen mit einer guten Idee und sich da bewerben für eine Förderung, das hat meistens recht gute Chancen, weil es eben *(führt Satz nicht zu Ende).*

P: Also ist es eher situationsabhängig?

E: Genau. Genau.

P: Ok. Jetzt sind wir eigentlich schon bei der letzten Frage. Welche positiven und negativen Entwicklungen sehen Sie für die Zukunft für die smart city im Allgemeinen in Wien? Ich mein die Ziele sind ja hoch gesteckt und für 2050, wie Sie selber schon gesagt haben, die Zeit vergeht sehr schnell. Und inwiefern glauben Sie sind auch negative Effekte von dieser Strategie wichtig?

E: Was man wahrscheinlich beachten muss in all diesen Optimierungsversuchen eben was diese ganze Mobilität betrifft, wenn man das jetzt wirklich umsetzen würde bis 2030 müsste man jetzt sofort anfangen sämtliche Fuhrparks, sämtliche Fahrzeuge eigentlich auszutauschen. Wo dann halt wieder die Gegenfrage ist, wenn man sich das große Gesamte anschaut, wenn man jetzt nicht nur schaut welche Emissionen verursachen diese Fahrzeuge am Standort sondern was ist mit der Verschrottung der vorigen Dinge, was ist mit der Produktion der neuen Fahrzeuge, wo kommt eben die Energie her, wie ist das mit den Batterien, wo ja doch sehr fragwürdige Dinge passieren im Ausland. Mit den ganzen Rohstoffen, die da in diesen Batterien drin sind. Ob sich das wirklich auszahlt wenn man sich da so beeilt. Wenn man den Gesamtlebenszyklus von all diesen Dingen anschaut. Und sich jetzt nicht nur fokussiert auf was passiert bei mir wenn ich ja vor Ort weder die meisten Dinge produziere, noch abbaue, noch sonst irgendwas damit mache.

P: Sozusagen im Ausland emittiere aber dann meine eigenen Emissionen sind ziemlich niedrig.

E: Genau.

P: Glauben Sie dann, dass z.B. dass im Sinn von warten, dass es wichtig ist, dass man der Innovation noch ein bisschen Zeit lässt, bis sich das entwickelt.

E: Genau. Das ist sicher auch ein Thema, weil das ist ja, wenn man sich anschaut die letzten Jahre Elektrofahrzeug. Die ersten Elektrofahrzeuge, das war ja eher eine Spielerei wo man dann halt ein paar Kilometer fährt und dann das Ding wieder einen Tag auflädt. Da hat sich jetzt doch einiges getan aber ich glaub das ist noch lange nicht am Optimalpunkt.

P: aha. ok.

E: Also was jetzt auch den Verbrauch angeht.

P: Ok. Und jetzt ist mir noch eine letzte Frage eingefallen.

E: Ja bitte.

P: Wegen. Es ist ja auch so, dass umso mehr ich als Bewohner schlecht angebunden bin an die Stadt, weil die Stadt wächst ja immer weiter, umso mehr vielleicht bin ich, verleitet es mich dazu mein eigenes Auto zu benutzen, weil ich einfach schneller bin und ja unkomplizierter. Und wie glauben Sie ist Wien. Wie wird sich Wien entwickeln wenn neue Stadtteile hinzuwachsen. Wird die Stadt es schaffen, das zu integrieren, dass vergleichsweise mit London, was ziemlich gut angebunden ist und ich kann auch eine Stunde, also in einer Stunde kann ich von weit draußen in die Stadt rein fahren.

E: Ich mein ich glaub wenn man sich die Pläne der Wiener Linien anschaut für die nächsten Jahre, dass da schon sich noch einiges zum positiven verändern wird. Mit der U1 Verlängerung in den Süden, die ja dann ja fast bis zur Stadtgrenze geht. Wo doch ein Bereich erschlossen wird mit der U-Bahn, die dann in 10 Minuten in der Innenstadt sind, die jetzt eine Dreiviertelstunde brauchen.

P: aha. Ok.

E: Es ist natürlich es gibt sicher einige Bereiche wo das weiterhin schwierig sein wird eben 21., 22. Bezirk. Alles was nicht direkt in der Nähe von der U-Bahn ist, glaub ich wird schwierig die Recht schnell von einem eigenen Auto abzubringen. Aber ich glaub die Entwicklung ist da doch im Vergleich zu anderen Städten doch sehr fortschrittlich.

P: Für Wien jetzt?

E: Genau.

P: Ja das stimmt sicher. Ok. das war's eigentlich schon!

Interview: Georg Hauger Transport Scientist TU-Vienna 25th April 2017

Interviewer: Monika Pichler (P)

Interviewe: Georg Hauger (H)

Date the interview was conducted: 25th April 2017 in Vienna

Person, who is transcribing the interview: Monika Pichler

Date of transcription: 21st May 2017 in Lisbon

H: Es ist ein sehr vereinfachtes Model, wo sehr, sehr viele Annahmen dahinterstecken, die man aus meiner Sicht mal transparent machen müsste. Weil diese Pfeile, verstärken, abschwächen, das ist nicht immer und überall zwingend so, das hängt von Rahmenbedingungen ab. Und das ökonomische Wachstum z.B. hängt vielleicht von der Anzahl der Personen ab, vielleicht aber auch nicht. Die Alterspflege, wie Sie gesagt haben, je mehr Menschen desto mehr Alterspflege ja aber möglicherweise je mehr Menschen, desto leichter wird die Alterspflege, *economies of scale* kommt dann ins Spiel.

P: Ja.

H: Was ich woanders vielleicht nicht hab. Das ist, diese Dinge sind nicht so simpel wie sie dargestellt werden. Passt es auf wen? Im Großen und Ganzen ist das eigentlich unabhängig von einer bestimmten Stadt. Also entweder das passt überall oder es passt nirgends. Es könnte aber sein oder im Bereich der Annahmen, dass ein paar Vorraussetzungen in Wien günstiger sind als in anderen Städten zum Beispiel.

P: Können Sie da ein Beispiel machen, wenn Sie, auf die Kreisläufe, also auf die Namen der Kreisläufe schauen?

H: Naja, ein Beispiel: number of vehicle, ja. Da könnte man jetzt sagen, also number of vehicles alleine ist ein z.B. ein schlechter Indikator für emissions, also da müsste ich z.B. sagen number of polluting oder emission vehicles.
Weil Wien ist ja gerade dabei zu versuchen die Anzahl der motorisierten Individualverkehrsteilnehmer oder Fahrzeuge zu reduzieren, also genau die, die Sie hier ansprechen.

P: Ok.

H: Also weniger fahrende Privatfahrzeuge.

P: Ja

H: Und da hat Wien zum Beispiel eine sehr gute Ausgangsposition, weil´s einen sehr, sehr guten öffentlichen Verkehr hat. Weil es Initiativen gibt immer mehr zu, im sogenannten Umweltverbund zu machen, also öffentlicher Verkehr, zu Fuß gehen und Fahrrad fahren. Also viel mehr Fahrräder.

P: Ok.

H: Number of vehicles, also wenn die Fahrräder steigen, dann sinken auch die Emissionen, also wenn man dann z.B. nicht mit dem Auto sondern mit dem Fahrrad fährt und auch wenn man nicht mit dem öffentlichen Verkehr fährt, weil der öffentliche Verkehr hat auch Emissionen, muss man dazusagen. Also da hat Wien einen Vorteil, wenn man so will, dieser Parameter ganz gut abgefedert ist, weil man versucht auf den Umweltverbund zu setzen.

P: Ok.

H: Dazu kommt, dass Wien eine gewisse Attraktivität hat und das müsste man vielleicht noch irgendwo darstellen, wie die Vorraussetzungen sind. Also Wien hat eine wachsende Bevölkerung. Ob mit der wachsenden Bevölkerung automatisch smart solutions kommen weiß ich nicht. Der Zwischenschritt wäre mit einer wachsenden Bevölkerung kommen aber kommen aber in einem gewissen Punkt Probleme.

P: Ok.

H: Und wenn man Probleme hat, dann kommen wahrscheinlich solutions aber nicht notwendigerweise kommt durch ein Wachstum, kommen gleich die Lösungen. Die Frage ist nämlich, wo sind die Wachstumsgrenzen.

P: Ok.

H: Also das ist ein typisches Beispiel, wenn man sich Holland oder so anschaut, da ist die Siedlungsdichte enorm im Vergleich zu Österreich oder im Vergleich zu Südtirol z.B. Und weil die schon solche Probleme haben aufgrund der Siedlungsdichte gibt’s dort natürlich viel schneller Lösungen, die wir noch gar nicht haben. Wir haben de facto in Wien noch keine dramatischen Probleme. Wir sind in allen rankings irgendwo immer auf Platz eins, zwei, drei und somit gibt’s auch de facto keine Emissionsprobleme.

P: Ok.

H: Und es gibt keinen Druck. Also die Emissionen, die Sie hier anschreiben, die sind noch nicht so hoch, dass ein unmittelbarer Handlungsbedarf der Politik ist zu sagen: Und jetzt ist Fahrverbot, so wie in Peking. Es ist ein Luxusproblem de facto. Also man müsste sich bei diesen Punkten sehr wohl anschauen, wie weit bin ich von einer Grenze entfernt. Erst wenn ich eine Grenze erreich, dann, dann kommt, also die environmental quality ist in Wien hervorragend nach wie vor. Sie könnte besser sein aber sie ist immer noch gut. Und weil sie gut ist, gibt’s kaum regulations. Es wird sich kaum ein Politiker trauen zu sagen jetzt machen wir Fahrverbot in Wien. Und wenn es diese regulations nicht gibt, dann ist auch die nächste Frage, wer, welcher Akteur kann Regeln überhaupt aufstellen. Angenommen in Wien wäre die Umweltqualität schlecht, wer kann bitte environmental oder fossil fuel tax machen? Wien nicht, das ist Bundeslogik. Also sie haben ja gar nicht die Werkzeuge in der Hand dann. Eine kleine Gemeinde hat das Werkzeug gar nicht in der Hand nationale Steuern zu beeinflussen, nicht mal Österreich kann sinnvoller Weise an der Steuern was ändern. Wenn wir die Mineralölsteuer dramatisch erhöhen würden, dann haben wir Tanktourismus, dann fahren die Leute halt irgendwo anders hin. Diese Dinge sind extremst komplex.

P: Ok.

H: Aber Wien, passt für Wien, Wien macht vorausschauend schon Einiges, um, bleiben wir beim Hauptpunkt von B1, die vehicles zu reduzieren. Was vor 20 Jahren eingeführt worden ist, ist die Parkraumbewirtschaftung.

P: Ok.

H: Der öffentliche Verkehr wird systematisch verbessert durch park and ride Anlagen. Die Pendler, die von Außen kommen, möglichst schon an der Stadtgrenze zu stoppen und dann in der Stadt zu kanalisieren. Viel mehr passiert da jetzt mal nicht. Stichwort city maut hat sich Wien noch nicht entscheiden können, da gibt´s aber andere Länder, die das haben. Mailand, Bergen, Stockholm, London, Singapur usw. Da wäre auch sozusagen, da gibt es verschiedene Maßnahmen um, entweder die number of vehicles oder vor allen Dingen die emissions, um die gehts ja eigentlich. Weil die Anzahl der vehicle ist ja im Prinzip "*wurscht*" *(österreichischer Ausdruck, dass etwas egal ist).* Das ist ja eher ein Kapazitätsproblem.

P: Ok.

H: Stellen Sie sich vor von heute auf morgen werden alle Autos in Wien elektrobetrieben. Gäbe es kein Problem mehr. Weil Stau haben wir nicht so viel und auch die Emissions wären dann weg.

P: Ok.

H: Die congestion, ja das ist Thema, ja das stimmt, da gibt es einen eindeutigen Zusammenhang zwischen congestion und number of vehicles, ist de facto aber kein Problem, kann man aber mit Mautlösungen lösen und wird auch gelöst durch z.B. zeitliche und räumliche Staffelungen von Preisen.

P: Und die city maut könnte Wien als Stadt selber durchführen?

H: Das könnte sie als Stadt selber durchführen, genau, ja. Da gibt's sozusagen wieder den einfachen Algorithmus: je attraktiver eine Stadt ist und darum ist es vielleicht auch, deswegen der Fall Wien, je attraktiver eine Stadt ist, umso strikter können Maßnahmen sein.

P: aha. Ok.

H: Also wenn Sie, nehmen wir jetzt ein Beispiel aus Südtirol, in Bruneck z.B. eine rigorose Parkraumbewirtschaftung machen, dann werden die Leute halt nach Bozen und nach Brixen fahren und nicht nach Bruneck, weils "*wurscht*" *(österreichischer Ausdruck, dass etwas egal ist)* ist, ja. Aber wenn eine Stadt sehr, sehr attraktiv ist, Venedig, dann zahlen die Leute einen Wahnsinnspreis fürs Parken, fürs Parken vielleicht bald so viel wie die Übernachtung.

P: Ok.

H: Also je attraktiver ich bin, umso eher kann ich als Stadt Maßnahmen setzen, also das müssen jetzt keine taxativen Sachen sein, sondern irgendwelche regulatorischen Maßnahmen.

P: Ok. Ok.

H: Also, da hat Wien eine großen Vorteil, als sehr attraktive Stadt, als mehr oder weniger Hauptstadt von Ostösterreich, kann man sagen oder auf jedenfalls von Niederösterreich, liegt genau in der Mitte, da findet die Wertschöpfung statt, da ist die Wirtschaft.

(Pause aufgrund von Telefonat)

H: Gut.

P: Kann ich schnell *(führt den Satz nicht zu Ende).*

H: Fragen Sie mir ist das lieber, als wenn ich so lange rede.

P: Sie haben ja gesagt, dass Emissionen für Wien nicht wirklich ein Problem sind. Trotzdem steht in der smart city Strategie, dass 2050 eine bestimmte Anzahl von, also um eine bestimmte Anzahl sollen Emissionen gesenkt werden. Also ist das trotzdem irgendwo relevant?

H: Naja, man muss unterscheiden zwischen Fakten und politischen Zielvorstellungen. Keine Frage, man braucht sich nur Fakten anschauen, man brauch sich nur Messstellen anschauen an wie vielen Tagen, werden an diesen Messstellen Grenzwerte überschritten und dann muss man sozusagen schauen, wer legt Grenzwerte fest. Wieder anderes Thema. Ist der Grenzwert ok? Ist der Grenzwert, werden die gleichen Grenzwerte zu Grunde gelegt in Wien, Peking, Stockholm oder gibt es woanders andere Grenzwerte. Und ich hab sehr pauschal gesagt die Emissionen sind kein Problem. Einzelne Emissionen, sind an bestimmten Tagen tatsächlich ein Problem, bei bestimmten Inversionswetterlagen, ist wahrscheinlich an bestimmten Tagen eine bestimmte Feinstaubbelastung besonders hoch oder NOX oder Ozonwerte, überhaupt keine Frage, dann bräuchte man aber ganz gezielte Maßnahmen, um exakt diese Emissionen zu senken und nicht Emissionen als Ganzes.

P: Ok.

H: Wenn Sie jetzt sagen so Emissionen generell no na will man Emissionen senken. No na will man die Verkehrssicherheit erhöhen. Jeder Unfall ist zu viel, das ist eh keine Frage.

P: Ok.

H: Also von daher ist klar, dass in einer smart city Strategie so Dinge drinnen stehen, wie eine wunderschöne, blühende Welt für alle, no na. Die Frage ist nur der politische Druck wo kommt der her? Der kommt dorthin, wo ein Engpass ist. Und ich kann Ihnen sagen, wenn es einen Nachweis gibt, dass keine Ahnung, Umweltmaßnahmen wirtschaftsschädigend sind, zumindest kurzfristig, dann wir man das nur schwer argumentieren könnnen.

Also ein aktuelles Beispiel, ich weiß nicht ob Sie es mitbekommen haben, ist in Wien am Flughafen die dritte Piste.

P: Ok.

H: Die wollten eine dritte Piste planen. Dafür gab es eine Umweltverträglichkeitsprüfung und in letzter Instanz wurde vom Bundesverwaltungsgerichtshof die dritte Piste abgelehnt. Aber interessanterweise nicht aus klassischen UVP-Gründen, sondern aus Gründen einer Abwägung von öffentlichen Interessen und das öffentliche Interesse, so der Bundesverwaltungsgerichtshof, nach Emissionsreduzierung ist größer, ist größer, als die wirtschaftlichen Vorteile durch diese Piste.

P: Ok.

H: Das ist zum ersten Mal, dass ein Bundesgericht, wenn Sie so wollen, die Umweltaspekte höher gewichtet haben, als das sogenannte Wirtschaftswachstum usw.

P: Ok. Verstanden.

H: Das geht aber nur so lange gut, so lang es der Wirtschaft einigermaßen gut geht. Wenn es jetzt der Wirtschaft nicht gut geht und wir haben Beispiele aus Deutschland, Deutschland war immer Vorreiter, was Klimaschutz betrifft, wenn dann aber große Konzerne sagen, gut wenn ihr so strenge Auflagen habt, dann wandern wir halt aus. Dann sind wir halt nicht mehr in Deutschland, sondern in China oder sonst wo, na dann wird sehr schnell zurückgerudert und gesagt, da hängen viele Arbeitsplätze dran.

P: Ja. Ok.

H: Machen wirs lieber so. Also es werden die Maßnahmen, dann eher abgeschwächt gemacht und in Tirol als Beispiel haben wir diesen typischen Lufthunderter im Inntal zum Beispiel, das werden Sie schon gesehen haben, Emissionsschutzgesetz Luft. Weil die Politik, der Landeshauptmann im Konkreten die Aufgabe hat die Gesetze einzuhalten und er muss geeignete Maßnahmen finden. Da ist die geringste Maßnahme zu sagen, machen wir statt 130, 100.

P: Ja. Ok. Verstanden. Und bei die Maßnahmen für die, also es geht ja auch viel um e-mobility jetzt und car sharing, ja und inwiefern ist das für Wien, ist das ein relevantes Thema und woher glauben Sie wird die Energie herkommen, wenn man auf e-mobility umstellt?

H: Ja kommt immer darauf an in welchem Land ich mich befinde.

P: Also immer auf Wien bezogen.

H: Ich wollt nur grad sagen, befind ich mich in Norwegen kommt die Energie aus Wasserkraft zu 99%. Befinde ich mich in Österreich haben wir einen anderen Strommix. Man müsste sich anschauen, ich weiß es nicht auswendig, woher Wien konkret seine Energie bezieht. Es wird ein großer Teil Wasserkraft dabei sein. Es ist aber auch, wir sitzen da vis a vis von einem Fernzheizwerk und Müllverbrennungsanlage. Es wird viel nach wie vor aus kalorischen

Kraftwerken kommen. Wir haben Gott sei Dank kein Atomkraftwerk, aber wir haben kalorische Kraftwerke, wir haben Müllverbrennungsthemen, also es kommt aus verschiedensten Quellen. Nur, man muss eines aufpassen, man muss sich immer sozusagen den Gesamtkuchen anschauen. Wie viele Personenkilometer werden in Wien pro Jahr gefahren?

P: Ok.

H: Und wie viel davon werden in irgendeiner Form ge-shared gefahren?

P: Ok.

H: Und wie viel davon mit Elektromobilität. Und da kommt man drauf wir reden von Promillbereichen, von irgendwas.

P: Also jetzt in der Gegenwart?

H: Jetzt in der Gegenwart.

P: Aber in der nahen Zukunft auch.

P: Nahe Zukunft ist 10 bis 15 Jahre.

H: Da wird sich ja, selbst wenn sich, selbst wenn Elektromobilität einschlägt, vielleicht haben wir irgendwann Mal 10-15%, 20% keine Ahnung Elektromobilität, ja. Das ist immer noch ein kleiner Teil der gesamten Mobilität. Und wenn man sich anschaut, Vorreiterländer wie z.B. Norwegen: In Norwegen ist es ab 2025 verboten Benzin und Diesel betriebene Kraftfahrzeuge anzumelden. Dann heißt bis 2024 werden aber solche Fahrzeuge noch angemeldet und wie lang fahren diese Fahrzeuge dann noch. Die fahren dann ja noch 10, 15, 20 Jahre. Sind dann ja noch da, außer es kommt was Dramatisches, wie dramatische Benzinpreiserhöhung oder Steuern oder Einfahrtsverbote oder wirklich harte Maßnahmen. Also das Ganze hat einen wirklich sehr, sehr langen time-lack bis das dann zum wirken anfängt.

P: Ok. Aber dann ist jetzt Wien, nicht so, also nicht so wie Norwegen, wo das schon so geregelt ist?

H: Das ist bei weitem nicht so. Also was man braucht sich nur smart city Strategie von verschiedenen Ländern anschauen, es steht ja de facto überall das gleiche drinnen.

P: Ja, ja das stimmt.

H: Wäre jetzt nicht so besonders was Innovatives. Allerdings man muss schon dazusagen in Wien gibt´s den Vorteil, dass sozusagen ein breiter Konsens darüber besteht, dass diese Maßnahmen gut sind. Also sowohl bei der Politik, als auch bei den Nutzern. Es sind sehr viele junge Leute da, es sind sehr viele innovative Leute da, die sagen ja uns "*taugt*" *(österreichischer Ausdruck für es gefällt mir)* diese Art von Politik. Es könnte ja eine ganz andere Politik auch sein. Es könnte ja eine Politik sein, die sagt es geht uns gut, wir wollen nichts ändern, also es ist schon so, dass die Politik da versucht etwas zu ändern und auf ein offenes Ohr von einem großen Teil der Bevölkerung, vor allem aufgrund der jungen Bevölkerung, trifft.

P: Ok. Und um Wien noch umweltfreundlicher zu machen, als es schon ist, glauben Sie dass ein bestimmter Kreislauf wichtiger ist, als der andere, oder sozusagen der Startpunkt ist, für die nächsten zu folgen?

H: Das ist eine ganz schwierige Frage, weil das ist je nachdem wen Sie fragen. Ich würde sagen was das Wichtigste ist, ich bin geneigt zu sagen ein gewisses Wirtschaftswachstum ist das Wichtigste.

P: Ok.

H: Weil, so wie es in dem Kreislauf drinnensteht. Die Menschen werden älter, es werden mehr Menschen und sagen wir so, die Bedürfnisse bleiben gleich oder steigen sogar. Und alle drei Argumente kann man nur befriedigen indem die Wirtschaft wächst.

P: Ok.

H: Weil man kann nur das Verteilen auch zum Beispiel jetzt, auch an Studierende, an Pensionisten, an Sozialbedürftige wenn was zum verteilen da ist. Wenn ich nichts habe, dann kann ich auch nichts verteilen. Und damit man gut verteilen kann auf der einen Seite und auf der anderen Seite wirklich gute Maßnahmen im Sinne von, Umweltmaßnahmen sind teuer, setzen kann, brauch ich eine gewisse Wirtschaftskraft hier.

P: Ok. Aber es wird ja oft kritisiert dass irgendwann wird das Wachstum zu Ende sein, also Wirtschaftswachstum und wie glauben Sie kann man das dann *(führt den Satz nicht zu Ende).*

H: Das kann sein, das kann sein, bin ich jetzt nicht so pessimistisch, dass das Wirtschaftswachstum zu Ende ist. Es wird vielleicht intelligenter werden, es wird smarter werden.

P: Ok. Ok.

H: Weil es ist ja nicht gesagt. Schauen wir uns mal die Sektoren an. Wie viele waren früher im Landwirtschafts, primären Sektor tätig, wie viele im sekundären, wie viele im tertiären Sektor. Was haben wir jetzt in Österreich 1, 2% im Agrarsektor, der Rest sind Dienstleistung. Und wenn, wenn das Wirtschaftswachstum durch Dienstleistungen generiert wird *(führt den Satz nicht zu Ende).*

P: Ok.

H: Kann es ja eine saubere Dienstleistung sein. Das sind Transfers von Geldströmen von einer App zur anderen wo irgendwelche sauberen Mobilitätsformen angeboten werden. Wenn wir uns jetzt über eine Handygeschichte ein Uber bestellen oder uns eine shared mobility organisieren, dann entsteht dadurch ja auch ein Wirtschaftswachstum ohne, dass da jetzt bestimmte Emissionen entstehen würden dabei. Also intelligentes Wirtschaftswachstum würde ich sagen.

P: Würden Sie das dann zusammenhängen mit ICT?

H: Auf alle Fälle ja. Das ist derzeit natürlich die vierte industrielle Revolution, dass ICT die Basis für alle weiteren smarten Technologien sind. Smarte Technologien, smart unter Anführungszeichen beruhen im weitesten Sinn ja von Sensorik, Überwachen, regeln und steuern und das natürlich von irgendwo. Ob das, angefangen von der Raumtemperatur, dass man nicht sinnlos, wenn man nicht zu Hause ist, auf 25 Grad heizen muss, das man die Wärme allenfalls nutzt, das die Heizkreise zurückgefahren werden und so weiter, da gibt es ja viele Beispiele, wo man sozusagen nicht einmal einen Qualitätsverlust hat. Es geht ja nicht darum, so wie man in den 70iger Jahren gesagt hat, na diese Grünen, das sind die was mit einem Wollpullover im Kalten sitzen. Das muss nicht sein. Also man kann sozusagen Ressourcen sparen ohne einen Wohlfahrtsverlust zu haben.

P: Ok.

H: Ja, weil wie gesagt, wenn ich um 7 in der Früh das Haus verlasse, kann sich die Temperatur langsam absenken ohne dass da irgendjemand was juckt, ja. Alle Standby-Geräte können sich abschalten. Und wenn ich wieder da bin oder kurz vorher, kann ich über mein Handy das aktivieren, damit´s wieder usw., usw. Da kann man schon mit ICT unglaublich Ressourcen sparen ohne das irgendjemand was merkt.

P: Ok. Und im Bezug auf Logistik, also ICT und Logistik?

H: Da gibt´s auch ganz, ganz viele Forschungsthemen, wie man das alles noch effizienter gestalten kann. Von banalsten, von einer banalsten Lagerlogistik, wie ein Gabelstapler in einem Lager herumfährt, da gibt´s Einsparungspotential, unglaublich.

P: Ok. Ok.

H: Was auch durch eine gewisse Logik, Sensorik entsteht.

P: Ja.

H: Also da kann man auch wahnsinnig viel, viel, unsinnige Fahrten, unsinnige Energie, unsinnige Emissionen eliminieren dabei.

P: Und wenn man bei dem Thema Innovation bleibt. Wie glauben Sie entwickelt sich das Konsumentenverhalten mit neuen Technologien und hat das dann auch positive Auswirkungen auf den ganzen Verkehr, oder auf die Logistik? Wenn man jetzt sagt Leute bestellen mehr im Internet, es gibt Abholzentren oder es gibt sogar die Drohne, die irgendwas nach Hause bringt. Ist das für Wien relevant oder glauben Sie, dass Wiener, also die Bevölkerung von Wien auf so was anspricht oder ist das noch eher, der Kontakt zwischen Anbieter und Konsument wichtiger?

H: Da muss man nach Akteuren unterscheiden was die Akteure wollen. Wenn man es jetzt banal sagt, der Konsument, die Konsumentin wollen wahrscheinlich ihre Produkte möglichst schnell und billig haben in erster Linie.

P: Ja.

H: Die Stadt selber, also wenn ich jetzt sag die Stadt, die Stadtregierung, die will lebendige Städte haben. Die will lebendige Innenstädte haben, rein theoretisch könnte es sein, ich weiß es nicht, ich habe es mir noch nicht durchüberlegt, rein theoretisch könnte wahrscheinlich Wien weitgehend existieren ohne einem Einzelhandel.

P: Ok.

H: Alles wird nur mehr geschickt. Es gibt irgendwelche am Stadtrand Bäckereien, die backen die Semmeln, alles wird nach Hause, ins Büro geliefert. Ich brauch keine Bäckereien mehr, ich brauch das nicht mehr. Also möglicherweise kann man tatsächlich viel ersetzen. Die Frage als Stadt ist natürlich will ich so was? Will ich in so einer Stadt leben? Daher ist es genau dieser Eiertanz. Auf der einen Seite den stationären Handel z.B. einerseits zu fördern, zu stützen, dass es dem gut geht, auf der anderen Seite haben wir ein leicht geändertes Konsumentenverhalten. Ich bin mir da auch nicht ganz sicher ob sozusagen die Industrie, ich sag jetzt Mal Amazon & CO ein Bedürfnis der Konsumenten nur befriedigt oder umgekehrt, ob die sozusagen Angebote schaffen, Bedürfnisse erschaffen, die ein Konsument vorher noch gar nicht gehabt hat und wenn er mal Blut geleckt hat, kommt er drauf eigentlich ist das super cool, also eigentlich ist das super. Ich brauch eigentlich gar nicht in eine Buchhandlung gehen, wo mich vielleicht eh keiner "*gscheid*" *(österreichischer Ausdruck für fachgemäß)* beraten kann und das Buch, das ich möchte ist gerade nicht da, weil der schickt es mir dann auch erst Recht, na das kann ich gleich bei Amazon machen und da habe ich super Algorithmen drinnen, die kennen mein Profil, die wissen genau was mich interessiert, also da gibt’s jetzt sehr viel, sehr viele durch ICT und durch sehr viele neue Geschäftsmodelle, intelligente Geschäftsmodelle, weil smart solution ist immer die Frage, smart für wen? Smart für den, der Geld verdienen will, smart für die Konsumenten, smart für die Stadt, ja. Und da sind wir leider Gottes, bei drei verschiedenen Paar Schuhen, und teilweise sind wir schizophren. Ich selbst, als schizophren das mal zu sagen, geh selber gern in die Stadt und sehe gern Auslagen und buntes Treiben und Kaffeehäuser und Bäckereien und so weiter, aber kaufen tu ich eigentlich nichts, bin aber froh, dass es gibt. Und wenn es jetzt nicht gibt, würde mir was fehlen und da kommt jetzt wieder die Stadt ins Spiel, dass die Stadt sagt sie muss das große Ganze im Kopf haben.

P: Ja.

H: Wie kann ich für die Bevölkerung einerseits es schaffen, dass sie tatsächlich mit Amazon und CO super beliefert werden, weil wenn Amazon just in time anbietet, aber die Stadt blockiert sämtliche Wege für Logistikdienstleister, dann wird´s Amazon nicht schaffen pünktlich zu liefern und früher oder später wird man sagen: "Pfeifen wir auf Wien".

P: Ok. Ja.

H: Verdienen wir unser Geld irgendwo anders, ja. Gleichzeitig will die Stadt aber auch haben, dass die Leute investieren, dass die Kaufkraft in der Stadt bleibt, ja. Dass man in der Stadt wirtschaften kann. Also das ist ein Eiertanz, den muss die Politik aushalten. Das muss man mit solchen smarten Konzepten unter einen Hut kriegen.

P: Ok und um nochmal bei dem Thema zu bleiben. Wie glauben Sie kann man die Privatisierung von Daten regeln oder wie wird sich das entwickeln, weil ICT beruhen ja großteils auch auf Datensammlung und Daten sharing, aber es ist ja, ich hab noch kein Wissen darüber gesammelt, wie das handgehabt wird von einer Stadt, also wem dann eigentlich die Daten gehören.

H: Das ist eine sehr spannende, wichtige Klammer auf ungeklärte Frage. Wenn es um Daten geht, die letztendlich im öffentlichen Interesse sind oder von der öffentlichen Hand zur Verfügung gestellt werden.

P: Ok.

H: Ich gebe Ihnen gleich ein Beispiel dafür. Wenn es private Daten sind, dann werden das weiterhin private Daten bleiben. Alle Daten, die durch Ihr Konsumentenverhalten auf Facebook, Amazon und CO an diese Institutionen übermittelt werden, werden weiter privat bleiben. Punkt. So wie Sie heute, früher bei irgendeinem Geschäft Ihren Namen hingeschrieben haben und von denen dann eine Post gekriegt haben zum Geburtstag, dass die Schuhe um 3€ billiger sind. Das sind zwischen Ihnen und einer Institution sind das Daten, da gibt es keinen Datenschutz in dem Sinn, außer übergeordnete Datenschutzgeschichten: Amazon darf es nicht verkaufen oder sonst was, ja. Schwieriger wird es jetzt wenn wir beim Thema, autonomes Fahren und so weiter bleiben, wenn Private angewiesen sind auf öffentliche Daten. Also z.B. einen Verkehrsgraph, wie breit ist die Straße, wo ist eine Kante, wo ist eine Ampel. Das sind eigentlich öffentliche Daten und Private benötigen diese öffentliche Daten aber, damit sie ordentliche Produkte anbieten können.

P: Ja. Ja.

H: Wie dass dann da ausschaut mit open data ist ein schwieriges Thema, nicht zuletzt auch Daten zur Verfügung stellen, gratis ist die eine Sache, die Datenhoheit zu besitzen, hat aber eine andere Sache, nämlich, die der Verantwortung. Wenn dann was passiert, ist dann möglicherweise der haftbar, der die Daten zur Verfügung gestellt hat. Und darum werden ja oft etliche Daten nicht zur Verfügung gestellt, weil damit bin ich auch haftbar.

P: Ja. Ja.

H: Also das ist ein schwieriges Thema.

P: Und das durch Regulierungen vom Land, also von Österreich selber, glauben Sie das wäre eine Möglichkeit, oder?

H: Das glaub ich eher nicht. Also gerade bei Daten denk ich mir, dass man da nur im Europäischen Kontext denken kann und soll und es tritt ja glaub ich nächstes Jahr eine neue Datenschutzrichtlinie in Kraft, also die Richtlinie ist schon in Kraft getreten, Österreich muss es bis zum nächsten Jahr über ein nationales Datenschutzgesetz umsetzen, also solche Dinge, wie Daten, Datenschutz, aber auch Treibstoffpreise und gewisse Arten von Steuern sind sinnvollerweise nur europaweit zu handhaben, weil sonst entstehen wieder lokale Unterschiede und das entspricht ja überhaupt nicht der Idee der Europäischen Union. Weil dann verschieben sich ja wieder Wirtschaftsgleichgewichte.

P: Ok. Und wenn man auf den Kreislauf schaut von den sogenannten cross sectoral collaborations, also im Sinne von, dass man zuerst zusammenarbeitet um einen Erfolg zu erzielen oder eine Innovation zu entwickeln, aber dann will wieder jeder seinen eigenen Weg gehen, weil er sozusagen ja am meisten Erfolg für sich haben will. Glauben Sie, dass partizipative Methoden, eine Methode sind für die Zukunft?

H: Ich glaube es wird nicht anders gehen. Diese cross sectoral collaboration im Zusammenhang mit public private partnerships werden sicher eine Form der Lösung sein, weil die öffentliche Hand wird immer gewissermaßen mehr Möglichkeiten haben was die Durchsetzung von manchen Politiken betrifft, das kann ein Privater gar nicht. Der Private hat aber mehr Zugang zum Markt. Innerhalb der Sektoren hat jeder gewisse, wie soll ich sagen, Stärken. Und zukünftige Systeme, wenn wir an das Auto der Zukunft denken, dann hat das mit dem Auto der Vergangenheit sehr wenig zu tun.

P: Ja.

H: Da haben wir auf der einen Seite Elektrotechnik ohne Ende drinnen, was früher nicht der Fall war, sprich es ist kein Autohersteller mehr, sondern ein kleiner Elektrokonzern.

P: Ok. Ja.

H: Auf der anderen Seite haben wir aber doch noch die traditionellen Dinge, wie Antrieb und Allrad und Kupplung und Getriebe und das Zeugs, also der klassische Autobauer und dann haben wir aber noch dieses ganze andere Segment, wie Entertainment, wie Navigation, Routenfindung und und und. Also ohne cross sectoral collaboration geht es gar nicht mehr. Man ist eigentlich mittlerweile aufeinander angewiesen.

P: Ok.

H: Und letztendlich aber trotzdem sehr, sehr stark, oder zumindest im Verkehrsbereich auch auf die öffentliche Hand, weil das ganze spielt sich auf öffentlichem Grund ab und rein theoretisch, derjenige der den öffentlichen Grund bewirtschaftet, kann die Regeln aufstellen.

P: aha.

H: Also wenn Österreich sagt bist zum Jahr 2130 fährt bei uns kein autonomes Fahrzeug, dann wird da Keines fahren. Die können noch so toll sein, wenn ich es nicht erlaube auf meinen Straßen, dann wird es nicht stattfinden. Also, das ist eine Art Geben und Nehmen. Eine Kollaboration, wo alle zum Schluss hoffentlich Vorteile haben werden. Also Österreich wird tatsächlich z.B. autonome Fahrzeuge, Uber und wie alle diese shared economy Geschichten heißen in irgendeiner Weise zulassen, sich aber für dieses Zulassen, erstens

Regeln aufstellen und zweitens für dieses Zulassen etwas abkaufen lassen. Also in irgendeiner Weise muss dann eine Verpflichtung übernommen werden.
Also es ist ja jetzt auch schon so, wenn Sie z.B. an die Lizenzvergaben von 3G, 4G und LTE Netz denken, dann, da wird die Lizenz, da ist eine Bedingung du kriegst die Lizenz aber du musst auch schwachversorgte Gebiete, nördliches Waldviertel, zumindest in einem gewissen Standard auch mit ausbauen. Also werden Auflagen erteilt.

P: aha. Ok.

H: Und so ähnlich wird das sein, dass man sagt, man nützt die schöpferische Kraft der Privatwirtschaft *(führt den Satz nicht zu Ende).*

P: Ja.

H: kanalisiert sie bis zu einem gewissen Grad, macht Konzessionen im wahrsten Sinne des Wortes, sie dürfen gewisse Sachen machen, aber unter diesen und jenen Rahmenbedingungen und quasi so ein bisschen, keine Ahnung, Studenten dürfen gratis fahren usw. Also in irgendeiner Weise muss da sozusagen ein Abgleich geschaffen werden.

P: Also sich in der Mitte treffen sozusagen.

H: Wo auch immer, aber jedenfalls treffen, ja.

P: Ok. Und bei der Entwicklung jetzt von der Verkehrsplanung werden dort auch, also Zielgruppen miteinbezogen, wie ältere Menschen oder Studenten, die ja eigentlich kein Geld, wo es Budget einfach niedriger ist, jetzt car sharing zu benutzen oder e-mobility?

H: Das ist jetzt komplett eine andere Frage. Das ist wie geht die Stadt Wien, konkret wie geht man in der Verkehrsplanung um. Da ist, soweit ich das beurteilen kann, ein partizipativer Zugang von allen betroffenen Gruppen schon lange verankert. Also davon kann man ausgehen, dass da wirklich alle Gruppen, ich weiß jetzt nicht wie es beim smart city Konzept gemacht worden ist, ich weiß es beim Masterplan Verkehr konkret, da ist wirklich mit allen Akteuren gesprochen worden über ihre Visionen, über ihre Befürchtungen, über ihre Vorstellungen also da ist alles eingeflossen.

P: Ok. Und laut Literatur ist ja efficiency of urban public transportation: accessibility, safety und transport time. Glauben Sie Wien erfüllt diese Kriterien?

H: Das waren jetzt welche, die Kriterien nochmal ?

P: accessibility.

H: Accessibility würde ich zu einem großen Prozentsatz sagen, vergleichsweise mit anderen Städten zu einem hohen Grad. Perfekt, ja. Also ein sauberes, verlässliches, das war auch so reliability, ein sauberes, verlässliches, weitgehend umweltfreundliches, Strom, E-Busse und so weiter, Niederflursysteme; also in weiten Teilen gutes System, überhaupt keine Frage im öffentlichen Verkehr. Die efficiency, naja das ist Frage streng wirtschaftlich nein, null, überhaupt nicht effizient. Es tragt sich nicht selber natürlich. Das geht nur über Querfinanzierung.

P: Ok.

H: Es ist klar. Also mit den Fahrtgeldeinnahmen können die Wiener Linien nicht erfolgreich wirtschaften.

P: Ok.

H: Also der Kostendeckungsbeitrag, der ist nicht bei 100%, sondern deutlich, deutlich drunter. Liegt vielleicht bei 30%.
Also effizient im klassischen Sinne, Input zu Output ist es nicht. Es ist aber bei allen anderen Aspekten der Nachhaltigkeit, ökologisch und sozial, weitgehend perfekt, kann man sagen. Klar, kann man immer noch was besser machen, für bestimmte Benutzergruppen noch besser machen und so, aber da wird sehr viel getan für Mobilitätseingeschränkte Personen, Menschen mit besonderen Bedürfnissen, Kinder, Senioren, Ticketpreise. Also das ist würde ich sagen, im öffentlichen Verkehr wirklich sehr, sehr gut gelungen.

P: Ok und die letzte Frage wäre ?

H: Ok, da waren noch andere Indikatoren?

P: Ja safety.

H: Ja safety, das ist auf alle Fälle. Öffentlicher Verkehr ist vergleichsweise sicher, jedenfalls sicherer als Fahrrad fahren und Auto fahren.

P: In Wien jetzt meinen Sie?

H: Generell. Und in Wien besonders. Also Unfälle, wo irgendwo im öffentlichen Verkehr was passiert, das steht dann tatsächlich in der Zeitung.

P: Ok.

H: Weil das wirklich selten vorkommt.

P: Ok. Ok. Und die letzte Frage ist eine allgemeine Frage eigentlich. Welche glauben Sie, sind die positiven und negativen Entwicklungen von der smart city in der Zukunft für Wien?

H: Negative würden mir jetzt eigentlich keine einfallen. Es ist zu 99% eigentlich eine Vision und von daher unschädlich. Es macht Dinge möglich, die vielleicht sonst nicht so schnell, ist ein Katalisator für bestimmte Entwicklungen. Also negativ, das einzige was man vielleicht erwähnen könnte, dass das Wort smart dann schon so abgenutzt ist, dass man eigentlich nichts mehr darunter versteht.

P: Ok.

H: Aber auch da muss ich sagen, sind ganz konkrete Ziele gesetzt worden, im Energiesektor, im Verkehrssektor usw. Also negative Aspekte sehe ich keine, ich sehe das eigentlich positiv. Wichtig wäre vielleicht, dass man diejenigen die das machen, dass sie nicht vor den Vorhang treten und sagen wir lösen damit alle Probleme der Welt, weil sonst wird die Erwartungshaltung zu hoch, sondern wir lösen halt gewisse Probleme, in einem bestimmten Zeitraum auf eine elegante Art und Weise, weil sonst wird es ein Konzept sein wo man halt, früher, früher gab es ein Konzept, die autogerechte Stadt. In den 50iger Jahren hatte man wirklich als Slogan, wie man jetzt halt die smart city, hatte man früher einen Slogan, die autogerechte Stadt.

P: Ok.

H: Wie baut man eine Stadt, dass sie zu einem Auto gut passt?

P: Ok.

H: Komplett andere Denke, 50iger Jahre des letzten Jahrhunderts, Wiederaufbau, an Umwelt hat da keiner gedacht. Die Leute haben mal überlebt in erster Linie, einen Krieg haben sie überlebt und dann haben sie gesehen die Wirtschaft steigt und plötzlich ist die Mobilität da und in der Mobilität Arbeitsplätze und Modernität, das wurde damals als toll erachtet, weil man viel nicht gewusst hat und damals war das Konzept die autogerechte Stadt. Jetzt lachen wir drüber aber vielleicht lachen wir in 50 Jahren über die smart city.

(lachen)

P: Ok. Aber wie sehen Sie das, weil Sie gemeint haben oder Sie meinen keine negativen oder großteils nur positive Effekte sind von der smart city. Wie sehen Sie das, dass die smart city Strategie sagt wir wollen die grünste Stadt werden aber zur gleichen Zeit auch die bevölkerungsreichste. Das sind ja eigentlich Widersprüche.

H: Nicht unbedingt. Das geht jetzt aber sehr stark in die Soziologie, wo ich kein Profi bin.

P: ah. Ok.

H: Die grünste und bevölkerungsreichste Stadt geht schon auch gut. Schauen Sie sich einfach mal manche asiatische Städte an, die sehr grün und sehr bevölkerungsreich sind. Das geht mit Hochhäusern. Dann haben Sie halt einen 300m hohen Turm, da wohnen dann plötzlich 5000 Leute, ja, auf einem Hektar und es ist extrem grün dazwischen, ja. Also wenn natürlich alles in die Fläche geht mit lauter Einfamilienhäusern, auch das ist mehr oder weniger grün, wobei man sagen muss ob das besonders schön ist, weiß ich jetzt nicht, aber man kann über Dichte tatsächlich eine Stadt bevölkerungsreich gestalten und trotzdem grün. Man kann Straßenräume begrünen, schauen Sie sich die Diagonale in Barcelona an. Das ist eine Hauptverkehrsader, die aber auch wunderbar grün ist. Sie hat ein schönes, eine schöne Alleestruktur. Parks, Vernetzung von Grünflächen. Also das geht schon auch, also wenn Sie mit grün diese Art von grün meinen.

P: Ja, ja. Also jetzt habe ich eine persönliche Frage *(führt den Satz nicht zu Ende).*

H: Persönliche Frage.

P: Also im Sinn von, was ich nicht ganz verstehe, Sie haben gemeint die Hochhäuser, Wien hat so einen historischen Kern, da kann man jetzt ja nicht Sachen runterreißen und Hochhäuser bauen. Das wäre ja auch nicht im Sinne der Stadt wahrscheinlich.

H: Naja. Erstens Mal man kann alles. Alles geht. Und wenn Ihnen Paris gefällt, waren Sie schon Mal in Paris?

P: Ja, ja.

H: Paris ist von Haussmann, sagt Ihnen das was, wenn nicht googlen Sie das Mal, der hat die halbe Stadt abgerissen und hat diese Achsenstruktur hineingelegt: Chance Elysee und alles mögliche. Paris schaut jetzt so aus, weil irgendeiner Mal gesagt hat, ich reiß den ganzen alten Scheiß weg und mach was neu.

P: Ok.

H: Und Wien schaut auch nicht mehr so aus wie im Mittelalter. Also man kann, vor allem kann man was abreißen, was hässlich ist und was Neues hinstellen, kann man auch machen. Und vor allem kann man Baulücken schließen. Es ist ja Wien nicht flächig bebaut. Also die Stadtentwicklung findet ja eh derzeit, hauptsächlich in den sogenannten Flächenbezirken statt.

P: Ja.

H: Flächenbezirke sind diese großen Bezirke: 21, 22 usw. Bei der UNO- City wachsen die Hochhäuser in die Höhe, ja. Also das würde man eh nicht neben den Stephansdom hinstellen. Also es gibt schon sowas wie diesen musealen Kern Kaiser, Sissi, Fiacca, Mozartkugel und da gibt es dann halt noch andere Gebiete, je nachdem was man halt möchte. Die einen wollen in einer Stadt wohnen, die urban ist, im Sinne, so wie der 7., 8. Bezirk, wo die Häuser nicht höher als 3, 4 Stockwerke sind, 6 Stockwerke, so wie Altprag usw. Manche wollen ein bisschen weiter draußen in einem 1, 2-stöckigen Haus wohnen mit ein bisschen Grün herum und trotzdem nicht allzu weit von der Stadt entfernt und andere wiederum finden es ultracool im 17ten Stock zu wohnen mit waterfront und Blick auf die neue Donau.

P: Ok.

H: So hab ich das gemeint.

P: Danke, das war's schon!

Interview: Harald Semela Urban Planning Vienna 25th April 2017

Interviewer: Monika Pichler (P)

Interviewe: Harald Semela (S)

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P: Ob Sie sagen, inwiefern Sie diese, wenn Sie sich hier die Kreislaufnamen anschauen: energy transition, transport system change usw. inwiefern das mit Wien übereinstimmt? Gibt es, sagen Sie, dass alle Bereiche beziehen sich auf Wien oder nur bestimmte?

S: Mhm. Also energy transition auf jeden Fall, das haben Sie aus der smart city Rahmenstrategie rausgelesen, dass es da zu einem Rahmen der eingesetzten Strategie kommen muss, transport system change ist logisch, ja. Environmental tax, da sind wir nicht so ganz betroffen, weil wir selber keine Steuern beschließen. Also die Stadt Wien kann keine eigenen Steuern einheben. Da sind wir vom Bund abhängig. Land use, ok. Urban traffic, wie unterscheidet sich das jetzt von transport system change, urban traffic?

P: Also, urban traffic wär so das Traditionelle, was wir jetzt kennen mit Stau und eigentlich Individualverkehr und transport system change bezieht sich mehr drauf, dass es so eine Wende gibt im Transportverhalten, also, dass z.B. meine Generation nicht mehr so darauf bedacht ist ein eigenes Auto zu besitzen, sondern mehr car-sharing benutzt und so Alternativen.

S: Ja.

P: Dann costumer behaviour. Also, dass sich das praktisch verändert mit, ob Leute dennoch mehr in die Stadt gehen, um Sachen zu kaufen oder sich Sachen bestellen.

S: Also das ist auf jeden Fall ein Thema der city logistic. Ist eigentlich fast das dominierende Thema.

P: aha.

S: Weil eben der e-commerce sehr stark zunimmt und da spezielle logistische Herausforderungen daraus entstehen.

P: Ok.

S: Ja.

P: Das nächste wäre healthcare, also das praktisch die Altersbetreuung von zu Hause aus geht.

S: Ja ist nicht unbedingt so ein Stadtplanungsthema.

P: Ok. Ok.

S: Aber im Gesundheitsressort ist das auf jeden Fall ein Thema, ja.
Ja quality of life ist das was über allem eigentlich darübersteht. Wir machen natürlich diese CO_2 Reduktion, um die Lebensqualität insgesamt zu verbessern und das ist auch gut, dass das so pauschal da steht, weil quality of life natürlich sehr viel bedeutet, auf sehr vielen Ebenen verbessert werden muss. Oder es gibt die verschiedensten Parameter, die quality of life definieren.

P: Dann ist cross sectoral collaboration, also diese Zusammenarbeit von Organisationen und Unternehmen *(Zustimmung von S durch Kopfnicken)* auch? Ok. Und ICT?

S: Natürlich, ja.

P: Ok. Ok.

S: Das passt alles, ja.

P: Ok. Gut. Würden Sie eines wichtiger einstufen, als andere oder ist für Wien alles gleich wichtig?

S: Mhm.

P: Sagen es gibt so einen Überhänger sozusagen, von, also einen sogenannten Startpunkt, einen Bereich, der es ins rollen bringt oder kann man das nicht so genau definieren?

S: Ja also, hab ich schon gesagt, was über allem schwebt ist die quality of life.

P: Ok.

S: Und energy transition würd ich dann an zweiter Stelle, gemeinsam mit urban traffic sehen.

P: Ok.

S: Von der Wichtigkeit her, ja.

P: Ok. Dann, was ist das Interesse von Ihrer Organisation, oder vom Planungsbüro, in der Entwicklung von der smart city, oder immer bezogen auf die Logistik in Wien. Was ist Ihr Hauptinteresse, dass Sie sich beteiligen an der Umsetzung?

S: Das Logistikkonzept?

P: Ja.

S: Also auf city logistic bezogen?

P: Ja genau.

S: Naja, wichtig ist, dass einerseits der Handel und der Transport der Waren sichergestellt ist, aber auf der anderen Seite mit Einsatz von möglichst wenig Energie erfolgen soll, was heißt, dass die Fahrten soweit wie möglich minimiert werden sollten bzw. auf Verkehrsmittel verlagert werden sollten, die eben möglichst umweltschonend sind. Elektromobilität spielt da ganz eine große Rolle. Ja wichtig ist halt, dass die Wege so kurz wie möglich gehalten werden. Das es nicht zu einem totalen überboarden der Verbindungen, also der Verkehrsbeziehungen kommt. Also, dass man versucht, das weitgehend zu bündeln.

P: Ok.

S: Und dazu braucht´s dann halt auch entsprechende hubs, von denen aus dann gebündelt der Verkehr mit umweltfreundlichen Verkehrsmitteln transportiert werden.

P: Ok. Und glauben Sie, dass Wien vor der Energiewende steht, oder war diese Energiewende schon, in Wien.

S: Die Energiewende ist im Gang. Sie ist zögerlich im Gang.

P: Ok.

S: Weil die Elektromobilität noch vor gewissen Hindernissen steht. Also was das Angebot an Fahrzeugen betrifft und Reichweite und Kosten und auch die Lademöglichkeiten sind auch noch Recht beschränkt.

P: Ok. Und woher kommt der Strom in Wien? Oder woher würde der Strom kommen, wenn jetzt *(führt den Satz nicht zu Ende).*

S: Der Energiemix ist in Wien vergleichsweise sehr gut, weil wir sehr viel aus erneuerbaren Energien schon jetzt beziehen, also für die Elektrizitätsgewinnung, für die Stromerzeugung. Soll aber noch weiter ausgebaut werden. Und der, das größte Problem ist halt der Verkehr.

P: Der Individualverkehr jetzt?

S: Bei den Gebäuden ist der Fortschritt schon recht gut gelungen und auch in der Industrie, was den Einsatz von Energie betrifft. Beim Verkehr sind wir doch ein gutes Stück zurück.

P: Ok.

S: Weil da noch immer zum stark überwiegenden Teil, fossile Brennstoffe verwendet werden.

P: Aber dann wäre die Zukunft mehr in Richtung solar oder Fernwärme, oder?

S: Ja das sind so die Tendenzen. Und natürlich auch in der Energieeffizienz spielt eine große Rolle. Also weniger Energie einsetzen müssen.

P: Ok.

S: Solar wird sehr stark gefördert. Aber Windkraft auch, wobei da die Möglichkeiten in Wien eher beschränkt sind und deswegen beteiligen sich die Wiener Stadtwerke an Solarparks außerhalb von Wien. Was aber bedeutet dass da relativ viel Windstrom nach Wien importiert wird und auch eingesetzt wird.

P: Ok. Und würden Sie sagen, dass bei der Entwicklung von diesen erneuerbaren Energiefahrzeugen alle Zielgruppen miteinbezogen werden, also auch, keine Ahnung, Studenten, die ein kleineres Budget haben als, ja, ein normaler Arbeiter oder ein Unternehmer? Oder Senioren, ältere Menschen, werden die alle miteinbezogen?

S: Also bei der Elektromobilität ist es so, dass wir vor allem fördern wollen den Umstieg von Flotten auf Elektrofahrzeuge. Weil man da den größten Effekt erzielen kann. Flotten heißt von Firmenflotten, oder städtische Flotten, aber auch z.b. car-sharing Flotten oder Taxiflotten.

P: Ok.

S: Die Individualförderung ist, mit der wird eher zögerlich umgegangen, weil man vermeiden möchte, dass Elektromobilität wenn sie gefördert wird zu einem Umstieg von öffentlichen Verkehr auf Individualverkehr, was Elektromobilität ja auch ist, führen kann. Also grundsätzlich möchte man den Individualverkehr nicht fördern, auch nicht die Elektromobilität.
Monetäre Förderungen sind im Moment nicht geplant aber durchaus vorstellbar sind gewisse Privilegien für Elektrofahrzeugen, also z.b. das Parken im Halteverbotsbereichen zum Zweck des Ladens und vielleicht auch eher so, ja also nicht die Mitbenützung von Busspuren z.B. damit der öffentliche Verkehr nicht behindert wird.

P: Und sie haben ja auch schon angedeutet, dass

S: Was haben Sie gemeint, verschiedene Personengruppen?

P: Ja genau, Zielgruppen.

S: Ja also das steht in unserer Elektromobilitätsstrategie nicht wirklich drinnen, dass bestimmte Zielgruppen verschieden gefördert werden sollen.

P: Aso ok.

S: Naja. Ja.

P: Der Gedanke dahinter ist eigentlich, dass meine Generation ein stärkeres Umweltbewusstsein hat und mit dem mehr aufgewachsen ist und wir wären die größte Nachfragegruppe, aber wir können es uns einfach nicht leisten und das war der Hintergrund der Frage eigentlich.

S: Tatsache ist, dass junge Menschen vor allem, junge umweltfreundlichorientierte Leute, die *early adopters* nennen wir das, die sich am ehesten, als erste anfreunden können mit dieser Technologie, die auch nicht die Scheu haben, da jetzt einen Systemwechsel vollziehen zu müssen. Die auch flexibel sind. Und ja!

P: Ok.

S: Aber das braucht man nicht speziell fördern, das passiert von allein.

P: Ok. super! Und Sie haben schon angedeutet, dass halt wichtig ist, dass die Verkehrswege so kurz und, und Wien hat ja den historischen Kern und glauben Sie da gibt es Probleme in der Entwicklung oder in der Zukunft das effizient zu gestalten?

S: Ja also wir versuchen natürlich die Stadtzentren zu entlasten vom Individualverkehr und da wird auch die Elektromobilität nicht unbedingt gefördert im inneren Bereich.

P: aha. Ok.

S: Außen schaut es ein bisschen anders aus, weil Elektromobile schon auch Zubringer zum öffentlichen Verkehrsmittel sein können. *Park and ride* z.B. betreibt.
Wenn man das in der Innenstadt fördern würde, dann hieße das, dass man die Straßen dann konsequent mit Lademöglichkeiten ausstatten müsste. Was zu Problemen in den engen Straßenräumen führt und auch im Konflikt mit Fußgängern und Radfahrern, wenn die Kabel dann verlegt werden.
Also grundsätzlich sehen wir die größten Potenziale für Elektromobilität im Stadt-Umlandverkehr. Was nicht leicht ist die Fahrten auf den öffentlichen Verkehr zu verlagern, weil´s einfach teuer ist für den öffentlichen Verkehr so viel Fläche anzubieten und da bietet sich natürlich ein umweltfreundliches Auto als Alternative zu einem flächendeckenden UV-Netz durchaus an.

P: Ok. Und wenn Sie jetzt die, immer auf die Logistik und den Verkehr schauen, wie wichtig ist ICT für die zukünftige Entwicklung?

S: Ja die sind ganz wichtig. Weil natürlich mit ICT die Abwicklung des Warentransports optimiert werden kann und das ist die Vorraussetzung dafür, dass man Warenströme bündelt, spezielle Organisationsformen entwickelt, die Kommissionierung mit den Waren besser gestaltet. Ohne EKD geht das sicher nicht, eine ganz wichtige Vorraussetzung.

P: Ok. Und ja jetzt zum Verhalten von Konsument und Produzent immer bezogen auf Wien. Sie haben ja schon vorher gesagt, dass sich das auf online stark verändert. Ja. Glauben Sie, dass es sich soweit entwickelt, dass es den Verkehr entlastet? Und muss es neue Entwicklungen geben, damit man diese Entwicklung praktisch unterstützt?

S: Also grundsätzlich kann e-commerce oder Onlinehandel schon dazu beitragen, dass der Verkehr reduziert wird aber halt nur wenn der Transport von diesen online gekauften Waren effizient erfolgt. Also so wie es momentan ist, dass es 6 verschiedene Paketzusteller gibt und zusätzlich noch Supermarktketten, die solche Transporte durchführen, das ist nicht wirklich, das ist eher kontraproduktiv.

P: Ja. Ja. Ok.

S: Also da sollte es verstärkt zu Kooperationen kommen zwischen diesen Paketzustellern, caps oder wie die heißen.

P: Aber glauben Sie, dass der Durchschnittsösterreicher trotzdem es bevorzugt ins Geschäft zu gehen und diesen Austausch zu haben mit dem Anbieter.

S: Das ist sicher der Fall. Es ist ja auch so, das beobachtet man ja auch bei sich selbst bevor man im Internet etwas bestellt schaut man es sich mal an.

P: Ja genau.

S: Wo man’s praktisch auch erleben kann, wo man sich auch beraten lassen kann und so. Und eigentlich wird dann erst der Kaufabschluss im Internet gemacht.

P: Sagt Ihnen *joint delivery systems* was?

S: Ich könnt mir vorstellen, dass das so etwas ist, was ich vorher gemeint hab.

P: Ja genau, das ist schon *(führt den Satz nicht zu Ende).*

S: Gemeinsame Zustellung. Also wo mehrere Partner zusammenarbeiten um gebündelt Waren zu transportieren. Oder?

P: Ja es ist, ja es wurde jetzt schon in China und Frankreich ausprobiert, dass einfach so kleine Logistikzentren in der Stadt sind, wo ich dann 24h lang mein Paket abholen kann.

S: Ja also, das steht auch in unserer Strategie. Das gehört auch zu unserer Strategie, so Paketboxen, *Grätzlboxen* oder mobile hubs zu installieren von denen aus dann, also von den mobilen hubs aus, in den mobilen hubs werden die Waren gesammelt und können dann mit alternativen Verkehrsmitteln transportiert werden z.B. Lastenfahrräder oder kleine Elektromobile. Also das ist schon ein Teil der Strategie.

P: Aber immer, also sind so autonome Fahrzeuge oder Drohnen auch ein Thema?

S: Das kann auch sein.

P: Ok.

S: City logistics ist ein Anwendungsfall von autonomen Fahren.

P: Ok.

S: Aber es wird halt noch dauern. Es wird nicht so bald kommen, aber es wird auch schon in die Richtung geforscht und es gibt auch schon Modelle wo das gemacht wird.

P: In der smart city Strategie steht ja als Jahr 2050. Glauben Sie das ist schaffbar oder weniger? Oder kann man noch nicht genau sagen?

S: Also, Sie meinen, dass dann alles CO_2 frei transportiert wird.

(lachen)

P: Ja.

S: Das ist sicher ein sehr engagiertes Ziel. Wird halt sehr stark davon abhängen, wie die Elektromobilität einschlägt. Wann der peak oil, also oil peak, wenn der erreicht ist, dann schaut die Sache schon anders aus. Wenn die Fahrzeuge billiger werden, dann wird´s sehr schnell zu einer, also dann wird die Bereitschaft der Leute sich ein Elektromobil zu kaufen ist ja durchaus gegeben. Es ist für viele noch nicht leistbar, aber es ist schon glaub ich sehr breit erkannt, dass es eine effiziente Form des Verkehrs ist. Aber es gibt halt immer Diskrepanzen zwischen den Aussagen der Leute und dem tatsächlichen Verhalten.

P: Und hängt vielleicht auch mit dem Druck zusammen *(führt den Satz nicht zu Ende).*

S: Viele glauben auch, weil sie modern sein wollen, das ist super. Und zu Hause rechnen sie dann nach und überlegen sich wie das in der praktischen Handhabung ist mit den Kabeln. Das wird dann schwierig.

P: Ok. Ok. Und wir haben es ja schon angeschnitten, ICT, die hängen ja ganz stark von Datensammlungen und daten sharing zusammen. Was halten Sie, was glauben Sie wie sich das entwickelt mit der oder wie das ist mit der Privatisierung von Daten, weil wem gehören dann die eigentlichen Daten, die es dazu braucht diese Innovationen umzusetzen?

S: Ja also die Stadt Wien verfolgt da eine sehr offene Strategie, also open data. Und gibt die Daten, also ich weiß es jetzt nicht aber ich vermute, dass sie die Daten gratis hergibt, um eben zu fördern dass die Leute Apps entwickeln und weil sonst müsste die Stadt Wien das selber machen irgendwie, und es gibt da einen sehr großen Interessentenkreis von Entwicklern von Apps.

P: Also Sie glauben nicht, dass später ein Zielkonflikt irgendwann entsteht zwischen die ganzen Entwickler.

S: Also man wird sicher draufkommen, dass man mit Daten ein gutes Geschäft machen kann. Das ist sicher richtig. Aber ehrlich gesagt bin ich da jetzt nicht unbedingt der Experte.

P: Ok.

S: Und ich nehme auch an, dass das von der EU reguliert wird mit Richtlinien. Aber fragen Sie mich da nicht zu viel.

(lachen)

P: Ist Ihr Büro hier abhängig von Datenaustausch?

S: von Datenaustausch?

P: Damit Sie arbeiten können.

S: Nicht wirklich, weil wir auf einer strategischen Ebene aktiv sind. Und nicht mit konkreten Projekten befasst sind, wo das wichtig wäre. Also wir vergeben auch keine Aufträge an Auftragnehmer, die dann Daten handhaben müssten. Wir erarbeiten mit den Stakeholdern gemeinsam eine generelle Strategie.

P: ah. Ok.

S: Beziehungsweise koordinieren wir die Stellen die Strategien zu entwickeln haben, so ist das eigentlich.

P: aha. Ok. Interessant. Und ja genau, in dem Model gibt es ja auch den Punkt von cross sectoral collaboration und glauben Sie das trifft zu, also diese Theorie, die ich Ihnen vorher erklärt habe, dass es zuerst ein Ziel gibt auf das alle hinarbeiten, aber dann wenn das Ziel erreicht ist und es praktisch darum geht den Erfolg einzusähen, ob sich das dann wieder splittet, diese Zusammenarbeit, weil jeder auf sich selbst bedacht ist in Wien oder ist es Wien schon so gemacht, dass eigentlich alle stakeholder sagen sie, dass das ist das oberste Ziel und wir wollen diese Zusammenarbeit beibehalten?

S: Ja ich glaub dass da Wien schon anders ist. Weil wir von Anfang an die smart city Strategie eben mit den Stakeholdern entwickelt haben. Es sind roadmaps entwickelt worden. Die Ziele sind mit den Stakeholdern diskutiert worden. Sodass es doch eine sehr starke Identifikation bei allen Beteiligten mit diesen Zielen gibt. Und es gibt eher einen Wettlauf, um die Erreichung der Ziele. Nämlich einen positiven Wettlauf. Aber ich glaube nicht, dass das dann so sein wird, dass einzelne Sektoren den Erfolg für sich in Anspruch nehmen wollen. Man kann eigentlich auch nicht sagen, dass das eine Strategie ist, die nur der Stadt Wien gehört sondern es ist eine Strategie für Wien, die alle Stakeholder, Betroffenen, Betroffene weniger aber Stakeholder einbindet in die Verantwortung auch.

P: aha. Ok. Ok. Daraus kann man eigentlich auch schließen, dass partizipative Methoden schon eine wichtige Rolle spielen, jetzt und später?

S: Die haben von Anfang an eine Rolle gespielt.

P: Und *(wird von S unterbrochen)* ja bitte?

S: *(lachen)*

P: Ok. Und der Menschenfokus spielt der auch eine Rolle in der smart city Strategie?

S: Natürlich, ja.

P: Zum Beispiel auch das mit der Altenbetreuung? Oder ist das zu spezifisch jetzt?

S: Nein, nein, das ist nicht zu spezifisch. Die smart city Rahmenstrategie ist eine sehr breite Strategie und die Gesundheit gehört da auch dazu. Also im Gegensatz zu anderen smart city Strategien ist das nicht so stark, also nicht so stark fokussiert auf reine Energiefragen und ICT, sondern weil eben das oberste Ziel ist die Lebensqualität so hoch wie möglich zu halten ist es eine sehr breite Strategie und umfasst Bildung, Gesundheit, Wohnen, sogar Sport. Man kann eigentlich sagen es ist so eine Gesamtstrategie der Stadt Wien mit dem Ziel die Lebensverhältnisse zu verbessern oder nachhaltig zu sichern für die Zukunft. Obwohl wir mehr werden und mehr Verkehr entstehen wird und verschiedene Parameter dafür sprechen, dass, das die Belastungen stärker werden, wollen wir auf jeden Fall die Qualität halten bzw. verbessern.

P: Und Sie glauben auch, dass es Wien schaffen wird, also Wien will ja 2050 die attraktivste Stadt sein und auch die bevölkerungsreichste. Glauben Sie, dass diese Strategie, praktisch das handhaben kann den Bevölkerungswachstum, also diese ganze Attraktivität und diese Anziehungskraft? Im Sinn von kann Wien die Qualität halten, auch wenn dann wirklich so viele Menschen nach Wien ziehen?

S: Ja. Man braucht das ganze Bündel an Maßnahmen, um das zu verhindern, dass durch mehr Menschen, mehr Belastung entsteht. Also da muss es auf Fall Paradigmenwechsel geben und sehr starke Umwälzungen im Verkehr vor allem. Und auch in der Flächennutzung. Und da wird man zu Flächen sparenderen, Ressourcen sparenderen Formen des Wohnens und Arbeitens und so kommen müssen. Heißt z.B. auch Verdichtung, dort wo´s möglich und sinnvoll ist. Man wird sich verabschieden müssen von so Flachbau, von eingeschossigen Bau.

P: Ok. Ok.

S: Und weil man natürlich auch die Grünflächen sichern muss. Es wird ja der Anspruch größer an Grünflächen, wenn´s mehr Leute gibt. Und ja. Also es wird nicht leicht, vor allem weil Wien relativ enge Grenzen hat. Und die Möglichkeiten der Ansiedlung von zusätzlicher Bevölkerung halt nicht unerschöpflich sind.

P: Ok.

S: Deswegen wird man da mit dem Stadtumland, also tut man jetzt schon, stark kooperieren.

P: aha. Ok. Also würde man die Stadtgrenze verschieben?

S: Das nicht.

P: Das nicht.

S: Kooperieren. Nur kooperieren. Regionale Leitbilder abstimmen miteinander, Verkehrspolitik abstimmen.

P: Gibt es schon eine Abstimmung zwischen dem Verkehr von der Stadt selber und dem Verkehr vom Umland.

S: Ja es gibt eine eigene Plattform, Regionalverkehr. Von der Planungsgemeinschaft OST und dort laufen die Abstimmung auch der Strategien und so.

P: Ok. Dann noch eine bisschen andere Frage. Also die Effizienz, laut Literatur ist die Effizienz von urbanen, öffentlichen Verkehrsnetzen beinhaltet drei Kriterien, die Sicherheit, die Anbindung und die Zeit, die man zum, also praktisch im Transport verbraucht oder benötigt. Glauben Sie, dass Wien diese drei Kriterien erfüllt im Verkehrsnetz?

S: Sicherheit, da meinen Sie Zuverlässigkeit?

P: Ja Sicherheit, ja oder auch Unfälle z.B. Oder einfach Störungen.

S: Also bei der Sicherheit ist es ganz sicher so. Also in den letzten Jahren hat die Zahl der Getöteten und der Verletzten sehr stark abgenommen. Was damit zu tun hat, dass man, ja, also dass viele verkehrsberuhigende Maßnahmen gesetzt worden sind und natürlich auch der höher werdende Anteil der Benutzer des öffentlichen Verkehrs spielt da eine Rolle. Einfach weil der öffentliche Verkehr eine total sichere Verkehrsform ist.

P: Ok.

S: Bisschen Probleme gibt es noch so und Konflikte zwischen Fußgängern und Autoverkehr, auch der zunehmende Radverkehrsanteil tendiert eher dazu, dass man, dass mehr Unfälle mit Fahrrädern passieren, einfach weil mehr unterwegs sind. Aber ansonsten sind wir da sehr gut unterwegs.

P: Und die anderen zwei: Anbindung und Reisezeit?

S: Ja, da liegen wir auch sehr gut. Da gibt's umfassende Untersuchungen und durch die dichten Intervalle, die im öffentlichen Verkehr gegeben sind und die starke flächendeckende Versorgung, ist das sehr gut gelöst. Auch das Zusammenspiel zwischen U-Bahn und Bus funktioniert sehr gut.

P: Und Sie glauben auch in Zukunft, wenn angebaut wird an der Stadtgrenze dass das kein Problem darstellen wird?

S: Also darauf nimmt der Stadtentwicklungsplan schon Rücksicht. Indem er Gebiete definiert, die sich aufgrund der Erreichbarkeit eignen. Gut eignen für die Ansiedlungen. Also dort wo kein öffentlicher Verkehr vorhanden ist oder nur mit sehr hohem Aufwand bereitgestellt werden könnte, dort kommt die Stadtentwicklung nicht in Frage. Das sind dann eher die Vorhalteflächen für Erholung und Freizeit und so oder Landwirtschaft. Die Entwicklung passiert auch im Wesentlichen an den Hauptachsen des Verkehrs, also an S-Bahn Stationen, U-Bahn Stationen aber auch Straßenbahn. Man ist immer darauf bedacht möglichst wenig zusätzliche Kosten durch die Stadtentwicklung zu erzeugen. Nicht nur einmalige Kosten für die Errichtung sondern auch für den Betrieb muss das dann ja auch aufgewendet werden.

P: Und jetzt sind wir eigentlich schon bei der letzten Frage. Was glauben Sie sind die positiven und negativen Entwicklungen der smart city logistics Wien für die Zukunft?

S: Positiv. Die positiven angestrebten Entwicklungen, oder?

P: Ja. Oder die angestrebten und auch möglichen. Also wo Sie denken, dass diese auch umgesetzt werden. Dass die Umsetzung nicht so eine große Herausforderung darstellt, also die nicht utopisch sind.

S: Ja also ich glaub schon, dass dieses Konzept mit den mini hubs also mit den kleinen Verteilzentren aufgehen wird. Also, das in den verschiedenen Stadtvierteln solche Verteilzentren eingerichtet werden und von dort aus der Weitertransport erfolgt. Also Anlieferung mit größeren Einheiten und Auslieferungen dann mit kleineren Einheiten, die vielleicht auch auf Elektromobilität umgestellt werden können. Also da sehe ich große Chancen, vor allem, weil diese Güterverteilung im Kleinen dann wirklich mit umweltfreundlichen Verkehrsmitteln gestaltet werden kann. Also mit dem Fahrrad, mit Lastenfahrrädern und vielleicht autonomen Fahrzeugen.

P: *(lachen)* Ok.

S: Und es ist einfach zu hoffen, dass die Logistiker über ihren eigenen Tellerrand schauen und bereit sind miteinander zu kooperieren. Die Stadt Wien kann das nur fördern durch die Sicherung von Flächen für Logistikzentren aber ein Logistikzentrum wird nur dann errichtet werden, wenn sich engagierte Leute finden, die kooperieren wollen und die nicht wie *Merkur* oder *Billa* da ihre eigene Suppe kochen.

P: Also wieder Punkt Zusammenarbeit eigentlich.

S: Genau.

P: Wäre dass dann eine negative Entwicklung, wenn oder fällt Ihnen noch was anderes ein für negative Entwicklung. Gibt's negative Nebeneffekte?

S: Ich glaube, dass die Logistiker irgendwie, es wird ihnen einfach nichts anderes übrig bleiben, als zu kooperieren, da die Möglichkeiten in der Stadt begrenzt sind und die Stadt Wien, wenn das überboardet, sich Maßnahmen überlegen muss, um das einzudämmen. Und da wird´s dann eben zeitliche Befristungen von Anlieferungen geben oder Fahrverbote oder solche Dinge. Oder Beschränkungen der Größe von Fahrzeugen oder was auch immer und da werden sich die Transportunternehmer etwas überlegen müssen, wie sie um diese Hindernisse herumkommen.

P: Aber das liegt noch in ferner Zukunft denken Sie?

S: Ja ich glaub, dass das gar nicht so fern ist. Da die Entwicklung im Onlinehandel eigentlich schon sehr rasant ist. Und mit zunehmender Bevölkerung wird das Problem eigentlich evidenter.

P: Ok. Danke das war´s eigentlich!

Interview: Jürgen Schrampf e-consult Vienna 27th April 2017

Interviewer: Monika Pichler (P)

Interviewe: Jürgen Schrampf (Sch)

Date the interview was conducted: 27th April 2017 in Vienna

Person, who is transcribing the interview: Monika Pichler

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P: Also wenn Sie keine Fragen haben, dann möchte ich beginnen mit ob Sie diese Regelungskreisläufe, die ich Ihnen gerade erklärt habe, ob Sie die auch mit Wien identifizieren können?

Sch: Ja ich glaub grundsätzlich sind die sehr allgemein und die gelten sicher in Wien genauso.

P: Ok. Gibt es irgendwie, können Sie irgendwie sagen in Wien hat eines mehr Priorität als das andere?

Sch: Das sind nochmal die Kreisläufe?

P: Genau.

Sch: Also das Thema land use ist vor allem in älteren, gewachsenen Städten natürlich auch ein stärkeres Thema darum wahrscheinlich auch in Wien.

P: mhm.

Sch: Also wenn ich eines hervorheben müsste, dann wäre es mal dieses.

P: Ok. Ok und was ist eigentlich das Interesse von Ihrem Unternehmen, dass Sie an der Entwicklung und der Umsetzung von smart city sich beteiligen?

Sch: Wir sind ja kein operativer Akteur. Wir sind ja kein Transportunternehmen. Wir sind ein Beratungsunternehmen. Wir beraten Unternehmen im Logistikbereich. Also, wir machen für Unternehmen die Logistikplanung, egal ob Standardplanung, Lagerplanung und Transportplanung und da ist natürlich das Umfeld entscheidend, darum sind wir auch interessiert wie sich das Umfeld entwickelt, also die Städte, wie sind die Möglichkeiten in Zukunft in Städten Logistik abzuwickeln und vor allem Investitionen in der Logistik sind ja auch immer in die Zukunft gerichtet. Wenn ich jetzt an einem Standort investiere dann mach ich das ja mit einem Fokus, für die nächsten 20-30 Jahre und muss ja auch wissen, wie ich diesen Standort in Zukunft nutzen kann. Daher auch das Interesse wie sich das Umfeld entwickelt.

P: Ok. Und welche Rollen glauben Sie spielt ICT bei den smart city logistics in Wien?

Sch: Eine zunehmend stärker werdende.

P: Ok.

Sch: Wenn die Frage ist welche Rolle sie jetzt spielen, dann spielen sie jetzt noch keine große, weil es noch nicht so viele Angebote gibt, aber die Angebote werden natürlich zunehmen, es wird neue Services geben und vor allem im Bereich der Verkehrssteuerung eben auch im Logistikbereich wird über ICT viel mehr möglich sein in Zukunft als jetzt schon ist. Und da ist Optimierungspotential drin.

P: Ok. Aber Sie glauben nicht, dass das so ein Überhänger ist über die ganze Strategie? Also die Beispiele von anderen smart cities sagen ja, dass ICT das non plus ultra sind, um eine smart city überhaupt möglich zu machen.

Sch: Nein, ich glaub das ist ein enabler aber nicht die große Überschrift, die drüber steht. Das ist ein Werkzeug, um Ziele zu erreichen aber wenn Sie jetzt meinen, das wäre so das non plus ultra *(führt den Satz nicht zu Ende).*

P: Ja.

Sch: Ist es jetzt aus meiner Sicht nicht; ein Baustein von mehreren.

P: Ok. Gibt es ein non plus ultra in Wien?

Sch: mhm. Nein ich glaub das ist generell bei vielen Projekten und solchen Prozessen sieht man auch, dass es dieses, also, dass es diese eine Vorgabe, dieses eine Ziel nicht gibt, sondern eben viele kleine Bausteine, die auf mehreren Ebenen parallel betrachtet werden müssen und das wird auch so bleiben glaub ich. Da gibt es sehr viele Teilbereiche, was ja eben in der Komplexität durch so ein Model ganz klar herauskommt. Würde es dann jetzt nur ein Rad geben, an dem man dreht mit dem sich dann alles zum Besseren wendet, dann würde man natürlich nur auf dieses Rad schauen und genau deswegen kommt ja glaub ich auch so ein Model raus, dass man sieht man muss eigentlich an allem ein bisschen drehen und überall in die richtige Richtung.

P: mhm Ok. Und um eine Stadt nachhaltig zu gestalten, spielt ja die Energie eine wichtige Rolle. Glauben Sie, dass Wien vor der Energiewende steht, oder in der Energiewende schon drinnen ist oder liegt das auch noch in ferner Zukunft?

Sch: Da bin ich leider kein Experte dafür, also im Bereich Energie. Da könnte ich jetzt nur mutmaßen oder das was man in den Medien liest nachzitieren, aber *(führt den Satz nicht zu Ende).*

P: Aber im Hinblick auf Logistik, es entwickelt sich ja viel in Richtung e-mobility oder Fahrzeuge mit erneuerbaren Energien. Glauben Sie, dass Wien das bis 2050 schaffen könnte, dass es sich komplett umstellt oder *(führt den Satz nicht zu Ende).*

Sch: Bezogen jetzt auf was? Auf alle Bereiche, auch im Gesamtgüterverkehr oder reden wir immer nur vom Güterverkehr?

P: Vom Güterverkehr jetzt.

Sch: Als das komplett entkoppelt zu sehen ist natürlich schwierig, man muss, also es geht ja immer um das Gesamtverkehrssystem, also mit dem motorisierten Individualverkehr und dem ÖPNV (= *öffentlicher Personennahverkehr*) und dann ist der Güterverkehr ein Teil vom Gesamtverkehrssystem bis zu einem gewissen Teil die Elektrifizierung, die wird kommen. Also die wird passieren, auch im Güterverkehr bis zu gewissen Fahrzeugklassen und in gewissen Geschäftsbereichen.

P: Ok. Und *(führt den Satz nicht zu Ende).*

Sch: Und ob da jetzt ein Energiethema dahinter ist, das kann ich nicht beurteilen. Also da ist immer die Frage, wird die Energie prioritär im Vorfeld für was anderes eher verwendet, als dann wirklich zur, für Fahrzeuge im Güterverkehr.

P: Aber Sie beziehen das auch mit ein, bei Ihrer Beratung und Planung in die smart city, oder weniger?

Sch: Was genau?

P: Dass sich die Energiewende, oder dass eine Wende auch im ganzen Verkehrsverhalten abspielen wird also z.B. car-sharing oder Uber oder so?

Sch: Naja, ich weiß nicht ob das jetzt etwas mit Energiewende überhaupt per se zu tun hat. Das sind ja neue Geschäftsmodelle und das sind Fahrzeugtechnologien, die es gibt und die man einsetzen kann und ja, wenn jetzt die Frage dahinter ist, gibt es in Zukunft genug Strom, dass auch *(führt den Satz nicht zu Ende).*

P: Ja

Sch: Dass überhaupt für Elektrofahrzeuge im Güterverkehr Strom da ist, dann weiß ich jetzt nicht ob das jetzt wer beantworten kann.

P: Ja ok, ok.

Sch: Und dann wäre eben die Frage, wofür wird er dann prioritär eingesetzt. Also bei den Energiethemen, ich glaub jetzt nicht, dass das für Logistikentscheidungen vorrangig ist. Ob es ein Energiethema ist, eher ein Technologiethema ist das verfügbar und hab ich die Möglichkeit das zu nutzen.

P: Ok.

Sch: Das wäre eine ähnliche Frage, wie wenn Sie jetzt sagen: "Ich kauf mir ein Auto und weiß nicht genau ob es in Zukunft noch genügend Benzing geben wird".

P: mhm. Das stimmt ja.

Wir haben in einem Kreislauf ja gesehen, dass sich das Konsumentenverhalten verändert. Glauben Sie, dass das in Wien auch stärker wird mit online Shopping oder dass ein Durschnitts-Wiener-Bewohner sagt, nein mir ist wichtiger dieses Verhältnis, diese Beziehung zum Verkäufer beizubehalten? Und inwiefern stellt es dann auch eine Herausforderung für die Logistiker dar?

Sch: Na das wird natürlich wesentlich steigen. Da führt glaub ich gar kein Weg dran vorbei, selbst wenn man da versuchen würde gegenzusteuern also das ist ein Trend, der ist unmöglich aufzuhalten und es bereiten sich auch alle Akteure darauf vor mit neuen Geschäftsmodellen, neuen Services. Das mit, wie Sie das formuliert haben, der Durchschnittswiener ob er noch die Beziehung noch zu seinem *(führt den Satz nicht zu Ende).*

P: Ja

Sch: Also ob es so was generell noch gibt, sicher in Einzelfällen, aber ich glaub das wird überhaupt keine Rolle mehr in der Zukunft dann einnehmen. Das wird genauso digitalisierbar, austauschbar sein. Also im Endeffekt geht es um die Verfügbarkeit, um das Produkt, um den Service. Die Rolle einer persönlichen Beziehung spielt sich dann wahrscheinlich auf anderen Ebenen aber nicht mehr weil dort ein gewisser Verkäufer/ Verkäuferin mir genau das Gebäck verkauft, das ich jetzt die letzten 20 Jahre gekauft habe. Also das wird glaub ich nicht mehr das Thema sein.

P: Können Sie schon sagen in welche Richtung die Strategien gehen werden, im Sinn von Drohnen oder wird es mehr so Paketstellen geben, wo man was abholen kann. Was ist in dieser Hinsicht möglich für die Stadt Wien, auch im Bezug auf, es ist ja ziemlich viel Altstadt, die man erhalten möchte.

Sch: Es muss künftig natürlich verstärkt Möglichkeiten geben, wo man die Zustellung entkoppeln kann, also der Lieferant trifft den Empfänger nicht mehr. Also es gibt irgendwelche Stationen. Also das Thema mit den Boxen kommt sehr gut, zum Hinterlegen von Sendungen. Das wird stärker werden, das wird auch in irgendeiner Form kommen müssen, dass es da eine Lösung gibt. Das wäre auch eine große Chance für eine Stadt, also auch für Wien jetzt, dass man da Initiative ergreift und auch selbst mitsteuert und auch mitdefiniert wie so etwas ausschaut. Vor allem es ist ja auch schon gesagt worden, dass das Thema Boxe, Übergabesysteme, micro hubs geht, dass das dann auch ein Thema wird, wenn es im öffentlichen Raum steht.

P: Ok. Ok.

Sch: Wenn es im öffentlichen Raum steht dann ist es Aufgabe einer Stadt das auch mit zu entscheiden, mit zu planen und natürlich auch in die Richtung quality of life, urban space, alles was da in den Regelkreisen drinnen ist. Es ist natürlich von niemanden der Wunsch, dass es da einen Wildwuchs gibt an Systemen die mehr oder weniger proprietär von einzelnen Unternehmen betrieben werden. Also wenn, dann muss da eine gemeinsame, koordinierte, vielleicht auch eben offene Lösung geben.

P: Ok. Und wir haben ja schon angesprochen, dass ICT ein Baustein darstellen bei der smart city. So viel ich weiß, hängen diese stark von Daten ab, von Datensammlungen und Daten sharing. Inwiefern glauben Sie könnte dies ein Problem sein später, dass Daten privat sind? Aber trotzdem die Nachfrage besteht smart solutions und diese sogenannten smart innovations herzustellen, zu entwickeln?

Sch: Also die Frage ist jetzt?

P: Die Frage ist *(führt den Satz nicht zu Ende).*

Sch: Ob es ein Problem sein könnte?

P: Ja oder wie glauben Sie könnte das Wien lösen das Daten privatisiert sind?

Sch: Welche Art von Daten wären das jetzt? Fahrzeugdaten oder *(führt den Satz nicht zu Ende).*

P: Ja oder sie viel ich weiß Daten von Apps, von mir z.B. auch.

Sch: Ich weiß nicht ob es ein Problem ist, dass Daten, und privatisiert würde jetzt heißen, dass sie vorher nicht privat waren. Das waren ja immer private Daten?

P: Also ich kann Ihnen ein Beispiel machen: Die smart city Wien möchte einen einzigen Verkehrsanbieter haben oder ganz Österreich möchte einen Verkehrsanbieter haben, das heißt wenn ich ein Ticket habe, kann ich damit auch die ÖBB benutzen, aber die ÖBB möchte ihre Daten nicht teilen und deswegen kommt es nicht zu diesem Zusammenschluss, weil sie sagt: das ist unsere Datenanalyse, unsere Datensammlung. Wie kann man so was überbrücken glauben Sie oder ist das nicht überbrückbar?

Sch: Gut ich versuch jetzt die Schnittstelle zum, weil es geht ja um Logistik bei uns jetzt hier

P: Ja

Sch: Dem großen Thema. Die Schnittstelle zu Logistik auch zu finden. Im Endeffekt gibt es nur zwei Möglichkeiten, entweder hat jeder in Summe dann einen Nutzen davon, dass er diese Daten in einen Pool oder wo auch immer einbringt, also brauchst ein Geschäftsmodel für diesen Zusatznutzen oder es gibt eine Art von Zwang, dass man eine gewisse Services, Einrichtungen, Infrastrukturen nur dann nutzen kann, wenn man diese Daten zur Verfügung stellt. Also es ist jetzt ja eigentlich auch so, dass wenn ich als Autofahrer auf die Autobahn fahre, dann ist es ja ein Zwang, dass dort, auch wenn es anonymisierte Fahrzeugdaten sind, die Fahrzeugdaten werden ja erfasst, dadurch dass ich die Infrastruktur nutze

P: mhm. Ok.

Sch: Und damit werden die Daten automatisch irgendwo in einem größeren pool gesammelt. Noch detaillierter ist z.B. beim Mautsystem auf der Autobahn also für LKWs. Also eingeschlossenes System, da gibt es eine ICT Infrastruktur dazu und damit gibt´s genaue

Daten, dann gibt es eine Nutzungsgebühr. So, das könnte man alles in einer Stadt auch umsetzen. Die Frage ist ob´s Mehrwert bringt oder nicht.

P: Ok. Ok. Und inwiefern glauben Sie ist Zusammenarbeit bei der Umsetzung all dieser Strategien wichtig? Also die Frage bezieht sich auf die cross sectoral collaborations, dass man zuerst *(führt den Satz nicht zu Ende).* Also so viel ich weiß ist bei der smart city Strategie Wien sind alle stakeholder miteinbezogen und haben sich auch daran beteiligt diese Strategie zu entwickeln. Wie wichtig glauben Sie ist das beizubehalten? Glauben Sie, dass sollte es Wien wirklich schaffen die attraktivste und emissionsfreiste Stadt zu werden von Europa, was ja das Ziel ist, dass sich das weiter erhält in Zukunft, auch wenn dieser Erfolg schon da ist, also das Ziel erreicht ist.

Sch: Ja es ist nicht nur wichtig diese Kooperation, die ist sogar zwingend notwendig glaub ich. Nur den Status quo zu halten wird ja in Zukunft nicht mehr genügen. Man muss ja mit den zusätzlichen Herausforderungen mitwachsen und auch entsprechende neue Services, Modelle, Infrastrukturen, die müssen sich ja mitentwickeln mit dem Markt, mit der demographischen Situation, mit den generellen Rahmenbedingungen, mit Nutzerverhalten, mit Lebensgewohnheiten und da kann man automatisch ja nicht auf denselben Level bleiben, wenn man nichts tut. Also dieser Zwang zum Handeln der ist da und der geht nur in gemeinsamer Abstimmung mit den anderen Akteuren.

P: Also sprich es wird sich in Zukunft auch halten? Also *(führt den Satz nicht zu Ende).*

Sch: Nur dann wenn man was tut.

P: Glauben Sie, dass so partizipativen Methoden, wie diejenige, die ich eigentlich vorgeschlagen haben, also im Zusammenhang mit Systemwissenschaften ist das eine mögliche Lösung für die Zukunft, um Stakeholder zusammenzubringen und zum Ziel zu bringen?

Sch: Es ist sicher eine mögliche Lösung. Die Frage ist was wären andere Lösungsvorschläge?

P: Ok. Ok.

Sch: Was wären die Alternativen?

P: Ja nicht-partizipative Methoden z.B. aber wie Sie schon gesagt haben, ist das ja sehr, also unerlässlich für die Zukunft eigentlich.

Sch: Also es geht sogar mehr in Richtung, ich sag mal wenn man die zwei Enden sieht, nicht partizipativ oder rein Vorschriftsmäßig und das andere dann partizipativ dann geht´s noch mehr in die Richtung weg von Vorschriften und Reglementierungen hin zu Verhandlungs- und Diskussionsverfahren, also so dass man gemeinsam die Lösung findet und einen gemeinsam akzeptierten Weg dann abstimmt und nicht nur in diesem, sagen wir öffentlichen Bereich, sondern auch im Geschäftsbereich vielleicht mehr in die Richtung gehen. Also es gibt ja jetzt schon bei consumer Angeboten, wenn Sei ein Angebot nicht annehmen, dann kommt´s zu einem Verhandlungsvorschlag und vielleicht wäre dann das die bessere Lösung. So macht man einen Schritt aufeinander zu.

P: ah Ok. Ok. Und jetzt ein bisschen ein anderes Thema. Ich habe Ihnen auch diesen Kreislauf gezeigt mit den immer älter werdenden Menschen und der wachsenden Bevölkerung und die Pflege von zu Hause. Inwiefern wird das in Wien berücksichtigt glauben Sie, dieser Menschenfokus?

Sch: Kann ich jetzt schwer sagen.

P: Ok.

Sch: Dafür hab ich kein Expertenwissen dazu. Hat jetzt auch nichts, nichts bisschen schon auch mit Güterverkehr zu tun. Es ist insofern wichtig weil, ja gerade ältere Menschen und das spielt jetzt eigentlich mit dem oberen Thema zusammen, so Veränderung der Handelsstruktur, also e-commerce, gerade ältere Menschen sind dann ja doch eher angewiesen auf Nahversorgungsstrukturen und die dünnen sich laufend aus und werden eigentlich durch Logistikangebote ersetzt. Eigentlich wird der Handel ersetzt durch Logistikangebote.

P: aha. Ok.

Sch: Also wenn Sie vorher in ein Geschäft gegangen sind und gewusst haben so bekomm ich das, dann ist jetzt der Weg jetzt Mal zu einer Onlineplattform und dann wird das bestellt und eigentlich geht es nur darum kann der jeweilige Logistiker dahinter das so abwickeln, wie Sie das brauchen. Also, dass es ins Büro geliefert wird, oder zu Hause oder zu einer Übergabestelle und da werden eben ältere Leute nicht diese Services in diesem Ausmaß nutzen können und ob es da schon genug Lösungen und Ideen dafür gibt, das weiß ich nicht. Könnte man aber auch bezweifeln, dass es da schon die Ansätze gibt. Also eben grad in diesen Themen alles sicherzustellen, dass da auch die Qualität passt und so.

P: Und allgemein wenn Logistikpläne erstellt werden, sind eigentlich, werden die erstellt anhand von Zielgruppen oder weniger?

Sch: Die Frage ist jetzt wieder, Logistikpläne für Städte oder für Unternehmen?

P: Für Städte ja.

Sch: Da ist gleich die nächste Frage: Städte selbst haben ja keine Logistikpläne in dem Sinn, weil sie selber betreiben ja keine Logistik, außer vielleicht durch irgendwelche sub-Firmen, wie Müllentsorgung, oder städtische Einrichtungen. Das heißt sie schaffen ja nur Rahmenbedingungen für Logistikunternehmen, die ihre eigenen Logistikpläne haben.

P: Ok.

Sch: Darum ist das schwer jetzt direkt so zu beantworten.

P: Ok. Ok. Und welche, also noch zur vorletzten Frage: Die Literatur sagt, dass die efficiency of urban public transportation die Anbindung, die Sicherheit und die Reisezeit ist. Das ist jetzt aber mehr auf Personenverkehr bezogen. Können Sie das bestätigen für Wien oder nicht oder wissen Sie nicht?

Sch: Ich könnte es aus dem subjektiven Gefühl generell bestätigen, wüsste jetzt aber nicht warum in einer anderen Stadt, da ein anderes, eine andere Prioritätenreihung sein sollte. Gilt das nicht generell für ÖPNV?

P: Doch, aber ob Wien das erfüllt?

Sch: Ob´s es erfüllt?

P: Oder nicht.

Sch: Was waren die vier Punkte noch einmal?

P: Anbindung, Sicherheit und Reisezeit.

Sch: Also Sicherheit und Reisezeit kann ich mir schon vorstellen. Und ich glaub da sind wir ja auch insgesamt führend dabei. Bei Anbindung, das ist eine Frage, die lässt sich schwer vergleichen. Bei Anbindung kann man natürlich immer besser werden. Jetzt weiß ich nicht, Anbindung da gibt es wahrscheinlich auch Parameter, an denen man das misst und vergleicht.

P: Ja.

Sch: Das ist aber natürlich sehr stark immer abhängig von, es gibt natürlich irgendeinen quantitativen Wert dahinter, aber im Endeffekt, wenn man dann befragt, entsteht ein subjektives Gefühl ob das gut angebunden ist oder nicht, von der Region her.

P: Ok.

Sch: Aber da gibt´s, glaube gerade in diesem Punkt würde es auch Verbesserungsbedarf geben in manchen Regionen von Wien.

P: Ok. Und jetzt schon zur letzten Frage. Was glauben Sie sind die positiven und negativen Entwicklungen der smart city Wien, in Zukunft?

Sch: Die positiven und negativen. Also generell von Wien oder der smart city?

P: Wenn möglich Wien.

Sch: Es ist schwer zu sagen. Positive und negative, es wird Entwicklungen geben und die Frage ist, je nachdem wie man die Rahmenbedingungen gestaltet, oder wie man mit diesen Entwicklungen umgeht, können die positiv, als auch negativ ausschlagen.

P: Ok.

Sch: Also ein generelles Bevölkerungswachstum das passiert, das kann sich in Bereichen dann negativ auswirken, kann auch aber wenn man es richtig steuert und handhabt, genauso positiv sein, also das ist schwer zu sagen, genauso wird das Verkehrsaufkommen steigen. Das ist insgesamt, wenn man es gut abwickelt, positiv, weil man dadurch ja eine bessere Versorgungsqualität hat, wenn die Logistiksysteme sich mitentwickeln, dann wird das auch effizienter, dann ist das positiv. Wenn man das falsch macht, dann schlägt es negativ aus.

P: Ok. Aber glauben Sie es gibt positive Entwicklungen mit negativen Nebeneffekten?

Sch: Das ist aber eine komplexe Frage. Positive Entwicklungen.

P: Also, das hat jetzt weniger mit Logistik zu tun aber wenn eine Stadt wächst, dann probieren Sie auch mehr zu bauen, mehr Wohnhäuser, mehr Schulen, mehr Viertel aber oft ist das nicht so durchdacht und dann treten negative Nebeneffekte auf, wie z.B. Abgrenzung oder wo dann die Integration zwischen Außenbezirk und Stadt fehlt. Glauben Sie so was in diese Richtung stellt eine Gefahr für Wien dar oder ist die smart city Strategie in Wien schon so durchdacht, dass auch, dass man das auch mit ein bezieht.

Sch: Also ich glaub auf jeden Fall, dass es eine Gefahr darstellt, ob es jetzt insgesamt so durchdacht ist in Wien, das kann ich nicht sagen. Ich beschäftige mich wirklich hauptsächlich im Logistikbereich, also ich könnte dieses Urteil jetzt nicht treffen. Ich weiß es einfach nicht, ob es so gut durchdacht ist, aber eine Gefahr ist es auf jeden Fall. Aber man merkt es z.B. es trifft ja auch das Thema Logistik in einer smart city, da ist das ja auch nicht überall berücksichtigt und da passiert ja auch dieses Thema der Abgrenzung bzw. der nicht-integrierten Planung oder ist bisher passiert, wo man sich ja jetzt stark bemüht, das nicht mehr oder in Zukunft zu integrieren.

P: Ok.

Sch: Auch stärker die Logistik in diese smart city Thematik.

P: Also es Bewusstsein besteht, aber man kann es nicht 100% sichern, wenn ich das richtig verstanden habe?

Sch: 100% sichern, ist immer die Frage, was ist schon 100% sichern, aber es ist jetzt zumindest Mal im Bewusstsein, in der Wahrnehmung und wird jetzt zumindest Mal planungsmäßig auch berücksichtigt.

P: Ok. Ok. Danke das war’s eigentlich schon!

Annex C: Coding method

This coding step was used to find influences and consequences of each theme of the smart city strategy Vienna. This way the author was able to show influence factors and to conduct CLDs in chapter 5.

Table C-22: Coding step

Theme	*Influence*	*Consequence*
Cross Sectoral Collaboration	Need of alignment of urban traffic plans (+)	Invention of new services (+)
	Successful strategy implementation (-) (-)	Pool of goods (+)
	Demand of green spaces (+)	Alternative ways of transport (+) (+)
		Benefits for all parties (+)
		Power of Public Domain (+)
		New business models (+)
Tax		Side effects (+)
		Local differences (+)
		Shift of local economies (+)
Healthcare		Local supply structure (-)
		Needs of elderly (-)
Public Transportation System	Accessibility of locations (+)	Utilisation of public transportation (+)
	Integration of City Districts (+)	Individual traffic (-)
		Identification with smart city strategy (+)
Economy	Funding start- ups (+)	Environmental regulations (+)
	Need of jobs (+)	Diversity of companies in Vienna (+)
	Diverse business concepts (+)	Need of property (-) (-)
		Importance of public interest (+)
		Sustainability (+)
		Intelligent/ innovative economic growth (+)
City Participation		Negotiation (+)
		Discussion (+)
		Quality of mobility (+)
		Quality of energy supply (+)
		Quality of traffic (+)

		Quality of living (+)
		Quality of city quarters (+)
Land use	Population (+) (+) (+)	Need of land conservation (+) (+)
		Need of resources (+)
		Skyscrapers (+)
		Single family houses (-)
Green Space	Population (+) (+)	
ICT- technologies	Ideas (+) (+)	Changes in logistics (+)
		Emissions (-)
		Usage of energy (-)
		Optimization transport of goods (+)
		Pool of flows of goods (+)
		Number of new forms of organization (+)
		Smart solutions (+)
		Quality of delivery systems (+)
		Changes in traffic control (+)
Data	Personal rights (-)	Data sharing (+)
	Open data sharing (+)	Realisation of applications (+)
		Realisation of innovations (+)
Regulations	Data sharing (+) (+) (+)	Quality of delivery system (+)
	Attractiveness (+)	Number of new systems (-)
	Political Pressure (+)	Quality of organization of systems (+)
	Support of population (+)	Traffic accidents (-)
		Local differences (-)
		Commuters (-)
		Vehicles (-)
		Congestion (-)
		Number of licenses (+)
Consumption Behaviour	Accessibility of 24/7 pick up stations (+)	Online shopping (+) (+)
	Austrian culture (-) (-)	Need of smart concepts (+)
	Online platforms (+)	Need of collaboration with logistic service provider (+)
		Challenges in logistic sector (+) (+)
		Need of micro hubs (+)

		Need of transfer systems (+)
Emissions	Walking (-) Cycling (-) (-) Production in third countries (-) Traffic (+) Regulations (-) (-) Environmental means of transport (-) Population (+) Public transportation (+) Capacity of driven kilometres (-) Electro mobility (-)	Environmental quality (-) (-) Quality of life (-)
Electro Mobility	Funding of electro mobility (+) Price of fossil fuels (+)	Energy consumption (+) Number of fleet transports (+) Congestion (-) Quality of life (+)
Energy Transition	Price of fossil fuels (+)	Electrification (+) Need of hydropower (+) Need of solar energy (+) (+) Need of geothermic (+) Import of wind power (+) Need of district heating (+) Need of waste incineration plant (+) Need of caloric power plant (+) Change in vehicles (+) Change in businesses (+)

Source: Compiled by the author

Annex D: Model specifications

Model settings: Initial Time = 2000; Final Time = 2050; Time step = 1/64; Unit for time = Year; Integration method: Euler

- The model represents a simulation period of 50 years.
- Software: Stella Architect 1.4.1

Annex E: Green Space sector

Table E-23: Model description of green space sector

Variable name	*Equation*	*Unit*	*Comment*
Time for City Greening	1	Years	The time the city takes for greening a specific amount of hectares. *(assumption)*
Constant amount of City Greening	100	Hectares	The amount of hectares the city is greening every year. *(assumption)*
Greening	Constant amount of City Greening/ Time for City Greening	Hectares/Years	The amount of hectares per year the city is becoming greener.
Green space	20.700	Hectares	(Stadt Wien, accessed 30.07.17)
Time to turn into Construction Land	2,5	Years	The time it takes to turn green space into construction land. *(assumption)*
Fraction of Construction Land	0,1	Dimensionless	The percentage of green space which turns into construction land every year. *(assumption)*
Green Space be used	(Green space*Fraction of Construction Land)/ Time to turn into Construction Land	Hectares/Years	The amount of hectares of green space which turns into construction land per year.
Amount of Green Space that can be used per Person	Green space/ Total Population	Hectares/People	The amount of hectares which can be used per citizen.
Total amount Green Space used in the City	Actual amount of Green Space used per Person* Total Population	Hectares	The amount of hectares which is actually used by all citizens together.

Actual amount of Green Space used per Person	0,0011	Hectares/Person	(Stadt Wien, accessed 30.07.17)
Overusage of Green Space	Amount of Green Space that can be used per Person - actual amount of Green Space used per Person	Hectares/People	The amount of hectares which are overused per citizen.
Time to perceive Green Space	1	Years	The time a citizen takes to perceive green space. *(assumption)*
Change in Green Space Perception	(Overusage of Green Space - Green Space Perception)/ Time to perceive Green Space	Hectares/People/Years	The change of perception of available green space per citizen.
Green Space Perception	Overusage of Green Space	Hectares/People	The perception of available green space per citizen.
Green Space Attractiveness	(- Green Space in other Cities + Green Space Perception)/ (Green Space in other Cities + Green Space Perception)	Dimensionless	The resulting attractiveness of the city due to the availability of green space.
Green Space in other Cities	0,00055	Hectares/People	The average percentage of green space in other European capitals. *(assumption)*

Source: Compiled by the author

Annex F: Land & Housing sector

Table F-24: Model description of land and housing sector

Variable name	*Equation*	*Unit*	*Comment*
Land becoming available	(Skyscraper Demolition* avg Land for Skyscraper)+ (Single Family House Demolition* avg Land for Single Family House)+ Green Space be used	Hectares/Year	The amount of hectares of green space becoming available for turning into construction land.
Amount of Land	20.700	Hectares	(Stadt Wien, accessed 30.07.17)
Land be used	(Single Family House Construction* avg Land for Single Family House) + (Skyscraper Construction * avg Land for Skyscraper)	Hectares/Years	The amount of hectares which are used for constructions in the city.
Avg Land for Skyscraper	0,7	Hectares/Skyscraper	The amount of hectares necessary to build a skyscraper. *(assumption)*
Avg Land for Single Family House	0,03	Hectares/House	The amount of hectares necessary to build a single family house. *(assumption)*
Construction Time of Single Family House	1	Years	The time necessary to build a single family house. *(assumption)*
Single Family House Construction	Construction of Single Family Houses/ Construction Time of Single Family House	House/Years	The amount of single family houses built per year.
Single Family Houses	150000	House	The amount of single family houses in the city. *(assumption)*

Single Family House Demolition	Single Family Houses/ avg Life Time of a House	House/Years	The amount of single family houses demolished per year.
Avg Life Time of a House	50	Years	The average life time per single family house. *(assumption)*
Construction of Single Family Houses	Needed Single Family Houses - Single Family Houses	House	The amount of single family houses which need to build based on the number of families living in the city.
Needed Single Family Houses	(Families in Need of a House * Fraction of Families willing to live in a Single Family House)/ avg Families living in a Single Family House	House	The amount of single family houses needed in the city.
Fraction of Families willing to live in a Single Family House	0,7	Dimensionless	The percentage of families who is willing to live in a single family house. *(assumption)*
Avg Families living in a Single Family House	2	Family/House	The average amount of families living per single family house. *(assumption)*
Total Amount of Families living in Single Family Houses	Single Family Houses * avg Families living in a Single Family House	Family	The total amount of families living in a single family house.
Skyscraper Construction	Construction of Skyscrapers/ Construction Time of Skyscrapers	Skyscraper/Years	The amount of skyscrapers built per year.
Construction of Skyscrapers	Needed Skyscrapers - Skyscrapers	Skyscraper	The amount of skyscrapers which need to build based on the number of families living in the city.
Construction Time of Skyscrapers	5	Years	The time necessary to build a skyscraper. *(assumption)*

Skyscrapers	60	Skyscraper	The amount of skyscrapers in the city. *(assumption)*
Skyscraper Demolition	Skyscrapers/ avg Life Time of a Skyscraper	Skyscraper/Years	The amount of skyscrapers demolished per year.
Avg Life Time of a Skyscraper	50	Years	The average life time per skyscraper. *(assumption)*
Needed Skyscrapers	(Families in Need of a House * Fraction of Families willing to live in a Skyscraper) / avg Families living per Skyscraper	Skyscraper	The amount of skyscrapers needed in the city.
Fraction of Families willing to live in a Skyscraper	0,3	Dimensionless	The percentage of families who is willing to live in a skyscraper. *(assumption)*
Avg Families living per Skyscraper	1.200	Family/Skyscraper	The average amount of families living per skyscraper. *(assumption)*
Total Amount of Families in Skyscrapers	Skyscrapers * avg Families living per Skyscraper	Family	The total amount of families living in a skyscraper.
Total Amount of Families that can live in the city	Total Amount of Families in Skyscrapers + Total Amount of Families living in Single Family Houses	Family	The total amount of families that have an accommodation.
Families in Need of a House	Total Amount of Families in the City - Total Amount of Families that can live in the city	Family	The amount of families that are in need of an accommodation.
Avg People per Family	4	People/Family	The average amount of people per family. *(assumption)*

Total Amount of Families in the City	Total Population / avg People per Family	Family	The total amount of families living in the city.
Housing Attractiveness	(Total Amount of Families in the City - Single Family Housing Perception) / (Total Amount of Families in the City + Single Family Housing Perception)	Dimensionless	The resulting attractiveness of the city due to the availability of housing.
Change of Housing Perception	(Families in Need of a House - Single Family Housing Perception) / Time to perceive Housing	Family/Years	The change of perception of available housing per citizen.
Time to perceive Housing	1	Years	The time a citizen takes to perceive housing availability. *(assumption)*
Single Family Housing Perception	Families in Need of a House	Families	The perception of available housing per citizen.

Source: Compiled by the author

Annex G: Job sector

Table G-25: Model description of job sector

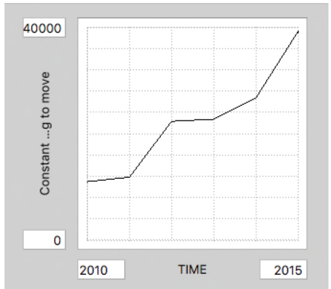
Variable name	*Equation*	*Unit*	*Comment*
Actual Creation of Jobs	20.000	Jobs	The actual amount of jobs created. *(assumption)*
Time to create Jobs	1	Years	The time it takes to create a new workplace. *(assumption)*
Creation of Jobs	actual Creation of Jobs / Time to create Jobs	Jobs/Years	The amount of jobs created per year.
Jobs in the City	830.000	Jobs	The total amount of jobs in the city. *(assumption)*
Cutting of Jobs	actual Cutting of Jobs / Time to cut Jobs	Jobs/Years	The actual amount of jobs cut per year.
Actual Cutting of Jobs	10.000	Jobs	The amount of jobs which are reduced. *(assumption)*
Time to cut Jobs	1	Years	The time it takes to cut workplaces. *(assumption)*
Jobs per Person	1	People/Jobs	The amount of jobs per citizen. *(assumption)*
Unemployed People	MAX (Working age population - ((Jobs in the City) * Jobs per Person); 0)	People	The amount of unemployed people in the city. The MAX-function prevents that the amount of unemployed people turns negative.

Working age population	"15 to 44 yrs Population "+" 45 to 64 yrs Population"	People	Citizens between 15 and 64 years old form the working population in the city.
Actual Unemployment Rate	Unemployed People / Working age population	Dimensionless	The actual rate of people being unemployed in the city.
Change of Unemployment Perception	(Actual Unemployment Rate - Perception of Unemployment) / Time to perceive Unemployment	Dimensionless/Year	The change of perception of unemployment in the city.
Time to perceive Unemployment	1	Years	The time a citizen takes to perceive unemployment. *(assumption)*
Perception of Unemployment	Actual Unemployment Rate	Dimensionless	The perception of unemployment per citizen.
Employment attractiveness	(Unemployment Rate in other Cities - Perception of Unemployment) / (Unemployment Rate in other Cities + Perception of Unemployment)	Dimensionless	The resulting attractiveness of the city due to the availability of jobs.

Source: Compiled by the author

Annex H: People sector

Table H-26: Model description of people sector

Variable name	*Equation*	*Unit*	*Comment*
Constant Amount of People willing to move	 Graphical function	People/Years	(Stadt Wien, accessed 14.08.17)
People willing to move	(Constant Amount of People willing to move)	People/Years	The number of people willing to move to the city per year.
People willing to move to the Smart City	1.000	People	The number of people willing to move to the city. *(assumption)*
People moving to the City	(People willing to move to the Smart City *Total Smart City Attractiveness) / Time to move	People/Years	The number of people moving to the city.
Time to move	1	Years	The time it takes to move to the city. *(assumption)*
People per Couple	2	People/Couple	The number of people per couple. *(assumption)*

Number of Couples	"15 to 44 yrs Population"/ People per Couple	Couple	The number of couples in the city in the age range of 15 to 44.
Avg Children per Couple	1,5	People/Couple	The average number of children per couple.
Fertility Time	32	Years	(Stadt Wien, accessed 30.07.17)
Birth rate	(Number of Couples *avg Children per Couple) / Fertility Time	People/Years	The number of people born per year in the city.
0 to 14 yrs Population	227.579	People	Citizens from 0 to 14 years old. *(estimation)*
Death Rate 0 to 14	0,012	Dimensionless/Years	The percentage of people dying per year in the age range of 0 to 14. *(assumption)*
Fraction of 0 to 14 moving in	0,3	Dimensionless	The percentage of people moving into the city in the age range of 0 to 14. *(assumption)*
Net Change 0 to 14	(People moving to the City * Fraction of 0 to 14 moving in) - ("0 to 14 yrs Population" * Death Rate 0 to 14)	People/Years	The change of the amount of people in the age range of 0 to 14 per year.
Aging 0 to 14	"0 to 14 yrs Population"/ "Aging Delay 0-14"	People/Years	The number of people who are aging per year in the age range of 0 to 14.

Aging Delay 0-14	14	Years	The time it takes to age from 0 to 14.
15 to 44 yrs Population	674.347	People	Citizens from 15 to 44 years old. *(estimation)*
Net Change 15 to 44	(People moving to the City *F raction of 15 to 44 moving in) - ("15 to 44 yrs Population" * Death Rate 15 to 44)	People/Years	The change of the amount of people in the age range of 15 to 44 per year.
Fraction of 15 to 44 moving in	0,5	Dimensionless	The percentage of people moving into the city in the age range of 15 to 44. *(assumption)*
Death Rate 15 to 44	0,012	Dimensionless/Years	The percentage of people dying per year in the age range of 15 to 44. *(assumption)*
Aging 15 to 44	"15 to 44 yrs Population"/" Aging Delay 15-44"	People/Years	The number of people who are aging per year in the age range of 15 to 44.
Aging Delay 15-44	30	Years	The time it takes to age from 15 to 44.
45 to 64 yrs Population	30.0060	People	Citizens from 45 to 64 years old. *(estimation)*
Net Change 45 to 64	(People moving to the City * Fraction of 45 to 64 moving in) - ("45 to 64 yrs Population"*Death Rate 45 to 64)	People/Years	The change of the amount of people in the age range of 45 to 64 per year.

Fraction of 45 to 64 moving in	0,1	Dimensionless	The percentage of people moving into the city in the age range of 45 to 64. *(assumption)*
Death Rate 45 to 64	0,25	Dimensionless/Years	The percentage of people dying per year in the age range of 45 to 64. *(assumption)*
Aging 45 to 64	"45 to 64 yrs Population"/ Aging Delay 45 to 64	People/Years	The number of people who are aging per year in the age range of 45 to 64.
Aging Delay 45 to 64	20	Years	The time it takes to age from 45 to 64.
65 plus Population	248.137	People	Citizens 65 years old plus older. *(estimation)*
Net Change 65	(People moving to the City * Fraction of 65 moving in) - ("65 plus Population" * Death Rate 65 plus)	People/Years	The change of the amount of people in the age range of 65 plus.
Fraction of 65 moving in	0,1	Dimensionless	The percentage of people moving into the city in the age range of 65 plus. *(assumption)*
Death Rate 65 plus	0,8	Dimensionless	The percentage of people dying per year. *(assumption)*
Total Population	"0 to 14 yrs Population"+"15 to 44 yrs Population"+" 45 to 64 yrs Population"+"65 plus Population"	People	The total amount of people in the city.
Attractiveness Characteristics	3	Dimensionless	The number of characteristics that make the city attractive.

Total Smart City Attractiveness	MAX ((((Employment attractiveness+ Housing Attractiveness +Green Space Attractiveness))); 0) / Attractiveness Characteristics	Dimensionless	The total smart city attractiveness. The MAX-function prevents that the smart city attractiveness turns negative.

Source: Compiled by the author