Systems Thinking and Sustainable Urban Development

- How to improve the planning of sustainable cities

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Abstract

In order to get the world on the right path we must move the cities towards a more sustainable direction. However, sustainable issues are wicked problems which have no optimal solution. Sustainability is also an interdisciplinary area that includes a variety of perspectives and stakeholders with different wants and needs in how to gain sustainability. Good planning is essential for achieving sustainable urban development, and by identifying the critical interactions and conflicts that arise between stakeholders, we will improve our planning processes and thus be better equipped to make beneficial decisions. The thesis argues that we need to change the way we think and improve our mental models. By integrating system thinking the imbalance that exists between the many perspectives of sustainability are to be identified and confronted. The thesis will demonstrate how we by the use of systems thinking and development of models sharpen our mental models and increase our understanding of the main challenges and conflicts we must face. Oslo is examined as a case analysis of a real world example in order to identify how the theory can be applied to a real city and what kind of concrete challenges Oslo is facing.

Sammendrag

For å bevege verden mot en bærekraftig framtid må vi begynne i byene. Bærekraftige utfordringer er såkalte *wicked problems* som ikke er mulig å finne optimale løsninger på. I tillegg er bærekraft et tverrfaglig område som inkluderer en rekke interessenter og perspektiver med forskjellige ønsker og behov ved oppnåelsen av bærekraft. God planlegging er essensielt for å oppnå bærekraftig urban utvikling, og ved å identifisere de kritiske skjæringspunktene samt konfliktene som oppstår mellom interessenter kan vi forbedre planleggingsprosesser og bli bedre rustet til å ta fordelaktige avgjørelser. Denne oppgaven argumenterer at vi må endre måten vi tenker på og forbedre våre mentale modeller av verden. Ved å integrere systemtenkning vil ubalansen mellom de mange perspektivene innen bærekraft bli identifisert og konfrontert. Oppgaven vil derfor demonstrere hvordan vi ved hjelp av systemtenkning and utviklingen av modeller spisser våre mentale modeller og øker forståelsen over hvilke hovedkonflikter og utfordringer vi står ovenfor. Oslo er brukt som en case analyse for å belyse hvordan disse modellene er reelt for en virkelig by, for å vise hvordan teorien bak systemtenkning kan bli tilført et virkelig eksempel og demonstrere hvilke konkrete problemer Oslo står ovenfor.

Table of contents

Figures and tables

1. Introduction

"The era of procrastination, of half-measures, of soothing and baffling expedients, of delays, is coming to its close. In its place we are entering a period of consequences"

-Winston Churchill

from his speech The Locust Years, Nov 12th 1936

1.1. Background

What we consume, how we move around, and how we handle our waste are important factors of how our decisions on an everyday level utilize the Earth's resources. The world we live in is being characterized and dominated by cities, as the growth in urban areas is significantly larger compared to the overall growth in the world UNFPA (2007). The reality is that most city dwellers have an ecological footprint many times higher than the Earth can sustain, an issue constantly becoming more critical as the world is facing challenges in providing people with enough resources. In order to move the world on a more sustainable path it is beneficial to start in the cities. They are responsible for the majority of our greenhouse gas emissions and waste generation, which is believed to be the number one reason behind the rapid climate change experienced today (UN Habitat, 2011). Sir Nicholas Stern, the former Chief Economist for the World Bank has estimated that the failure to handle climate change crisis can cost the global economy $ 6.6 trillion a year (BBC, 2006). Hence, the world is facing pressure to change the way we delegate and manage our resources in order to prevent emissions and further damage to the planet.

The trend in cities brings economic, environmental, and social challenges and is the reason why cities are the focal point of present-day problems. It is also in the cities where future quality of life often is determined and where we have to start in order to lead the human population towards a more sustainable path. It is a local, national, and global task and all regions of the world are affected by this challenge, from the developed world which typically faces high consumption to the developing world facing rapid population growth. In reality, regardless of which continent is examined, the same question is asked; how can we understand and influence the challenges we face and approach in cities in such a way that all inhabitants now and in the future experience social justice, parallel with a sound environment and healthy economic growth? This question is hard to answer as cities are the largest and most complex creation of human organization and must be handled carefully. They contain a variety of different stakeholders and interest groups that different wants and need in regard to the city's future. They also represent opposing perceptions of nature and resource

allocation which leads them towards conflicting situations and makes it difficult for decision makers to find better resolutions, if they even exist. Cities need to shift towards less wasteful patterns of consumption and demonstrate that urban growth and sustainable living can go hand in hand. Urban areas have to be managed effectively as population growth constantly increases (World Bank II, undated). Constant growth in population, consumption and pollution places pressure on local governments and decision makers to facilitate initiatives for economy, environment, and social health in the city.

Cities and urban growth

Cities appear as unsustainable human creations for many citizens of the world which implies the need to develop a sustainable approach economically and socially as well as environmentally in the time to come. Today, these processes are becoming more interconnected which makes the management of cities to complex systems. It demands a better planning methods and process structures that take care of all stakeholders into consideration. The lack of precision in goals and achievements along with the absence of focusing on all stakeholders' arguments will counteract with the development of a sustainable urban form. This calls for a multi-challenging and interdisciplinary cooperation between the many sectors in which sustainable urban development contains of (Frey, 1999).

Even though cities are seen as problem creators they are just as much problem solvers. From being blamed for causing more pollution, waste generation, and criminality they are on the other hand seen as areas with high potential to solve the same problems they have caused and still generates. Cities can be seen as urban clusters of potential sustainable development full of innovation and knowledge. Communication is one of the city's strong cards, and they often send a strong signal to the surrounding areas as well as other cities when doing something exceptional or excellent compared to competing cities. Cities are no longer just economic headquarters but also social, environmental and cultural promoters as well (Rotmans and Van Asselt, 2000).

Globalization, technological development, and advances in knowledge about the cities' complex systems are among the factors Rotmans and Van Asselt (2000) emphasizes in their article *Towards an Integrated Approach for Sustainable City Planning* that is increasing the complexity of cities. They also point out the important trends occurring in cities and stress that it is not just the physical growth of cities themselves with their increased interconnection with other cities and their reshaped economic potential that has led to a more complicated present. Social issues like inequity, unemployment, and decreased quality of urban life operates in different scales and vary in appearance making the system structure of urban thinking more complicated. In order to identify the

complexity of these interrelated problems it is argued to use the system dynamics approach (Sustainable Cities Collective, 2011). This approach must encourage long-term sustainable development in urban management and make sure the stakeholders of the sustainable urban development's best interest are involved in this process.

The city is a mass of humans and human activities at a greater scale and density than the surrounding space. Over time, cities attract a higher number of people increasing the pressure on these resources and thus making the city dependent on importing energy and materials from outside eco-systems. The decrease in resources is correlated to the increase in population (Bithas and Christofakis, 2006) which has been the case in both the industrial and post-industrial eras. Simultaneously, the relationship between human and nature is transformed into a relationship concerning human-human pattern establishments (Camagni, 1995) which may behave as a threat to other parts of the living environment.

Why growth?

According to Hall and Pfeiffer (2000) the explosive growth world cities have experienced in the last centuries is a result of three great forces. First, *industrialization* changed the developed world drastically from the late 1700 to the 1950 and transformed the developing world ever since. The proportion of manufacturing workers has also risen in the countries that are experiencing industrialization today, but decreased in the developed parts of the world. Despite both the rise of factory workers in some cities and the decrease in others per capita income in cities has risen as a result of increased economic growth. Second, since the invention of the bicycle, mass transit, and the private automobile people have been able to move around easier and more efficiently. This has led to a world of possibilities and contributed to urban growth. Last, new communication methods have made it more convenient to interact with people around the world. From the telephone, fax, and internet a whole world has been linked together and made the cities to administrative Mekkas spread around the globe.

Industrialization has brought labor opportunities and thus the opportunity for a better life. By improving the conditions and the rights of workers and city individuals more people have found it attractive to move to the city. When there are more opportunities in the city more people are attracted to stay there by immigrating or simply just by not moving away. Along with the population growth and increased opportunities comes the higher demand of goods and services, and increasing pressure on the already existing built environment. This in turn encourage technology to improve, density to increase, and more efficient systems to take place. While creating more densely populated areas, more goods and services are demanded, technology evolves, and the city offers a wider range

of opportunities compared to less urban areas. This way the loop is mutually dependent and dynamically evolves over time as *figure 1* demonstrates. This has been the practice for centuries and will most likely to continue in the time to come. Growth engenders growth and turn cities to attractive metropolises for people who search for more opportunities, and have thus contributed to an emphasis on the social and economic objectives of the human beings (Bithas and Christofakis, 2006).

However, the city cannot grow forever and without factors for slowing down the growth, such as regulations and incentives, the growth may increase exponentially to a point where the urban system can no longer support growth and thus result in collapse of the city. *Limits to Growth* described this global situation already in the seventies (Meadows et. al., 1972) and how urban growth is thus very much dependent on good economic, environmental, and social conditions which improve under a certain control from the policy and decision-makers.

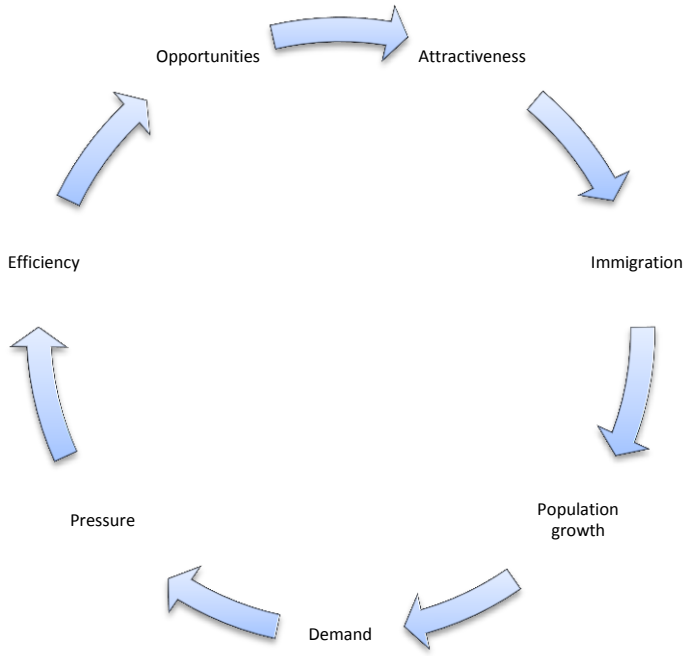

Figure 1: Cause and loop diagram over a typical city related development

The urban population is twenty times higher today than it was in 1900. By comparison, the total global population increased four times in the same period (Newman and Jennings, 2008). According to Sheehan (2007) urban population has an annual growth of 1.75 % while the rural population stays the same or might even decrease. If this development continues, 66 % of the world's population will live in cities where up to 90 % of the increase will be in developing countries (UN Habitat, 2006). Most of this increase (53 %) will happen in cities with *less* than a half million inhabitants and in cities of between 1-5 million (22 %) (ibid). Even though *only* 9 % will live in megacities, this is where the population growth is increasing most rapidly (ibid).

The importance of cities

According to the OECD (1996), cities are essentially important as they create new objectives and social goals as a result of the evolution of social life. Additionally, they increase the efficiency of these social and individually based goals and play a creative role as they encourage new procedures and patterns of economic, environmental and social structures based on the existing ones. Society thus develops rapidly in urban areas, a main driving force behind innovative social evolution in human societies (Bithas and Christofakis, 2006). The city has in many ways naturally been the front for the rest of the nation as the city provoke to more participation and interaction between different fields. The city dominance is eventually forcing the rest of the nation to adapt to the same structure, mindset and development making it more than a driving force for other cities but for the world's population as a whole. However, the city's form and structure must merge with the environment and improve in a way present and future dwellers identify as fair (Frey, 1999).

We observe that cities grow rapidly and play an important role in a nation's development, wealth, and opportunities. In accordance to this, cities are critical to the national economies of the world, and the well-being of the city is the main force of economic growth. For example, Bangkok produces 41 % of the economic wealth in Thailand, which only accounts for 9 % of its population (Newman and Jennings, 2008). Prague in the Czech Republic is another example which produces 20 % of the wealth in the country, from 10 % of the economy (ibid). The same principle counts for many of the world's cities, and emphasizes the importance of cities in a national as well as a global scale.

Challenges of urban growth

With many opportunities and a redundant economy, urban growth brings tremendous impacts and externalities to the urban economy and surrounding environment, both within and beyond the city boundaries. As these sustainability problems are impossible to solve and find optimal solutions for and simultaneously multidimensional negative ramifications unavoidably rise in conjunction with the positive contributions. The sustainability debate of the city is thus a result of the unsustainable

environmental stress we observe. In addition to being socially stratified and not functional, unsustainable cities are expensive to run. Through *Green Paper on the Urban Environment* sustainability was given attention in identifying economic, environmental and social problems of today, as well as identifying objectives towards a sustainable urban environment (WCED, 1987). Later, the Rio Earth Summit stated that there was a need for indicators and that sustainability should be a basis in all decision-making (United Nations, 1993). Both papers have had a significant impact on the debate on sustainable urban development because of the global political support.

However, growth is hard to counter and we have to realize that it is here to stay. It may appear to live its own life, but it is important that cities learn how to handle the complexity and speed of change before it gets overloaded and breaks down. Urban growth, or even decline, needs physical planning solutions to be managed and we must prevent tragedies caused by air, water, sea, or forest issues, and improve urban infrastructure like transit systems and water sewage. We must implement a holistic approach in our decision-making and make sure we do not neglect other interests like the dilemma between better housing for the poor versus increased property tax revenues versus preservation of open space. Also, non-renewable resources should be phased out, and the gap between rich and poor should have some solid social planning strategies. Planning is the key word in the search for more sustainable solutions.

Sustainability and the Planners Model

Sustainability is a multidisciplinary concept representing a variety of sciences, interests, and challenges. In order to understand the concept of sustainable urban development it is essential to understand that sustainability can mean different things for different stakeholders. Sustainability in general is a matter of needs and limitations, and the aim to balance them sufficiently. In the article *Green Cities, Growing Cities, Just Cities?* Scott Campbell (1996) proposes a model that divides sustainability into three sectors of different goals; economic growth, environmental preservation, and social equity. These three aspects of sustainability is commonly referred to by a variety of authors and seen as the essence of sustainable development (Campbell, 1996; Rosenthal and Brandt-Rauf, 1996; Flint, 2007). As an example, economic stakeholders are typically interested in cheap labor, industrial growth and the access of resources, while the environmental interests emphasize biodiversity, resilient ecosystems, and clean air and water. Social needs, on the other hand, may prioritize equity among people, empowerment, and security in society. *Figure 2* illustrates some of the variety in interests between the three aspects of sustainable development. Campbell underscores that extensive conflicts arise between these different aspects, and as their needs and

interests often oppose each other and challenging planners in evaluating and prioritize the many needs in the work of bringing the city towards a sustainable future.

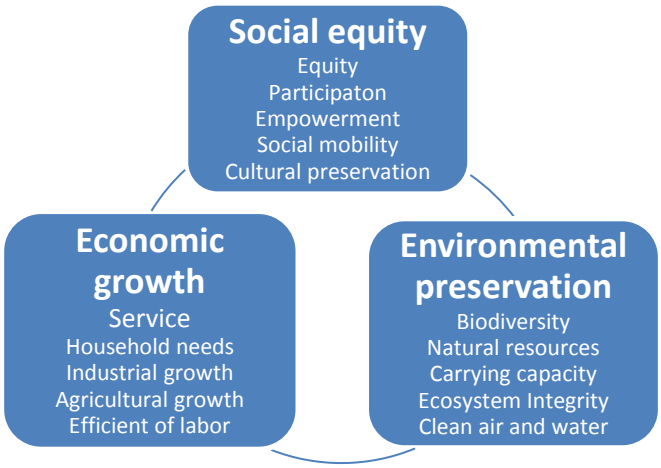

Figure 2: The three main aspects of sustainability

The challenges arising between these sectors can be addressed more specifically as how we choose between cheap labor for industry to utilize and ensuring workers' needs for survivable wages; the need for more real estate and the farmers' needs for farmland; or the industries' needs for more commodities and the environment's need for biodiversity. How do we decide which needs should be met and whose needs should go first? According to the World Bank I (undated) and Campbell (1996), people concerned about sustainable development argues that by balancing the economic, environmental and social goals planners will meet the needs for the future. In the short-term many of these objectives will conflict with each other but they are mutually dependent in order to survive and grow in the long-term perspective. How can economy survive without the society and how can society survive without a healthy environment?

However, in sustainable development related issues it is also a major challenge to determine the problem as it has no definite solution. Stakeholders and planners represent a variety of perceptions of what is equitable, what is the right solution, and what is the optimal solution, as they see the world from different perspectives. In the context of sustainable urban development no definition of equity is common for all city dwellers, no right or wrong exist, and there are no solutions that solve all the problems involved. There is simply no such thing that solve the challenge of sustainability by fully satisfying all stakeholders at the same time. These problems are known as wicked problems (Conklin, 2005).

Wicked problem

Sustainable development is a problem impossible to define terms like equity, good or bad decisions, or optimal solutions. It is a wicked problem which cannot be described and have no final solutions where all stakeholders' interests are obtained. Hence, in resolutions of wicked problems no true or false and no correct or incorrect exist. Wicked problems are in other words difficult or sometimes impossible to solve as they consist of a high level of complexity and constantly changing requirements. What is right or optimal simply depend on background and interests of the stakeholder (Kolko, 2012). By trying to solve one aspect of the wicked problem new wicked problems may occur making it even more challenging to find a resolution. This is why it is said that wicked problems cannot be solved (Conklin, 2005).

Sustainable urban development is dominated by wicked problems. They typically consist of problems in which no definitive or objective answers can be made and hence no total solutions to undefined problems can be found. Social problems are never solved but at best decreased by being resolved over and over again (Conklin, 2005). Wicked problems represent most public policy problems and in the context of sustainable urban development can be translated into issues like the location of a freeway, determine the best tax rate, or defeat crime due to their complexity. The complicated interdependency and interrelations within these public issues also demonstrates the challenge for policy makers to find the optimal scale of interaction in the society. How much should the public control and what should be up to the market forces and capitalism?

Wicked problems	
Lead to complex situations	Has no stopping rule
Are essentially unique	Reflects diversity among stakeholders
Try to find solution → understand problem	Has no right or wrong solutions
Has no given alternative solutions	Solutions are "one-shot operation"
Problem evolves as new solutions are considered	Creating solution changes understanding of problem

Table 1: Characteristics of wicked problems

Table 1 sums up some of the most important characteristics of wicked problems, and it demonstrates that wicked problems are both malignant and tricky, and sometimes even vicious and aggressive (Rittel and Webber, 1973). Planners must thus treat wicked problems as *wicked* and not try to tame them or treat them as *tamed* problems. The recognition and understanding of wicked problems are essential in order to find resolutions that bring more advantages than disadvantages. Complex social

problems like sustainable urban development are thus never solved but can improve by moving *towards* a more sustainable direction. Planning a dynamic problem never reach a final solution. Wicked problems are therefore unique problems and considered to be a symptom of other problem (Rittel and Webber, 1973).

System thinking

By seeing the urban sustainability issue as a wicked problem we understand that the complexity of the situation and impossibility of defining the problem objectively will lead to further challenges. System thinking is an approach to deal with the complexity of the situation by attempting to understand the cause and effects relationships of the system components. This approach helps us reveal and reshape our mental models, and approve it compared to what is the *real* model. Hence, we better understand how things are correlated and improve our ability to see ourselves in the complex world. This way we handle complex problems and challenges more sufficiently and understand the variety of stakeholders' interests and desired outcomes, and how underlying conflicts due to sustainable development occur. Sustainability is a matter of seeing the world as the dynamic system that it really is.

In contrast to linear thinking, dynamic systems thinking emphasize how cause and effects in systems are mutually related and dependent on each other. It demonstrates the gaps between goals and the current situation and shows systems consists of loops that effects itself over time. These systems changes dynamically and makes the system variables affect each other simultaneously. By involving all stakeholders and seeing the world as a system over space and time we understand how factors affect other part of the system. The complex system dynamics approach will thus generate an in-depth understanding of the causality in real world systems and it will be a helpful approach in understanding how to resolve sustainability issues by understanding the wicked problem system dynamics.

Planning towards sustainability

In the context of sustainability, good decisions are essential in order to balance the economic, environmental, and social aspects. But without comprehensive and well thought-through planning processes good decisions are harder to achieve. As sustainability is an interdisciplinary area, redefine and incorporate sustainability into a broader understanding in terms of complex system dynamics, it can be a useful approach for planning towards sustainability. The challenges between environmental, economic and social interests are revealed, and the sharpened focus on system structures may lead to better long-term sustainable development actions.

The challenges we face today demand various points and perspectives. To foster a resilient, healthy, and qualitative urban environment we need to quickly respond to new challenges, and prepare for the new problems future generations will meet. Comprehensive and reflective planning practices are thus essential in order to gain sustainable development in urban centers. For present cities to survive the test of all time understanding system behavior and developing long-term sustainable strategy is desired. A successful urban strategy is dependent on what environmental, economic, and social interests and dilemmas we include, how we understand the complexity of their interaction and opposition, and how we emphasize them in planning.

Resolutions will be complex, hard to implement, and not possible to transfer to all cities, but in order to gain future achievements the identification of these dilemmas and understanding of causalities are essential. By understanding that these dilemmas are wicked problems we can see how sustainable development are composed, and by taking advantage of system thinking we can improve this knowledge and create clearer mental models of how components are linked together and dependent on each other. The vitality of preventing future crisis and demolition of economies, environments and societies to ensure that humanity lives for generations to come is thus possible to resolve. We need to both manage our planet and ourselves, and take long-term sustainable actions for the world. We must understand the human role in creating the conditions we now face, adapt to changes dynamically, and enhance the environmental support in the way we plan and act. Humans are the only species that can and must take sustainable actions for the world as the alternative unsustainable lifestyle is no alternative at all.

1.2. Problem statement and purpose

Campbell (1996) explains sustainable urban development as the balance between the three main aspects of economic growth, environmental protection and social equity. Between these aspects conflicts arise due to, among other things, different stakeholders' interests. The conflicting situations within the context of sustainability are the reason why sustainability is hard to achieve and thus make it impossible to find solutions. The different stakeholders have different interests, needs and goals for the urban development which make it impossible to find optimal solutions or solutions that satisfy all stakeholders simultaneously. These are call wicked problems and dominate in the context of develop the city more sustainably. Wicked problems challenge the planning of cities in finding resolutions and prioritize the many interests from stakeholders.

The problems and components within sustainable urban development are strongly related to each other which increase the system complexity to levels which are hard to see while being part of the system. This thesis will thus illustrate how we by implementing systems thinking can reveal the many conflicts and their system complexity. By applying dynamic systems thinking the thesis also shows how we by identifying the variables and their interdependencies and interrelations the creation models that can be used as a helpful tool to understand how the system is composed and how it behaves. A general model of the main conflicts cities face between the economic, environmental and equity interests is made, to illustrate the main conflicts cities must face in the future and how the three perspectives are closely related to each other.

The thesis will thus show how a case analysis of Oslo can go in-depth of the proposed general model to demonstrate how the model is valid for a real city. By increasing the level details and applying the specific characteristics of Oslo it is desired to illustrate that the use of models can help planners understand the many aspects of sustainability, their interactions and how planning processes can help a real world city achieve sustainable development.

1.3. Method

Case analysis

The thesis uses a case analysis to demonstrate how systems thinking and systems dynamics can improve our planning processes towards a sustainable future. It is used to illustrate how models can improve our understanding of system components and complexity and how we by using case analysis of a real city can identify and resolve wicked problems in the context of sustainability.

A case analysis is valuable as it generates and tests the hypothesis of the thesis, and is thus able to validate the general model. The case analysis stresses the development factors in relation to the context, and explores causation in order to find the underlying conflicts. It represents an empirical inquiry that investigates phenomena within a real city with the gains from the prior development of theoretical propositions.

Qualitative method

This thesis in based on a qualitative method as the thesis wants to gain an in-depth understanding of how the complex world is composed (i.e. the framework for an analytical approach). It aims to understand the behavior of conflicts, and how they arise in the context of sustainable development. A qualitative method is interested in how incidents can be interpret and understood rather than base the results on statistical analysis and numerous frameworks as in a quantitative model. The survey is done strategically and is done for understanding sociological processes and interactions. The qualitative dynamic approach is explained in chapter two.

1.4. Assumptions and limitations

To not grasp over too much information determining assumption and limitations is essential in advance of the investigation. As the area of sustainability includes a variety of perspectives and theory it is essential to limit the amount of theory included. It is a challenging task to determine where to limit the amount of information and make the outline precise, yet general enough, for the thesis purpose. Cities have many differences but also many similarities. For the thesis purpose we are interested in the big picture and create a general model on the background of the theory that all cities face the same challenge in balancing economic, environmental and equity aspects and thus face the property, research and development conflicts. The thesis will thus focus more on similarities than differences to gain overview of the challenges cities face.

Assuming that all cities have the same general challenges when speaking of sustainable urban development the thesis is not distinguishing cities in different categories. Developed and developing cities, eastern and western cities, small and large cities, and other diversities are not taken into account in order to make the model general in a global context. However, the simplification is adequate for the thesis purpose. Economic, environmental and social situations are different between cities, and the thesis does not account for the individual differences among them. Yet, to not loose insight of important generalization, characterizing cities as cities will be sufficient in the development of a general model and the understanding of the main conflicts cities face.

For this thesis, building mathematical or computer models which are part of the dynamic system approach to study the complex system behavior, is not the purpose. That is why a mathematical computer simulation is not created and not emphasized at all during the approach. We are not interested in simulating the outcomes of the implementation of different inputs in the system, but may me interesting for further study on the topic.

To gain greater knowledge of the system it is beneficial to observe the system over time. More can be learned about the system and decisions may be based on a broader knowledge. Yet, systems develop dynamically and it demands both time and resources in order to observe and understand a system over time. In the purpose of the thesis it is sufficient to propose models and discuss them without observing real world occurrences over time. This may, however, be interesting of further studies of the models.

1.5. Thesis structure

Chapter 1 gives insight in the background for the thesis problem and purpose, the method that is chosen, and the assumptions and limitations of the study.

Chapter 2 represents the literature review of the theoretical framework that the thesis is based on, where sustainability and the systems thinking approach is especially outlined.

Chapter 3 introduces Scott Campbell's *Planners' Triangle*. The chapter illustrates the aspects that need to be balanced and goes in-depth in the three main aspects of sustainability as it is the base for the model development in chapter four..

Chapter 4 goes further in-depth of the conflicts that arises due to the tension of the sustainability sectors different interests. Three general models are created by the use of feedback loops to demonstrate how these conflicts are common for all cities, and how they are interrelated and interdependent to each other while representing all three aspects of sustainability.

Chapter 5 introduces Oslo as a case study. It gives some background information about the city and some perspectives on the situation in Oslo.

Chapter 6 is the case analysis which use the model created in chapter four to implement it for a real city situation. The analysis adds the characteristics of Oslo and created more detailed and complex systems.

Chapter 7 discusses the linkage between the general model and the case study model and whether a system dynamics approach is appropriate. Thereafter the conclusion is set with an additional view on the strengths, weaknesses and potential further study.

2. Literature review

"Sustainability is a new idea to many people, and many find it hard to understand. But all over the world there are people who have entered into the exercise of imagining and bringing into being a sustainable world. They see it as a world to move toward not reluctantly, but joyfully, not with a sense of sacrifice, but a sense of adventure. A sustainable world could be very much better than the one we live in today."

- Donella Meadows

in The Limits to Growth: The 30-Year Update

2.1. Sustainable development

Defining sustainable development

In the 1970's and 1980's the world opened its eyes for sustainable development, and was the era in which the classic and most influencal definition of sustainable development was produced (Rosenthal and Brandt-Rauf, 2006). The term *sustainable* was first commonly used after Donella Meadows and the Club of Rome came out with *Limits To Growth* in 1972. They used the world sustainable in their search for understanding the real world with models demonstrating population growth. Later, the Brundtland report from 1987 tried to determine sustainable development in order to spread the message and to make people understand the meaning of the term. The definition of sustainable development was stated as «…meeting the needs of the present without compromising the ability of future generations to meet their needs» (WCED, 1987). The definition gained broad recognition and embraced the environmental and socio-economic relation. By enhancing intergenerational and intragenerational justice both across nation and between classes of people, the goal of sustainable development was to provide further economic growth, social justice, and environmental protection in societies and in the world as a whole.

However, the Brundtland Report's statement appeared as weak for many by lacking a clear framework (Workshop on Urban Sustainability, 2000) and concrete steps on how to achieve sustainable development (Rosenthal and Brandt-Rauf, 2006). The Brundtland Report also tended to emphasized the human aspect of the sustainability development context by avoiding some conflicts between economic, environmental, and social equity (Giddings et. al., 2002). Yet, over the years, the Brundtland definition has been the most frequently quoted and adopted by local governments and global organizations as a basis for a variety of planning efforts (Rosenthal and Brandt-Rauf, 2006).

The concept of sustainable development proposed in *Our Common Future* brought first and foremost a new terminology into the policy making future by placing economic activities in cooperation with environmental and social needs and limitations. Others, both organizations and professionals, have

proposed definitions of sustainable development. One of the most precise definition is UNESCO determining Sustainable Development as "…socially desirable, economically viable, culturally appropriate and ecologically sustainable" (Johnston, 2004). However, it often occurs that all definitions have lacked the correlation between the three aspects and rather focused on one or two of them.

Consumption of resources	State	Sustainability
> rate to renew and replace	Degradation	Not sustainable
=rate to renew and replace	Equilibrium	Steady state
< rate to renew and replace	Renewal	Sustainable

Table 2: Sustainability and consumption

Sustainability is an interdisciplinary area and theories about sustainable development have been shaped by people and organizations for a long time, based on their different worldview and point of interest (Giddings et.al, 2002). Businesses, governments, environmentalists, and others have influenced how issues are formulated and actions proposed, and is the reason the term has a wide range of meanings. For example, sustainable development is often divided into economy, environment and society (Hardi and Zdan, 1997; McKeown, 2002; Campbell, 1996) as explained earlier and can be seen as three circles affecting each other while also being mutually depend like *figure 3* demonstrates. Due to all the definitions which included the three E's of sustainable development the World Summit in 2005 required the reestablishment of the three E's; economy, environment and equity as the pillars of sustainability and are now a common ground for sustainable strategies and in the resolving of undesired city patterns.

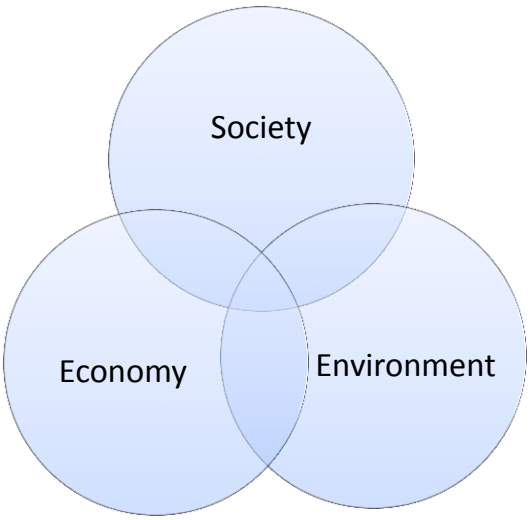

Figure 3: Common three-ring sector view on sustainable development

The goals of sustainable development

Sustainable development strives to bring these three components in balance. However, environment and economy are often prioritized in sustainability debates (Campbell, 1996; Giddings et.al., 2002). Under the Rio Conference in 1992, the Agenda 21 turned focus on issues due to social and economic development, strengthening both the means and the participation of sustainable development implementation in nations. Since then, the social aspect of sustainability has been enhanced to include meeting poverty and juridical question simultaneously.

The economic aspect has been seen as the main priority of cities as they are dependent on the economic growth to maintain their dominance. Also, the environment has been seen as apart from the social aspect of sustainability even though they are highly interconnected and interdependent. The stakeholders represent different mental models and separating the aspects of sustainable development result is a narrow approach that at worse results in damaging decisions instead of provide sustainability to the city. It is thus important to see the three components as a whole and understand how they affect each other both in a short-term and a long-term perspective.

Environmental sustainability is characterized as a state where the systems natural-biological existence is ensured. The system itself and has a particular significance in terms of sustainable urban development as it is a necessary condition for other perspectives of sustainability to exist (Bithas and Christofakis, 2006). The environment forms the basic needs for humans and urban systems, and is the critical factor in order to obtain organic life. The natural environment is in control of the functioning of urban and human systems, and has an irreplaceable role in this term.

The social aspect is more concerned about the perceived just of the city dwellers. The opportunities they possess, the equality between gender, class or age, or their right to be involved in the city development. For all three factors the city should take into account both the positive and negative effects on the city function (Bithas and Christofakis, 2006). The smaller the ratio between them, the less impact does the city have on the environment. This way one may be able to measure level of sustainability and thus understand the effects actions have on the city life.

Yet, even though the three E's are interdependent and interrelated today *figure 4* illustrates how they act relative to each other. The economy is dependent on the existence of a healthy and sustainable environment as well as a well-functional society. This is due to the fact that the economy is a man-made invention built around the existing human settlements and trade of goods and services. The economy cannot grow without a society and an environment providing the society and economy with resource.

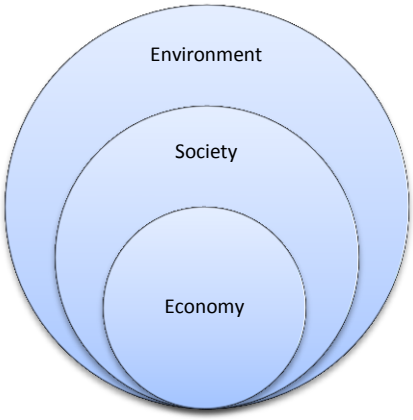

Figure 4: How economy, society and environment are dependent on infinite survival based on each other

By creating economic growth cities must also ensure that environmental and social problems are preserved. Societies however are depending on unfolding and develop in an environment, but do not necessarily need an economy in order to survive. This is however debatable as the modern society is flourishing around the existing economy and experiences crisis whenever the economy fails or goes bad. The environment on the other hand can live without both the society and the economy as eco-systems are able to survive only with the help of other environmental variables, and thus not infinitely dependent on neither societies nor economies. Yet, human built environments like constructions of any type are often dependent on maintenance and financial support in order to survive and behave as desired.

Challenges to sustainable development

Even though most people have a perception of what sustainability and sustainable development is the term has met criticism of being vague, diffuse and immeasurable. It is said that due to the different world views sustainable development has been obscured and have had no definite meaning (Taylor, 1992). Knowing whether we are sustainable is hard to measure but it is to a certain level intuitive for humans to understand, and the more knowledge is gained the more likely it is to understand the consequences of our behavior. In trying to measure the level of sustainability it makes us focus on the existence of challenges but does not tell us how to solve them (Hecht, undated). Yet, most authors argue that well-defined indicators can make sustainability tangible and able to be adjusted through empirical observations (Reed et. al., 2006).

Another challenge is how we can break down sustainability into operational actions. Transforming the broad range of sustainability concern into specific steps in the short term is a difficult task. It is however easier for those who can learn from previous mistakes as sustainability experiences are being translated and conveyed over time. But how can we measure sustainability, how do we know that we have achieved it, and how do we know that what we are doing is really *sustainable*? It is easy

to get tricked by adding *sustainable* to any verb. By remembering that sustainability is a long-term dynamic approach which brings together a number of concerns under a superior interest it improves the implementation of actions and increases the chance of achieving desired outcomes. We might not ever be able to measure it, know if we achieved it, nor understand what is the best sustainable path, but by adding system thinking and comprehend complex system dynamics we will gain a reflective understanding of the many aspects of this interdisciplinary topic and the conflicts that may occur and develop.

In theory, everybody wants their city to develop and achieve success in the sustainable context. Although sustainable development has gained great recognition the last decades, the concept can mean different things to different people depending on a number of factors. It does not require any specific policy and makes people think they are sustainable without seeing the long-term consequences of their action. Hence, we are not able to evaluate how actions and positions affect the development over time. One might argue that the action itself is not environmental unfriendly, but the causality between actions and outcomes is the reason why decisions may occur as unsustainable. This emphasizes the importance of having a broad and comprehensive understanding of the system before decisions are being made.

The task of the concerns today must be met by reducing the gap between theory and practice, and make a dynamic affords to achieve sustainability in practice. Conflict resolution is, in this context, important as the tension between different perceptions of goals or interests of action outcomes may demonstrate the gap between the wanted and the needed. For stakeholders involved in the development of a city it is important to ensure that the desired is implemented and does not end up in shallow thoughts about how we *wish* the city was more sustainable.

Planning and decision-making

The planning of sustainable actions is significantly dependent on the planners' understanding of the wicked problem they are facing, and is affected by the emphasizing of goals, objectives, and values in the development work (Tennøy, 2010). Today, the environment and society is being dominated by the economy in the context of sustainable urban development as national and international companies dominate planning and decision-making both in which governments rely on. Forums and organizations also make decisions without a greater form of democracy (Giddings et.al., 2002), which leads to narrow insight of the total picture and at worse unfortunate and damaging consequences. As potential conflicts and synergies lies between the three main aspects of sustainable urban development pressure on the planners to include all stakeholders is made in order to gain insight in the conflicts. Social equity is about including and empowering the city stakeholders and help decision

makers understand the complexity and synergies when moving the city towards a sustainable urban path. What works and not are best answered when taking as many stakeholders as possible into account.

According to Campbell (1996), sustainability can be a powerful and effective planning principle if it is redefined and implemented more broadly in political conflicts. He argues that the idea of sustainability will be more effective in the long run by stirring up the conflicts and edge the debate. To let the equity criteria form the interaction between the interdisciplinary fields of sustainable development one can address the disadvantaged communities in conflict with public or private institutions are being addressed. The power imbalance will also be identified when environmental justice puts pressure on procedural equity (Rosenthal and Brandt-Rauf, 2006). System thinking and system thinking skills will thus promote the concept of sustainability in actions taking processes by involving and activating different stakeholders and interest groups. Sustainability is not the product but the process that does not happen by itself.

The planning of cities includes more than the concern about the physical structure. When planning sustainable housing, transportation, and sanitation systems the socio-cultural, economic, and environmental infrastructure are just as important. This demonstrates the complexity and connectedness across borders and must be included in order to move the city to a long-term viable and sustainable future. Ensuring environmental and economic satisfaction in parallel with sociological awareness is a challenge but also essential in order to achieve success. In urban planning, some system approaches have been made the last decades, often including one or at most two of the sustainability aspects. Forrester (1969) developed a system approach integrating a holistic view on urban planning linking the environment with urban infrastructure and economic development. The urban metabolism's (Wolman, 1965) holistic view indicated that the environmental quality was dependent on the use and removal of energy and material usage. However, the problem with urban metabolism is the main focus on land, transport, and energy use and ignores the other aspects which also play a significant role.

2.2. Systems thinking

The human species tend to emphasize our own needs over other species' in the world. No matter how much we try to account for their requirements it is impossible for humans to fully understand them. The human species is, however, highly dependent on the surrounding nature and thus dependent on taking care of the resources we possess. To develop in the right direction we must ensure sustainable and wide understanding about the systems dynamics in urban development. The thesis will thus emphasize the use of complex system thinking approach in order to improve decision-making in cities. The wicked problems that arise due to the context of sustainability goals and conflicts will in conjunction with the use of complex systems dynamics and feedback loops bring better in-sight in the real world complexity and thus promote better planning for the sustainable future.

Seeing ourselves from above and being able to analyze and criticize ourselves from a wider context is essential when moving a city towards a sustainable future. We want to understand the problems and the underlying conflicts that arise between the many interests of sustainability. The complexity of the systems we live in is growing, constantly causing unanticipated side effects which further increase the system complexity. By applying system thinking, originally formed by Professor Jay Forrester in the 1960's, humans gain greater understanding of the world by seeing patterns that change over time rather than seeing them as individual occurrences. If we are able to see the big picture with its system components we realize what actions that may involve, the interactions between them, the growing patterns, and the pattern consequences. In other words, we will understand that problems that arise in the urban environment are integrated parts of the society's complex system dynamics. When seeing the real world as a system with interdependent components constantly interacting with each other the ability of managing the city improves by the increased understanding of the underlying causalities in the world.

Understanding how everything is holistically connected rather than only focusing on one thing and neglecting the others will be essential in planning in order to make better decisions for the future. The holistic view looks at relationships and interactions between parts and is the essence of the system perspective. It is also argued to be in great consonance with the long-term best interest of systems as it sees the world's complexity by including all its parts (Sterman, 2000). Systems thinking emphasizes integrative devise solutions and keeps a distance to more reductionist approach which focuses on one part of the system which often leads to unintended and unexpected impacts on other parts of the system. Yet, the dominant approach due to globalization is modernism and relies on the reductionist approach to problems like water, traffic, energy and housing. It turns out that most of these modernist solutions are unsustainable in regard to the consequences of urban life (Newman

and Jennings, 2008). When introducing a system perspective, sustainable ways to live can more easily be found and lead our attention on relationships and processes in the complex world. The living systems around us have properties that emerge trough system parts' interactions and beyond the properties of individual components. The characteristics of systems are that all parts must be present, which requires a specific arrangement and purpose (Sterman, 2000). The composition of the system components provides feedback that makes us able to use the system perspective processes and relationships to better understand the emergent properties and complexity of the system, and ensure that we do not isolate parts from each other when analyzing different components.

Problem solving and analytic understanding of complex real world systems is the main focus in systems thinking. The reason why we are interested in systems is to understand why events occur in the real world. Events are often seen as problems which trigger our interest in how in to change and control occurrences, and by focusing on the event itself short-term solutions are easily developed (Kim, 1996). These short-term solutions may not fulfill the long-term best interest of the society and thus bring undesired effects on the environment. When digging deeper we understand that events are outcomes of patterns, patterns which are changes in events over time. When taking a closer look at these patterns we will discover the relation of the initial issue and the events. The patterns are consequences of the system structure which is the overall system in which the parts are connected. Being able to find the structure lead to leverage answers which in the context of urban development imply how we can create better planning and hence move the city towards a more sustainable future.

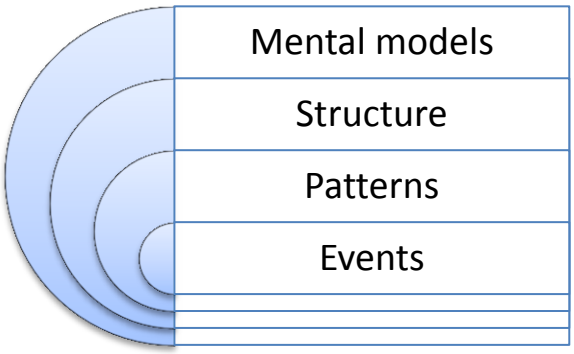

Figure 5: Dynamic systems compositions

The interaction between the interdependent components of the system forms a complex and unified whole. Humans are, however, not able to grasp all the details and complexity in the actual world as the amount of information is too extensive for our capacity. When describing the real world systems with its essential features we gain better knowledge of the big picture and create comprehensive decisions. For example, the thesis consider the three main perspectives of sustainability and their

respective critical interactions presented by Campbell in the article *Green Cities, Growing Cities, Just Cities (1996)* instead of integrating *all* aspects and challenges in the context of urban sustainable development. The simplification is sufficient and makes the point the thesis wants to investigate without including all the details in the system, details which are impossible to encounter at any given point in time. In other words, dynamic systems are visualized by models which improve our understanding of the behavior and processes behind them. Decision-makers, societies, and the global future are dependent on the creation of more correct mental models in order to understand that systems consist of interrelated components humans directly or indirectly affect.

According to Sterman (2000), the survival of humanity is depending on the development of system thinking. Yet, learning about complex systems, while simultaneously living in them, is difficult. Being able to take a step out of the system and see it from above is what systems thinking is all about. It will be challenging to find tools and processes that help us understand complexity, construct better policies, and guide societies and organizations towards a common goal. However, by implementing the systems thinking approach problems will be seen as part of the overall system, rather than responding to separate parts alone. It focuses on a cyclical composition and not as a linear cause and effect approach which is easier and more intuitive to the human mind. By understanding the components' interaction we will better be able to influence the system behavior and achieve desired system outcomes. If we manage to implement systems thinking by seeing the forest instead of the threes the complex world may be manageable and we can develop urban areas more sustainably.

System dynamic approach

System dynamics implies the dynamic behavior of a system and is interested in conceiving, studying the dynamics of, and understanding the behavior of models representing a real world system. Due to the concern of improving and hopefully control system behavior (behavior which first and foremost is problematic) sustainability oriented planners apply this approach. Observing and identifying problematic behavior of systems over time is the essence of system dynamics. System dynamics are known for its holistic view which demands a multidisciplinary and general approach in order to render the real world system. In this thesis, sustainable urban development itself is an interdisciplinary area which makes it essential to accommodate this criterion.

In the real world, planning processes and their actors make interaction with physical and institutional structures in the society. These interactions lead to feedback loops, stocks and flows, and nonlinearities in the system structure which in turn result in system behavior. By understanding feedback loops we gain better knowledge of the complexity of the system and realize how to control or influence the system components in order for desired behavior and outcomes to occur. In linking

resources and information stocks and flows in feedback loops it demonstrates how the system components are woven together in a higher level of details.

Feedback loops

By nature, people tend to see the world as a linear *cause and effect* system. The world is however more complex than that. When implementing feedback loops the core of the system dynamic concept is captured. The mental models we obtain and created by feedbacks which determine the dynamics of real world systems. Then we address how the processes of information influence other parts of the system and in turn influence itself our mental models alter and our understanding of the system complexity increase in value. Over time, the complex interplay between all the pieces in the system will increase. Feedback loops will thus evolve and may consist of additional variables and changing patterns.

Feedback loops are causal loops that demonstrate the influence dynamics of components in the system. By linking resources and information feedback loops are designed. F*igure 6* demonstrates the inter-dependency between goals, actions, outcomes and the environment in the general term. In the context of sustainable urban development the city's total environment is desired to be improved. On behalf of the city better environmental quality, increased economic growth, and improved social justice in the urban society are set as goals. The level of the goals is up to the person behind the evaluation, and can be concrete and sharpened for economic interests, or bigger and more diffuse for an overall sustainability concern. The goals further lead to certain actions which in turn result in outcomes. The outcomes may improve our environment as desired or cause undesired changes to it.

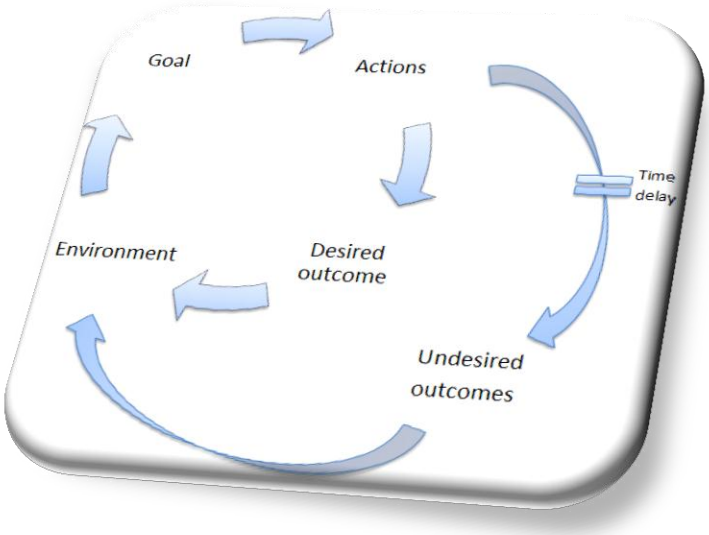

Figure 6: Feedback loop demonstrating decision-making in SD

Undesired outcomes may occur in longer time frames compared to desired outcomes due to a delay in time. Both undesired outcomes and time delays are often not taken into account when planning and actions are implemented as it is impossible to know all action effects and consequences. Even though a similar action has been implemented in other cities before, a city may experience other consequences and thus different outcomes than originally desired. This demonstrates that the more well though-through the system dynamic approach is, the better the knowledge of what might be the outcomes of the actions is, but that one never knows the total impact of actions until they are set to life and observed over time.

As desired outcomes influence the environment beneficially and undesired outcomes may lead to negative change in the environment the goal will adjust to the environmental change and hence change the actions involves if necessary. Due to this synergy the loop will continue to develop the city by the goals, actions and outcomes it brings. The goal changes and the whole process in the feedback loop start its dynamic process all over again. When understanding the interrelated and interdependent pieces of the puzzle a better picture on the world is given and we may be better equipped to make good decisions for the future. In terms of sustainable development it is especially important to be able to include the long-term perspective and time-delays, and thus understand what affects and outcomes actions may lead to and realize that in order to do the best thing for the future we must see the world as a system infinitely generating desired and undesired outcomes.

In the demonstration in *figure 6* feedback loops are simple and easy to understand the purpose of. However, when including more details the complexity increases. *Figure 7* takes others goals within the same topic into account. These goals will also affect the environment through desired and

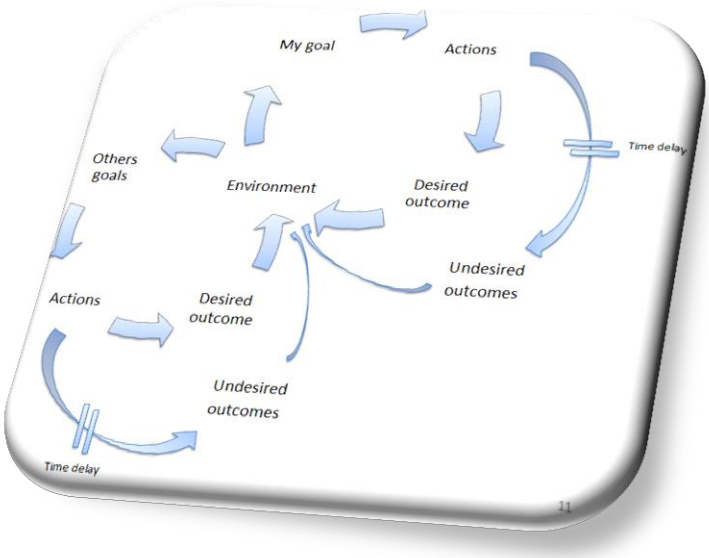

Figure 7: Feedback loop when more than one person's goal is included. The complexity increases.

undesired outcomes due to the actions made on the background of the initial goals. The system complexity increases and the feedback loop system includes more details. In the sustainable development issue the goals shown in the *figure 7* can be seen as the different goals of individuals, organizations, businesses, and governmental institutions in a society. They all have different goals for the development and further influence the environment in different ways at different levels. These impacts make the system complexity to change and develop dynamically and force the decision-makers to constantly adapt into change and also be able to understand static states as parts of a dynamical behavior over time.

Figure 8 demonstrates how the complexity and interaction between system components increases as a multi-dimensional occurrence are taken into account simultaneously. The level of details will determine how complex the created model is. Sustainability issues are experiencing the difficult task of managing all three perspectives at the same time, and as there exist many different goals and perspectives in all the three areas, the system complexity needs qualified planners in order to be resolved for a better sustainable future.

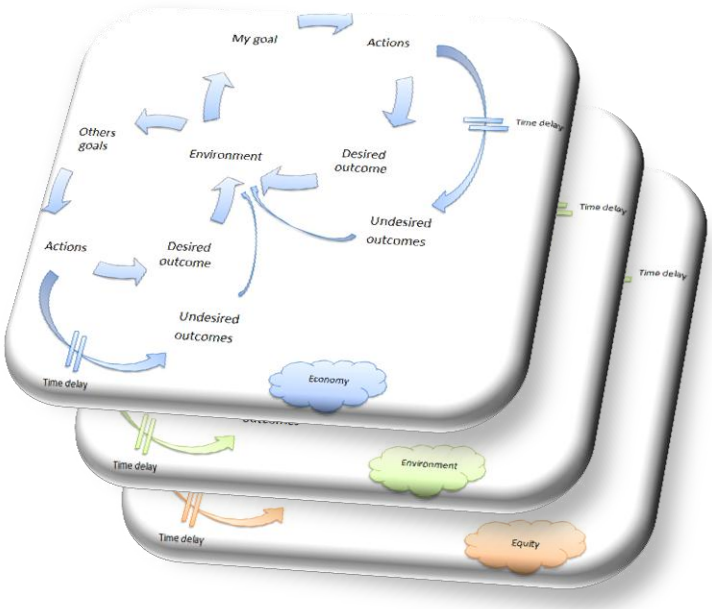

Figure 8: Complexity in feedback loops increases the more it includes. In this figure, my and others goals of some of the SD issues are included.

Qualitative system dynamics

With background in the cause and loop diagram presented in the previous section the thesis in done on the behalf of qualitative system dynamics. The cause and effect approach is used to explore and analyze the system in focus and thus explicit create mental models of the system structure and

strategy. This type of system is more convenient for systems that are hard to quantify. Qualitative systems are softer and do not necessary demand mathematical outcomes in order to gain understanding of the system. It is often more intuitive and require less numerical knowledge. A quantitative analysis is however more appropriate when we are interested in numerical outcomes of system behaviors in order to understand, control or influence it. Using mathematical sizes to simulate real world systems gives greater detail and understanding of how the future might me. However, the collection and use of these mathematical data has many potential pitfalls which makes the forecasts and simulations easy to wrongly estimate.

The depth of the thesis analysis is increased by the insight into the complex system, but requires cost and effort from the inquirer. The marginal cost and effort is representing the value added and can be applied infinitely to the system development. Yet, a qualitative analysis of the system is often sufficient with limited effort (i.e. the investment of time and cost) and is most appropriate when the resources available are minimized in the context of developing a model of sustainable urban development problems (Wolstenholme, 1990). However, by expanding the analysis with additional time and effort a quantitative analysis can be appropriate in understanding and gaining knowledge about the system. The additional computer simulations knowledge requires more effort in the application of these programs and understanding of software. Yet, the correlation between added value and in-depth understanding of systems is dynamic and is additionally improved by using computers to understand the real world. For this thesis purpose a qualitative approach is sufficient and comprehensible in order to design and understand dynamic complex systems.

Qualitative
Less use of time and effort
Simplified
Easy to understand for most people
Sufficient for most problems
Intuitive
Softer systems

Table 3: Advantages of qualitative system dynamics

Why we should chose system dynamics for the thesis purpose

The sections above describe the benefits and challenges due to system thinking and the complex dynamic approach. Even though the challenges are hard to solve the advantages of using this method increase the understanding of how the real world consists of a variety of interdependent and interrelated components. *Table 3* summarizes the advantages when applying a qualitative system dynamic approach. However, by using this tool it will be helpful to gain knowledge for the thesis purpose and increase the understanding of the world in general.

As the table summarize, system thinking is a process easy to understand and easy to implement to persons who have not used the approach before. The holistic view increases the understanding of

the interdisciplinary area of sustainability which leads to comprehensiveness and reflective decisions. Additionally, system thinking makes the researcher being able to both use qualitative or quantitative approaches depending on the hypothesis of the problem and the desired results. On the other hand, when we understand and model systems the essential components of the real world is difficult to identify. It is also a challenging task to find the right degree of complexity as systems can be created on many different levels depending on what is desired to include. The amount of time and effort must be in accordance with the system complexity and desired output. It is hard to determine as variables and complexities are evolving dynamically.

Dynamic system approach	
Advantages	**Challenges**
Holistic view	Find the essential components
Easy to understand	Find the right degree of complexity
Comprehensive	Right amount of time and effort spent
Qualitative vs. quantitative	

Table 4: Advantages and challenges due to a dynamic system approach

3. Model framework

"All models are wrong
–but some are useful"

-George E. P. Box

in *Empirical Model-Building and Response Surfaces (1987)* p.424, Wiley

3.1. Planner's Triangle

To grow the economy and distribute the growth fairly while not degrading the eco-system is a huge challenge for cities. Finding the balance between them in order to achieve sustainability in the city and the world is critical in the time to come. Planners at all levels are responsible of achieving sustainable development and sustainable planning have for centuries been challenged in the development of urban areas. All kinds of development demands planning, and good planning is important for the feasibility and fulfillment of sustainable goals. Scott Campbell's *Planner's Triangle* (1996) seeks to demonstrate that planners can achieve sustainable solutions by combining their substantive skills with techniques for community conflict resolution. He argues that the model is to help planners «…understand the divergent priorities of planning» and that misunderstandings that rise from the different languages of environmental, economic, and social foundation cannot be eliminated only by translating issues and interests across disciplines but that it is simultaneously dependent on understanding the underlying conflicts.

The planner's triangle demonstrates how economic, environmental and equity goals are mutually dependent and related to each other in the context of sustainable urban development. Conflicts arising between them represent tensions from the complementary stakeholders' interests within each goal. The triangle thus represents a model in order to understand what kinds of issues we must be aware of when finding our path towards sustainable urban development. Campbell's typology is thus useful in representing these conflicts and potential trade-offs between the sustainability goals. It is also useful to resolve conflicts and thus prevent negative consequences on development (Campbell, 1996; Rosenthal and Brandt-Rauf, 2006).

The triangle is relevant for the thesis as it visualizes the critical conflicts arising when we work to achieve sustainable development. Comprehensive planning is dependent on the identification of potential conflicts. When we understand and address the underlying conflicts we are better able to identify stakeholders' interests, improve our mental models, and most importantly achieve better

decisions-making. The model helps planners and decision-makers to understand the sources of conflicts and stakeholder values.

The triangle developed by Campbell (1996) is easy to understand and useful for its conceptual simplicity. It is divided into three main perspectives, also called *The Three E's*; economic growth, environmental protection, and social equity as previously explained as the essence of sustainable development. Although sustainable urban development also contains of a number of other aspects like architectural, psychological, and technological to name a few, the triangle represents the overview in which other aspects can be integrated. The range of details and complexity makes it beneficial to reduce the model to the three main goals, which is sufficient for the thesis purpose. Conflicting interests will occur and cause challenges in planning in regard to sustainable urban development. The main challenges represented by the model will represent the conflicting interest of (1) how to grow the economy and (2) distributing it fairly, while at the same time making sure that (3) the process is not degrading the ecosystem.

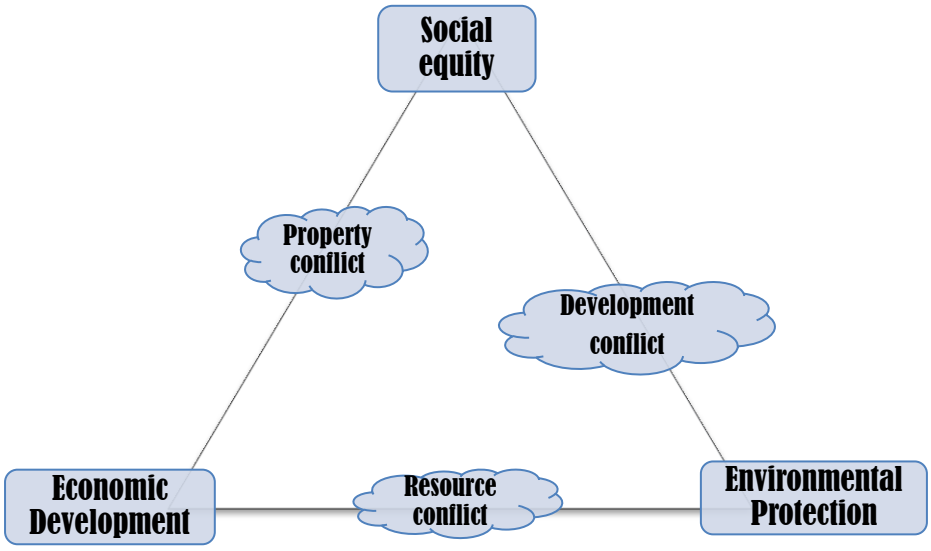

Figure 9: Planners triangle including main perspectives and the corresponding conflicts.

The triangle illustrates that each aspect of sustainable development represents the vertices at the triangle. Each aspect represents its own stakeholders and goals. The conflicts arise when efforts to achieve one aspect influences the ability of actors in the other sectors to achieve their goals. Sustainable development is therefore not achieved when we come out of dynamic balance between the vertices.

The three conflicts arising between economic growth, environmental protection, and social equity is by Campbell (1996) defined as the property conflict, the resource conflict, and the development

conflict. The property conflict is addressing the tension between economy's need for growth in outcome and the society's need for justice leading to a question of owning and distributing land our buildings. The resource conflict rises from the tension between economy's interest of production and growth, and the natural environment's interest of preserving resources for the quality of the nature and future exploitation. The resource conflict is thus representing the question of how to distribute, utilize and regulate the availability of resources. The last conflict rises between social demand for space and equity, and the environmental demand for green space and a healthy environment, called the development conflict. It brings the question of how to develop the land and resources available in order to develop the city fairly. The development conflict is to a high extend a result of the two other conflicts and driven by the balance between all the sustainability goals. However, all conflicts are mutually important and dependent on finding better solutions of the sustainable urban development challenges.

3.2. Model understanding

Campbell's model represents *the three E's* as the main interests of sustainable urban development; economic growth, environmental justice, and social equity. These are some of the desired goals we want to achieve for a sustainable development of urban areas. However, Campbell's goals can also be seen as aspects of sustainability with sub-goals that creates both external and internal conflicts. But however one look at it goals changes over time and create a dynamic process of handling challenges. Between the goals of sustainability conflicts occur making it significantly challenging to achieve these goals. As the goals themselves have different perceptions of the occurrence of the city and its potential, the arising conflicts are highly influenced by the opposing interests of what the city's best interest is.

The world we live in consists of a number of stakeholders and interest groups. They all have their own wants and needs representing the whole scale of values and mindsets. The goals of sustainable urban development are no exception. Within each goal of sustainable development there exist a number of interest groups who all have different perceptions of the goal and opinions on how to move towards the *right* direction. As an example, the economic stakeholders have strong interests within the economic goal, but there exist a range of economic stakeholders and each stakeholder or interests group represent somewhat different interests than the others. Businesses, governmental sectors, and even private actors can be represented as

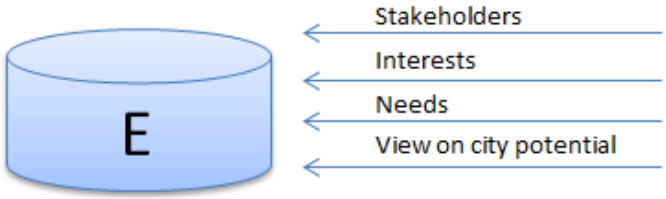

Figure 10: Each perspective includes a variety of stakeholders, interests, needs and views on the city potential

economic stakeholders as they want decision-makers to emphasize their interests in the city development. Their different wants and needs lead to conflicts within the economic goal, conflicts that further hamper the work towards sustainability. Additionally, interest groups representing the other goals of sustainability (i.e. social equity and environmental justice) are involved in the economic aspect of city development. Stakeholders within the goal and the interest of the stakeholders representing other goals increase the complexity of the arising conflicts. *Figure 11* reflects both the interrelation as well as the interdependency between the goals and the variety of interest groups involved. Hence, each sustainable urban development goal face challenges due to the many participants included.

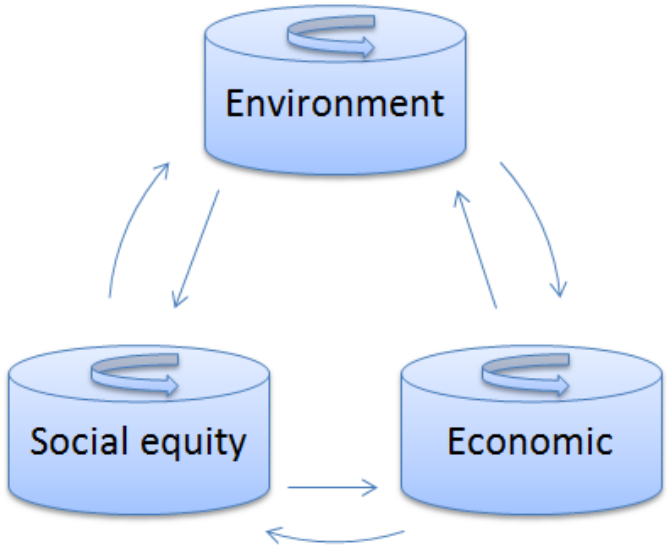

Figure 11: The three perspectives represent interrelations and interdependency to each other

Based on the previous argument it is clearer how everything is related, and how everything is dependent on everything in accordance to the theory of complex system dynamics. These stakeholders are simultaneously representing other goals like environment and equity making the goals to involve in each other's development. This way, internal and external conflicts are created. The internal conflicts within each sector represent the difficulty in determining which goals are most important for the perspective. The external conflicts represent the inter-sectorial conflicts that create challenges in achieving desired goals. The conflicts are thus represented as the loops in the triangle. This demonstrates what Campbell argued in his triangle where all goals and conflicts are interrelated and interdependent on each other resulting in increased system complexity.

However, system complexity is not the only challenge we face when understanding how the system is dependent on its different parts including stakeholders' needs and interests for the city. These systems are not static, they develop dynamic over time. It is important that the system has the ability

to adapt into changes in the environment where humans' values and mindset play a significant role. When we look at how we the last years have changed from society emphasizing automobiles and the access on roads, and how we today turn towards a society which increases the demand for public transport, electrical cars and bike lanes which degrade the value of cars and the demand for petroleum. These interests are due to changes in the environment and changes in the values of the society. Naturally, the systems in which we live and its stakeholders transform our evaluation of variables. To understand how the three E's of sustainable urban development oppose each other and lead to these conflicts in the first place the next section will go in depth of the goals and demonstrate how they differ.

3.2.1. Economic sector

In the world we live in today, economic growth plays a major role in the development of the society. As the technology has evolved the last centuries, followed by the industrial revolution, the world has become a result of global interdependency and the economic behavior of nations. That may be why the economy and economic growth have been the first priority by policy makers for centuries. Yet, while economic growth is threatening social justice and environmental development with segregation and waste accumulation, it is also dependent on both society and the environment in order to grow (Daly, 1992). This paradox stresses the importance for finding a balance between economic growth and the two other goals for achieving sustainable development in the city.

Economic growth and the city

As previously mentioned, economic growth is seen as the main engine of the city (Ayres and Warr, 2009). It is a place of innovation and constantly improving technology attracting people from near and far to take part in the development. The evolution has made cities to evolutionary breakthroughs as production has become more efficient, growth has occurred in goods and services, and the economic flow in terms of technology and information has improved. The economic surplus in the cities has encouraged further growth and made cities complex economic systems measured by the city's welfare. Social dynamics and innovation has been results of the economic growth and increased the attractiveness by improved opportunities for the population. In turn, growing cities attract investment which further result in growth and additional investment (Hall and Pfeiffer, 2000).

Economic development refers to the increase in beneficial outcome, measured by the amount of gained production, welfare and income (Bithas and Christofakis, 2006). Economic growth and progress is evaluated in purchasing power, also known as utility (Munasinghe, 2007) and gross domestic product (GDP) (Tucker, 2010) which in turn measure how wealthy we are. Policy makers on national and global levels seek to increase the GDP and stimulate to more efficient production and consumption in order to increase the growth (Mukherjee, 2002). Economic growth is concerned about stable inflation and employment, and constantly dependent on access of raw materials. As the world has gotten globalized trade has become an important factor of economic growth possibilities, and by that economy valuate welfare by monetary income and consumption within and between nations. Hence, the main mechanism of economic growth is the creation of wealth. However, the economy is often forgetting the wealth of other aspects like equality of city dwellers and the preservation of scarce resources and a fragile environment.

There is a variety of effects caused by economic growth. Change in the structure of local economy is a result of changing development, and makes the nature of environmental problems change

simultaneously. It can reduce pollution in the city by reducing the energy consumption as the economy is approaching more energy-efficient activities. However, economic growth also leads to increased income and purchasing power which in turn generate higher consumption and car usage as well as increased space and energy demand. The result is more pollution and consumption, and thus increased problems like climate change.

As income rates are growing it can generate more resource-intensive consumption patterns, and, hence, increase pollution before cleaner technology is applied. Later on, people may care more about environment as improved information about the environment leads to more consciousness about clean air, clean water, and a healthy environment in general. However, although some cities have the same income level, the engagement and choices of achieving sustainable development vary greatly. One example is how gasoline consumption differs from city to city dependent on density and the facilitation of transit-systems and fuel intensive sprawl. This may be why many emphasize the importance of high density areas in order to escape from the consumption and pollution in the city.

Sustainable economic growth

Economic sufficiency is essential in order to maintain sustainable amounts of consumption and production patterns. The underlying concept of economic sustainability is how to increase the income and revenue while maintaining or reducing the stocks of assets (Munasinghe, 2007). This can be seen in accordance with the definition of maximum sustainable consumption as «… the amount we can consume without impoverishing ourselves» (Hicks, 1946). When talking about sustainable economic development it is often questioned which kind of capital we want to maintain and its ability to be substituted. Human, social, material, or natural capital all have values but the one we value the most and appoints with highest potential will most likely be the one we rely on in the future.

Along with production and consumption, healthy distribution and innovation are also important factors for obtain sustainable economic growth. The city is in constant competition with other cities for markets and new industries and wants to ensure that the potential added value is not transferred to other cities. Yet, cities are depending on good communication and transportation possibilities and prefer highways, market areas, and other commuter zones when delegating space in order to elicit the investment attraction. However, the space usage must develop sustainably. Green investment and policy incentives may increase the interest of sustainable economic growth and lead to an increased sustainable economy. The symbolic outcome of green investment in businesses may also increase the value of the firm, lead to further interest from consumers and other stakeholders, and

increase their competitive advantages over businesses which underestimate the value of a green actions and profile.

Economic oriented stakeholders

Based on the theory above economic stakeholders are interested in increasing the value added. Growth in GDP and hence wealth will lead to stronger purchasing power and further economic growth. Cheap labor, high return on investment, and low taxes are some of the factors economic stakeholders are valuing in order to earn more money and ensure that the city is developing and growing in monetary terms. Economic stakeholders are typically interested in variables like investment, prices and attractiveness of the city. These are variables are which highly linked to each other. As prices rise investors are attracted to invest in the actual good in order to gain high profits. At the same time, if the prices are too high, it will decrease the attractiveness of the city as people find the city too expensive and thus chose to settle down elsewhere. In order to achieve economic growth the availability of resources along with price and quality of the goods and services are essential to make sure that consumers find their products beneficial. The availability of resources will determine the price of the product where good availability will lead to lower prices and probably larger sales volumes. Yet, the economic interests in the city will to a high extend be driven by capitalism and monetary terms. The conflicts described in *chapter 4.3* demonstrate this.

In short term, economic growth is interested in extracting as many resources as possible in order to generate immediate income and revenue. However, in the long run businesses are dependent on having resources available at all times which implies the importance of restricting and regulating the rate of exploitation. That is why economic interests indirectly are dependent on regulations that ensure the availability of resources in the future. Yet, the economy is often focused on short-term benefits and have a hard time evolving in long-term strategies as business need to generate revenue rapidly in order to survive in the competition with other businesses. The fine line between regulations and the free market therefore may lead to great challenges for decision-makers. It is also in the best interest of the economy to utilize the resources optimally, by being efficient and productive in the transformation of products from raw material to the final good.

Interest	Pros	Cons
•Value added	•Technology	•Pollution
•Purchasing power	•Innovation	•Waste
•Raw materials	•Sufficiency	•Consumption
•Production	•Image building	•Materialism
•Investment	•Opportunities	•Use-and-throw
•Increased GNP	•Market forces	•Market uncertainty
•Capital intensiveness	•Employment	
•Attractiveness	•Recycling	

Figure 12: Interests, pros and cons of economic growth

3.2.2. Environmental sector

The historic tendency has shown that the development of cities has been promoted on the cost of nature and natural destruction by clearing forests, poisoning rivers and transformed large pieces of land to the benefit of human existence (Campbell, 1996). This is partially why the twenty-first century is about preserving the environment with eco-saving technology, similar to how the twentieth century replaced men with machines in the labor-saving technology. This task is however much more challenging as the environment consists of complex systems and often gets affected both directly and indirectly by human activities in desired and undesired ways. Damage to the environment is hard to measure, and the alignment is depending on collective human actions. However, cities cannot wait forever to take action, as the human species is highly dependent on the environment in order to survive. The nature cannot wait and an effective strategy along with vigorous actions is critical to ensure a sustainable development of the modern society.

Environmental protection and the city

As mentioned in the previous section, production will always need resources and raw materials in order to generate products significant for humans and human existence. This demand cannot be replaced by technology nor substituted to a large extend, which underlines the importance of protecting the natural environment to ensure that we have enough resources to feed ourselves. Even though production in present time may require fewer resources as technology, knowledge and information improves we still need a critical amount of raw materials to satisfy our energy-intensive needs. In other words, cities are growing and the urban area is becoming even more energy-intensive, but people have the same basic needs per person no matter how many we get.

The majority of urban growth occurs on the land surrounding the city center. This separates housing and workplaces and increases the need for cars and other transport alternatives. The demand for transportation is among the most serious problems urban development is facing today (Cone and Hayes, 1984). The idea of densely populated cities is a goal for ameliorating the sprawling effect along with problems like energy and material usage. Nevertheless, densification may lead to other challenges, like how to provide dwellers with satisfying access of goods and services, how to build a satisfying sanitary infrastructure, and how to preserve green spaces in the city. An eventual reduction of urban green spaces may lead to degraded ecosystem services, lower air quality, and reduced recreation possibilities. Multifunctional green structures are advantageous and require integrated planning approaches to manage economic, environmental and social sustainability prudently. Urban life is dependent on green sites both for citizens' well-being and for ecological processes to maintain. In addition, planners and decision-makers must remember to not treat land as leftovers, but rather see land has potential fruitful functions in the future.

The concern for the environment differs between cities, as do the economy which often plays the leading role when determining which environmental aspects are prioritized and not. Germany is a country where waste is recycled, but simultaneously a country where the auto industry stands strong. Along with cheap gasoline prices Germany's environmental plan is different than for Chile, where waste is not recycled and expensive gas courage people to choose public transportation alternatives. Elsewhere, like in the United States, people are willing to offer time and money to be able to live in low-density communities in the suburbs and drive their car to work. This demonstrates how different countries and communities are relating to the environment and that the challenge of achieving sustainable urban development will differ greatly among nations and cities. Hence, environmental actions are necessary and must be taken despite the city's income level and location.

Sustainable environmental protection

The environment differs from the other two objectives as it can live without both society and the economy (Lovelock, 1988) showed in *figure 3d*. The environment includes both the wilderness as well as the concrete-dominated cities of the 21st century. The untouched or managed areas all are part of the environment and ensure that humans and other species find a way to survive in the long run. Environmental protection is a matter of preserving the ecological potential both for humans to utilize and for other species and ecosystems as they ultimately depend on ecological services (MA-CF, 2003). It underlines the need to evaluate their common sustainability and improve the ability to adapt to change without only conserve resources for a static ideal state (Munasinghe, 2007). By obtaining resilience we increase the ability for the system to return to its equilibrium when experiencing disturbances (Pimm, 1984). A resilient environment is also better equipped to adapt to these changes as it is able to maintain the system function even if disturbed (Holling and Walker, 2003) and increases system sustainability. The current change in environment might overload the resilience and ability of the urban population to adapt. The ability of overcome environmental change is determined by monetary capacity and favors wealthy cities compared to poor cities. But even with a wealthy local government the budget priorities decide if the city government can meet the need for better housing and infrastructure improvements with the need for a resilient and healthy natural environment (Rosenthal and Brandt-Rauf, 2006).

Environmental stakeholders interests

The environment sees the city as a consumer of resources and producer of waste which might be why urban areas stress environmental protection in the city more than environmental protection in rural areas. As cities consist of a limited amount of available land scarce resources are in constant competition with the city posing a threat on nature. From the environmental point of view, space is

therefore a possibility for greenways to grow, river basins to flow, and eco-systems to obtain the resilience of the land. Viability and the health of the living systems are in the best interest of environmental protection, and having a satisfying adapting capacity makes sure that the environment and society can live on for centuries. By understanding how ecological resources are limited and increase the risk of hindering long-term potential of development the basis of the environmental aspects of these stakeholders' interests is met. To demonstrate the genuine dependency on Earth's resources one can thus argue that without the environment neither economy nor society will survive.

However, there are challenges for the environmental stakeholders to ensure environmental protection. It is impossible to know the total importance of the environment surrounding us which makes it hard for environmental stakeholders to argue against powerful businesses that need the same piece of land for making economic growth in the city. Our inherent anthropocentric view makes it challenging to know the true interest of the environment and humans can thus never fully see or understand the true eco-centric side of sustainability. These stakeholders are therefore representing the *human* perception of what is best for the natural environment. Humans however want to preserve the environment to live better, be equitable, and gain more human benefits. Energy efficiency and productive processes are thus in the interest of the environmental protection. Basic human welfare is dependent on the ecological services the natural resources provides, and indicated that environmental protection and management of scarce resources must be made in a prudent manner (Ma-CF, 2003). However, by over-focusing on the environment undesired consequences may strike other goals with inequity, less production of necessary goods, and slow development. Environment oriented stakeholders worry about variables as transportation, waste and pollution, and population growth and density. In other words, resources within the natural environment or even the built environment are being pushed towards a less resilient state by variables. These variables are often in opposition to both economic and equity interests like we will see in the conflict section.

Interest	Pros	Cons
•Ability to adapt to change •Preserve resources •Greenfields •Future generations •Other species rights •Environmental quality	•Recreation opportunities •Biodiversity •Resilience •Healthy environment •Future opportunities •Wilderness •Eco-system survival	•Inequity •Slow production •Increased prices •Value other species over humans •Anthropocentric view •Hindering opportunities •"Over" regulation

Figure 13: Interests, pros and cons of environmental protection

3.2.3. Equity sector

In the Western society social equity has improved greatly since the industrial revolution as public policies in the cities have tried to improve social integration and reduce inequality. Humans' well-being is essential for a sustainable city and dependent on the economy and the environment in the city (Giddings et. al., 2002). By introducing health care system, cheap education, and pension systems social equity in the urban society has experienced great improvements the last decades. Social equity is important for the urban development to move towards a better future where all inhabitants are taken into account and given the same opportunities. By providing dwellers with the same opportunities for property and the ownership of other goods the urban citizens perceive greater just and options. The degree of social justice will however differ greatly among cities and nations, and is important when developing a city in a sustainable direction. Social equity represents the psychological aspect of the city dwellers interest in achieving sustainable urban development.

Social equity and the city

All cities have their own story based on history, culture, traditions, and economy. They also experience social behavior which lifestyle, social pattern, individual preferences, and values and mindset set the standard for. Social equity in the city is a result of the above, and varies from place to place and nation to nation. It determines empowerment, opportunities, and possibility of being involved in the decision-making. The equity refers to the equity among individuals as well as the overall welfare of the society, and emphasizes the importance for people to have the opportunity to owe and buy. Social equity is important for a city to make sure the urban dwellers are treated fairly and experience social justice. A city that does not take care of its inhabitants will be neither sufficient nor sustainable.

The human need for food, shelter, and consumer goods for human needs are all made of materials and energy from the environment, and nearly all human activity has unavoidable effects on the environment as we operate within it with our habits (Giddings et. al., 2002). Side effects of city consumption and lifestyles are more unfortunate compared to rural areas as its limited ground contains of a large amount of consumers and thus producers of waste. The pressure on the sewage system, waste disposal, and the sanitary infrastructure in general is high in the city leading to challenges in sufficient operation. However, the level of the waste accumulation and the quality of waste they generate may vary greatly. The most wealthy dwellers can chose the more expensive goods and services, making them being able to possess a great range of opportunities, while dwellers with a lower income may only have limited opportunities. Hall and Pfeiffer (2000) state that income differences are the main reason for inequity as income determines a person's purchasing power. This is also reflected in the outcome of waste in the nature, where all consumption ends up, as it is highly

dependent on the community, its values and mindset, and the technology in use (Giddings et. al., 2002).

From an equity point of view, the city is a location for conflicts. Conflicts are a result of people with different wants and needs, and emphasize the importance of focusing on this aspect of sustainability. The city is a location for conflicts over resources, goods and services, and opportunities. It is in constant competition with the city itself among different interest groups. This means that the city wants to satisfy every inhabitant, a task that is impossible as the variety of stakeholders represent different interests dynamically developing and influenced by other factors. By distributing and giving access to the space in the city social needs can be facilitated. Space considered as a social space brings opportunities and access for communities, neighborhoods, labor unions, and others to enhance social bounds and needs.

Sustainable social equity

Social sustainability is defined by reducing vulnerability and maintaining social and cultural health. Like the other goals, it is important for the society to be resilient in order to withstand shocks (Chambers, 1989). By strengthening social values, education, institutions, and equity resilience will improve and social systems will be able to handle future challenges that will develop. To achieve social sustainability it is important to understand all social groups, and identify their interests. Poor communities are among these groups which have had restricted ability to own or speak out by being neglected or simply by not knowing their rights and opportunities. Building connections and enhance participation will make dwellers feel ownership and stake in the society, and further be able to increase their equity. Along with increased social capital, it will provide pathways for poor people out of poverty and give them opportunities for a more meaningful life (Munasinghe, 2007). With the high level of globalization today it is easier for dwellers to move between cities and find better opportunities elsewhere. Therefore it is in the long-term best interest of the city to provide the dwellers with freedom and opportunities to make sure their existing dwellers chose to stay and increase the attractiveness to ensure a healthy flow of immigration. By ensuring fair distribution of resources, services and opportunities robustness and sustainability of the city will be achieved and increase the attractiveness.

Social stakeholders interests

As mentioned, it is in the best interest of the city's long-term strategy to ensure that all dwellers have opportunities. This also means the opportunities in consumptions of goods and services, as well as opportunities in employment, transportation, and housing. These opportunities lead to increased equality which in turn makes the city dwellers more satisfied. Social equity also wants to promote

social capital like human or cultural capital. This means advocating factors that make the society develop and improve like education, skills, social relations, and customs. Social capital is determined by the quantity and quality of social interactions like trust and social norms, and grows with greater use of social capital in contrast with economic and environmental capital which decreases with increased capital usage. Social equity is strengthened by the accumulation for individuals or groups of individuals to work together and understand each other's interests. Increased social capital in the city increase the ability to achieve shared objectives, and thus increases the possibility to move towards a sustainable future for the city as a whole (World Bank III, undated).

Bridging individuals, organizations and governmental institutions give better in-sight and a more comprehensive knowledge about the whole aspect of the society. Access to power and the opportunity to participate in decision-making is critical to give dwellers opportunities. Good governance and leaders play a major role in ensuring that trust and empowerment are experiences as just. Decentralization of decision-making is in the interest of equity stakeholders leading to empowerment and broader access of participation in the conflict resolution. The goal of social equity is a protective strategy that improves equality among all people, reduces the vulnerability of the city life, and meets the basic needs of human existence.

The consequence of inequity may lead to segregation where people are ranged after variables such as income level or demographics, find themselves living in monocultures where some income levels or demographic groups are dominant. Equity variables are thus typically level of segregation, employment, and opportunities. They can often be understood and measured by comparing different areas, cities, or the development of the variables relative to others over time. In the models in the next section and in *chapter six* these variables will be further examined and explained.

Interest	Pros	Cons
•Opportunities	•Mental health	•Consumption
•Empowerment	•Interaction	•Waste/pollution
•Social capital	•Acceptance	•Space
•Employment	•Understanding	•Generate energy/materials
•Housing	•Knowledge	•Habits
•Education	•Equality	•Lifestyle
•Rights	•Networks	•Centralization
•Wealth distribution	•Resilience	
•Freedom		

Figure 14: Interests, pros and cons of social equity

3.2.4. Summary

Table 5 summarizes some of the differences between the three main aspects of sustainable urban development. The table shows that there are significant differences between the goals for each sector in the context of city development which creates conflicts. In the perspective of *sustainable* urban development the interests may be somewhat different, and very much a matter of having a resilient and viable future in hand. The opposing interests among economic, environmental, and social stakeholders thus wants their own specific needs to be accounted for while at the same time being dependent on the two other goals to be achieved showed in *figure 3b.*

In the following section of conflicts these differences will be put in context demonstrating how conflicts occur due to the variety of interests they represent and the different perceptions of what is important in the city development. It will also show the complexity and the causality of the conflicts with the help of feedback models in order to acknowledge the challenges in the development of a sustainable urban area.

Perspectives	**Sees city as**	**Interested in**	**City in competition with**	**Priorities of space**	**Typical variables of interest**
Economic	Location for: Production Consumption Distribution Innovation	Markets New industries	Other cities	Highways Market area new Industry	Attractiveness Investment Prices
Environmental	Consumer of resources Producer of waste	Preserving land and resources	Nature	Greenways River basins Ecological niches	Transportation Waste/ pollution Population/ density
Social	Location for: Distribution conflicts on -Resources -Services -Opportunities	Promoting all interest groups	The city itself	Communities Neighborhoods Access Segregation	Employment Segregation Opportunities

Table 5: Summary of the differences between the three main aspects of sustainable urban development

4.Conflicts and model development

"...the unhealthiness of our world today is in direct proportion to our inability to see it as a whole"

- Peter M. Senge

in The Fifth Discipline: The Art and Practice of the Learning Organization

4.1. Conflicts

Campbell (1996) explains how the triangle is meant to "…integrate the environmentalist's and socialist's world views" into the development of a sustainable city where the economic power havs dominated for a long time. The three opposed interests in the triangle lead to three fundamental conflicts caused by the tension between them. The linking between the property, resource, and development conflicts arises as they are mutually connected together. As conflicts and the handling of them are essential in the context of sustainable urban development it is important to explain why they occur and how they increase the complexity of the system. The systems thinking approach can provide insight into these questions by operationalize the conflicts. By developing a model for the complexity of sustainable urban development it is demonstrated how conflicts are related to each other and how they are better understood by using systems thinking. The three conflicts will be used to explain the sustainable development complexity and why it is important to emphasize conflict and conflicts resolution in planning sustainable development decision-making.

Conflict occurrence

The general theory of conflicts says that a conflict is when two parties are in opposition of interests (Oxford dictionary, undated). It starts when one party disagrees with another party and seeks change which is not agreed by the other party. In reality, it only takes one to initiate a conflict where the other part is often drawn into it without having a choice. Sustainability conflicts occur when individuals, organizations or institutions disagree in how to achieve sustainability. The main problem behind the sustainability related conflicts is that all sustainability goals cannot be met at once and have to be compromised for or prioritized in order to achieve anything at all. It requires a high degree of give-and-take, meaning that all stakeholders must be interested in finding a common path in order for urban society to develop sustainably.

It is important to remember that even though groups have different limits, needs, and interest they do not necessarily attack the other goals but rather possess different priorities, range of priorities, or perception of the desired goal. The difference within the context of sustainability fundamentally lies in the stakeholders' perception of nature and how we use and give nature value like showed in *table 5*. Also, the narrow mental models of the stakeholders' frequently do not include the interests of others. Based on this, planning for the purpose of sustainability growth contains of a variety of conflicting interests. The fact that sustainability issues are wicked problems also increases the complexity and the difficulty to find resolutions that simultaneously satisfy all stakeholders.

Despite all the negative aspects of conflicts they also have good qualities essential for the development of human society. It is often through conflicts that changes arise and societies develop to the better (Segal and Smith, 2012). Conflicts are not perceived as something nice for those involved, but in terms of sustainability, conflicts must be solved in order to gain a more harmonious and long-term viable urban development. By disagreeing about what is wrong, what is right and what is fair individuals and organizations as well as governments are constantly involved in conflicts. Yet, by being parts of conflicting situations we also evolve. During conflicts we define important issues and sharpen the debate for what we are concerned about (Campbell, 1996; Segal and Smith, 2012). We get better in investigating our wants and needs, and understand which limitations may hold us back.

Resolving conflicts

The skill to solve conflicts fairly and in a best possible way is always challenging. By shifting our attitude to see conflicts as potential long-term opportunities we will accept them and most likely manage them better (Segal and Smith, 2012). Successfully solving conflicts can lead to empowerment and in gaining knowledge about how we may better solve conflicts next time. This may in turn lead to better relationships and less anxiety to avoid conflicts in the future. By resolving the three main conflicts presented in the triangle, Campbell (1996) argues that society will form the definition of "fair" through evolution.

However, when identifying and resolving conflicts it is also important to remember that it is not only all present life that must be treated equally. Intergenerational equity as well as equity across species is also important to gain over time. The challenge is how present decision-makers know what is best for future generations as well as for other species than humans.

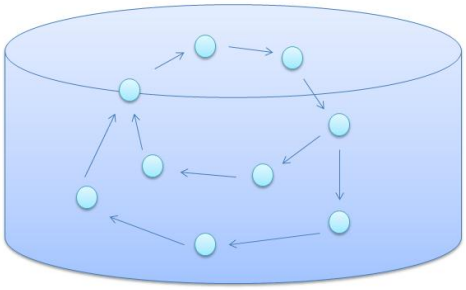

Figure 15: The feedback loops within aspect of the goals of sustainability

Someone has to speak from their point of view without knowing for sure what others' most important interests are.

Conflict complexity

In the development of models it is important to understand how conflicts are present both in general terms like property, resource, and development conflicts but also within specific variables that define the system. Within the three E's there exist a number of variables that defines the system with cause-and-effect, also known as feedback loops. For example, it shows how different economic variables within the economic goal affect each other. These economic related variables can represent price, demand and investment to name a few, and imply how some stakeholders see the variable as a problem or opportunity and want to regulate its stock for their benefit. Others may desire the opposite. When we see the world as a complex system including a variety of goals and stakeholders the loops for every goal and conflict interact with each other making the system even more complex. As the figure below demonstrates, the loops then consist of economic, environmental and equity variables. All stakeholders may have an opinion in each variable, but it is important to emphasize *who* sees certain variables as a problem, and what the desired outcome should be. It is also important to have in mind that the loops will develop dynamically where some variables may be desired at one point, but experience or changes in the human mindset and even environment develop different perceptions of the variable over time.

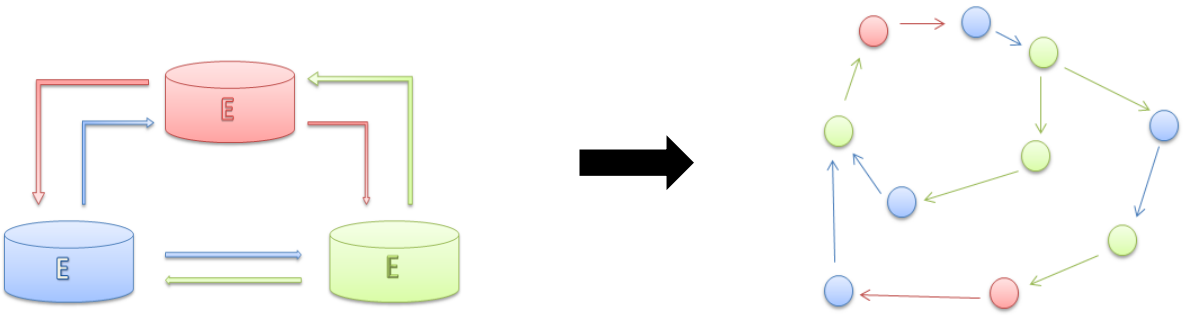

Figure 16: The complex system's variety of goals and stakeholders creates feedback loops that consist of economic, environmental, and social variables all representing opposing interests from the range of stakeholders

According to Hall and Pfeiffer (2000) local autonomy in the long run will improve economic and social development as democratic governments are confronted with the local interests and the everyday life of city dwellers. This way, humans are able to take action on a local scale and improve the city life despite being part of it. It is in the best interest of the city government to improve the city and make it more viable and attractive to outsiders in order to achieve more labor and capital. When working together, identifying the conflict and its roots, and hence being interested in finding a joint solution the desire of achieving sustainable urban development may be fulfilled. By understanding the system complexity of the world when testing existing mental models and identifying the cause-and-effects

between the variables planning is based on are more thought-through and comprehensive. The next section will demonstrate this by creating models for the three main conflicts that arise, and show how they together form an interrelated and interdependent complex system.

4.2. Conflict modeling

4.2.1. Property conflict

The conflict rising from the tension between economic growth and social equity is by Campbell (1996) defined as the property conflict. While the economic interest is to generate revenue and increase capital outcomes the social equity goal emphasizes the need for social justice like prevention of segregation, discrimination, and imbalance of rights and opportunities in the city. The relation between capitalistic interests and social needs (redistribution) is important to take into consideration as they both will determine how well the city has been able to move towards sustainable urban development.

The property conflict reflects the challenge of fair distribution of property in the city. Existing buildings as well as plots, land, and sites play an important role. The opposing interest in the claims on and in the use of property is what Campbell (1996) emphasizes as the main reason for property conflict. City dwellers need a place to live and the economy a place to generate income and revenue, and most dwellers desire their own property. Property owners have different interests than the tenants in how to manage and distribute property. The private sectors' belief in capitalism and market forces to determine property value will often not coincide with the public sector interest in affordable and available housing for all city dwellers. Buying and selling property involves the same aspect. How can the city be fair on who has the right to buy and sell, what the criteria are for buying and selling, and how are these factors include the interest of both private and public sectors? It is essential for any city to facilitate activities that all dwellers can take advantage of, and is often done by regulation and incentives to make sure that segregation of land and communities does not take place.

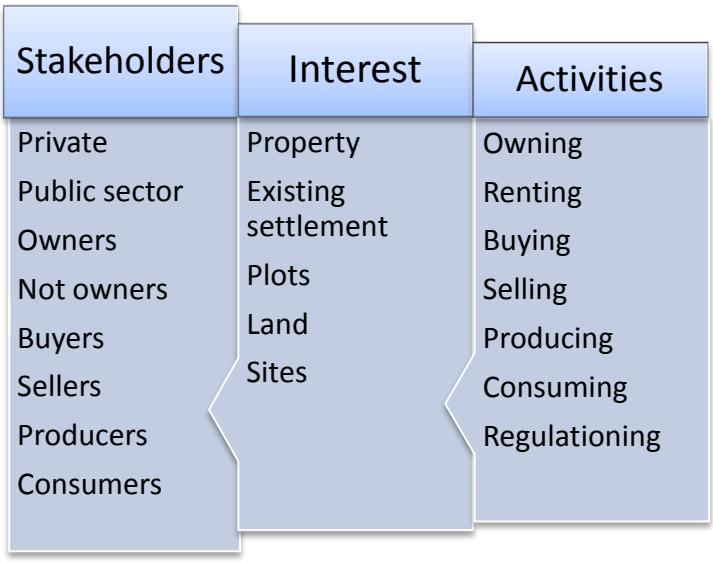

Figure 17: Stakeholders, interests and activities in the property conflict

The tension between economic growth and social equity can also be determined as the tension between production and consumption. Most economic stakeholders are interested in producing and generating revenues, while equity stakeholders emphasize the importance of justice and equal rights. As the producer and property owner are interested in optimal outcome of their property value the consumer have limited abilities to satisfy the producers wants and needs. Increased property value as a result of an economic growing city is a place where only the capital-intensive consumers and buyers can afford to enter the marked, while less capital-intensive consumers are forced to other areas. This is equal to the theory of supply and demand in micro economy and stresses how the city must balance the two in order to maintain as a just city.

Even though economic growth and social equity have opposing interests, they are mutually dependent on each other. This makes the property conflict even more complicated. Land owners need tenants, sellers need buyers, producers need consumers, and vice versa. In other words, the property conflict tells us that in order to satisfy the interest of economic growth to keep on growing, while ensuring social equity among all the city dwellers, the conflict must be taken into consideration when moving towards sustainable urban development. If the market relation between owners and non-owners fails both stakeholders may suffer significantly. It illustrates the importance of the private sector seeing property as private commodity in balance with governmental initiatives to make sure the property issue meets the need of both the social and capitalistic aspects. Hence, it must be taken into consideration the balance between the private interests of property in conjunction with the public good. The property conflict must be an integrated part of the decision making in order to prevent segregation or at worst a discrimination of dwellers. Through property regulations and incentives the market relation between the two sustainability goals may be better stimulated and ensure continuous economic growth.

Affordable and adequate housing for all –one god of equity

The general feedback model of the property conflict is demonstrated in *figure 18* shows the causality between some of the variables the property conflicts consists of. In general terms, when the population increases the demand of housing will increase as more people need to find a place to work and live. Hence, the pressure on the existing housing in the city rises which further increase the prices so property owners can utilize the market of desperate buyers. If the prices rise too fast or to a needless level people find it uneconomic and chose to live elsewhere. A city which is too expensive decreases the attractiveness of the city as there will not be affordable or beneficial properties relative to other areas or cities. If fewer people find it attractive to move to the city less people will find their way there and more people will probably move out of the city. The population variable

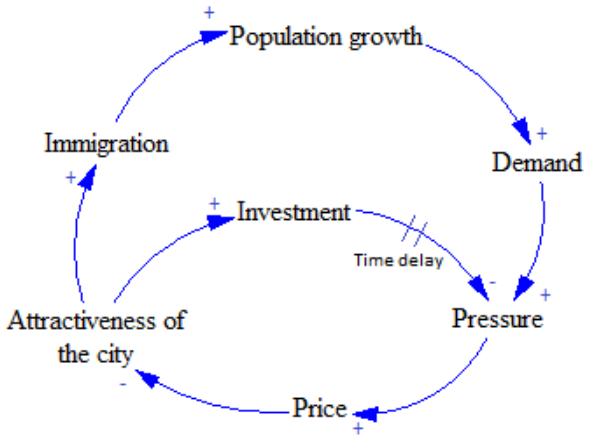

Figure 18: A general model of the property conflict

thus gets regulated by the immigration to and the emigration from the city. As the prices in the city increases, investors see potential in investing in housing as it will generate high profits. Investment is dependent on the attractiveness and thus the prices of the city in order to be tempted to invest. If the investment is done, the pressure on housing decreases and reduces the prices as there is more houses per inhabitant. However, a time delay between investment and the reduction of the pressure for housing may lead to challenges for the investment side. They need to find the balance between investing enough to utilize the beneficial pricing thus not investing too much so the prices dramatically decrease and the revenue gained from the sales are peeled down to a minimum. The time delay in this situation has brought investment to chronically suffer from an oscillating effect for centuries as economic investors are interested in great instant revenues, and do not consider time-delay or that their investment in turn will influence the market and other investors. It has turned out that the oscillation has been due to the heavy investment in shorter periods making competition among dwellers decrease the profit and thus stop investment. After a period with population growth prices increase and the same thing it happens all over again.

It is also important in a model to understand who wants what from the different variables involved. Economic stakeholders are interested in increasing the benefit of the economic variables in the model and the conflict occurs when equity interests oppose this. Economic growth is interested in population, demand, and prices to grow in order to gain revenues and economic utility. Equity stakeholders on the other hand see challenges in increasing the population and do not want the demand and pressure to grow too a high level as it will lead to unfortunate consequences for the civil society when more people fight for the same bone. Isolated, increased prices are also undesired as it limits the opportunities for dwellers and favors the wealthiest. The feedback loop will regulate itself by somewhat automatically balance population growth due to the other variables involved. However,

the population will increase over time but not exponentially as it would have if there was no variable breaking the development.

Table 6 demonstrates the overview of the variables and their corresponding way of measuring the goal. It also says which sustainability perspective is related to it. Some variables are measured by economic terms others by equity terms, but there will also be variables that are related perspectives which are not the dominant ones in the conflict.

Variable	Measured by	Related to
Population	Number of people	Economic
Demand	Number of people wanting a house of property	Economic Equity
Pressure	Existing amount of housing relative to number of people	Equity Environment
Price	Price on housing (price per m^2)	Economic
Attractiveness	Level of opportunities/freedom in the city	Equity
Investment	Investment in housing	Economic

Table 6: Model variables for the proposed property conflict

4.2.2. Resource conflict

The resource conflict is perhaps the most intuitive conflict when considering sustainable urban development. How to ensure further economic growth while properly protecting the environment is the reality businesses and industries must determine along with the necessity of maintaining a certain amount of land, resources, and green space in the city. Present and future demand relies on the availability of resources and this makes the economy dependent on regulation and conservation of land and resources. As the economy grows businesses and industries need access to more resources in order to maintain the supply and increase the production. It produces a certain amount of waste through the production processes which the environment must deal with. Some of the main interests in the resource conflict are land, natural resources, and human resources. Waste generation from production and consumption is also a field which has a certain impact on the resource conflict. It is crucial for the self-sustainability of the environment to not have to deal with large amounts of waste in order to be capable to take care of the biological decomposition.

The main question within the conflict of resource allocation and utilization is how to prioritize the use of natural resources while also ensure further economic growth. Similar to the economy's interest in distributing to the property conflict, the same is interesting in the resource conflict. This question must be answered during the decision-making progress in order to ensure a sustainable future for the city. The activities in the resource conflict are very much a result of the economy's interest in generating goods and services. This implies production of commodities, expansion due to economic interests in utilizing more land, pollution from production and expansion, redistribution of brownfield or greenfield sites, and the demand for goods and services from the consumers. The activities must be balanced carefully as present sustainable urban development and future

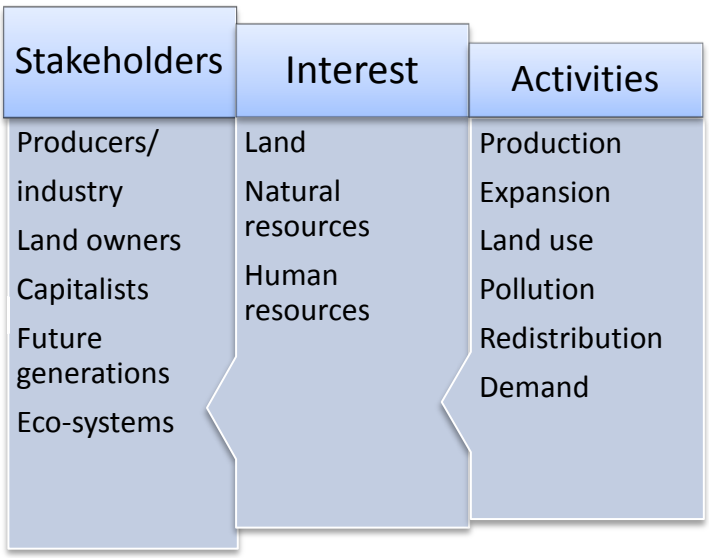

Figure 19: Stakeholders, interests and activities in the resource conflict

sustainable development is significantly dependent on the resources available. The activities occurring in the resource conflict is putting pressure on the environment leading to the conflict itself. The opposing stakeholders have different interest and desired outcomes when competing about the scale and regulations of other activities, which is demonstrated in *figure 19*.

The industry and capitalists must control the increased profit to make sure resource yields increase and is why the economy is dependent on sustained yield in order to survive in the future. Without reducing the fundamental capital ecological yield is extracted. This is similar to how a forest reproduces itself only when felling a reasonable amount of threes. It forces the economic perspective to take care of the environmental dilemmas industry and capitalism are causing. The main focus in this conflict will thus imply where to limit and how to regulate the extraction and production which consume natural resources. An essential problem is how to find the balance between pollution from industry on one side and dealing with waste and absorption of emissions by organic material on the other side. It is important to make sure that the green and natural environment is not being reduced too much as the environment has qualities that help the society to absorb waste and pollution efficiently. Finding the limits, common goals and interests of the future path are part of the wicked situation. It also illustrates the dilemma of who decides how much is *too much.*

The economic stakeholders are in theory interested in utilizing as much of the resources as possible in order to produce products and thereby generate revenues for further economic growth. The environment on the other hand is interested in preserving as much of the land available to make sure eco-systems, which include plants, animals, water, air and soil among others, encounter a sustainable future. Future generations of businesses, eco-systems, and urban citizens are also dependent on finding the balance between economic growth and natural environment. Without leaving available and healthy resources to the future generation we could only imagine what consequences it may result in.

Control of waste accumulation –one goal of environmental protection

The model in *figure 20* is a simple demonstration of how the resource conflict may occur. By understanding the variables and how they are linked together we are better able to address the potential internal conflicts and see how the development of the resource dilemma may evolve. Also within this conflict, population growth may lead to an increase in the productions of goods and services as more people need and demand more products for consumption. Production is a variable that have both positive and negative associations. On the positive side, production brings more consumer goods and thus more market options for the consumer. It also stimulates the economy by generating revenues previously not utilized. On the other hand, production of goods and services

demand resources. Production simply cannot take place without consuming resources. These resources can be natural resources found in the natural environment like minerals, organic material, or energy or resources based on human capital like knowledge, technology, and services.

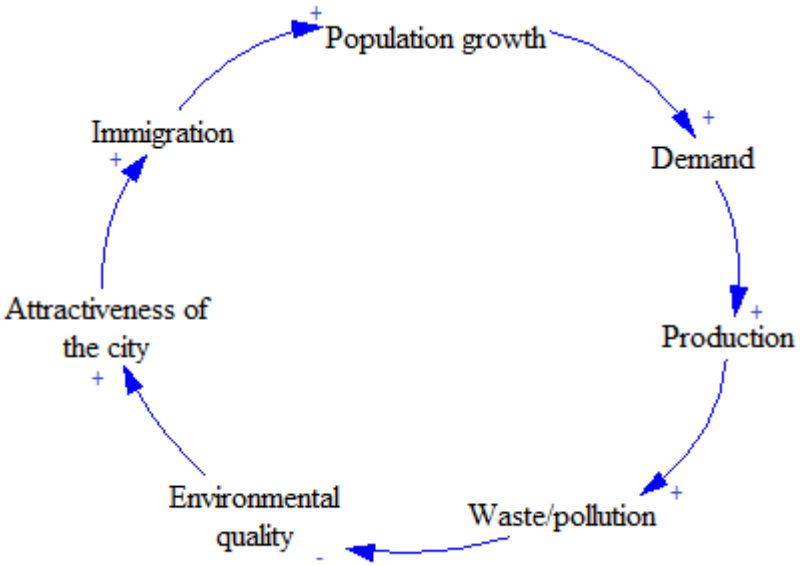

Figure 20: A general model of the resource conflict

All production generates waste, and hence pollution, due to the transformation of resources. This is one of the main issues why increased production may lead to insufficient sustainable actions. Production generates waste and emissions during the production processes which end up as environmental waste in the end if recycling strategies do not exist. By changing the life cycle of products from linear to circular more produced goods can continue to circulate in the system which reduces the need for raw materials and prevent waste generation. Knowledge about *Life Cycle Assessment* helps addressing impacts and thus increases the understanding of where we should improve processes (US Environmental Protection Agency, 2010). This also demonstrates the importance of utilizing the existing products like household products, electronics, and the built environment. The consequence of increased waste and pollution in the city is the degraded environmental quality as more landfills, toxic gasses in the air, and reduced quality of the soil and drinking water are generated. These are some of the factors which have negative effects on the eco-system and the quality of life of humans in the city. The negative effects will in turn reduce the attractiveness of the city and slow the population growth. No one can or will live in a dirty city without a clean and healthy environment, nor with the lack of green space both for recreation and for future consumption of space and products.

Production sites today is often located outside of the city boundaries and thus making cities unable to supply their dwellers with locally produced products. However, the consumption of these goods and the utilizing of more built environment like housing will lead to generation of waste and pollution. Housing and industry does at the same time occupy space and land which alternatively could have been exploited as open or green spaces for the protection of the environment and its eco-systems. Cities today face a challenge in how to ensure that consumption, which is impossible to eliminate, is more energy-efficient and sufficient in order to sustain the materials longer and emit the lowest amount possible.

Variable	Measured by	Related to
Population	Number of people	Economic
Demand	Number of people wanting consumer products (see also GDP)	Economic
Production	Amount of consumer product produced (LCA as indicator)	Economic
Waste/pollution	Amount of waste or emission	Environment
Environmental quality	Quality non air, water, soil Level of green space	Environment
Attractiveness	Level of opportunities, cleanliness, safety and freedom in the city	Economic

Table 7: Model variables for the proposed resource conflict

4.2.3. Development conflict

The development conflict is a result of the interaction of attempting to meet the social equity goal while simultaneously protecting the environment. If we are about to ensure that all dwellers have the same rights and opportunities we may stress the environment as a result. Nature, eco-systems and green spaces are challenged when society needs more space to achieve equity and development. Finding the balance between these two goals is challenging as both social equity and environmental protection is essential in order to achieve sustainable development.

Nature is a scarce resource and the environment is depending on a fair distribution. As humans have acted like they are in charge of nature and the superior species on the planet fair distribution increase the importance to ensure enough land and development opportunities for future generations to maintain a green and healthy planet. Humans are depending on the availability and quality of the environment, while the environment can sustain without any impact by humans. It is important for us to understand, that by not taking care of the planet, there will be no more humans or at worst no more organic material left on the planet.

When cities develop, more people find their place in the city, and the city expands. The main opposing interests in the development conflict are thus the environment (i.e. nature, green spaces, and parks) and the social equity interest of people. People need a place to live, work, and consume which leads to a development conflicts with the land available. Transportation is a significant contributor to the development of land, as roads and new communities demand more space. The same is valid for the accumulation of waste, an increasing factor resulting from human consumption which threatens the environment. Social equity is about the right and opportunity of consuming goods and services produced by economic growth. Waste is generated as these products are both consumed and abandoned. It results in challenges for the environment to handle and threaten the quality of the nature and land available.

Yet, social equity and environmental protection goes hand in hand, and less developed countries are struggling with meeting the economic growth, social equity, and environmental protection at once (UNDESA, 2011). In the big picture, many resource-dependent communities prove the link between poverty and environmental protection. These are communities where residents have no choice than silently downgrade the environment due to the lack of economic opportunities. Landfills, toxic waste land, and poisonous rivers are often results of the insufficient way of living, and the no-win choice between environmental quality and economic survival (Bullard, 1990). *Environmental racism (*Westra and Wenz, 1995) is part of the development conflict (Campbell, 1996) and is argued to be a result the privilege of environmental protection by the wealthy. NIMBY (Ibitayo, 2008) is another factor that is

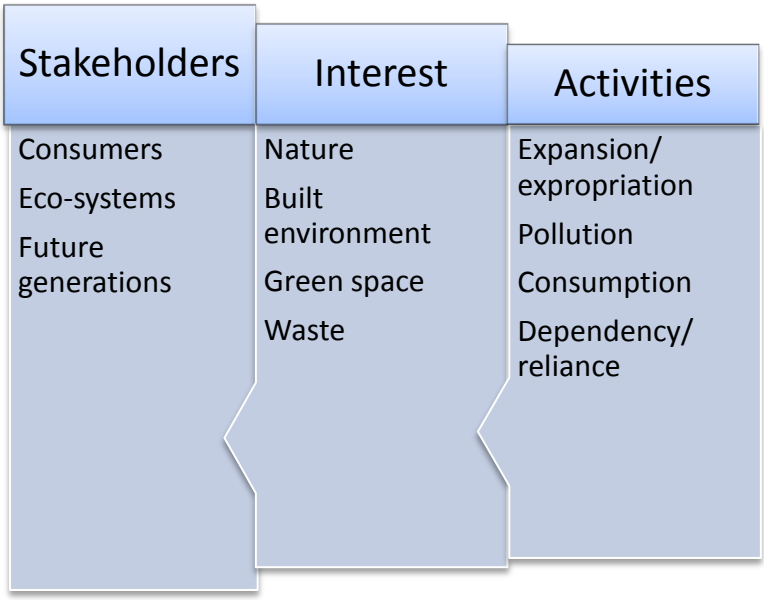

Figure 21: Stakeholders, interests and activities in the development conflict

an outcome of the economic power to choose where to locate landfills, wasteland, and other environmental challenging consequences. Not-In-My-Back-Yard is a classic conflict in the civil society as people «want» to consume and pollute, but no one wants to deal with the waste accumulation or have undesired housing in their neighborhood, to name a few. Zoning (Merrian, 2005) has been one of the devices land use planners have taken advantage of in order to find solutions on the many wants and needs in the society. The less developed communities often have no choice in deciding where to put the waste land, and communities even settle in these locations as the price of land and living is affordable there (UNFPA, 2007). Slowed economic growth might be a consequence of the preservation of the environment, which in turn might lead to increased inequalities between rich and poor. The dilemma demonstrates the challenge of balancing social equity and environmental protection, which turning into a question of wealth distribution and economic growth.

The process of turning natural resources to products leads to economic segregation. Simultaneously, the waste from the production process is returned to nature and may result in environmental segregation. Hence, the material cycle largely affects the unfair development. The tension between social equity and environmental protection must be seen in conjunction with economic growth in order to understand the opposition and collaboration the three perspectives lead to. How could those struggling with social equity find economic opportunities if preserving the environment is hindering economic growth? If we protect the environment too much the economy will be affected and the opportunities economic growth brings will in turn affect the society in reduced options. This may in turn bring increased differences between rich and poor. Finding the balance in the economic growth without rapid impacts on the environment, and thus society, is constantly going to challenge city planners. This dilemma demonstrates the difficulty of resolving wicked problems.

A general development model

The simplified development model in *figure 22* demonstrates how population growth also leads to increased use of land and expansion of the city as the built environment may not be sufficient enough. Increased pressure on land and resources due to population growth means more use of land for buildings, roads, and other space consuming necessities. The use of land is desired by the social side of the development as well as for economic growth to continue. Opportunities will be made as housing options increase due to land developed for housing, and work options increase due to commute alternatives where land is developed for roads and transportation. As the opportunities increase, the attractiveness of the city will increase making the city tempting for new dwellers. On the other side, environmental protection will have opposite interests due to the pressure and negative consequences the utilization of resources leads to. Roads and traffic will increase and result in more emission and noise around these areas affecting eco-systems and the quality of air, soil, and water. By expanding the city at a fast pace and place housing away from working sites it will facilitate the use of car and other transportation methods and make the society dependent on transportation. This in turn will demand time and money from the consumers and lead to a society where moving over longer distances is a matter for course, while also bringing new and expanded opportunities.

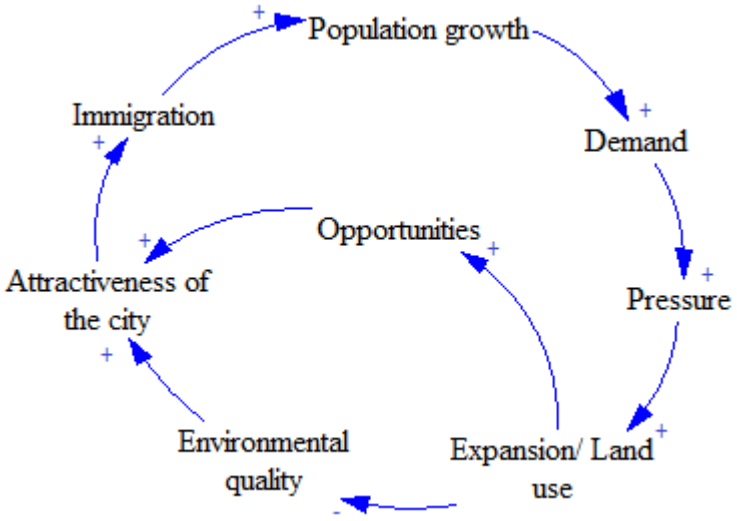

Figure 22: A general model of the development conflict

The expansion of land has thus positive and negative consequences. It is first and foremost in the interest of humans in the short-run making them able to live and move where they want. It is in a lower interest of the environment to build on the existing greenfields as it gets demolished and reduces the rate at which the green environment absorb emissions and provide the area with a rich and resilient eco-system. In the long run, the society will need development but will experience challenges due to the built environment. By not having environmental protection in mind when

expanding the city insufficient and unsustainable development may be the result. Finding the balance between social equity and environmental protection is therefore a challenging task for the city decision-makers, and emphasizes the importance of including the interest groups and thinking in a long time perspective when deciding on how to develop the city.

Variable	Measured by	Related to goal
Population	Number of people	Economic
Demand	Number of people wanting housing	Economic, Equity
Pressure	Existing amount of housing relative to number of people	Economic, Equity
Expansion/land use	Built land and density	Environment
Environmental quality	Quality of air, water, soil, Level of green space	Environment
Opportunities	Increased amount of new housing, work and transportation alternatives	Economic, Equity
Attractiveness	Level of opportunities, cleanliness, safety and freedom in the city	Economic, Equity

Table 8: Model variables for the proposed development conflict

4.2.4. Summary

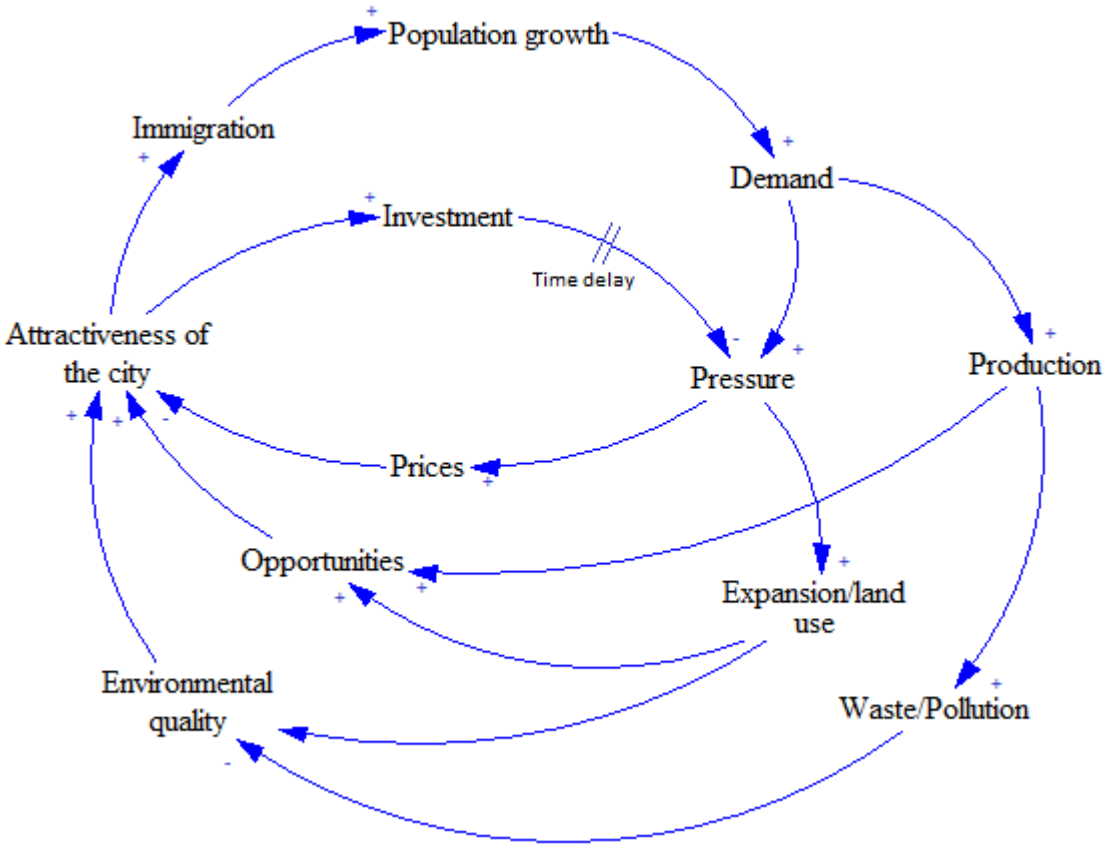

Figure: 23: The total general model of the sustainability conflicts that occurs

We now see how these conflicts are connected to each other. As *figure 23* illustrates economic, environmental and equity dilemmas cannot be seen separately. Their conflicts are parts of a larger system, and in order to understand the situation and model of sustainable urban development we must consider these strong relations. Yet, it also demonstrates that in order to see the whole we must also see the smaller pieces. If decisions are to be made it is beneficial to take a closer look at the conflicts and divide the overall model parts which are easier to relate to planning and decision-making. It will ease the understanding of where to intervene in the system. In other words, by understanding the whole we understand the system and by taking a closer look at its parts we understand where our leverage points are in terms of better planning of sustainable development. We need to understand the whole in order to understand the pieces, and vice versa.

5. Case description

> "Clearly, then, the city is not a concrete jungle,
> it is an human zoo"
>
> - Desmond Morris
>
> In The Human Zoo, 1959

5.1. Case study

Why a case study and what can we gain from a case study?

As shown in chapter four a number of conflicts occur when identifying how to move the city towards a sustainable urban future. All stakeholders in the society have their own interests and their own perception on what sustainability implies in the urban development context. The model described in chapter four is a general description of the challenges cities must expect to deal with in decision making, but may differ as cities have different challenges, structure, and system patterns. The level of urbanization, globalization, or development in terms of social interference and technological outcome are factors that can vary between cities. Some struggle with environmental problems like polluted air and water, restricted land available, or access to renewable and non-renewable resources. Others may struggle with economic growth, rapidly changing consumption patterns, and a transforming industry.

Cities are all unique models of the same human organization method, and have different needs and limits in the fields of sustainability. To show how the general model developed in the previous chapter is valid for any city, we introduce Oslo, the capitol of Norway as an example. This city is first and foremost representing the western civilization and the many conflicts that may rise in the western part of the world. It shows that despite the modern and highly developed society, conflicts occur and cannot be neglected, and that although fiscal dilemmas should be easier to solve in one of the world's wealthiest nations, the path towards sustainability is still a challenging process also here.

Why Oslo?

Oslo is chosen for a number of reasons. First and foremost Oslo has an open democratic society where information and statistics are easy access for the public. Most of the information can be found in public libraries, databases, or online. Public authorities collect all material about the city for the public to take advantage of in either research, science, or for personal interest. The government has

interests and priorities about sustainability related development and is committed to a range of sustainable development strategies.

Oslo is a city concerned about the sustainability issue, and has a government continuously interested in improving Oslo's score and appearance in both the national and global perspective. The City of Oslo is also continuously working with its plan, regulation, and strategies in order to meet the challenges they face in the future due to climate changes and other consequences of human development (Oslo Municipality II, 2012). This shows how the region is interested in developing in a best possible way and that sustainable urban development is an essential part of the Oslo spirit. However, even if has been said and discussed in the context of sustainability, Oslo has still a long way to go in order to meet the needs of all city dwellers and for the surrounding area to find a long-term viable and sustainable urban development strategy.

Oslo represents the modern world and has during the last century been growing to a wealthy city in pace with the national wealth creation. Due to the modern and liberal approach the city obtain, the mindset and values found in Oslo is for many cities a leading figure when it comes to democratic equity and power to implement regulations, without distinctive problems with corruption (Transparency International, 2011). To a lot of less developed cities, developed wealthy cities like Oslo is looked up to and is why the city has opportunities in influencing other cities when investing in sustainable urban development. The city and national government are engaged in helping and guiding other nations towards a more democratic and sustainable path, and a nation involved in the development of other nations (Sengupta, undated).

Despite Oslo's modern and sophisticated image, the city is not the blueprint of how to develop a city. This is another reason why it is interesting to take this city under the loop to demonstrate that even wealthy modern cities struggle to achieve long-term sustainable urban development. Oslo is not facing the fundamental challenges for human rights and environmental protection as it has a solid economy, is liberal, and built on the values of the freedom of speech and equal rights for all (Stirø, 2009). Oslo faces, however, challenges due to an increasing population and a rising price level (Horjen and De Rosa, 2012). It is common that dwellers utilizes and enjoys the nature as part of their culture, which also implies that the city planners are committed to take this aspect of the desired goals into account.. These factors make Oslo an interesting city as it is a growing and wealthy urban center that values the nature and the recreation possibilities it possesses. Yet, these are values that may bring conflicts due to both economic interests and equity stakeholders.

The city of Oslo has a sustainability approach found in a number of western cities which represent different mindset and fundamental values than most non-western cities. Like in many other western

cities the time spent on planning is significantly lower than the time spent on the implementation and construction of actions and policies. It turns the focus on the importance of having comprehensive and reflective planning in order to make sure the implementation gain success and the urban development move towards more sustainable patterns. Like any other city, Oslo has also conducted initiatives that was not as efficient as planned, and is why the model will be beneficial for this city in order to identify and handle existing and potential conflict that arise in the context of sustainable development. An alternative model for the city is represented in chapter six, but first we need to take a look at some facts about the city.

5.2. Oslo

Oslo is the capital of Norway and located in the Oslo fjord in the south eastern part of the country. The city is the biggest in the region as well as in the whole country with its current 600 000 city dwellers (UKE I, 2012). Oslo municipality is approximately 454 km^2 dominated by urban areas, forests, water, and rural land not regulated for residential housing (Oslo Municipality I, 2012). 25 % of the municipality consists of urban land dominated by buildings, roads and some industry. Oslo has been a city for more than 1000 years, and is one of the oldest capitals in Northern Europe today (Hougen, 1996). The city is small in global terms but it still possesses the qualities and challenges most cities face. The city's age and ability to handle challenges may indicate that the city has made conscious choices and well-thought decisions the last thousand years. Yet, challenges constantly arise and the city face difficult tasks in order to please all stakeholders involved and to move the city toward a more sustainable future.

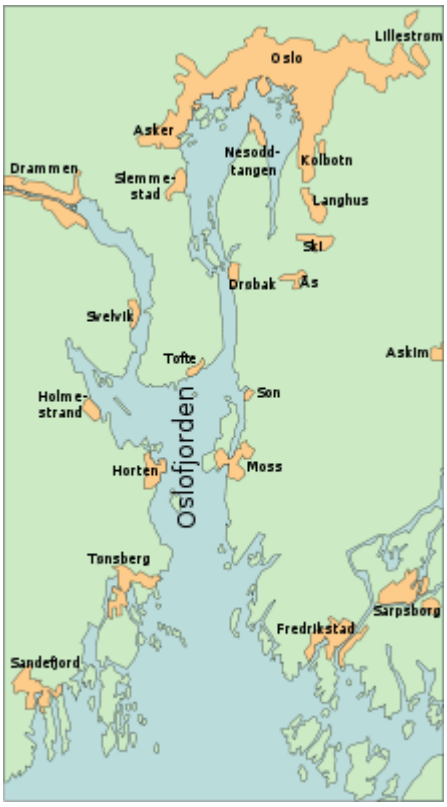

Figure 24: The Oslofjord region and its surrounding urban centers

The capital is the center for Norwegian economy, cultural life, education and knowledge, and is naturally an administrative and political center for the country as a whole. It holds the government, the national bank, the national embassies, the royal family, and most of the important national institutions in the country. It also plays a leading role in the partnership with neighboring municipalities, cities, and state governments in the region to enhance the advantages, qualities, and opportunities it creates. As the Oslo region consists of approximately 1 650 000 inhabitants (SSB, 2012) the city is very important for the area and for the country as a whole. In order to grow and

develop in a sustainable direction it is essential to provide a healthy and viable city for the dwellers.

Population

Oslo has developed from a religious and military oriented market place consisting of a few thousand inhabitants to a large city with over half a million dwellers. These 600 000 dwellers imply a density of 1300 dwellers per km^2 and a real density of over 5000 p/km^2 due to the large portion of forests and water. Compared to the other Scandinavian capitols like Stockholm (3597 inh/km^2) and Copenhagen (6300 inh/km^2) the density of Oslo is quite normal (Wikipedia I and II, 2012). Additional 900 000 people live in the whole Oslo region which means that one third of the inhabitants in Norway live in the area in and around Oslo. The area has experienced constant growth and much of the growth outside of the city boundaries are due to the good economy and business activities in the city. Totally, 12 % of the population in Norway live in Oslo, which makes the city the largest in Norway followed by Bergen (265 000) and Trondheim (177 000) (SSB, 2012). The city is expected to grow to over 800 000 inhabitants within 2030 (UKE, 2012) which is an average population growth of 10 000 new dwellers every year.

As *figure 25* demonstrates, the population of Oslo has increased more the last 10 years than the previous 50 years. According to the Municipality plan of Oslo the growth rate has been approximately twice as high as the national growth rate (Oslo Municipality II, 2012). The graph also shows how the growth rate in Oslo has experienced instability the last two hundred years. During the start of the industrial revolution in Norway people found their way to the city, as industry bloomed and thus demanded labor. People moved to the city in search of a better life as new tools and equipment made agriculture and fishery less dependent on labor. The labor market got slowly saturated and during the two world wars the population growth was not as strong. The growth rate maintained steady at a level of 1% from the petroleum was discovered until 2005, as petroleum made people able to stay where they lived (due to shift work) or move to petroleum producing areas first and foremost on the west coast. This made the growth rate to decrease and even decline during this period. However, the city began slowly to build its strong administrative status during this time, and during the 90's and early 21st century Oslo's population growth increased.

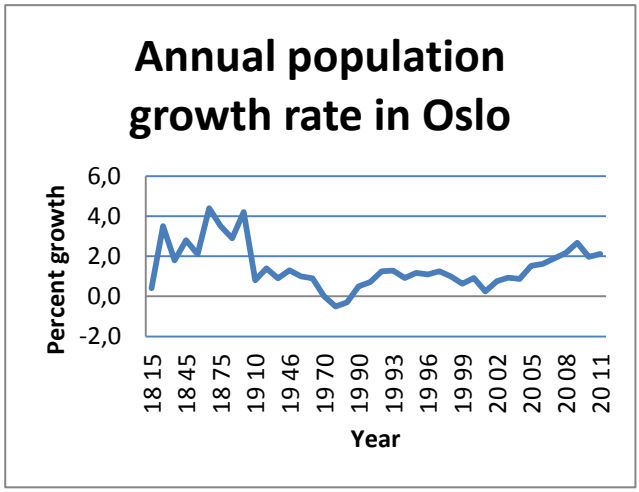

Figure 25: Annual population growth in Oslo 1800-2011

The strong population growth today is due to both immigration and birth surplus shown in *figure 26.* The strong economic growth in Norway in recent times has led to more demand for labor and thus made Oslo an attractive city in Europe. The attractiveness of the city is reflected in the graph as the level of net immigrants is a large share of the annual population growth. It may imply the opportunities the city brings and that dwellers see it as a beneficial place to settle down. However, as a later graph will demonstrate, a smaller fraction of the children in school age grow up in the city.

Figure 27 shows how the two previous graphs result in a steady and recently escalating increase in population. It is said that the population will continue to grow and by 2030 reach the magic number of 800 000 city dwellers (UKE, 2012). The population increase will be Oslo's main challenge to deal with in the time to come and is crucial to handle sufficiently in order to ensure a healthy and sustainable development of the city as a whole.

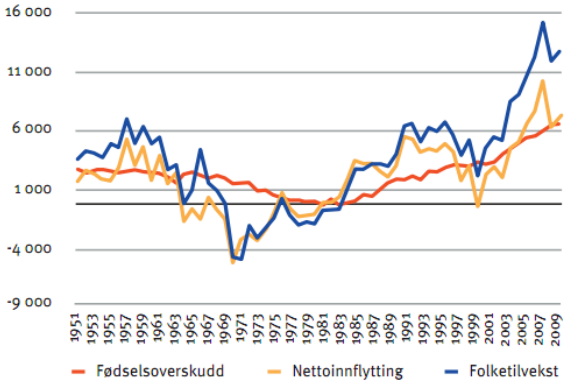

Figure 26: Birth rate, net immigration and total population growth in Oslo (Source: UKE)

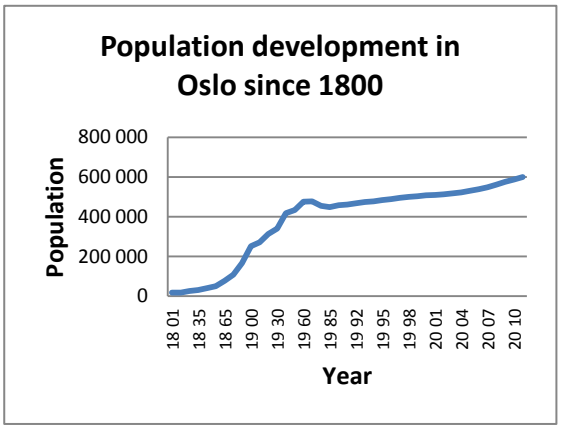

Figure 27: Population development in Oslo 1800-2010 (Source: SSB)

Demographics

The demographics in Oslo compared to the national population are shown in *figure 28*. It turns out that a large share of the total births is happening in Oslo. It is also observed that the fraction of children decrease during kindergarten, elementary school, and high school age. The predominance of people in their twenties and thirties may be due to their quest for urban life and higher education, and as much as 20 % of this proportion of the demographic group lives in Oslo. However, young adults in their thirties, often with small children, seem to move out of the city center in the search of a safer place for their children to grow up, affordable housing, and larger lots. The steady fraction of adults from forty to eighty may imply that during this age big changes in life due to settlement decrease. The increase in share of elderly people over eighty years old is however interesting. Over 20 % of the >100 year olds are living in Oslo, which may indicate that people in the city get very old. However, this graph should be seen in accordance with the demographic development over time.

Although many children and young adults chose to live outside of the city today, it may change over time as decision and policy-makers facilitate the wants and needs of different demographic groups. The composition of the city's demographics develops dynamically and challenges today may not be challenging tomorrow.

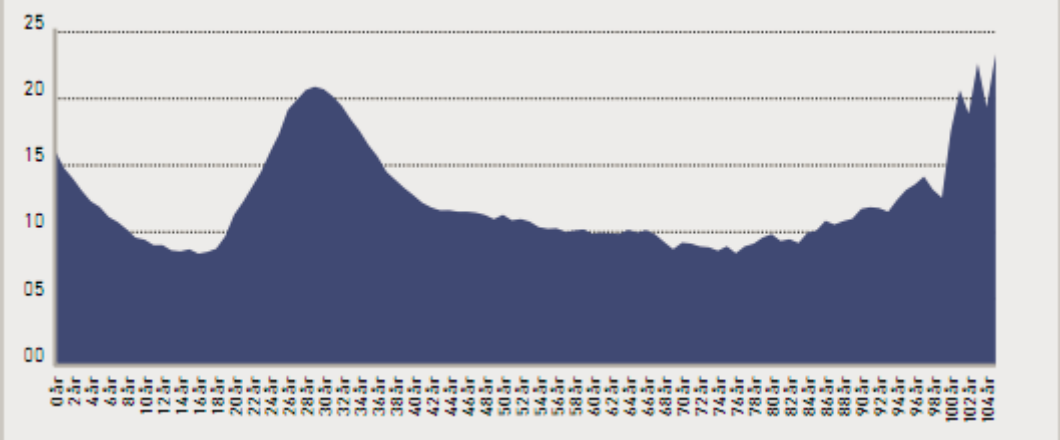

Figure 28 Oslo's proportion of Norway's population by demographics in percentage (Source: SSB)

Figure 29 illustrates how the age groups will develop towards 2030. The most interesting observation is the rapid increase in the age group 67-79 years old compared to the other groups. This demographic group will challenge the health system, pension plan, and other incentives due to an aging population (NHO, 2004). It will also increase the demand for affordable housing and for areas that are less car dependent than the present. The increase in people over sixty seven compared to the potential increase in work force will put pressure on local governments to prepare for the future as these groups do not grow in parallel. It results in a different demographic distribution in the city and different wants and needs from stakeholders and the society as a whole. Within the next 20 years the age group of 67-79 will increase by 70 % while potential work force of people between the age group of 20-66 will only increase by 30 %. The challenge increases when we know that only 70 % of this potential work force in Oslo is working, a percentage which is approximately the average for the country and thus normal. Hence, the city must keep in mind the demographic development in the city in order to make sure that a long-term and sustainable strategy includes the challenges for the future.

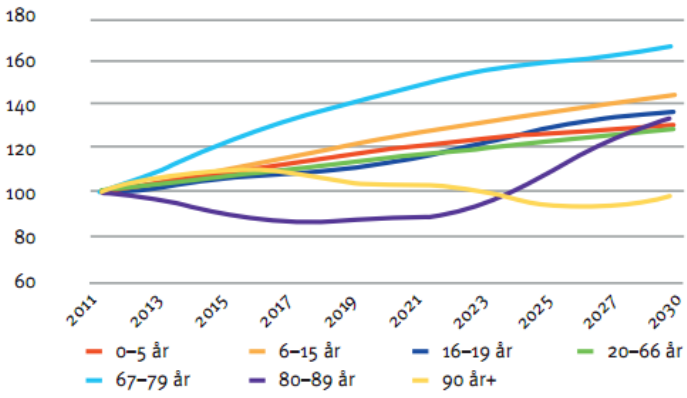

Figure 29: Population projection 2012-2030 (Source: UKE)

In an article posted in Aftenposten June 20th 2012 Norway is described as the second most rapidly growing country in Europe (Horjen and De Rosa, 2012). The main reason is the immigration, and the growth the city is experiencing is said to be exceptional and significant for an industrial country like Norway. Oslo will be highly affected by the national population growth as most people seek to the cities. The annual growth rate of 2 % proofs the strong growth in the city, and reflects the challenges the city face. Job opportunities and income level are factors that determine whether people want to move to the country and hence the city, and stay for a longer time span. The rapid population growth will make pressure on infrastructure, environment, economy, and the city's areas.

Economy and social welfare

The employment and the economic wealth in Oslo are two mutually dependent forces. Oslo became an industrial city around 1840 when industries grew in the area. Many plants and fabrics were located along the Aker River, which runs through the city, due to the easy access to energy, fresh water, and the fjord. The growth in industry led to more jobs in other sectors as well and was one of the main reasons why Oslo further expanded during the late 1800 and early 1900 (Danielsen, et. al., 1991). However, most of the industry moved to other municipalities and even abroad during the 60's and 70's turning Oslo into an administrative area as mentioned earlier. After the turn down in industry, the city experienced redevelopment and turned the old industry buildings into residential buildings, office buildings, and schools to name a few. During the turnover the service sector increased within both the private and public sector, and today Oslo has limited industry but a large share of service jobs.

Since the petroleum age arrived Norway in the 1960's and 1970's much of the national income has been produced on the west coast and in the North Sea. As the west coast has been producing commodities Oslo has been growing as the administrative center of Norway. From *figure 30* the distribution of GDP illustrates that the main economic areas are the Oslo region and the west coast. These are also the most populated areas and where large shares of the wealth creation are processed. Today, Oslo is still characterized by being the administrative center where most national and international businesses have their headquarters.

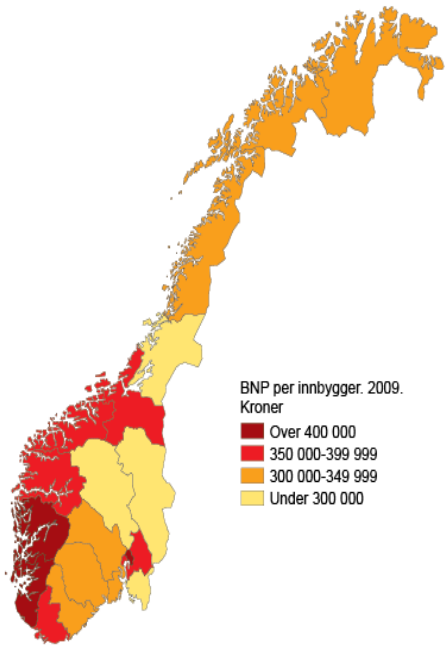

Figure 30: GDP distributed by region (Source: SSB)

Petroleum and gas export is still the main income for the country, but industries like metal, shipping, and fishery are also important for the country mainly due to its export value. Oslo is however a base for administrative and service-related business. *Figure 31* is an overview of the distribution of GDP by main industries. It illustrates how the petroleum industry represents almost one quarter of the total wealth creation in the country. Industry, public administration and trade are also among the largest contributors and generate many jobs in the country as well as the city of Oslo.

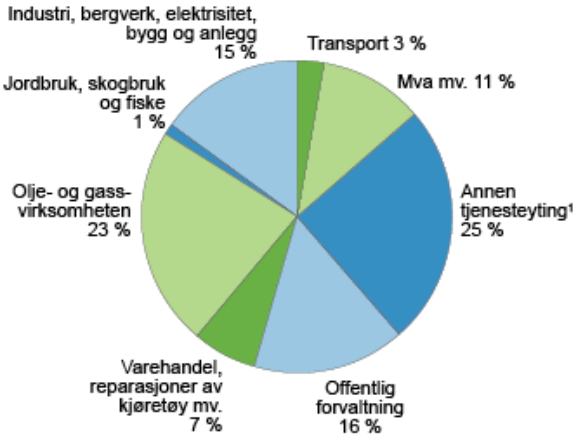

Figure 31: GDP distributed between the main industries (Source: SSB)

Social and economic development is important in the urban context and has played a critical role in moving towards a sustainable future. Oslo has a relatively low concern about social equality compared to other large and dense cities in the world. High incomes and low criminal rates lead to a safe society. Poverty rates are low and the average life expectancy is high (UNHDR, 2009; NIPH, 2009). However, within the city there are differences between the east and west part of the city. The areas west of the city center have a higher income rate and experience higher life expectancy and wealth (SSB, 2005). Yet, in a global term, these differences are not critical, but significant enough for the city counselors to engage in ensuring a more balanced distribution of income and demographics (Oslo Municipality II, 2012).

Oslo is the capital in one of the world's most wealthy nations due to the values brought from petroleum and export the last decades. That is also why Oslo is experiencing prosperity, wealth and living conditions on the top of the global scale. As *figure 32* illustrates, Norway's GDP is one of the highest compared to other OECD countries. It even lays 50% over the average level for these countries. The main industrial countries like USA, Germany and Japan are a few steps behind.

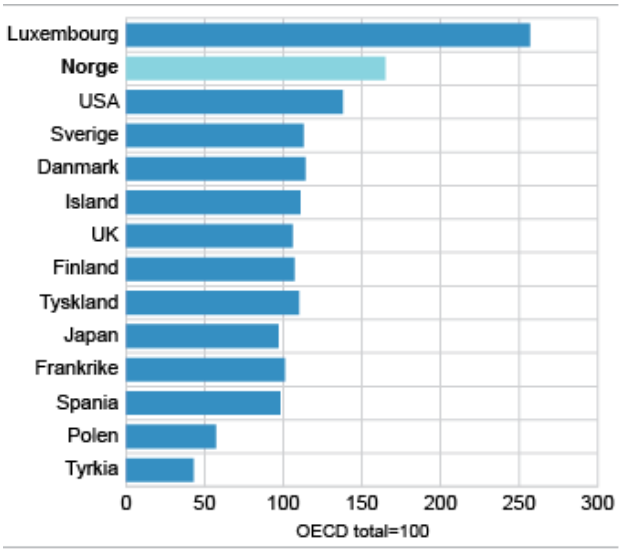

Figure 32: Ranking of GDP per inhabitant between OECD countries (Source: SSB)

Housing

The last years, housing has been one of the main topics in the Norwegian media. As the population is expected to grow it is also expected to put pressure on the housing. The population growth is constantly being adjusted and turns out to become larger than expected, which puts additional pressure on the local and regional governments to establish strategies that will make the city able to receive the additional 200.000 dwellers over the next 18 years. According to the Strategy Plan for the Municipality (Oslo Municipality II, 2012) Oslo had 1.94 persons per dwelling in 2011, which correspond to the need of an additional 100 000 new dwellings before 2030. If the number of persons per dwelling increases to 2.35 in the new residents, only another 83 000 dwellings will be sufficient to keep up with the population growth.

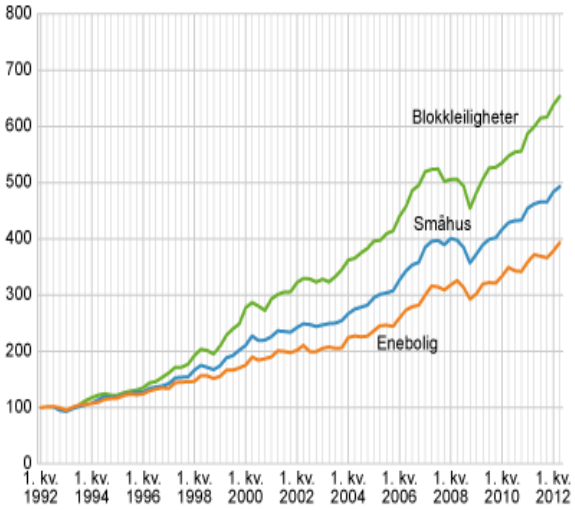

Figure 33: Development in housing prices 1992-2012 between apartments, small houses and other houses (Source: SSB)

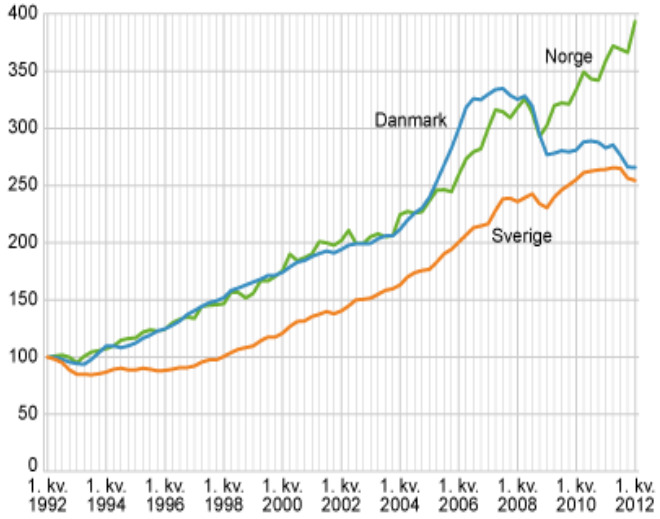

Figure 34: Development in housing prices 1992-2012 between Norway, Sweden and Denmark (Source: SSB)

When taking a look at *figure 33* we see that the housing prices have increased between 4 and 6.5 times during the last twenty years. The prices of apartments have experiences the highest price increase as they are 6.5 times more expensive today than in 1992. In order to demonstrate that Norway, and thus Oslo is experiencing growth in housing prices compared to other countries we observe in *figure 34* that Norway has continued growing after the financial crisis while Sweden and Denmark countries have experiences some stagnation. In other words, it looks like Norway has escaped the crisis and is experiencing growth in population compared to the other Scandinavian countries. According to Oslo Municipality II (2012), housing prices have increased by 54 % in Oslo between 2003 and 2010 while the neighboring county Akershus has experiences an increase around 34 %. The country as a whole had within the same period an increase in housing prices around 44 %. This also emphasizes the theory of people moving out of the city in search for affordable housing.

Urban sprawl

The suburbs of Oslo are mainly placed along the Oslo fjord and north along the E6 highway. Oslo and the surrounding region, including Akershus and parts of Buskerud, contains over a million inhabitants, while the population along the Oslofjord region includes around 1.5 million people (SSB, 2012). The region has had a relatively strong growth the last decades and the growth in jobs has led a number of new inhabitants to find their way to the city. 34 % of the total population in Norway lives around the Oslo fjord in the counties of Oslo, Akershus, Østfold and Vestfold, which contains of only 3,63 % of the total area of Norway. There are more people working in Oslo than workers living in Oslo (Bråthen et. al., 2007). About 150 000 people commute to the city, which demonstrates the importance of Oslo as an attractive labor market. This implies that masses of people are depending on travelling into the city every day and as most of the growth in the Oslo region is occurring outside the city boundaries places where infrastructure, i.e. transportation, is not sufficiently operational.

The population growth brings challenges to the infrastructure which is important to expand in order for workers living outside the city and to efficiently commute into the city. Oslo has a public transit system consisting of trams, metro, busses and trains. Although the city has just around 600 000 inhabitants it has a fully developed metro system and has had electrical trams since the 19th hundreds. Transportation is important for Oslo as it often sets the national and regional standard. The expected growth in population in the surrounding area brings expected pressure on the roads and public transportation in the time to come, which will demand further investments by the local government.

Consumption and waste

Compared to other capitals in the world, Oslo is located far north which naturally affects the energy consumption. High energy demand for housing and transportation are results for a country where cold climate and long internal distances are a fact. Yet, Oslo has still a huge potential to reduce the energy consumption and lower its waste production. The inhabitants in Oslo consume more than what is sustainable in the global context (Dalen, 2010). Food, housing, transport, and recreation stand for over 70 % of the consumption. The consumption in Oslo is a somewhat bigger than the rest of the country due to the higher income level, higher housing prices, greater consumption of food, and high use of air transportation (ibid). Yet, the ecological footprint is lower compared to the rest of the country (Oslo Municipality, 2007). The smaller footprint is a result of high density, lack of industry, less car usage, and the increased share of recycling in the city. However, the high share of air transportation and food consumption delete the gains from higher density and less car usage.

Good economy is often consistent with consumption. As the Norwegian economy gains wealth due to the petroleum industry the consumption has increased and by that raised the amount of waste the city produce. On average an Oslo citizen produced 379 kg waste from household in 2010, which have been reduced every year since 2005 (Renovasjonsetaten, 2011). Even if Oslo has implemented recycling and 55 % of the waste from households is being recycled it only represent a small share of the total waste production of Oslo. However, the municipality's focus on facilitating recycling paper, glass, metal and fabric, to name a few, is a step in the right direction in order to become more sustainable and optimally utilize the resources.

The increased care usage may reflect the growth in wealth and population. According to the Strategy Plan for Oslo Municipality (Oslo Municipality II, 2012) transport on the roads represent over 50 % of the annual GHG emissions in Oslo where car usage is the main contributor to pollution and noise. Taxes on gas and car ownership and have been implemented to prevent to increased demand and car usage. Simultaneously, Oslo has made incentives encouraging use of environmental friendlier alternatives like electrical cars. Many places around the capital people can charge and park their electrical car for free, which are hoped to alternate the share of these transport alternatives.

The pollution and noise in Oslo is low compared to other cities in the world, but during the winter Oslo may experience days where the air quality is low and not satisfactory. Also, the country has strict regulations of greenhouse gas emissions to prevent the industry in general to represent hazardous effects on air, water, and soil. Between 2001 and 2009 the GHG emission in Oslo increased by 13 % (Oslo Municipality, 2011). However, the average emission per person decreased by 9 % in the same period. The city goal for the future is to reduce the GHG emissions by 50 % from the level in 1990, and that 50 % of the waste from households shall be recycled.

Green space and nature

The majority of the city dwellers in Oslo have easy access to green spaces and open plots as the area around Oslo is dominated by forests and water. It is in the interest of both the city inhabitants as well as the decision makers to provide all urban areas with elements of green spacing. Recreation and the access to recreational areas are important for the average Oslo inhabitant (KUV, undated). As the city is surrounded by forest and water many seek to use these opportunities close by the city both during summer and winter time. It is also said to be a part of the Norwegian identity to be close to the nature. Yet, green spaces in cities are often sacrificed for economic purposes which reduce the biodiversity in the city, but green spaces and biodiversity can be provided by regulating the impact of building zones and ensure that they are preserved. The building zone of Oslo is about one third of the total area where green areas are included. The city has many green parks and other green lungs, and

the local government has regulated areas for the benefit of green sites. These areas have increased from 970 daa to 23 200 daa between 2000 and 2010 (Oslo Municipality, 2011). However, the amount is not increasing along with the population growth as it within the same period has decreased from 43.9 m^2 to 39.6 m^2 per inhabitant.

The city gets a high score on the European Common Indicators which measure the environmental sustainability at the local level in different fields like housing standard, social services, working opportunities, access to recreation, quality of the urban space, transportation, involvement in local decision-making, and security (European Common Indicator, 2012). It turns out that Oslo's inhabitants are most satisfied by the access to nature and recreational areas and the work opportunities, and less satisfied by the public transportation and opportunity and participation in decision-making.

Oslo municipality's work for sustainable development

Through the centuries, Oslo has worked specifically with environmental and sustainable issues as the need and demand have changed with alternating interests and availability of resources. The city's vision of «*Handing over the city to the next generation in a better environmental condition than we received the city*» proofs this fact and shows that sustainable urban development is an important part of the city's strategy for the future. Oslo other vision of « (…) being an urban community in sustainable development, characterized by economic and social growth within the limits of an environmental ecological carrying capacity» reflects the engagement the municipality has in terms of constantly improve the city towards a sustainable direction. The integration of the economic, environmental, and social aspects shows that the city has a wide and reflective approach to meet the challenges we face in urban development (Oslo Municipality II, 2012).

According to the Strategy Plan for 2013 (Oslo Municipality II,2012) the City of Oslo will facilitate that the growth in the city evolves sustainably whereas the municipality administer and delegate the economy sustainably and develop strategies that will deal with increasing growing population. The City Counselors in Oslo want to take care of the recreational areas and natural resources in the city and by that improve social health gains and biodiversity. By implying «Markagrense» the city wants to ensure not to expand on the cost of these green areas. Environmental management and leaderships are implemented to systematically improve the environment. Tools such as ISO 14001, EMAS, Environmental lighthouse (Miljøfyrtårn), and the Swan-label (Svanen) are used to achieve these goals (Oslo Municipality II, 2012). By enhancing environmental oriented budgets, reports, and evaluations in businesses the sustainability focus is implemented in all economic stakeholders and improves the ability of reaching the goal of a sustainable future. Environmental friendly transport,

environmental requirements when purchasing, waste reduction and recycling, renewable resources, incentives, and energy management will become more important in the time to come. Oslo municipality works actively to make businesses achieve environmental certification, a strong initiative for focusing on optimal resource allocation and environmental management in all businesses (Oslo Municipality II, 2012). This way the city can move towards a sustainable urban development path together.

Oslo is participating in international organizations and networks, and within the EU-organization through different programs and projects, and is also participating through bilateral agreements and cooperation with cities outside the country to work towards a sustainable future. Some of them are international environmental networks like the *International Council of Local Environmental Initiatives* (ICLEI), *European Sustainable Cities and Towns Campaign* (ESCTC), and *Intercities* for the benefit of exchanging ideas and experiences, and the participation of developing indicators which can help cities measure their environmental impact and level of sustainable performance (Oslo Municipality, 2008). By that, Oslo will be able to identify and measure the effect of implemented initiatives and understand the development over a time period. Collaboration with the University of Oslo has also made the city being able to determine its ecological footprint. This has been important to identify consumption patterns in the society, and measure how it will affect the Earth if all inhabitants on the planet had the same consumption. The city's work with Local Agenda 21 has turned the focus on the participation of other actors than just municipal agencies. By integrating districts, schools, businesses, organizations, and the national government and establish new dialogs and partnerships make the city better prepared to ensure an comprehensive urban development. This way, Oslo can be promoted as Europe's sustainable city, as environmental management is integrated in the whole city dynamics.

6.Case analysis

"No matter how complex global problems may seem,
it is we ourselves who have given rise to them.
They cannot be beyond our power to resolve."

- Daisaku Ikeda

Oslo has, like any other city in the world, challenges in providing all city dwellers with their wants and needs while simultaneously making sure that the economy is growing and that the environment is prevented from suffering due to unconscious and hazardous human behavior. This section will analyze what challenges Oslo faces in achieving a sustainable future. Housing has been explained as an example in the previous chapter as one of the main challenges the city is being confronted with today, and is thus a common link between all the three conflict areas. The analysis of Oslo will demonstrate how the general model outlined in chapter four is validated for a real city. It will show the causality of the three conflicts arising in sustainable urban development and increase the understanding of how they are linked together. Based on the increased housing challenges a better understanding of the compound correlation between the three conflicts will be gained. The chapter divides the three challenges and analyzes them separately to show how each conflict occurs in the context of sustainable urban development in Oslo. By looking at each conflict area we will see how they are interrelated and interdependent on each other due to the conflicts and opposing interests that occur.

The different models for the conflict areas are represented in this chapter. The models are demonstrating a proposed causality of the system in which Oslo is experiencing conflicts. The different variables are of economic, environmental or equity concern, and measured by different entities. The variables must be able to be measured in order to understand whether the stock of the variable is increasing or decreasing, and thus whether the system growing or being balanced. The variables are also related to one or more of the goals and demonstrate the perspective which is concerned of the level of the variable. A variety of stakeholders may be interested in the development and regulations of variables which create conflicts and result in difficulties in understanding whether the level of the variable is good or bad. However, understanding the causalities and how the system consists of variables, comprehensiveness is gained and it is easier to understand the dependency and relation between them.

6.1. Property conflict

The population in Oslo has grown rapidly the last decades due to a steady economic growth. The petroleum industry may be the number one reason for the economic stability in the country. As Norway is not a member of the European Union Norway has not been affected by the recent financial crisis the same way as most of the countries in Europe and most of the World. With high pressure on wages, low inflation, low interest rates and low unemployment rate compared to other European countries Norway and its capitol Oslo is an attractive place to live and work. Due to these factors many international citizens find their way to Oslo every year as demonstrated in *figure 26*, as well as Norwegians who immigrate to the city for the many education and job opportunities. This has led to a rapid increase in population in accordance with the nation being the second fastest growing population in Europe (Tollersrud, 2012). The rapid growth demand more property opportunities for people and makes it challenging to balance the demand and supply if the population grows at fast pace. If the city's decision-makers are not following the growth people may be forced to the outskirts of the city. Sprawl is a common result of rapid population growth which will lead to a variety of subsequent issues. The unfortunate consequence may be increased differences among demographic groups and at worse; class distinction. This may lead to segregation in the society and thus inequity among the dwellers (Watson, et. al., (2006). In order to ensure sustainable urban development in Oslo, the property conflict must be understood and resolved.

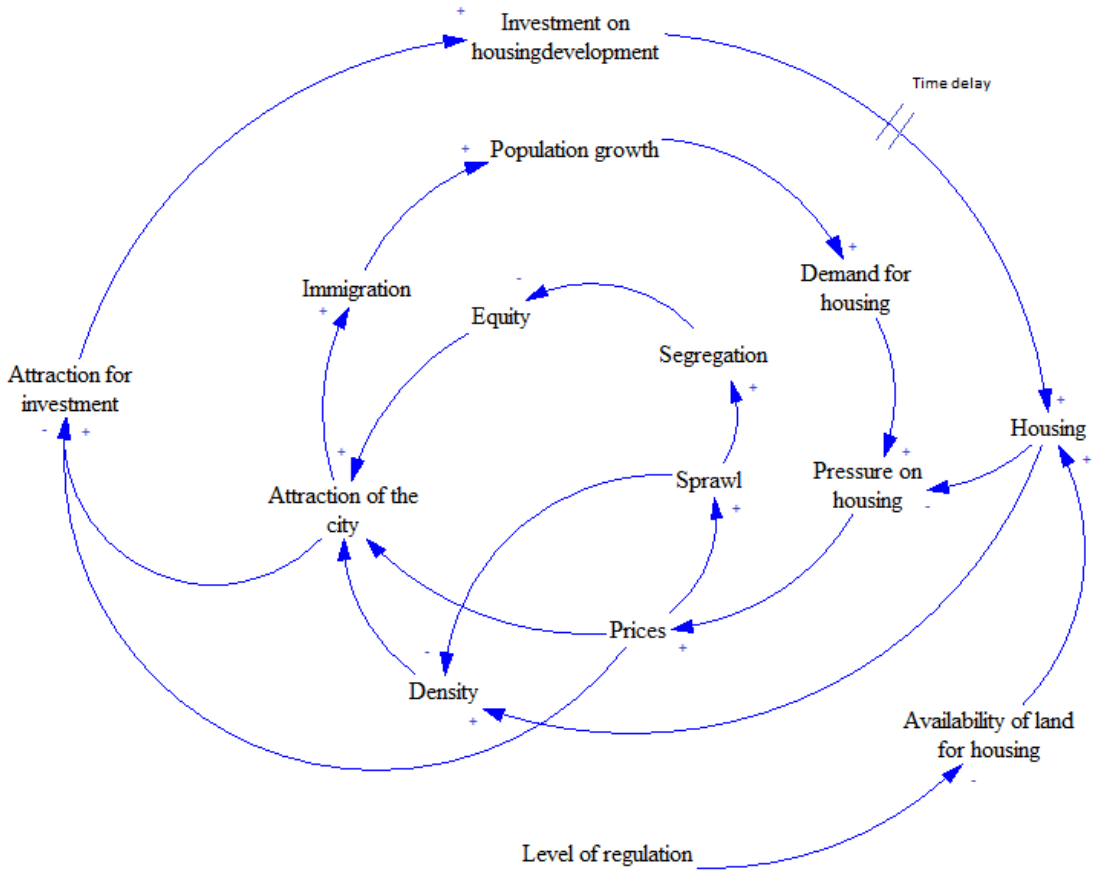

Figure 35: Proposed property conflict of Oslo

Demand and prices

The economic growth and increase in population bring challenges to the city of Oslo. One of the major challenges Oslo faces today is how to fit all new dwellers into the existing built environment. Due to the strong centralization Norwegian cities are experiencing the demand for housing in the city increases which in turn increases the pressure on property. The pressure leads to higher prices in the city center and counteracts the ability to buy and own property in the city for many demographic or income groups. There are naturally some groups that struggle more than others. Hence, the attraction of living in the city may decrease and force potential dwellers to look elsewhere for housing opportunities in order to buy property. In the city, dwellers with the strongest financial background will dominate. These may typically be adults with high incomes and low debt. If the development favors one demographic group or one income group it may lead to undesired consequences like segregation, domination of one group on cost of others, or at worst a monoculture (Watson, et. al., 2006). If certain demographic groups do not find it beneficial to settle in the city we might face areas where some demographic groups are underrepresented or even absent.

As explained in chapter five, a smaller fraction of children and young adults with children are settled in the city. It may imply that the city do not provide the wants and needs for these groups which makes them more interested in settling down somewhere else. This can at worse cause bias in the urban society like the need of schools and kindergartens here and more elderly homes and recreation centers there. Suburbs where young adults with children chose to live in an example. It is part of the sprawl effect which is a common result of the reluctance of settling in the city, often due to the lack of affordable housing or other requirements these dwellers possess. The sprawling effect may cause harm to the environment as more land is used to the benefit of housing, commuter distances increase and people get more dependent on transportation. However, sprawling may also lead to opportunities for many people as they are able to find affordable housing outside the city boundaries and new job opportunities, and thus force the infrastructure to evolve. It will also result in new opportunities due to transportation and affordable property. The increased travelling and dependency in transportation do however have a backside. The social environment will negatively be influenced by these factors as environmental damage hurt the social health. This effect may increase society's demand more infrastructure and thus more sprawl. These undesired effects seen from a social perspective along with the increased amount of time consumed by people depending on transportation will be further discussed in the *development conflict.*

Prices

A result of the high housing prices in the city people seek affordable housing in the city outskirts and outside the city. These are often young adult with small children with the desire of larger lots, low-density areas, green space, and cheaper housing. In the city, young people mostly rent apartments or obtain big mortgages to finance a buy. However, the buying process is often not an option for young people as Norwegian banks demand 15 % financing from the borrower in order to offer a mortgage (Finanstilsynet, 2011). Due to the high prices in Oslo most young people do not satisfy this limit which in turn will favor persons with financially strong parents who can bail them out. The high price level results in ownership by the financial strongest in the center, and young or less capital strong inhabitants in the outskirts, if they can afford a property at all. The tenants and house owners different interest and needs turn into a conflict due to the economic benefits and inequity that arises. Likewise, the market tension between buying and selling favors the economic strong part of the society. This allocation may lead to economic segregation as it separate the opportunities between dwellers and moves toward an unequal society as a cost of the economic growth and price increase. Social class distinction increases and the composition of property owners the city changes. Segregation can however be perceived as positive for some stakeholders while negative by others. Rich and wealthy neighborhoods may be interested in only having wealthy and financially strong neighbors, while poorer families may appreciate the mix of families in the community. Yet, property owners will be interested in gaining high profits on their property when selling and is thus dependent on the amount of buyers and the market price. This stands in contrast to people who do not own property and who are interested in affordable prices and higher supply rates. Equity is thus a matter of perceived equality, opportunities, and desired living conditions. In the general term however economic or demographic segregation is not desired for the city as a whole and decreases the attractively of the city. The property conflict is thus essential for Oslo to resolve.

Oslo is experiencing another challenge as young adults searching for jobs and higher education find their way to the city. Due to the high prices they must pay high living costs which force them to work more or reduce their savings. It also creates bigger difficulties in saving for potential investment in the future. The same can be said about people with lower income. The price issue in Oslo is driven by the market forces, and as the population grows available housing is needed even more. Along with a good economy the income and wages also rise. However, the wages in Oslo have not increased in pace with the housing prices, or vice versa. The residential prices in Oslo have increased 25 % more than the already strong growth in wages in Oslo. This means that people are paying 1.3 times more on housing compared to 1970 (Norli, 2012). It implies an over pricing by 30 % in the city which may

turn the economy more fragile. If the housing bobble bursts people may not be able to operate their mortgage. It also means that only the financially strongest inhabitants can afford to buy property in the city, forcing people without solid capital earnings to rent or move out of the center. Young people studying or working in Oslo are however living in the city center due to the excitement of the city life and short distances to everything. When these people rent at a high price it takes even longer time for them to be able to buy property. This price dilemma may lead to undesired consequences for certain demographic or age groups, and change the demographic and financial structure of the city dwellers over a longer time frame.

Investment and regulation

However, high prices have benefits as well. The high prices on property may also attract certain stakeholders to invest in the area. Investors are attracted by the high property prices and tempted to invest in property and development of more property. If the investment in housing increases, more housing is being built and the amount of houses increases. This process includes however a time delay as constructions need time to get built and get ready for occupation. The increased housing will ease the pressure on housing and affect the price level. As mentioned earlier*;* if the price level decreases or do not increase with the increased inflation investors are less attracted to develop new dwellings. The building industry will thus typically experience an oscillation effect in the investment level over time, due to the changing market and oscillating market forces.

Yet, investors cannot build as they want as the regulation of land and resources are determining the availability of the amount of housing. The level is typically regulated by the local or central government and slows the construction of new residential or business area. It has turned out that Oslo with its rapidly growing population will need around 100 000 residents by 2030. Yet, the Planning and Building Authorities' only regulated 1846 dwellings compared to the goal of 4500 units in 2011 (Plan- og Bygningsetaten, 2012). On the other hand 3530 residential units were approved compared to the goal of 4500 units (ibid). The availability will be crucial also for the other conflicts as regulations decide how the development of the city will evolve over time. The regulations may affect the availability and thus the investment when regulating the cost of building houses. Mandatory building practices may be one of the regulations which make it more challenging to increase the availability and thus investment in order to gain more housing. It is thus important that rules, regulations, or even incentives provide guidelines based on a well though-through and comprehensive understanding of the city and its stakeholders. The level of regulation has increased in recent years making the process of creating new dwellings be more time consuming and detail oriented (Horjen and De Rosa, 2012). Contractors and the social society are interested in higher

availability and thus decreased level of regulation in order to keep up with the demand (ibid). It is no doubt Oslo needs more residential buildings in the time ahead, and that regulations must be planned and developed carefully

Density

Many argue that in order to move the city towards a sustainable urban path density must increase in the city. Less energy per square meter and placing people closer to their work sites may be some of the solutions. Higher density will reduce care usage, pollution, carbon emissions as distances and the consumption of land and energy is reduced by the efficient infrastructure. But how dense can a city get? Even a relatively low-density city like Oslo has challenges when increasing the density. The popularity of Oslo has made the city exploit its existing building mass the last decades, but the city contains of many older buildings, which cannot expand with several additional floors due to construction design or official conservation. Policy authorities may emphasize increased density due to both infrastructure and efficient use of land. Dwellers may however prefer lower density and more space. Oslo is reconstructing some of its existing built environment on sites along the fjord.

Another conflict that rises in this context is however the development of business buildings along the fjord and location of residential areas in the inland valleys like Groruddalen due to the lower property prices. It also turns into a debate of whether the sites along the fjord should be used for housing instead of office buildings as these properties are of higher value and should be used as dwellings. Yet, businesses may be the only ones who can pay the high property costs. It implies the interest conflicts one may face during and after areas are expanded.

It is important to find the balance between economic growth and social equity. Socioeconomic dilemmas bring challenges for the city to move towards a sustainable path. By ensuring that governmental rules and regulations keep pace with the development and include the property issue, demographic and class segregation may be prevented to evolve in both economic and equity terms. The economy is interested in growth in order to develop further, but is simultaneously dependent on available land and housing for its dwellers. Thus, the property conflict must find the balance between expanding the city and providing all dwellers with affordable housing, and ensuring that the prices are beneficial for the economy to grow and the investment in the city to continue. Parallel with the expansion infrastructure and communication, methods must be developed to gain more efficient expansion of the population. However, the expansion of property and population to surrounding areas lead to resource and development conflicts in which sustainability is put to the test. It is challenging to ensure that housing and property are provided for both residents and businesses

while not degrading the environment or differentiate the dwellers opportunities is challenging. It must however be emphasized in the time to come in order to follow the growth Oslo is experiencing.

6.2. Resource conflict

Oslo is an important center for administrative institutions and businesses development. The city possesses a lot of natural resources and both the city government and the dwellers are interested in healthy usage and preservation of the resources. The natural environment surrounding the city is dominated by forests and water, mostly wild and undeveloped by human activity. As much as 66 % of the area of Oslo is forests and water. But, even for a service oriented city it is important to find the balance between economic growth and environmental protection. Yet, even if Oslo not demand resources to enhance in the product industry and goods processing the city is facing conflicts between economic growth and environmental protection. Population growth, urban sprawl and the housing dilemma are affecting the tension between these two sustainability perspectives like in the property conflict in the previous section. Additionally, Oslo is a city which generates waste and pollution from consumption and transportation due to the high income rate which makes it especially important to control the amount of waste and emissions from dwellers' consumption habits. Finding a balance between economic growth and environmental protection in Oslo is thus a question of how and where to deal with the growth without degrading the environmental quality.

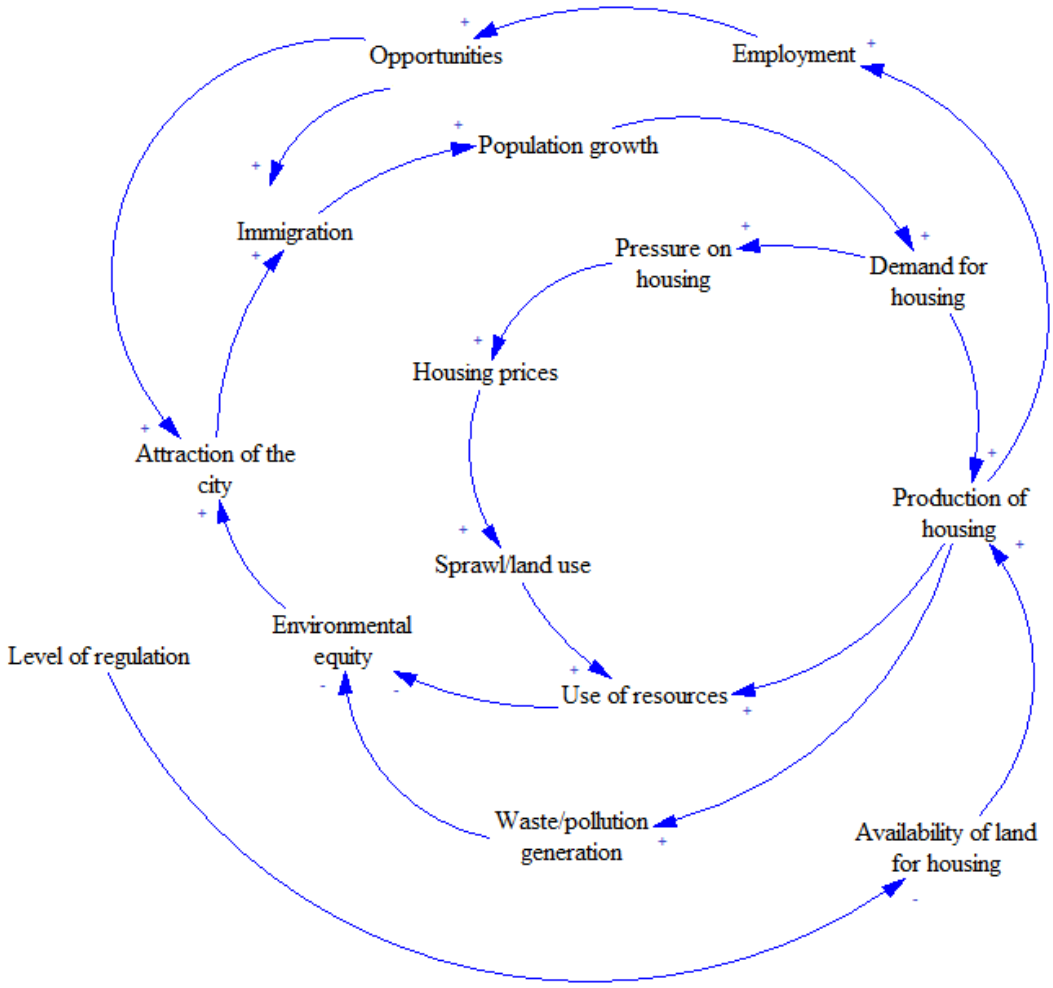

Figure 36: Proposed resource conflict of Oslo

Density and location

As discussed in the property conflict the density has a limited opportunity to expand in the existing built environment, especially as the city consists of older buildings which due to construction and governmental preservation cannot infinitely be utilized. Economic growth and increased population demand more residential and business areas which lead to the question of where this expansion should take place. It is an issue between economic growth and the protection of the existing resources and green environment. The city has transformed parts of the city's brownfields to new residential sites like Aker Brygge and the area along the Aker River. The Barcode area, Sørenga and Tjuvholmen are the newest additions to the creative ways of utilizing this fallow land. The Barcode strip is dominated by skyscrapers for business activities, and Sørenga is redeveloped to a residential area both built on former highways. Tjuvholmen, including both businesses and residential buildings, is an artificial island added to the existing Aker Brygge to keep up with the high demand in new innovative ways. The utilization of some of the existing brownfields in the city has increased the density of the city; however, the density cannot increase infinitely. As more brownfields are redeveloped and diminished the city must expand beyond the existing city boundaries. The city has been expanding east and west along the Oslo fjord and increased the population in the neighboring small towns. The forests surrounding the city have so far been protected. Today, Oslo is facing a dilemma of where to expand the city. The interests in protecting the forests in the north and the descending interest in continue to developing in the east part of Oslo are some of the challenges (Horjen and De Rosa, 2012). At the same time contractors are experiencing lower profits as the regulations are high and the regulated building lots are placed in less attractive areas. Oslo is challenged in finding the balance between rapid growth and the regulation of potential areas.

The practice the recent years of locating large business building along the shore of Oslo like Fornebu and Lysaker are now leading to a debate of how the city can distribute the land more fairly and ensure that the development involde future needs. While the city focuses on building residential areas in the inland of Oslo like Groruddalen and other places further away from the city center, it brings changes in the city structure due to infrastructure and skew distribution of areas. Businesses are located near the city core, while the residential areas are squeezed out, closer towards the city outskirts. The high price is one of the main reasons for the sprawling residential areas as businesses are able to afford the prices close to the city center and home owners are not. It is simultaneously forcing more people to be dependent on transportation and live in places where view and access to the ocean is limited. The economic growth is challenging the environment, and as economic growth lead to pollution and waste, it makes the environment to challenging the economic growth in return.

Demand, sprawl and environmental quality

As explained in the property conflict the increased population, the pressure on the existing buildings and the increased prices in the center leads to challenges for the city to find affordable room for all new dwellers. A consequence of the density and high housing prices in the city is people seeking affordable housing in the city outskirts, which brings pressure on land and transportation. However, sprawl is not only a negative occurrence, but may bring negative impacts on the society and the environment if it is not controlled this is typical for the development conflict but valid for the resource conflict as well. As the demand for housing increases the production of housing for residential and business interest increase in order to keep in pace with the development. As more people find their way to the city, so do new companies which again trigger each other to further grow. The production of housing and the sprawling effect both lead to more land usage and generation of waste and pollution due to increased consumption.

Regulation and availability

The production of housing and the sprawling effect is highly dependent on the level of regulation and the availability of land and resources that comes out of it. Due to new laws and regulations Oslo experienced a stricter and detailed procedure in approving applications for building and regulating land (Horjen and De Rosa, 2012). This may have reduced the use of land and resources in terms of new dwellings, but may have increased the pressure on the built environment as more dwellers must find ways to live and work within the same boundaries. In this context pressure on transportation and housing in the outskirts have increased leading to a variety of challenges in dealing with infrastructure. It is in the interest of all city inhabitants to ensure a healthy and vital environment, but the pressure on the environment and the consequences of it may not be visible for a period of time due to time delay. The consequences can thus be severe and may lead to a pressure that creates a backlog hard to follow without drastically change the existing system.

Attraction

The impacts on the environment due to economic interests and vice versa indicate the tension between growth and protection. Increased demand and redevelopment of land increase pollution in terms of emissions and waste generation from households and businesses. Hence, the environmental quality is decreased as the basic resources like air, soil and water and the perceived environment in which the dwellers is threaten. The attraction of the city will decrease if the care of environmental quality is not an essential part of the decision-making for the further by utilizing and protecting resources. Decreased attraction of the city is not in the interest of the economy and will thus lead to a reduction in the population growth if the environmental challenges get significantly high and

immigration stagnates. Finding the balance between the economic quality and the attractiveness of the city is important, and as the environmental damages often include a time delay before they occur a long term strategy is crucial. In conjunction with this concern it is also vital to think of the accessibility of resources for the next generations and the key position the environment plays in any living city in order to maintain and develop fruitfully.

Production and opportunities

Economic growth is dependent on being able to expand the built environment and have more room for residents, businesses and industry. The high demand forces the production of goods, services and buildings to increase in the city. Increased production demands work force, and the resulting high employment rate brings positive results like increased opportunities and thus increased attractiveness for settling in the city. The more options offered and the more equity is given priority, the more people will immigrate and continue staying in the city. In turn, population will increase and make the city face the same challenges all over again.

However, the competition over land and resources can be seen is a market principle. Land is potential to develop new property by the developer, and a potential for production for the industry and business owners. Land use policy determines how the land development of housing and industry will be in the future and the regulation and thus the availability plays a significant role in the distribution of land. Through utilization of resources loss of land for agriculture, wildlife, eco-systems, wetlands, biodiversity, coastal zone and watershed management may be the consequence. It emphasized the importance of understanding the balance between the need of the economic growth in the area and the consequences of utilizing resources at a higher level than what is sustainable. Availability and the regulation of the availability are essential to ensure that the market forces do not have free rains to develop as they desire. The demand for space must be considered carefully and the generation of waste and pollution due to the increased use of space must be integrated in the development of the city. The regulation of building practices in Norway results in increased cost for constructing and renovating buildings. Yet, the reason behind these regulations is the desire for decreasing energy demand by energy-efficient buildings. The evaluation between high initial costs versus saving in energy costs over time is a question which will be essential in the time to come.

It is important to take care of the green environment and its resources for many reasons. Biodiversity, recreation, and the potential for carbon storage from carbon emissions are some of the important factors. At the same time it is vital to leave resources in the city for future generations to utilize. By expanding the city without thinking of these components the urban development in the future will face challenges due to the *mistakes* done by the generations before them. By

understanding the opposing interests of the economic and environmental stakeholders undesired outcomes may be prevented, and by reshaping mental models it ease the knowledge of relations and dependency within the conflict. Finding the balance between utilizing and protection is the result, and will help planners finding the most robust and comprehensive solutions, and invite the stakeholders to understand each other. It may bridge their common and opposing interests for the benefit of the living city. In the resource conflict economic interest must understand the importance of environmental values and the planners must pave the way for a healthy regulation. By understanding how economic growth can minimize its impact on the environment the resource conflict can increase the possibility of being resolved.

6.3. Development conflict

Increased population and higher demand on housing and space lead to challenges to find a common path where both social equity and environmental protection are met. The tension that arises between the two is known as the development conflict. The development conflict must be seen in accordance with the property and resource conflicts as the development includes all the perspectives goals of development in the urban area. In the context of Oslo, equity is not a big social problem like in other World, cities as most Oslo dwellers experience high living standards, but as explained in the property conflict there exist challenges due to equity in Oslo as well. The development conflict is strongly linked to population growth and the need for space like in the two previous conflicts. As the pressure within the city increase the prices rise, and the city experience challenges due to social equity and environmental protection. More pressure on the ability of combining work in the city while living outside the city is also a typical conflict due to this tension. Developing the infrastructure in pace with economic growth and healthy environmental expansion while at the same time satisfying the dwellers' needs, infrastructure is a difficult task. The development conflict is a matter of how Oslo can expand and how big it can get.

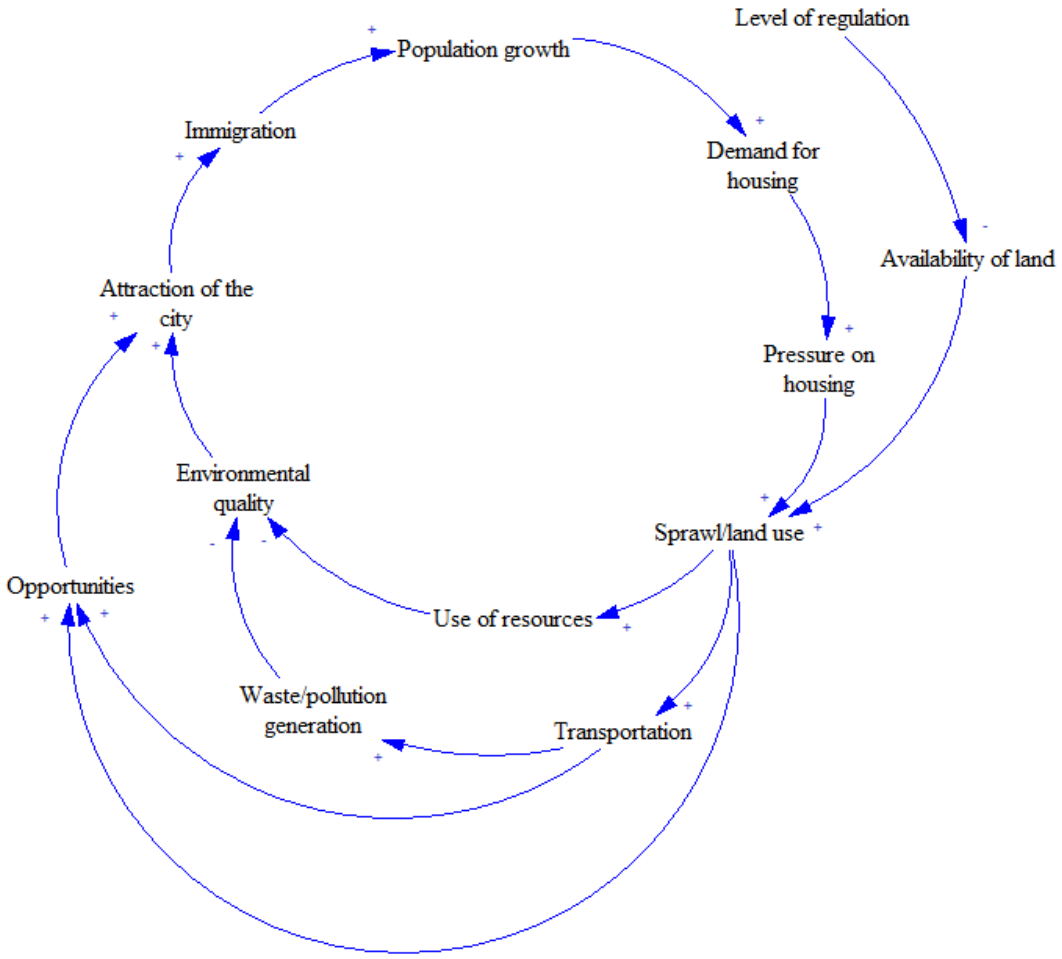

Figure 37: Proposed development conflict of Oslo

Sprawl, resources and transportation

Population growth, demand, and pressure on the scarce land of the city is argued to lead people to search for affordable housing outside of the city center. The challenges between social equity and environmental protection put pressure in the infrastructure of the whole area. How can the dwellers experience justice and equal opportunities without develope on the cost of the environment? The increased population leads to expansion of land which in turn results in more use of resources. The need for transportation and transportation alternatives increases in parallel with the above. Oslo is facing increased pressure on the infrastructure as the increased amount of commuters is leading to greater pressure on the environment as resource and transportation dependency increases. Transportation is associated with freedom and opportunities and if dwellers have the opportunity to use it. It is both a prerequisite for and a consequence of expanding cities today, making it easier for people to move around and open access to new opportunities. The increased use of resources and transportation is in the direct short-term interest of consumers. It is also crucial for the economy to provide an efficient and reliable infrastructure in order for the economy to flow and grow in the future. Any transportation alternative however demands both energy and space. It is thus essential to understand the need of transportation and how the pressure on transportation alternatives will develop over time. To evaluate the environmental impacts the transportation alternatives represent is also an important aspect of the transportation related concern. The balance between private and public transportation is an increasing issue where different stakeholders have different interests. Identifying and evaluating different alternatives and understand how the demand will develop in the future will provide guidelines of this issue. How the energy production, prices and sources develop must be taken into account to find the best solutions for the future.

Low transport costs and improved technology has made transportation affect all human life since the industrial revolution, and longer travel distances are possible within the same amount of time. The results are the dwellers ability to live, work and operate at different sites at different times, and residential buildings, businesses, and industry can be located at any site due to the accessibility of transportation alternatives and available land. Infrastructure and the availability of transportation and other resources affect the value of land and location. For example, the better the transportation alternatives are the more people are interested, and the higher the price of the property becomes. Infrastructure is thus not only affecting humans and the environment, but the economy and value creation as well.

Environmental quality

The increased use of resources and transportation causes stress on the environment. Pollution, traffic congestion, and increased use of space for property and transportation services bring unfortunate effect on the surrounding environment. This puts transportation in light of society's need of a healthy and safe environment, although the transportation alternatives also increase the opportunities for the dwellers. It is in the interest of the environment to take care of the available land and resources and have a healthy distribution and utilization of the land. Transportation priorities are important factors in shaping urban form and thus determining the amount of land taken up for housing and energy use. By transforming the society to become operative the city also makes it addicted and dependent on being mobile with different transportation alternatives. This type of development may turn the society fragile which demonstrates the importance of improving and expanding the transportation alternatives first and foremost to environmental friendly alternatives.

For present as well as future generations it is essential to ensure a viable level of environmental quality. The environmental quality like green spaces, clean water and drainable soil improves the perceived environment and tries to combat the pollution due to increased population, consumption, and transportation. The economy is thus interested in both expanding the city and make room for more people. At the same time it wants to ensure that the surroundings are handled carefully in order to attract more people, increase investment, and thus strengthen the economy in the city. In this context it is important to identify how much land is acceptable and necessary to use for expanding the housing and transportation opportunities. The regulation and availability is important for the control of spraw and the development of transportation and sets the standard of how much and in what way land and resources should be utilized.

Regulation and availability

In accordance with the land use and the wealth of the nation, people have the ability of owning bigger homes and bigger cars. As households today tend to decrease it implies that people are using more space and resources per dweller than earlier. This is a challenge in the time to come as buildings stand for 40 % of the energy-consumption in the world and transportation for around 25 % (International Energy Agency, undated; SINTEF, 2009; Rodrigue et. al, 2009). It will also create bigger homes which in turn will lead to more waste generation and energy demand. Yet, by ensuring improved technology and building techniques these houses will hopefully be present for decades to come. In this concern the question of availability is relevant. The determination of what is allowed in terms of sizes, building techniques, and energy consumption can be set by governmental regulations

improving the quality of the built environment. It can also encourage to more efficient use by implementing incentives and subsidies.

The regulation done by the policy-makers determines how the development evolves in the future. But finding the optimal solution is hard and even impossible due to the wicked problem situation. By prioritizing the building of roads and the utilization of land en resources the environmental quality decreases due to the generation of waste and pollution. By degrading the environment the city's health will decline over time and people may suffer from increasing health issues. On the other hand, if environmental interests are emphasized more than sustainable beneficial social consequences may occur here as well. Due to the lack of developing roads and transportation alternatives traffic congestion occurs and the pressure on the existing roads creates chaos. This affects the time consumption for the people involved and the cost of being on the road as traveling time, waiting time and time affecting other travelers are a cost for the society. The economy is affected by insufficient infrastructure, and human resources are wasted. It also leads to a high pressure on the existing built environment which threatens the environment in the neighboring area and degrades the environmental quality.

The issue is complex and one of the most challenging to resolve. As more investment in the infrastructure is made, more development follow, and opportunities increase the settlement and further demand. Finding a balance which advocates a healthy development of both infrastructure and expansion of housing are some of the main goals within the development conflict. It is desired to ensure continuous growth, but simultaneously prevent the development to grow faster than what is sustainable for the area as a whole. The city and surrounding are needs green spaces, lots, industry and wilderness, as well as roads, railways and other transport alternatives. Land use policies must see this complex situation in perspective of the different components and find a solution that emphasizes the kind of sustainable development the city wants.

Opportunities

Even if transportation and increased use of resources contains of unfortunate consequences the sprawling effect has corresponding benefits. Mobility and flexibility increases as transportation alternatives are expanded. Simultaneously will more housing and new residential areas due to sprawl create opportunities in where to live and work. This illustrates that even if transportation and sprawl bring unfortunate impacts on the environmental quality they also generate positive outcomes for the society, and increase the equity for the city dwellers.

6.4. Summary

As seen in the previous sections the interrelation and interdependency between variables goes cross the different fields of sustainability, the different interests of sustainability, and the conflicts arising within the context of sustainable urban development. The three main conflicts in this chapter show us how the understanding of cause and effect the variables bring increase our ability to see the system and find the right places to intervene. Planning and decision-making will thus be better equipped to handle the large amount of conflicts which need to be taken into account in the development of sustainable cities. The correlations of the separate conflict models also illustrates how closely related all perspectives, variables and conflicts are to each other. It demonstrates that finding better resolutions is possible, but that it is challenging to determine and prioritize which interests should go first. However, the use of system dynamics in this chapter shows that we can gain greater understanding of the real world and the system behavior, and that models is the right way to go in order to understand the system we live in.

7.Discussion and Conclusion

"Plans are nothing;
Planning is everything"

-Dwight D. Eisenhower

7.1. Discussion

Cities are seen as one of the main driving forces behind the unfortunate trends in lifestyles and human consumption patterns today. We consume more than earlier and utilize more resources that what is sustainable over time. As most of the world's population will live in cities in the closest future it calls for a change in the way cities act and operate. It also calls for a new way of managing ourselves and new way of developing in the future. The trend in cities brings economic, environmental and social challenges and makes the city a focal point of present-day problems. In order to manage cities better in the future it demands better planning and deeper understanding of how we can gain sustainable urban development. We need to understand the cities' complexity and how to control their behavior towards a more desired path of development. But even though cities are problem creators they are just as much problem solvers. They have the ability of changing human behavior and our unsustainable way of utilizing resources. Cities are thus clusters of potential sustainable development, and full of innovation and knowledge. By improving the ways cities behave and develop it will send a strong signal to the rest of the world's population.

Planning

However, sustainable urban development does not occur by itself. Planners must find the best approaches and decisions must perform as desired. In other worlds, it is a task for planners and decision-makers to ensure that the world's urban centers develop in a best possible way. Yet, who determines what is best and what factors should be given attention, is an important question. This is what makes sustainable development a difficult task as sustainability related questions are wicked and impossible to find optimal solutions for. Their resolutions depend on the people involved and on their view on what should be prioritized in the development planning. All cities contain of a variety of stakeholders which in turn represent an even wider range of interests and needs. The inconsistency between stakeholders and their opposing interests also make sustainable urban development hard to achieve. As we tend to divide them into three main sectors it demonstrates how sustainability is a multidisciplinary area which is dominated by a large amount of opposing interests. The contradictory

interests will thus crate conflicts in how to find better resolutions for the future, and challenge planning processes in finding desired alternatives that satisfy all stakeholders. The promotion of urban sustainable development is, in other words, dependent on city stakeholders and planners not ignoring challenges and conflicts in order to find the necessary priorities. It is impossible to fully satisfy all stakeholders simultaneously, but if planners manage to better balance the economic growth, environmental protection and social equity over time urban centers will move on a path towards sustainable urban development.

Until today, planners have had the tendency of focusing on one or at most two aspects of sustainability when planning for sustainable solutions for the future. This is a natural part of human behavior as each and every one of us represents certain ideas and interest. This reductionist approach has led to a variety of unfortunate effects on the economy, environment and society regardless of the aspects that was initially included in the planning process. The wicked problem of sustainability related issues illustrates this. It also increases the difficulty in managing problems and treat them properly without making damage. Economic oriented decision may harm the environment, but in turn it can also harm the economy itself. This is all due to the interrelation and interdependency of the many aspects our world consists of. The practice of neglecting this variety demonstrates a *hole* in planning processes and decision-making. It also implies that the hole must be closed in order to find reflective and comprehensive resolutions in moving towards a sustainable future.

Systems thinking

As the thesis has demonstrated, systems thinking is a helpful approach for understanding the system in which we live. It shows how the sustainability problem consist of a number of cause and effects, and how we by thinking differently can reveal the underlying conflicts which needs to be handled. By taking a step back and seeing the forest instead of the trees we are be able to understand how causalities in the world are linked together. System thinking increases the understanding of present and future problems, and the causalities among the many factors that determine how the world is composed. By including the many stakeholders that have their wants and needs in the society we become more aware of what we must take into account to find the desired behavior for the city as a whole. Additionally, by understanding their requirements it is easier to understand potential conflicts, resolve them more successfully, and even prevent unfortunate outcomes from appearing. It is a way of bridging stakeholders and makes them understand the many aspects of sustainability interests in order to find a common path for the future. This common path and the reflective

understanding of the complexity of the system will thus play an essential role in achieving sustainability.

Planning towards sustainable development is however hard as all World's cities are unique. It increases the difficulty to learn from others and find common paths of sustainable urban development. It also does not give cities free tickets to adapt already developed resolutions, as cities react and develop in different patterns. On the other hand, cities can learn from planning approaches and procedures other cities have applied. They can exchange their experiences, encourage each other to move towards a better path, and use their similarities to help each other achieve desired goals. But although cities face different problems, all cities must find the balance between the different aspects of sustainability in order to move the city towards a more sustainable direction. All cities face the challenge in balancing the three main perspectives of sustainability; economic growth, environmental protection and social equity, which illustrates that cities are more similar than we tend to think. By focusing on the similarities instead of the differences we are able to understand cities in a larger perspective and see their common structure. This can be a great benefit in the sustainability context. However, humans tend to focus on differences rather than similarities. We create stereotypes and forget that we may have more similarities than differences in the big picture. The ability to see differences is important, and things are rarely totally similar, but in the implementation of the systems dynamics approach similarities are to be found. A step is taken out of the system and encourages us to reflect on how different factors create the systems in which we live.

When we practice the fundamentals of systems thinking the theory of system dynamics is used to understand complex systems. It helps us create models which are sharpened and closer to the real world than our initial mental models of the system. The systems in which we live are hard to see, but by the application of systems thinking it makes us able to take a step out of the box and see it from above. These models created by systems dynamics approaches focus on the similarities in different aspects and the ability to reunite and bridge different aspects in order to move toward a common direction. Sustainable development in cities is one of these common directions that every city will be concerned about sooner than later. As cities by nature have fundamental similarities it is helpful to understand how to improve the planning process by taking a look at the big picture and create general models.

Models

The variety of cities, situations and perspectives all represent differences but as the thesis has demonstrated, we are able to understand similarities by using dynamic systems thinking. The general model is based on the theory that cities face the same challenge in balancing the three main aspects

of sustainability, and that the imbalance between them creates conflicts. The variety of stakeholders is often strong contrasts to each other and causes conflicts sustainability development processes has to resolve. The creation of models emphasizes the importance of learning from each other and to focus on what we have in common. This way, we are able to understand the causalities and thus resolve the conflicts together. The strong interrelations and interdependencies between the three main aspects of sustainability increases the complexity, but by finding the desired level of details the overview is gained and we increase our understanding in how everything is related to everything.

The thesis has demonstrated how we by the use of systems thinking and the theory of complex system dynamics are able to address factors that play a significant role in the movement towards sustainability. By identifying the stakeholders involved and how the system is composed by variables affecting each other we are able to make better models of the real world. These models make us conscious about different goals, variables, and conflicting interests of stakeholders we may had forgotten it was not for the increased consciousness. If we simultaneously understand the economic, environmental and social interests in the society planning towards sustainability improves. During the identification of the intersections between different variables that affect the ability to achieve and obtain the concept of sustainable cities, we reveal a clearer picture of the complexity of the real system. In turn, by understanding how everything is related to everything, consciousness is gained and we are better equipped to find reflective solutions for the future.

Cities have the same problems but different drivers of these problems, and different outcomes and consequences of their behavior. As mentioned, wicked problems cannot be solved but by identifying the underlying interests of the aspects of sustainability it is easier to understand what must be emphasized and combined in order for the development to satisfy its stakeholders. The triangle is thus a good guide in the model development and easy to understand. By using feedback loops to organize the variables by cause and effect correlations it sharpens the mental model and simulate the real world. It raises awareness and increase the understanding of how the development alters. However, to remember that models are *just* models and not blueprints of the real world is important, and may prevent us from solely rely on the created models but rather handle them carefully.

The general model developed in chapter four is helpful to understand variables of importance and the conflicting interests from stakeholders. It also demonstrates that a general model with less details and thus less complexity can make it easier to understand the main issue and challenges the cities face. It makes the developer gain an overview of the wicked problem and an understanding of the most critical interactions. General models guide the city, but are, however, not a true picture of the real world and must thus be handled correspondently. The reason why we create models is to

understand how real systems operate. In the aspect of sustainable urban development it is interesting to identify what challenges a real city is facing from the development of a general model of challenges.

Case

The case analysis of Oslo demonstrates how the general model can be implemented in the development of a real city. It shows the benefits of first starting with a general overview of the situations to understand the general challenges for thereafter to increase the level of details due to the real city situation. By rebuilding a model from a smaller and less complex one feedback loops can be developed step by step to a desired level of details. The more details, the more complexity and thus the more can be discovered in the analysis. However, for many problems it is sufficient to only include a limited number of variables to still have overview of the most important patterns. It is dependent on the planning outcome and purpose of the model development when deciding how detailed the created model should be. In the thesis, the number of variables was relatively few in the general model and still illustrated how economic and social interests opposed each other and what the main components of the conflict were. However, in an analysis of a real city it is desired to increase the level of details for understand the underlying conflicts and causalities that affect the development. The models created were interested in the big picture of the property, resource and development conflicts and thus how to resolve the problems to make systems behave as desired.

Conflicts

Within the aspects of sustainability is exists a number of goals and stakeholders. This is first and foremost how we reshape the general model for the purpose of examining Oslo's sustainability related challenges. The case analysis of Oslo showed that by focusing on the specific perspectives and stakeholders the drivers of the property, resource, and development conflicts were identified. It also illustrated how the drivers are typically representing the most dominant aspect of the problem. All variables are driven by economic, environmental or social interests and it occurs that the stakeholders' interests for these variables conflict with each other. Some variables are driven by economic forces as price, demand, and investment and other by environmental or equity factors.

The economy is often interested in increased prices to gain increased profit driven by market forces, but may also be interested in lower prices in order to gain larger shares of the market. This illustrates the internal conflicts in the economy aspect of sustainability within only one variable of the loop. Simultaneously, equity stakeholders may be interested in fair distribution of the resources and thus prices which make "everyone" able to have access to the same products. This demonstrates the external conflicts within variables. Yet, the variables are as mentioned driven by the dominant

perspective and are highly dependent on the rest of the loop in order to behave one way or the other. By creating models it improves our understanding of the causalities and what lies behind the factors that affect system behavior. This way we are able to see more than just the links between the variables, but also the underlying tension within the variables as they may represent conflicts as well.

It is interesting to observe how the systems thinking approach reveals the many conflicts the sustainability perspectives create due to external and internal interests. It shows how planners must be aware of a wide range of causalities in order to gain the best picture of the real world, and thus be able to make the better decisions for the city's development. The thesis shows that by creating models and being conscious about the relations and interactions we both discover conflicts and see where they come from. Knowledge and deeper understanding is thus the essence of handling the development in a best possible way and be able to predict what may happen due to the correlations.

Since the conflicts within the context of sustainability are the main reason these problems are hard to handle it is beneficial to reveal them and understand their occurrences and behavior. Yet, it does not mean that the sustainability perspectives always are in conflict with each other. There are many examples where the aspects have collaborated and found resolutions that benefits two or more sectors simultaneously. This happened in Sweden in the early nineties when a petroleum company asked the government to increase the taxes on leaded petroleum (Schley and Laur, 1996). This was to promote the lead-free fuels which the company sold, as the only one on the market. This led to a price advantage but also an advantage for the environment which experienced less leaded pollution. The case was in many ways a win-win situation and demonstrated that the perspectives of sustainability are able to collaborate and find sustainable solutions which benefits more than one perspective.

The analysis of Oslo also revealed that relatively small cities with stable economies and successfully developed welfare systems face challenges due to sustainability. Despite the city's fortunate position compared to general world societies the issues presented in the model are of great importance and has its daily appearance in the Norwegian media. The lack of affordable housing and housing in general is reflected in all the three conflicts which imply the significance of the dilemma. It also shows that the problem is complex and affects different components of the society and may cause undesired short-term and long-term effects. Population growth, increased prices, and the pressure on the limited resources turn the problem to a dynamic and challenging issue for the local government to control. The many stakeholders further complicate the picture by representing economic, environmental and equity interests which often oppose each other. These contrasts are

readily apparent in the model and highlight the areas which are essentially important to give priority in the time to come.

Other situations

To illustrate how system dynamics would have been a beneficial approach in many situations it is helpful to take a look at some real world situations. These are situations where planners did not see the system as a whole and made decisions that at first was excellent and gained great recognition, but later turned out to be unfortunate for other aspects of the society and the purpose of the decision itself. The housing dilemma in Oslo is one of these situations. It has many perspectives and a wide range of stakeholders that are interested in the topic and impact of the behavior of the system variables in different ways. The last decades is has been discovered that buildings stand for 40 % of the energy consumptions in the world. In this concept, Norwegian construction authorities and regulators implemented stricter rules for construction and restoring buildings in the country. The purpose was to provide the population with energy-efficient housing and lower energy bills, for a population becoming more conscious about sustainability and constantly more interested in environmental-friendly alternatives. The environmentalists cheered and the industry was facing a new era in building practices. However, it soon turns out that due to the new regulations the expense to build was so high that many people could not afford new and environmental-friendly dwellings. In turn it forced investors to pull out of these projects. It led to less new dwellings and an even more chaotic situation. Along with the rapidly growing population, the consequences today are that people are forced to seek housing elsewhere. If this event affects the system dynamics more than desired it may lead to an increase the pressure on transportation and other infrastructure related consequences. At worse the new regulation contribute to more pressure on the housing and thus increased prices. The equity is harmed if dwellers do not have the same opportunities anymore due to this pressure, and also harm the environment as people are dependent on transportation due to sprawl. The economy may also get affected if people spend more money on mortgage and limit their consumption of other goods and services. The whole complex systems generates undesired effects and do not behave for the best of the sustainable urban future.

Another example is taken from the min 19th hundreds in the industrial world. It is explained in Forrester's *Counterintuitive behavior of social systems* (1973) on how American cities failed to handle the urban processes and behavior of low-income dwellers. He explains how the behavior of the urban system changes for the worse if some of the desired incentives to handle the problem were implemented. It turned out that actions to improve the depressed nature of the central city were supposed to ease the difficulty in a city made matters worse. The study showed that while the

buildings age, employment opportunities decline, and as residential buildings age, the quality and price decline and low-income dwellers move in. This way, while jobs decline, the low-income population grows. The higher density of low-income dwellers leads to the need of more low-income jobs. Thus, a social trap is created due to low-cost housing exceeds low-income jobs. The population continues to grow until income opportunities are low and the living standards declines far enough. Hence, income to these sites gets lower and the maintenance of buildings is absent. If the government tries to handle the increased density by building more low-cost housing, more people will continue to move to these areas and thus put pressure on the environment. This will in turn continue to overload job opportunities, create congestion, increase waste and pollution, motivate crime, and reduce the quality of life of the city dwellers. This will also affect more than just the low-income community and thus create a bigger problem and pressure on the system than the initial dilemma. This situation also explains how systems thinking can help prevent unfortunate system behavior by being more aware and increase our understanding of how system components are related.

These situations imply that if the planning was more reflective and saw the system in a system dynamics perspective these undesired outcomes could have been prevented. It could have led to other regulations, which also implies that the level of regulations is not necessarily positive for the long-term development of systems. The system thinking approach is in other words a more appropriate way of resolving problems, and helpful in planning processes to gain reflective and comprehensive decision-making. This way society increase its chance of dealing with wicked problems, and see what is in the best interest for the city as a whole and which variables that are critical to handle effectively. In other words, systems thinking helps us find the best places to intervene in a system.

Is this it?

The thesis has demonstrated that system dynamics are helpful in closing the hole between reductionist and holistic ways of thinking. We get better understanding of the system we live in and what factors that plays important roles in the behavior and outcomes of dynamic systems. The causalities are revealed and we can find better solutions for the future. However, sustainable urban development consists of more than thinking that the use of a systems dynamics approach will generate all the answers. There are still many questions that need to be answered. How do we know that we gained sustainability, how do we measure it, and how do we ensure that we always makes the best decision? System thinking is only an approach to identify factors and help us understand the causalities between them. It does not tell us what to do or even if it is correct. We have to remember

that models are always wrong and not true copies of the real world, but helps us gain better understanding of the world's systems. System thinking may cause huge consequences if we do not use it carefully. If we are sloppy with the model development procedure we might create models that still are wrong but not even helpful. By trusting our developed models without being critical we may take decisions which are thought to create desired behavior of the system but harms it instead. It is therefore important to be able to be critical to our own models, and use them carefully. But by being able to see the system from different perspectives we will gain models that still are helpful.

7.2. Conclusion

Humans have insufficient knowledge about the system we live in and constantly misjudge the behavior of the actions we make. By nature, we tend to focus on one perspective instead of the others and are not aware of the systems dynamics when planning sustainable urban development. The effects of our decisions have thus led humans to make both destructive and irreversible mistakes which affect the economy, environment or society. Although decisions we make in the context of sustainability intend to be good, they also create devastating consequences after a certain time period. This situation is typical for sustainable urban development as we constantly want to move towards the better, but simultaneously lack understanding of system dynamics and wicked problems. This is why decisions in turn may bring higher costs than advantages.

This reveals a *hole* in the way we plan and act. Humans want to move towards the better, and must therefore do something with the way we plan and act. The reason behind bad decisions is bad planning. Good planning practices will therefore play an essential role in order to find better resolutions for the sustainable urban development. We must move from traditional thinking and implement a more holistically approach. Systems thinking have turned out to be helpful to improve planning, resolve wicked problems, and understand how to handle dynamically changing systems. By seeing the world as a system the many aspects and stakeholders which have interests in the city development are identified.

The different interests of stakeholders create the conflicts which make it hard to achieve sustainability. They may have interests in internal goals of the perspective they represent, or interests in goals other perspectives want to achieve. This increases the complexity of the sustainability problems and demonstrates that sustainability related problems are impossible to find optimal solutions for. System thinking helps us understanding how problems, conflicts and different variables creates systems and how they are linked together and created. We are able to deal with challenges in a different way when we step out of your traditional way of thinking and reveal that the world consists of a variety of factors and aspects which we were not conscious about.

The thesis has showed us how we by the use of systems thinking are able to develop models which are usable for the redevelopment of sustainable cities. The framework identifies the system components and increases our understanding of the interactions and interrelations between them. The development of models makes us understand the correlations between the many factors the system consists of and thus improve our mental models. When we create applicable models we gain insight and understanding of the problems that occur and the conflicts that lay behind the problems.

The general model outlines how all cities must deal with the same general conflicts between the three main perspectives of sustainability. A case analysis validate this approach for real cities by including real city details to address the specific challenges each city face. This increases the complexity but creates an improved mental model of the variables and drivers that challenge sustainability in the city. This way it is easier for the city planner to know where to intervene in the system and thus create desired system behavior.

By applying system thinking and a complex dynamics approach it will ease the understanding of the problems arising in the sustainability context and help decision-makers make better and more comprehensive decisions. When understanding how conflicts and variables occur and affect each other system dynamics will increase the knowledge for stakeholders and decision-makers. This will in turn increased the understanding about sustainability challenges and their complexity, and hence make planning more comprehensive and reflective. This is why system thinking is helpful in revealing systems complexity and dealing with wicked problems. Understanding system dynamics thinking is thus implies a way of thinking that works. System dynamics reshapes our mental models and increase the understanding how everything is related to everything. It can improve our planning skills and thus prevent unfortunate consequences to occur.

This approach can be used in a wide range of concepts. In the concept of sustainable urban development it is interesting to see how system thinking can change the way we deal with problems and find solutions for the future. The thesis shows that the creation of model to improve our mental models due to the understanding of system dynamics generates a deeper insight of how the system we live in dynamically changes and operates. By illustrating this with the help of models and case analysis we can use this approach in other situations in the dynamic world. The approach is typically interesting to prevent undesired consequences of the decisions we take or actions we make

7.3. Strengths, weaknesses and further study

Although the systems thinking approach emphasizes the importance of seeing all perspectives systems thinking does not guarantee that we will identify them all. How do we know how many stakeholders we should take into account and how do we know we have found them all is not easy to determine. This is closely related to the wicked problems of sustainability, but is however important in order to redevelop our mental models and make better decisions. Handling institutional barriers and implement adaptive management are other challenges due to the practical use of system thinking. The prevention of institutional barriers to limit our use of systems thinking and be able to implement adaptive management is an integrated part of the planning process, and may be interesting aspects to emphasize in the time ahead due to efficient planning.

In addition, the balance between time and resources spent on creating reflective models and identifying stakeholders are also challenging the use of systems thinking. To know there to set the limit and how many stakeholders and variables to include is difficult and dependent on the model developer's view on systems and will thus vary from case to case. As humans create individual mental models the outcome of an analysis like this will be dependent on the people involved and their perspective. We find many stakeholders and variables which reveals a relationships, patterns and systems. But models are however never true and only helpful if they are created properly. This way it is challenging to know if we have created helpful models or not, and whether believing in them can result in undesired consequences as well.

The use of qualitative approaches in the thesis has given insight in the general problems and systems that occur sufficient for the thesis purpose. Yet, in the understanding of systems and feedback loops it may be interesting to expand our understanding on systems and their behavior by using qualitative approaches. It will create additional knowledge of the system behavior and the levels of the variables involve. This way we may be better equipped to control system behavior by understand how they dynamically develop over time.

But even though we by systems thinking gain greater understanding of the system we live in undesired consequences from planning and decision-making are also related to our habits and values. In order to improve society's ability to handle development must go deeper, and along with a new way of thinking also create a new way of valuing our existence. The change in both the way we think and act change dynamically but the question is whether we are able to change before it is to late.

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